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The Impact Of The Development Of ICT In Several Hungarian Economic Sectors

Peter Sasvari

Abstract:

As the author could not find a reassuring mathematical and statistical method in the literature for studying the effect of information communication technology on enterprises, the author suggested a new research and analysis method that he also used to study the Hungarian economic sectors. The question of what factors have an effect on their net income is vital for enterprises. At first, the author studied some potential indicators related to economic sectors, then those indicators were compared to the net income of the surveyed enterprises. The resulting data showed that the growing penetration of electronic marketplaces contributed to the change of the net income of enterprises to the greatest extent. Furthermore, among all the potential indicators, it was the only indicator directly influencing the net income of enterprises.

With the help of the compound indicator and the financial data of the studied economic sectors, the author made an attempt to find a connection between the development level of ICT and profitability. Profitability and productivity are influenced by a lot of other factors as well. As the effect of the other factors could not be measured, the results – shown in a coordinate system - are not full but informative.

The highest increment of specific Gross Value Added was produced by the fields of 'Manufacturing', 'Electricity, gas and water supply', 'Transport, storage and communication' and 'Financial intermediation'. With the exception of 'Electricity, gas and water supply', the other economic sectors belong to the group of underdeveloped branches (below 50 percent).

On the other hand, 'Construction', 'Health and social work' and 'Hotels and restaurants' can be seen as laggards, so they got into the lower left part of the coordinate system.

'Agriculture, hunting and forestry' can also be classified as a laggard economic sector, but as the effect of the compound indicator on the increment of Gross Value Added was less significant, it can be found in the upper left part of the coordinate system. Drawing a trend line on the points, it can be made clear that it shows a positive gradient, that is, the higher the usage of ICT devices, the higher improvement can be detected in the specific Gross Value Added.

Index Terms: Information society, ICT, Economic sector, Electronic marketplace.

I. INTRODUCTION

The current age is often referred to as the Information Age. This concept was first introduced by Manuel Castells, the best-known theoretician of the information society [1]. The information society is a new, special variant of the existing societies in which producing, processing and distributing information can be regarded as a fundamental source in the economy.

According to the related data, the Information Age began in the second half of the 1950s when, for the first time in history, the number of white-collar workers (engineers, administrative employees etc.) exceeded the number of blue-collar workers [7].

One of the main driving forces of the Information Age is the phenomenon called Information and Communication Revolution. Its significance is often compared to the agricultural and industrial revolutions taken place in the history of mankind. In important fields of high-end technology (computer technology and telecommunication) not only the robust growth of quality, quantity and performance parameters can be observed but the approximation of these two fields along with the appearance of compound applications can also be detected. What is more important, these phenomena of the information society cannot only be seen as one of the results of technological development but also a coherent system affecting the society as a whole [3].

II. THE CHARACTERISTICS AND IMPACTS OF INFORMATION AND COMMUNICATION SYSTEMS

Information and communication technology can be regarded as a universal technological system, which is closely linked to all of the previous systems and creates new, more complex technological systems. ICT's main characterizing function is to assure acquiring, storing, processing, delivering, distributing, handling, controlling, transforming, retrieving and using information. ICT has a different effect on the actors of the economy, including companies, employees and consumers. Nowadays we can experience a change of paradigm in the operation of enterprises. They are becoming a rapidly changing system of independent work groups and project, characterized by flexible operation and demand for flexible labour force. In this new situation, employees have to leave the traditional patterns and are forced to develop a new kind of mentality. If they want to stay afloat in the labour market, they have to become more flexible as enterprises are no longer strongly interested in improving the professional knowledge of their employees through various trainings. Beside the changes experienced in the attitude of enterprises

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and employees, consumers' behaviour has also been changed essentially by the effect of ICT. As consumers are freed from their isolation by the Internet, they become active and conscious actors in the economy. As a consequence, the relationship between buyers and sellers has also been transformed, it has become harder for sellers to recognize and influence the trends in demand and consumers now are better informed than ever before.

Information and communication technology has brought a deep change into the opportunities for consumers compared to the opportunities provided by industrial capitalism. This change is as profound as the one caused by the Industrial Revolution earlier. The new generation of consumers is, first and foremost, well informed, collecting and relying on other consumers' experiences. Companies (especially corporations) previously focused on products and markets, nowadays they concentrate on consumers instead. It is not enough to recognize the problems of consumers, identifying those possible problems in order to solve them is also needed. The opportunities provided by ICT identify actual consumers, based on actual problems that may occur during the use of a product. The best way for companies to keep pace with the speed of the development of ICT is to introduce job enrichment. The requirement of versatility can be met only by employees with high-level general education [4].

The decrease of the number of strict positions together with the changing requirements of the remaining ones allows employees to acquire new skills, however, it also stretches their responsibilities. Cross-trainings are also organized for the group of employees in order to enable them to perform various tasks. Team-based companies are characterized by better problem-solving skills, higher productivity, more efficient use of human resources, more creativity and more innovation when compared to traditional non-team based organizations. Nowadays, when digital information is seen as the chief mean of production, the efficiency of production is highly dependent upon obtaining and processing information. Based on the achievements of ICT, companies have shaped up the infrastructure of obtaining and processing information, and help their employees to co-operate by compressing time and space. The intention of raising efficiency gave room for virtual teams. By being part of a virtual team, employees do not have to work under the same roof and other employees from outside the company can take part in the work performed by a virtual team.

Nowadays, the majority of changes in work organization, decision mechanisms and corporate organization structures requires enhanced flexibility. Flexibility means quick reaction, the removal of strict limits, the frequently mentioned job enrichment as well as openness for innovation and finding unconventional answers to the newer and newer challenges. The environmental impulses do not affect the operators of the assembly lines or the workers of call centres through a long chain. In the past companies were operated centrally from a single headquarters earlier, nowadays managers and workers try to find answers to the current challenges in many local corporate decision nodes. The coordination of numerous independent units is generated by the company as a self-organizing system, and the company's philosophy is determined by the self-organization of independently operating units based on market principles.

III. THE AIM OF THE RESEARCH

Based on the considerations presented above, it is not the subject of this paper to answer whether there is a need for ICT or creating the necessary conditions for the information society. The real subject is to measure what economic, social, cultural and environmental effects it has on the society. The rich literature of the information society discusses these aspects in detail. In this paper, the information society is taken as a normative future plan for Hungary, and I am looking for the answer of what progress has been made in building the information society in the Hungarian economic sectors. The following issues are examined here:

- to what extent we can speak about the information society in Hungary nowadays,
- what is the development level of the information society in several economic sectors and company sizes compared to each other and to the member states of the European Union,
- how this development level can be measured and calculated,
- how the development level of information and communication technology increases at certain company sizes,
- what trends can be observed in the development process in the individual economic sectors and company sizes.

The scope of this analysis extends to the static, momentary state of the development level of ICT devices used in the economic sector as well as to their dynamic analysis, expected pace of growth and their qualification. When establishing the aims of the research, there is always the question of how to position the individual parts of the subject. Should they be positioned in a broader subject or should they be selected for further and deeper examination? The former possibility means that we aim to make suggestions by putting the practical analysis into a broader structure. The aim of this research is exactly this, as the information society means a stage representing a new quality, and the changes of the information and communication technology can be observed in every part of our modern life.

IV. THE METHOD OF THE RESEARCH

Similar problems are raised by the quantification of the various components of the information society as the definition of its concept. There is a wide range of variables that can be measured: a great number of explanatory variables can be listed from the perhaps more easily measurable infrastructural components to the more difficult components related to knowledge and willingness for using information.

That is why most analyses use sets of variables along with complex indices as there are no easily measurable (one-dimensional) indices that would characterize the information society. The examination of the subject is interdisciplinary as it has social and scientific references, so a complex approach was needed when I set about processing the literature. In consideration of the complexity of the studied subject, several analytical methods and approaches were selected. In the phase of data collection, I relied on the available Hungarian (related reports issued by the Hungarian Central Statistical Office [9]) and international data (Statistical Office of the European Communities [8]) as well, and managed to process a large amount of secondary information consisting of more than 6.000 items. The actual research was extended to printed as well as electronic publications and artifacts available on the Internet. The reason for conducting a primary research was to reduce some shortcomings originated from secondary data sources. In fact, it covered an empirical survey among Hungarian companies and enterprises. The questionnaire used for collecting data on the subject was filled in by 554 respondents altogether, providing nearly 3.000 data records.

As Figure 1 shows, the literature on the development of ICT distinguishes five development stages.

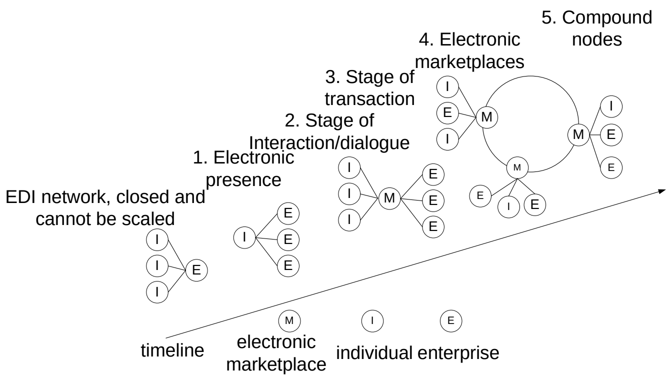

Fig.1. The development stages of information and communication technology [2]

These stages are built upon each other. With the help of the elaborated model, first, the individual development stages were measured. By averaging the data of the first three development stages, I examined the enterprises' willingness for adaptation. With the help of an own model, which comprises five elements, the development and growth of the size categories and economic sectors were analysed.

The steps of this procedure are as follows:

- Processing the data of the primary and secondary research,
- Assigning single indicators to individual development stages, calculating potential indicators,
- Calculating the values of potential indicators from single indicators,
- Studying potential indicators,
- Determining potential indicators at the individual development stages.

Then, with the help of the resulting indicators, a cluster analysis, a compound regression analysis, and finally a discriminant analysis were performed on the surveyed economic sectors.

V. The results of the analysis of information and communication technology

Clustering is the assignment of a set of observations into subsets so that observations in the same cluster are similar in some sense. The clustering process is successful when the subsets are similar to each-other and different from the elements of other subsets at the same time. Based on theoretical considerations, groups of economic activity categories were formed from the five previously defined potential indicators.

1st cluster	2nd cluster
(A) Agriculture, hunting and forestry (F) Construction (G) Wholesale and retail trade; repair work (H) Hotels and restaurants (K) Real estate, renting and business activities (M) Education (N) Health and social work	(C) Mining and quarrying (D) Manufacturing (E) Electricity, gas and water supply (I) Transport, storage and communication (J) Financial intermediation
Underdeveloped	Developed
relative	

Fig.2. Two-cluster model of the national economic sectors

As a summary of the results of the cluster analysis, it can be stated that the sectors "Electricity, gas and water supply", "Transport, storage and communication", “Mining and quarrying“, “Manufacturing” and "Financial intermediation" belong to the second cluster by better average values. The results of this analysis are presented in Figure 2.

A path model was applied to study how the potential indicators influenced one another and what direct or indirect effect they had on the average net income of the different economic sectors.

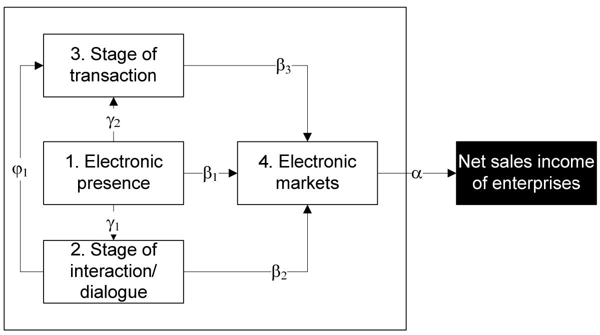

Fig.3. The scheme of the path model of the potential indicators

As it is indicated in Figure 3, the variables presented in the path model are linked with arrows to one another, showing the direction of their relationships. It was assumed in the causal model that the potential indicator of electronic presence was the exogenous variable. Based on the arrows starting from it, the potential indicator of electronic presence has an effect on the other potential indicators, also having an indirect effect on the average net income of enterprises in several economic sectors. These paths are called indirect paths by the literature and in this path model they show how the effect of the potential indicator of electronic presence takes place through the potential indicators of interaction/dialogue, transaction and electronic markets. The potential indicators of interaction/dialogue and transaction became endogenous variables. Endogenous variables are variables with causal links leading to them from other variables in the model. In other words, endogenous variables have explicit causes within the model. The dependent variable in the drawn-up model is the average net income of enterprises in economic sectors, the arrows starting from the other variables point at this one but it has no arrow or link pointing back at the other variables.

The aim of setting up a path model was to divide the zero linear correlation between the independent and the dependent variables into two parts. The first part is the effect that the independent variable directly has on the dependent variable, while the second part shows the effect being had on the dependent variable caused by the independent variable through another endogenous variable.

It turned out that only the potential indicator of electronic markets had a direct effect on the average net income of enterprises as it is illustrated in Figure 4. However, the effect of the potential indicator of electronic presence is significant as it influences the potential indicator of electronic markets to a great deal. The value of the indirect effect of electronic presence was (87.4%*60.5%) 56.2%. In the table below, a new arrow also appears with a value of 70%, showing the effect of non-specified variables from outside the model on the average net income of enterprises.

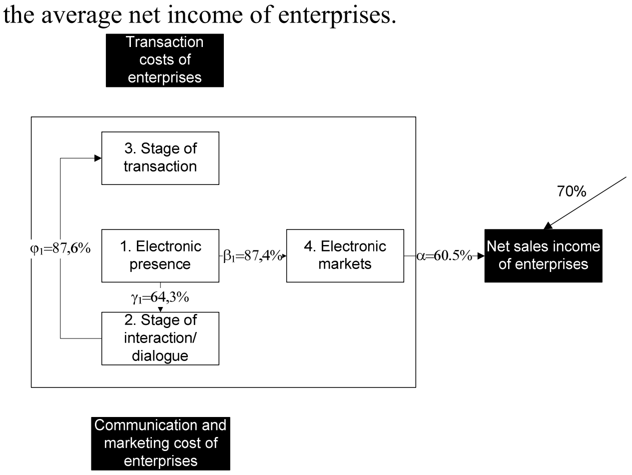

Fig.4. The final path model of the potential indicators

Electronic presence has no direct effect on the potential indicator of transaction. The value of the strength of its indirect effect was (64.3%*87.6%) 56.3%, according to the calculation. The model eventually verified the hypothesis according to which electronic presence largely determines interaction/dialogue, it has an indirect effect on transaction and it has the strongest correlation with electronic markets. Before creating the model, it was assumed that there was a direct correlation between transaction and electronic markets but the existence of this relationship could not be verified in the end. However, the new result of the research was that there was a direct correlation between electronic markets and the average net income of enterprises.

In the early phase of the research, there was a problem that could not be avoided: there were no explanatory variables in the typology created by cluster analysis. Typologies, different clusters are of a low measurement level, so the explanation of their development status is impossible with the formerly used techniques. Discriminant analysis is a useful method to explain a low measurement level variable with another variable of high measurement level. Discriminant analysis is a technique where dependent variables are not metric and are classified between two or more categories whereas independent variables (predictors) are measured on a metric scale. The summary of the methods used together with discriminant analysis is shown in Figure 5.

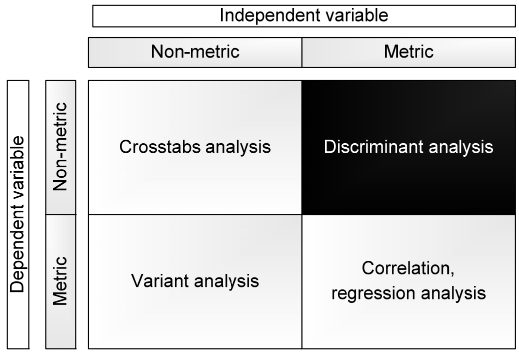

Fig.5. Partial summary of the methods used for structure analysis, along with discriminant analysis [5]

After completing the cluster analysis, it was found that the surveyed economic sectors could be classified into two, then four ICT development levels or clusters. The resulting four-cluster model is illustrated in Figure 6.

1.2 cluster	2.2 cluster
(G) Wholesale and retail trade; repair work (K) Real estate, renting and business activities (M) Education	(D) Manufacturing (E) Electricity, gas and water supply (I) Transport, storage and communication (J) Financial intermediation
1.1 cluster	**2.1 cluster**
(A) Agriculture, hunting and forestry (F) Construction (H) Hotels and restaurants (N) Health and social work	(C) Mining and quarrying
Underdeveloped	Developed
relative	

Fig.6. Four-cluster model of the national economic sectors

The following four economic sectors got into Cluster 1.1: 'Agriculture, hunting and forestry', 'Construction', 'Hotels and restaurants' and 'Health and social work'. The average of the potential indicators to electronic presence, interaction/dialogue, transaction and electronic markets was the lowest in the four clusters.

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Four economic sectors were classified into Cluster 1.2 as well: 'Wholesale and retail trade; repair work', 'Real estate, renting and business activities', 'Education' and 'Other community, social and personal service activities'. Examining the data of this cluster, it could be observed that its average values were higher than those of Cluster 1.1 but were lower than the average values of the other two clusters.

Only the 'Mining and quarrying' sector was classified into the Cluster 2.1. In terms of electronic presence and electronic markets, this sector was the most developed compared to the other sectors. This cluster produced the second highest ICT values based on the values of the other potential indicators.

'Manufacturing', 'Electricity, gas and water supply', 'Transport, storage and communication' and 'Financial intermediation' could be found in Cluster 2.2. The values of interaction/dialogue and transaction were the highest in this cluster comparing to the other ones.

The aim was to know more about the human resource demand of enterprises (the number of the employees regularly using computers), the cost of ICT services or availability (cost of computer-related services), and the amount of money spent on professional training (the total expenditure on professional training). These three explanatory variables jointly indicate the different ICT development stages, in this case discriminant analysis predicts whether an enterprise belongs to a specific development stage or not. Based on the primary research, it can be stated that education expenses have a more significant effect on belonging to various clusters. As the aim of the discriminant analysis is the classification of cases into groups, the classification table is one of the most important results of the analysis. The table below consists of two parts: the first presents the scores before the grouping took place. The chance of being classified into a cluster is 25% in each group and each cluster weight was different.

TABLE 1
CLASSIFICATION RESULTS

Cluster	Prior	Cases Used in Analysis	
		Unweighted	Weighted
1.1	,250	36	36,0
1.2	,250	4	4,0
2.1	,250	58	58,0
2.2	,250	82	82,0
Total	1,000	180	180,0

		Cluster	Predicted Group Membership				
			1	2	3	4	Total
Original	Count	1.1	19	0	0	17	36
		2.1	2	1	0	1	4
		2.2	24	0	4	30	58
		1.2	30	1	0	51	82
	Percent	1.1	52,8	,0	,0	47,2	100,0
		2.1	50,0	25,0	,0	25,0	100,0
		2.2	41,4	,0	6,9	51,7	100,0
		1.2	36,6	1,2	,0	62,2	100,0
Cross-validateda	Count	1.1	16	0	1	19	36
		2.1	2	0	0	2	4
		2.2	24	1	3	30	58
		1.2	32	1	1	48	82
	Percent	1.1	44,4	,0	2,8	52,8	100,0
		2.1	50,0	,0	,0	50,0	100,0
		2.2	41,4	1,7	5,2	51,7	100,0
		1.2	39,0	1,2	1,2	58,5	100,0

The actual hit ratio can be seen in the second part, it is given in percentage, its value ranging from 0 to 100. Instead of the lowest possible value, it needs to be compared to the expected hit ratio. The expected hit ratio means the hit ratio resulting from random categorization, its value is 25% in the case of the specified four groups.

The classification table is suitable for the evaluation of the results of the discriminant analysis as it shows the ratio of the adequately categorized group membership. The rows make up the categories of the dependent variables and their initially observed values, while the columns of the table constitute the values predicted by the independent variables. The table can be divided into two parts: the upper part of it shows the initial analysis, while its lower part presents the cross validation values. The data are presented in the same way in both parts of the table, they are expressed either in absolute value or in percentage. When analysing the absolute values of the table, it can be observed that only 19 cases got into Cluster 1.1 from its original 36 cases, while 17 of them got into Cluster 1.2. Expressing this data in percentage means that the rate of the adequately categorized cases is 52.8% in Cluster 1.1, 25% in Cluster 2.1, 6.9% in Cluster 2.2 and 62.2% in Cluster 1.2. Consequently, the procedure was successful only in the cases of Clusters 1.1 and 1.2. SPSS identifies values as adequate hit ratio on the diagonal: if the prediction equals the value of the initial sets of observations then the prediction is perfect and every value is situated on the diagonal. Enterprises were adequately categorized in 41.7% of the cases and 37.2% of the predictions based on the given variables.

In summary, it can be stated that the first and the fourth clusters are significantly different from the other two clusters, as their hit ratio is above 50% in the case of three independent variables. Examining the results, it can also be observed that these two clusters can hardly be divided in the case of three independent variables.

VI. THE MACROECONOMIC EFFECT OF THE INFORMATION AND COMMUNICATION TECHNOLOGY

ICT devices contribute to the improvement of productivity, the economic growth or the acceleration of the economy in several areas. As far as macroeconomic effects are concerned, the technological development is very rapid alongside with the productivity and the total factor productivity (TFP) in the economic sectors producing ICT devices. On the one hand, this process increases the national average in itself, especially when its share tends to grow in the GDP; on the other hand it makes other economic sectors more dynamic by the technological and economic links throughout the whole economic system.

(D) Manufacturing	(G) Wholesale and retail trade; repair work	(I) Transport, storage and communication	(K) Real estate, renting and business activities
Manufacture of	Wholesale trade	Telecommunicat	Software

business machines 3001 Manufacture of computers 3002 Manufacture of industrial electronics 3220 Manufacture of consumer electronics 3230	of softwares and computers 5164	ion 6420	publishing services 7221, Other software consultation services 7222, Lending office machinery and computers 7133, Hardware consultancy services 7210, Data processing services 7230, Data bank services 7240, Office machinery and computer repair services 7250, Other computer related services 7260

Fig.7. Economic activities classified as ICT activities according to TEÁOR-NACE

Profits gained with the help of the rapid technological development and the improvement of productivity was eroded by the dropping ICT prices. Countries producing ICT devices lost a part of their profits realized from production because of the deteriorating swap ratio.

The source of productivity and growth benefits from capital deepening (it describes an economy where the amount of capital per worker is increasing), that is the growing rate of using ICT devices, which is stimulated by the huge decrease in ICT prices. These benefits appear in the form of the increased output of existing products and services, manufacturing new products or providing new services, fulfilling customer needs more efficiently and decreasing transition costs etc. As the effect of ICT devices on increased productivity and more dynamic growth are connected to capital deepening, it can be seen that the countries and businesses using these new technologies have benefited more from the revolution of information technology, than the countries producing them.

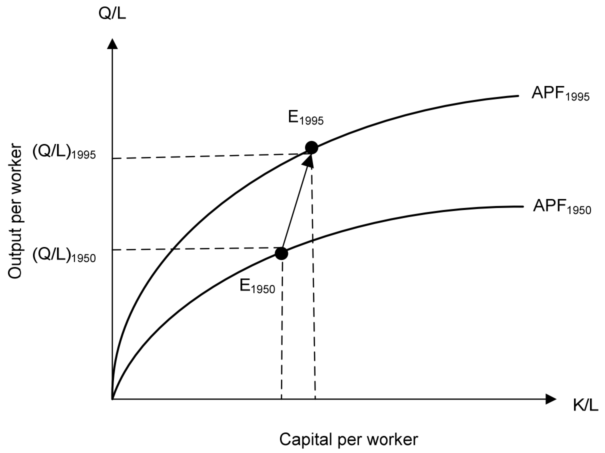

Fig.8. Technological development elongates the production curve [6]

ICT devices also increase the total factor productivity, that is they improve the degree of utilization of capital and labour force. The total factor productivity (TFP) is applied to express the overall effect on the savings of economies of scale, management skills, production externalities and other, non-traditional factors influencing productivity. The significance of the growing total factor productivity is that it accelerates the pace of economic growth without any additional costs as well as without having to increase the quantity input. Capital deepening is a necessary but not sufficient condition for improving productivity. It can only unfold in its fullest form when the potential efficiency surplus of ICT devices is exploited. A more dynamic TFP automatically accelerates the pace of labour productivity, thus it helps to boost economic performance.

Using ICT devices also improves productivity and makes economic growth more dynamic because information technology cannot be regarded as capital goods in the traditional sense of the word. The installation of a new information technology device raises the value of other existing devices as well. As a consequence, network effects may occur within companies, moreover they may appear between industrial sectors, and they may necessitate shaping new forms of cooperation (outsourcing).

As it was stated above, ICT devices increase productivity and output by capital deepening, improved total factor productivity and network externalities at the microeconomic level. The advantages of using ICT devices at the macroeconomic level come from all the advantages of the companies' improved productivity and from the network advantages based on the feature of reducing transition costs and accelerating innovation. The network advantage does not depend on the operation of a given company and its business strategy.

However, the effects of ICT devices on the productivity of companies cannot be measured unequivocally at the microeconomic level because of certain statistical and methodological imperfections, the difficulties in measuring network effect at a business level and the lack of data enabling to make international comparisons. Furthermore, the effects of ICT devices on productivity appear at a later time, as they are preceded by a longer or shorter learning process. The productivity paradox has started to vanish by now. It has become clear that statistics cannot or just partially show the secondary effects of using ICT devices in the economy (faster information processing, improvement of productivity in producing knowledge, for instance).

In countries where competition is fierce in the market, enterprises using ICT devices are not necessarily the main winners of capital deepening, it is the customers who can benefit from it by getting lower prices, better quality or more convenience.

It is not necessarily true in countries where competition is weak. Here, companies are able to realize a greater part of benefits coming from capital deepening. But it has its own price as the secondary effects of using ICT devices are more limited in the economy.

With the help of the compound indicator and the financial data of the studied economic sectors, an attempt was made in the research to find a connection between the development levels of ICT and their profitability. Profitability and productivity are influenced by a lot of other factors as well. As it was not possible to measure and show the effect of those other factors, the results are not full but informative.

Based on the statistical connection between the compound indicator and the increment of the Gross Value Added per worker, the correlation coefficient is 0.13, while the gradient of the regression trend line is 0.17. Both numbers show a positive connection between the compound indicator and profitability.

Then, using a coordinate system, the connection between the changes of the specific indicators of the studied economic sectors and the development level of those sectors was illustrated. The Y axis shows the growth pace of Gross Value Added per capita in the economic activities between 2003 and 2006. The X axis shows the compound indicator that was created for measurement purposes. The points defined by the two values show clearly where a given economic sector can be found in the coordinate system, what groups can be constituted, and what tendency can be observed.

The highest increment of specific Gross Value Added was produced by the sectors 'Manufacturing', 'Electricity, gas and water supply', 'Transport, storage and communication' and 'Financial intermediation'. With the exception of 'Electricity, gas and water supply', all of these economic activities belong to the group of underdeveloped sectors (below 50%).

High (but still not reaching the developed status) compound indicators were shown by the sectors 'Mining and quarrying' and 'Wholesale and retail trade; repair work', as they produced an increment of Gross Value Added below the average, these economic sectors can be found in the lower right part of the coordinate system.

The sectors 'Construction', 'Health and social work' and 'Hotels and restaurants' can be seen as laggards, so they got into the lower left part of the coordinate system.

The 'Agriculture, hunting and forestry' sector can also be classified as a laggard economic activity, but as the effect of the compound indicator on the increment of Gross Value Added was less significant, it can be found in the upper left part of the coordinate system.

Drawing a trend line on the points, it is clear that the line shows a positive gradient, that is, the higher the usage of ICT devices, the higher improvement can be detected in the specific Gross Value Added.

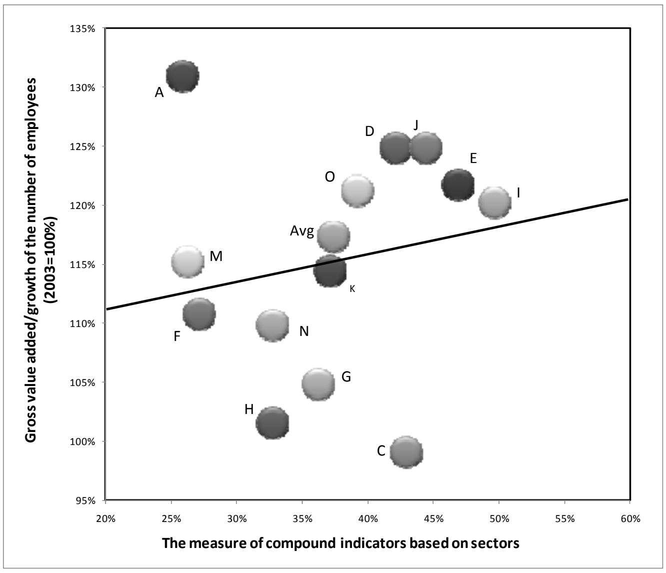

Fig.9. Connection between the growth of gross value added and the development level of information and communication technology in several economic activities[1]

VII. CONCLUSIONS AND SUGGESTIONS FOR THE PRACTICAL USE OF RESEARCH FINDINGS

The most important step of the cluster analysis is to determine the number of clusters. The data show that it is expedient to form two clusters based on the potential indicators. The first cluster comprises eight, while the second one comprises five economic activities. As a consequence, those economic sectors that use ICT devices less frequently than the national average belong to the first cluster, while the second cluster contains those economic sectors that can be seen as developed ICT-users.

The multiple regression analysis is the series of regression models built upon each other. Using the regression model, the direct and indirect effect of the potential indicators on each other and the companies' net income in several economic sectors were studied more closely. It was found that the only potential indicator affecting a company's net income was the indicator of electronic marketplaces. However, the effect of the electronic presence is also significant, since it has a great influence on the potential indicator of electronic marketplaces. During the primary research, it was revealed that the effect of the non-specified variables out of the regression model on a company's net income was 70%.

The typology carried out by cluster analysis does not contain independent variables. The discrimination analysis helps to explain the values of dependent variables with the help of independent variables. With the clusters showing the given development stages, the aim was to get a better idea on the companies' needs of human resources and on how much

[1] A=Agriculture, hunting and forestry, C=Mining and quarrying, D=Manufacturing, E=Electricity, gas and water supply, F=Construction, G=Wholesale and retail trade; repair work, H=Hotels and restaurants, I= Transport, storage and communication, J=Financial intermediation, K=Real estate, renting and business activities, M=Education, N=Health and social work, O=Other community, social and personal service activities.

money was spent on training and ICT services by the given company. It turned out that training expenses had a more significant effect on which cluster a company belonged to. It was possible to classify the companies into clusters based on the three independent variables in 42% of the cases.

The primary possibility of utilizing the proposed method appears in situation report. The following development levels were measured successfully by this paper: the relative (economic sectors correlated to each other) and the absolute (economic sectors correlated to the same ones in a different country) development level of the information communication technology with the help of creating development stages, quality categories and the willingness for adaptation belonging to the given development stages.

The secondary possibility for utilization lies in following patterns. The development of ICT is different in several countries, regions and economic sectors. The European Union proposed a strategic framework for its member countries. The main aims of establishing a strategic framework are:

- a single European information space;
- boosting investment and innovation in ICT researches;
- establishing a receptive European information society.

The economy of the United States is regarded as a model economy where two-third of the employees were dealing with information process during working hours in 2000. One of the causes of the massive economic performance in the United States is the highly-developed information processing. If it is possible to measure this level of development, a strategy can be formulated in the European Union together with the individual member states in order to catch up with the most developed countries.

The object of the study is generally the national economy of a given country. With the help of the method I have worked out, it is possible to analyse and assess the sections, subsections, divisions, groups and classes of a given national economy. Beside the economic sectors, company sizes and organization forms can also be studied the same way.

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References

[1] M. Castells, *The Information Age*, Gondolat- Infonia, 2000.

[2] A. Kápolnai, A. Nemeslaki, R. Pataki, *eBusiness stratégia vállalati felsővezetőknek* (E-business strategies for senior management), Aula, 2002.

[3] Z. L. Karvalics, *Információ, társadalom, történelem, Válogatott írások,* (Information, society, history, Selected works), Typotex Kiadó, 2003.

[4] Z. L. Karvalics, *Információs társadalom – mi az? Egy kifejezés jelentése, története és fogalomkörnyezete* (Information Society – what is it exactly? The meaning, history and conceptual framework of an expression), Az információs társadalom, Az elmélettől a politikai gyakorlatig (The Information Society, From theory to political practice), Gondolat – Új Mandátum, Budapest, 2007, pp. 29-47

[5] L. Sajtos, A. Mitev, *SPSS kutatási és adatelemzési kézikönyv* (The handbook of SPSS research and data analysis), Alinea Kiadó, Budapest, 2007.

[6] P. A. Samuelson, W. D. Nordhaus, *Közgazdaságtan* (Economics), Akadémiai Kiadó, 1998.

[7] K. Szabó, B. Hámori, *Információgazdaság* (Information Economy), Akadémiai Kiadó, Budapest, 2006.

[8] Eurostat, Your key to European statistics, Available: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home

[9] Hungarian Central Statistical Office, Available: http://www.ksh.hu

Security Issues in Automated Fingerprint Identification Systems

Shahzad Memon, Nadarajah Manivannan, Azad Noor, and Celalettin Tigli

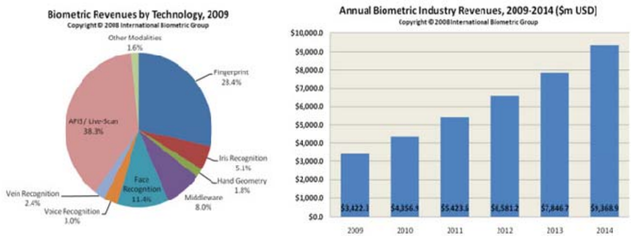
Abstract:
Automated electronic identification systems have been implemented in many sectors to provide identification and secure access. Although the widely accepted Automatic Fingerprint Identification systems (AFIS) have many potential applications in recent years, many published articles, reports and media news indicate that these systems are not fully secured and vulnerable to attacks at different levels. One of the most popular tests that have been carried out to spoof these systems was submission of fake fingertips or artificial fingers to the sensor. In many cases, these attacks have been successful. This paper discusses security issues with AFIS at various system levels. Furthermore, proposed solutions in literature and research articles have also been reviewed.

Index Terms: Fingerprint, AFIS, Security, Liveness Detection.

I. INTRODUCTION

Fingerprint biometrics based identification systems are so popular today and they have become the synonym for biometric systems. The use of Automatic Recognition and Identification Systems (ARIS) for maintaining security has increased globally in the last decade. These systems are practically implemented at various places such as airport, border and immigration control, cash machines and mobile devices. These ARIS uses physical and psychological traits of an individual (known as biometrics) for positive identification [1]-[5].

Among the available biometrics, the fingerprint as a biometric trait for personal identification is both the oldest mode of personal identification and the most prevalent in today use. Fingerprint has been used by law enforcement agencies since the late 1800s, and machine based fingerprint systems has been commonplace since the 1960s [6],[7] . In the recent years, the Automated Fingerprint Recognition Systems (AFIS) has become an essential tool for many physical and logical access control and homeland security and border control [9, 10].



(a) (b)

Fig. 1 Market Share for Biometric Technologies [8]

Fig. 1 shows the market share of Biometric Technologies during the period 2009 – 2014[8]. As can be seen in Figure 1(a), in 2009, fingerprint biometric (fingerprint and AFIS) is leading by having market share of ~62% followed by face recognition (~11%). Figure 1(b) shows that revenue of biometric market will triple in 2014 compared to 2009.

This paper is structured into six sections. Fingerprint characteristics are explained in section two and main functioning of AFIS is discussed in section three. Issues with AFIS are presented in section four. Proposed solutions to overcome major issues with AFIS are discussed in section five and finally a conclusion is drawn in section six.

II. FINGERPRINT CHARACTERISTICS

A number of features are extracted from the captured and processed fingerprint image. There are three levels of features identified in a typical fingerprint image [10]-[12]. Level-1 features are ridges and valleys as shown in Fig. 2. As can be seen in this figure, ridge-valley forms a number of different patterns; loop, arch, whorl and tented arch. Level-2 features are shown in Fig. 2; ridge endings, bifurcation (two ridges join), ridge ending or terminations, cross-over (two ridges are connected by a small ridge), point/island (isolated very small ridge) and spur (short branch in a ridge).

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Fig.2 Levels of Fingerprint Features

Level-3 features are basically pores, their shape, size and distribution and width of ridges. Pores are very small openings distributed on ridges and they become active to discharge sweat liquid to keep thermal balance of the body. While Level 1 and level 2 features are currently used in commercially available AFRSs, level 3 features is still under research and development stage as it requires high-resolution image capturing to extract and process [13]. However, level 3 features have been intensively used in forensic and high security applications which are mainly based on manual investigation of pores.

III. AUTOMATIC FINGERPRINT IDENTIFICATION SYSTEM (AFIS)

Automatic Fingerprint identification System (AFIS) is based on four modules:

- Fingerprint Sensor
- Signal processing
- Software interface
- Fingerprint Template database

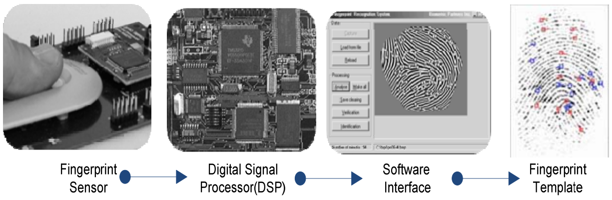

Fig.3 Automatic Fingerprint Identification System (AFIS)

In AFIS, sensor module is a basic and important module of system. There have various sensing technologies been introduced for performing fingerprint sensing. In general, they are divided into optical and solid state as shown in Figure 4. As shown in this figure, sensors based on optics include total internal reflection, optical fiber, sheet prism, electro-optical and In-finger light dispersion and solid state based sensors uses various techniques; capacitive, Thermal, pressure, acoustic and radiofrequency

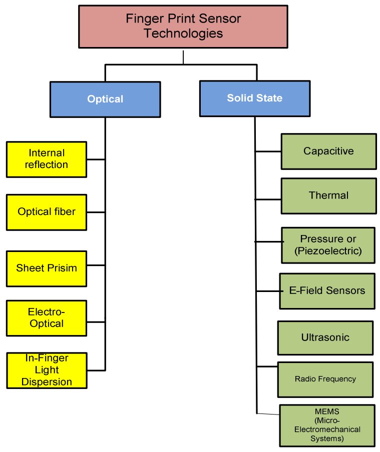

Fig.4 Fingerprint Sensor Technologies [14]

TABLE.1

VENDORS AND TECHNOLOGIES

Vendor	Technology	Model	DPI
Fujitsu http://www.fujitsu.com	Capacitive	MBF200	500
Atmel http://www.atmel.com	Thermal	AT77C104B	500
Ultra Scan http://www.ultra-scan.com	Acoustic (Ultrasonic)	Ultratouch Model 203	500
Biometric Fingerprint (BMF) http://www.bm-f.com	Pressure	BLP-100	500
Authentic http://www.authentec.com	Capacitive	TCS1	508
Biometrika http://www.biometrika.it	Optical	FX integrator	569
Mitsumi http://www.mitsumi.co.jp	Optical	SEF-A1F1	600
NEC http://www.nec.co.jp	Scattered light in the finger scanning system	PU900-10	1000
Light -On Semiconductor Corporation www.liteon-semi.com	Optical	FLB6100	1200

The performance of many of the existing fingerprint sensors is subject to spoofing (fake and dummy) and identification and authentication is limited to ~85%. For this purpose a critical literature review completed for this research to identify the problems in existing fingerprint sensing technologies. The information about the some vendors and their sensors are provided in following Table-1. Although various improvements to the existing technologies are still taking place, many problems still exit. Apart from their size, cost, their physical state and resolution, differentiation between real and gummy fingers is still a problem.

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AFIS involves two stages; enrolment and recognition. Each stage is consists of a number of sub-stages. These two stages and their basic sub-stages are illustrated in Fig. 5

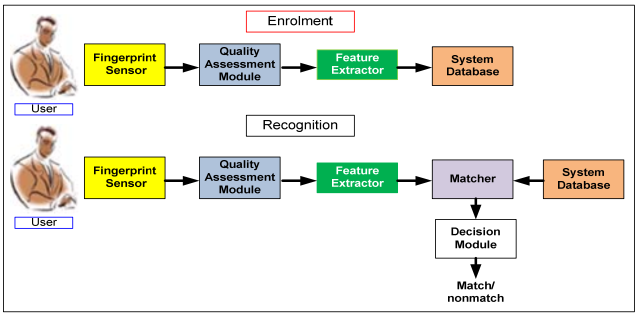

Fig 5. Stages of Fingerprint recognition

A. ENROLMENT STAGE

In this stage, each user enrolled their fingerprint as their unique ID. It is consist of five sub-stages as shown in figure 5. The fingerprint sensor captures the pattern of fingertip and the captured image passes through quality assessment module, which checks that quality of obtained image. If the quality of image is matches with the defined parameters then it will pass to feature extraction stage. If not the process of capturing is repeated for a pre-defined certain number of instances. Feature extracting stage enhances and extracts the features of the quality checked fingertip image. The resultant image of this module will be a binary image. Once features are extracted, then one or more templates are generated using the extracted features [1],[15]. These templates are then stored in a database for the use in the matching process. There are two type of matching process exist; 1:N matching and 1:1 matching. 1:N matching is performed for authentication (e.g.: access control) and 1:1 matching is performed for verification (e.g.: passport verification). There is a number of AFIS captures multiple fingerprints to increase the security and accuracy. The features obtained from the fingerprints are then fused and encrypted for efficient and secured storage [1], [16], [17].

B. RECOGNITION STAGE

In recognition stage, when user presented with his/her finger or fingers to the AFIS, it first captures the required fingers. Then captured image undergo same procedure and set of features are extracted same way as it is done in the enrolment stage. The extracted features are then matched against either the templates stored in the database for 1: N matching or the single identity stored on identity document (e.g.: passports or Identity cards) for 1:1 matching. Depending upon the predefined criteria, the final decision is made to either accept or reject the user as the user that claimed to be [17, 16].

IV. SECURITY ISSUES IN AFIS

Once a systems' weakness has been found, it gives intruders the ability to use, alter or destroy data stored on system. In AFIS, it is possible that hackers can gain access in system using hardware and software methods at three possible levels.

- Sensor level
- Processing level
- Template database

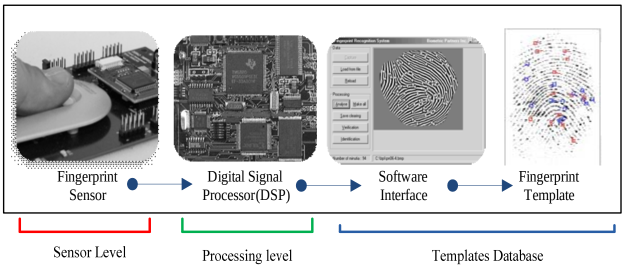

Fig.6 Levels of possible security issues with AFIS

A. SENSOR LEVEL ISSUES

The rapid developments in device fabrication technology facilitate to design and develop finger print capture devices with various technologies such as optical, thermal, capacitive, pressure, acoustic and radio frequency (RF). Parallel to improving the fingerprint sensing technologies, various types of attack and forge at sensor level is also improving. However, according to many recent research based on commercially available fingerprint sensing modules, indicates the possibilities of attacks with artificial or gummy fingerprints. Most of the AFIS are compact in size, has adequate resolution and has fast image processing capabilities, but they are not capable to detect liveness of the finger placed onto it. In addition, they have a high value of False Acceptance Rate (FAR) and False Rejection Rate (FRR)[1]-[3], [18],[19]. The FAR is a measure of the possibility that the access system will mistakenly accept an access attempt; that is, will allow the access attempt from an unauthorized user.

$$(\%)FAR = \frac{fa}{n} \times 100 \qquad (1)$$

fa = Number of incidents of false acceptance
n = Total number of Samples

and FRR is a measure the percentage of authorized users that have not been able to enter the system

$$(\%)FRR = \frac{fr}{n} \times 100 \qquad (2)$$

fr = Number of incidents of false rejection
n = Total number of Samples

In the following section the preparation of fake finger prints and tests on fingerprint modules are explained.

Fingerprint Stamps and Artificial Finger

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Fingerprint stamps are easy to make to duplicate a real fingertip. Most fake fingerprint stamps are made from gelatin and silicon. However, preparation of fake finger stamps is different and depends on the fingerprint sensing technology used by AFIS. Figure 7 illustrates four common methods for preparation of fake finger stamps that has been successfully tested with commercial AFIS systems[20-23].

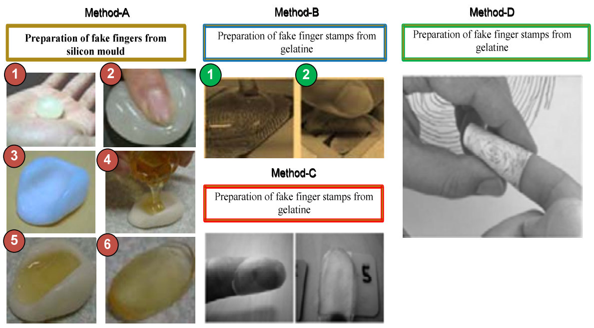


Fig.7 Methods A-D for preparing of fake fingerprint stamps

Method A

This method uses original fingerprint either by directly making a mold of user's finger fingerprint to make an artificial fingerprint as shown in figure 7 (Method A). After making mold from silicon or rubber, it filled with liquid gelatin. The molded fingers are rather transparent and amber while having ridges and valley similar to those of live finger in terms of outside appearance [21]. These duplicate finger stamps have been successfully tested on commercially available optic ` and capacitive technology based fingerprint sensors [21]. These sensors were successfully deceived by fake finger stamps created with a simple procedure. This study proved that AFIS are not capable to distinguish between fake and real fingerprints.

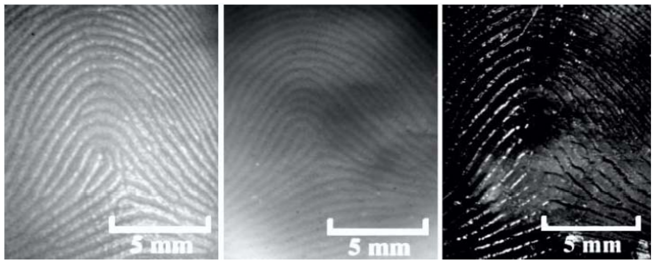
Method B

In this method, a residual fingerprint can be taken from sensor surface or other surface. The gummy finger was produced from a residual fingerprint on a glass plate, enhancing it with a cyanoacrylate adhesive. After taking picture of outside appearance it is scanned and enhanced with image processing software. The final image is further imposed on a printed and etched on a copper board (See Figure 7). Finally, liquid gelatin is spread on etched copper pattern. After drying and removing gelatin from the surface of board, a fake fingerprint is ready to use [21].

Method C & D

These methods are used to create artificial fingers to fool the touch less fingerprint scanners. In method C, the finger is made from glycerin supersedes gelatin which is illustrated in figure 7[24],[20].

Matsumoto[21] showed that 11 types of fingerprint sensors accepted gelatin/gummy fingers, which were easy to make with cheap, easily obtainable tools and materials. The images produced by these fake fingers can be accepted and processed by sensors as a real finger as shown in figure 8.



(a) (b) (c)

Fig 8. a) Live Finger b) Silicon Finger c) Gummy Finger [21]

There are many other possibilities to use fingerprints to get illegal access to the AFIS are discussed in the following section.

Residual fingerprint

Using the residual fingerprint on the sensor surface by dusting graphite powder and then pressing an adhesive film on the sensor's surface to make a fake fingerprint is one of many other techniques [25] . By adding preservative to gelatin based artificial finger, the fake finger can last even more than a week. Also high-resolution camera can be used to photograph the residual fingerprints and that can be used to make fake fingerprints.

The registered finger

Separating the finger from the legitimate user's body, stealing fingerprint of user by making mold or pressing fingerprint sensors by either force or sleeping drug to push the legitimate user [26].

The unregistered (illegitimate) finger

Impostor can use their own finger to try to log in as another user. The probability of this fraud is based either on the high FAR of the system or in case of categorized system such as "loops," "whorls," "arches," by presenting the similar unregistered pattern as registered finger [19].

A genetic clone of the registered finger

Generally, identical twins do not have the same fingerprint, and neither would clones. This can deceive the system if fingerprints are not entirely genetically determined or rather determined in part by its pattern of nerve growth into the skin [2, 19].

Advances in image processing and material technologies have made ways to copy and regenerate perfect patterns of fingertip (e.g valleys, ridges and bifurcation). It is now much easier to make artificial fingers than before. In the last ten years, a lot of

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commercially implemented AFIS have revealed their weaknesses in detecting fake finger [20, 22, 25-28].

B. PROCESSING LEVEL ISSUES

Denial of service (DoS)

DoS is a common attack in network based systems. In many applications, AFIS are implemented in a networked environment. A hacker can use DoS to control a system when a legitimate user can no longer access the system [29,30].

Privacy and Subversive

Get access to the system and change a registered user to unauthorized. In that case he/she may not get access to the AFIS or to manipulate the system and use the data for criminal activities [31][30].

Collusion

To get Access to the system by way of colluding between the administrator (super-users) and other users to overrule the decision made by the system[29].

Coercion

Coercion means forcing the legitimate user to identify themselves to the system and access to the system as genuine user [32].

Disclaiming

By using this way, denial of having accesses to the system by authorized user to obtain double personal benefit [31].

C. TEMPLATE DATBASE ISSUES

Another security concern with AFIS is that once the fingerprint data is compromised, the effect will be forever. In fact, many researchers have proven that fingerprint information stored in a database may leak features which can be used to reconstruct a fingerprint image [33]. Some examples are explained here

- A minutiae template can provide three levels of fingerprint information: orientation, class or type and friction ridge structure [34]
- Reconstruct a fingerprint image based on a standard template[35]
- Reconstruct the gray scale image through the phase image. It is also possible to produce the whole fingerprint with few spurious minutiae [36]
- Reconstructing a full fingerprint from partial fingerprint [34]

V. PROPSED CONTERMEASURES FOR AFIS

This section summarizes various protection scheme to find optimum solution to improve the security in AFIS as shown in Table 2.

TABLE.2 COUNTERMEASURES PROPOSED FOR AFIS

Option	Sensor Level	Processing Level	Template Database level
A	The best countermeasure against this attack is liveness detection or combining fingerprint with password or ID card [32]	Deployment of appropriate firewalls, routers, antiviral and anti-spam methods will help to reduce the impact of a system breach by a hacker [30].	A cancelable template is a potential solution in addressing the template security[34-36]
B	Use of method, that works under duress or two-person control or where the system requires fingerprints from two different persons, which are not capable and feasible in every situation [38] .		Diffusion and digital watermarking techniques can be used to improve the security and secrecy of the fingerprint templates database[26, 37].
C	To minimize this kind of attempts, the FAR of system should be reduced and in case of categorized system, not only the evaluation of categories is necessary but fingers within each category as well [39]		
D	Fingerprints are different in identical twins, but only slightly different, this similarity can be tried to deceive fingerprint systems. Therefore, it raises the demand of close watch on such possibility with genetic engineering in fingerprint identification system [40] .		

VI. CONCLUSION

In general, AFIS have been successfully implemented in many applications with the use of a single or multiple fingerprints. In addition, it has many advantages among other biometrics in terms of cost, reliability, robustness, and efficiency. Most importantly, it is cheap compared to other biometrics and user friendly. The possibility of defeating

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AFIS lies in its inability to detect liveness at sensing level. The fake fingerprint stamps can make AFIS vulnerable to various possible attacks. From this study, it can be concluded that more work need to be done to include liveness detection and facilitate unsupervised identification in order to make the AFRS more appropriate in modern-world high security applications.

It is therefore necessary to make AFIS more sophisticated by developing new fingerprint sensors with integrated liveness detection capability and high resolution image capturing with improvements in False Acceptance Rate (FAR) and False Rejection Rate (FRR). In addition, more research is required in securing communication channels in particular wireless channels when biometric data is transmitted. Secure database technologies and communication protocols can deter imposters and hackers from attacking AFIS.

REFERENCES

[1] AK Jain, A Ross and S Pankanti, "Biometrics: a tool for information security," IEEE Transactions on Information Forensics and Security, vol. 1, June 2006, 2006.

[2] Anonymous "Reliability, availability and maintainability of biometrics," Biometric Technology Today, vol. 16, pp. 8-10, 3, 2008.

[3] G. Wei and D. Li, "Biometrics: Applications, Challenges and the Future," Privacy and Technologies of Identity, pp. 135-149, 2006.

[4] A. K. Jain and A. Kumar, "Biometrics of Next Generation: An Overview," Second Generation Biometrics, 2010.

[5] A. Juels, "Biometrics in electronic travel documents," in Proceedings of the 12th ACM Workshop on Multimedia and Security, 2010, pp. 1-2.

[6] Cyril H. Wecht, John T. Rago, Forensic Science and Law. CRC Press, 2006.

[7] Maltoni, D., Maio, D., Jain, A.K., Prabhakar, S. (2009, Handbook of Fingerprint Recognition.

[8] International Biometric Group (2008, October 2008). Biometrics revenues by technology 2009. 2009 (/0315), pp. 1.

[9] Nalini Kanta Ratha, Ruud Bolle. (2004, Automatic Figerprint Recognition System.

[10] A. K. Jain, P. J. Flynn and A. A. Ross, Handbook of Biometrics. Springer, 2008.

[11] Anil K. Jain, "Biometric recognition," NATURE, vol. 449, pp. 38-40, September 2007, 2007.

[12] W. S. Coats, "The practitioner's guide to biometrics," in 2007, .

[13] Anil K. Jain, Yi Chen and Meltem Demirkus. (2007, Pores and ridges: High-resolution fingerprint matching using level 3 features. IEEE Transactions on Pattern Analysis and Machine Intelligence 29(1), pp. 15-27.

[14] S. Memon, M. Sepasian and W. Balachandran, "Review of finger print sensing technologies," in Multitopic Conference, 2008. INMIC 2008. IEEE International, 2008, pp. 226-231.

[15] R. Bolle, Guide to Biometrics. Springer verlag, 2004.

[16] A. K. Jain, S. Pankanti, S. Prabhakar, L. Hong and A. Ross, "Biometrics: A grand challenge," in Proc. of IC PR, 2004, pp. 935-942.

[17] A. Moore, "Biometric technologies — an introduction," Biometric Technology Today, vol. 15, pp. 6-7, 1, 2007.

[18] N. K. Ratha and V. Govindaraju, Advances in Biometrics: Sensors, Algorithms and Systems. Springer-Verlag New York Inc, 2008.

[19] V. Lee, "Biometrics and identity fraud," Biometric Technology Today, vol. 16, pp. 7-11, 2, 2008.

[20] C. Barral and A. Tria, "Fake Fingers in Fingerprint Recognition: Glycerin Supersedes Gelatin," Formal to Practical Security, pp. 57-69, 2009.

[21] T. Matsumoto, H. Matsumoto, K. Yamada and S. Hoshino, "Impact of artificial fingers on fingerprint systems," in San Jose, CA, USA, 2002, pp. 275-289.

[22] H. Kang, B. Lee, H. Kim, D. Shin and J. Kim, "A Study on Performance Evaluation of the Liveness Detection for Various Fingerprint Sensor Modules," Knowledge-Based Intelligent Information and Engineering Systems, pp. 1245-1253, 2003.

[23] [23] M. Tistarelli, S. Z. Li and R. Chellappa, "Handbook of Remote Biometrics: for Surveillance and Security," Advances in Pattern Recognition, pp. 382, 2009.

[24] [24] X. Boyen, Y. Dodis, J. Katz, R. Ostrovsky and A. Smith, "Secure remote authentication using biometric data," Advances in Cryptology–EUROCRYPT 2005, pp. 147-163, 2005.

[25] [25] Qinghan Xiao, "Security issues in biometric authentication," in Information Assurance Workshop, 2005. IAW '05. Proceedings from the Sixth Annual IEEE SMC, 2005, pp. 8-13.

[26] U. Uludag and A. K. Jain, "Attacks on biometric systems: A case study in fingerprints," in Proc. SPIE-EI 2004, Security, Seganography and Watermarking of Multimedia Contents VI, 2004, pp. 622-633.

[27] W. David , L. Mike. (2010, Six biometric devices point the finger at security. [Online]. 2010(03/05), pp. 2. Available: http://www.networkcomputing.com/910/910r1.html.

[28] Y. Flink. (2009, 08-01-2009). Million dollar border security machines fooled with ten cent tape. Find Biometrics-Global Identity Management [Online]. 2010(03/13), Available: http://www.findbiometrics.com/articles/i/6090/.

[29] N. Ratha, "Privacy Protection in High Security Biometrics Applications," Ethics and Policy of Biometrics, pp. 62-69, 2010.

[30] K. Saini and M. Dewal, "Designing of a Virtual System with Fingerprint Security by considering many Security threats," International Journal of Computer Applications IJCA, vol. 3, pp. 25-31, 2010.

[31] V. Matyáš, "Security of Biometric Authentication Systems–Extended Version," 2010.

[32] J. Galbally, R. Cappelli, A. Lumini, G. Gonzalez-de-Rivera, D. Maltoni, J. Fierrez, J. Ortega-Garcia and D. Maio, "An evaluation of direct attacks using fake fingers generated from ISO templates," Pattern Recog. Lett., vol. 31, pp. 725-732, 2010.

[33] K. Takahashi and S. Hirata, "Cancelable Biometrics with Provable Security and Its Application to Fingerprint Verification," IEICE Trans. Fund. Electron. Commun. Comput. Sci., vol. 94, pp. 233-244, 2011.

[34] A. T. B. Jin and L. M. Hui, "Cancelable biometrics," Scholarpedia, vol. 5, pp. 9201, 2010.

[35] A. M. P. Canuto, F. Pintro, A. F. Neto and M. C. Fairhurst, "Enhancing performance of cancellable fingerprint biometrics using classifier ensembles," in 2010 Eleventh Brazilian Symposium on Neural Networks, 2010, pp. 55-60.

[36] M. Kaur, S. Sofat and D. Saraswat, "Template and database security in Biometrics systems: A challenging task," International Journal of Computer Applications IJCA, vol. 4, pp. 1-5, 2010.

[37] G. Bhatnagar, Q. Jonathan Wu and B. Raman, "Biometric Template Security based on Watermarking," Procedia Computer Science, vol. 2, pp. 227-235, 2010.

[38] N. Ratha, "Privacy Protection in High Security Biometrics Applications," Ethics and Policy of Biometrics, pp. 62-69, 2010.

[39] F. Sabena, A. Dehghantanha and A. P. Seddon, "A review of vulnerabilities in identity management using biometrics," in 2010 Second International Conference on Future Networks, 2010, pp. 42-49.

[40] J. Fulton, "Fingerprint the point of sale," Biometric Technology Today, vol. 2011, pp. 7-9, 2011.

Real-Time Interactive Shape Editing Design Using OpenGL

Hla Myo Tun

Abstract:

Geometric design often requires the capability to manipulate flexible objects, including bending, twisting, compressing or stretching parts of the model or its entire geometry. The proposed approach comprises also shape deformations with multiple (real, auxiliary, and virtual) control points and constrained, directional, and anisotropic deformations. It allows a user to edit a given shape interactively and spontaneously.Our approach successfully suggests a sense of rigidity of the lattice, which is difficult in interactive shape editing approaches.Mathematically, the problem being addressed in this research work involves a Free-Form Deformation (FFD) of the features of the affine three dimensional geometry of the image. The algorithms primarily develop are projective geometry techniques, which form the basis for accurate deformation. Furthermore, these algorithms generally assume standardized images, i.e. no prior knowledge of either the shape, or its pose (position and orientation) with respect to the transformed coordinates. This project aims to develop a general framework for perform mesh deformation and editing in real-time. The prerequisites include C/C++, OpenGL and basic knowledge in differential geometry.

Index Terms: Interactive Shape Editing, Free-Form Deformation, OpenGL, Digital Geometric Modeling, Visual C++.

I. INTRODUCTION

In the early days of computer graphics, the shape editing techniques were very simple, ranging from static texture to simple particle systems using free form deformation. At that time, the only goal was to tell the researcher that the specific part was solid geometric model and did not prioritize much on the realism of the deformation techniques due to the restricted capabilities. With the fast development of free form deformation in recent years, realistic shape editing is possible and thus research in shape editing became more vigorous [1].

The general interactive shape editing design using free-form deformation is the simulation in geometric modeling in which each geometry value on every point in the region such as shape into a uniform value associated with the region. As a consequence, the simulation does not support very well geometric modeling aspects such as mesh boundary [2]. However, geometric modeling simulation will not be able to be handled by current computer as the computer has to evaluate every deform shape. The relatively new Free-Form Deformation Method (FFDM) is the interactive shape editing simulation which can handle shape editing simulation correctly as it stands on the middle between geometric modeling and interactive shape editing. FFDM is the extension of Sederberg Engine which originated from solid geometry modeling. In the Sederberg Engine, the simulation is done on discrete time step over discrete region, in which the set of deform image [3], [4], [5] and [6].

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II. MATHEMATICAL MODEL OF INTERACTIVE SHAPE EDITING

Mathematically, the FFD is defined in terms of a tensor product trivariate Bernstein polynomial. We instigate by arresting a local coordinate system on a parallel piped region, as shown in Fig.1. The red colour points are control points. Any point **ISD** has (s,t,u) coordinates in this system such that

$$\mathbf{ISD} = \mathbf{ISD}_0 + s\mathbf{S} * t\mathbf{T} * u\mathbf{U}. \quad (1)$$

The (s.t,u) coordinates of **ISD** can easily be originated using linear algebra. A vector solution is

$$s = \frac{\mathbf{T \times U\ (ISD\text{-}ISD_o)}}{\mathbf{T \times U.S}} \quad (2)$$

$$t = \frac{\mathbf{S \times U\ (ISD\text{-}ISD_o)}}{\mathbf{S \times U.T}} \quad (3)$$

$$u = \frac{\mathbf{S \times T\ (ISD\text{-}ISD_o)}}{\mathbf{S \times T.U}} \quad (4)$$

Note that for any point interior to the parallel piped that $0<s <1$, $0<t<l$ and $0<u<l$. We next compel a grid of control points $\mathbf{CP}_{ijk}$ on the parallelpiped. These form t+l planes in the s direction, m+l planes in the **T** direction, and n+l planes in the u direction. The control points are designated by small white diamonds, and the red bars indicate the neighbouring control points. These points lie on a lattice, and their locations are defined

$$\mathbf{CP}_{ijk} = \mathbf{ISD}_0 + \frac{i}{l}\mathbf{S} + \frac{j}{m}\mathbf{T} + \frac{k}{n}\mathbf{U} \quad (5)$$

where S, T and U represent the orthogonal axes of a bounding box (of size l, m and n) used to contain the object to be deformed. i, j and k are the evenly-spaced denominations of l, m and n used to denote the i-th Control Point along the l-axis, j-th Point along the m-axis, and so on. The deformation is stipulated by moving the $\mathbf{CP}_{ijk}$ from their undisplaced, lattieial positions. The deformation function is defined by a trivariate tensor product Bernstein polynomial. The deformed position $\mathbf{ISD}_{ffd}$ of an arbitrary point **ISD** is established by first computing its (s,t,u) coordinates from equation (1), and then evaluating the vector valued trivariate Bernstein polynomial:

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$$\mathbf{ISD}_{ffd}=\sum_{i=0}^{l}\binom{l}{i}(1\text{-}s)^{l\text{-}i}\,s^{i}\left|\sum_{j=0}^{m}\binom{m}{j}(1\text{-}t)^{m\text{-}j}\,s^{j}\left|\sum_{k=0}^{n}\binom{n}{k}(1\text{-}s)^{n\text{-}k}\,s^{k}\right|\right| \quad (6)$$

where$\mathbf{ISD}_{ffd}$ is a vector containing the Cartesian coordinates of the displaced point, and where $\mathbf{CP}_{ijk}$ is a vector containing the Cartesian coordinates of the control point [1], and [7].

The principle assumptions, for simplification, in this implementation are:

- that it only allows movement of one Control Point at a time, and
- that it assumes the axes of the initial bounding box to be parallel to the three principal axes.

From $\mathbf{ISD}_{ffd}$, for each v calculated, the ijk-values are constant, as well as the lmn-values. The stu-values belong to each point and so are saved with it. The Control Points will vary along with their movement. However, from $\mathbf{CP}_{ijk}$, the three recursive summations are expensive to compute, with several repeated calculations, especially when applied over all vertices. Therefore, a work-around was devised. By assuming that one control point can only be manipulated at a time, the equation is simplified to become

$$v'=v+\left(\mathbf{CP}'_{ijk}\text{-}\mathbf{CP}_{ijk}\right)*\mathbf{ISD}_{ffd} \quad (7)$$

The control points $\mathbf{CP}_{ijk}$ are actually the coefficients of the Bernstein polynomial. As in the ease of Bezier curves and surface patches, there are momentous relationships between the deformation and the control point placement. Note that the 12 edges of the parallel piped are actually mapped into Bezier curves, defined by the control points which initially lie on the respective edges. Also, the six planar faces map into tensor product Bezier surface patches, defined by the control points which initially lie on the respective faces. This deformation could be originated in terms of other polynomial bases, such as tensor product D-splines or non-tensor product Bernstein polynomials

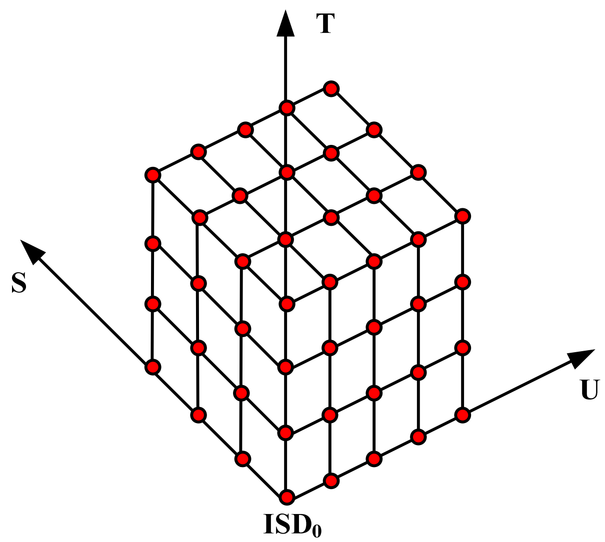

Fig.1. The s,t,uCoordinate System for Shape Editing

III. Shape Editing Domain

Although the purpose of this work is to establish FFD as a viable tool for solid modelling, we note that it can be applied to virtually any geometric model. Only the polygon vertices are transformed by the FFD, while maintaining the polygon connectivity. Deformation of polygonal data is conferred more thoroughly in [1]. The sphere and the plane could each be articulated in parametric equations, or in implicit equations. The FFD can be applied with equal validity to either representation. A very important characteristic of FFD is that a deformed parametric surface remnants a parametric surface. If the parametric surface is given by $x=f(\alpha,\beta)$, $y=g(\alpha,\beta)$ and $z=h(\alpha,\beta)$ and the FFD is given by $\mathbf{ISD}_{ffd} = \mathbf{ISD}(x, y, z)$), then the deformed parametric surface patch is given by $\mathbf{ISD}_{ffd}(\alpha, \beta) = x(f(\alpha,\beta), g(\alpha,\beta), h(\alpha,\beta))$.

An important corollary to this is that parametric curves remain parametric under FFD. If one performs FFD in a CSG modelling environment only after all Boolean operations are executed, and the primitive surfaces are planes or quadrics, then all intersection curves would be parametric, concerning rational polynomials and possibly square roots. Quadrics and planes make exceptional primitives because they possess both implicit and parametric equations. The parametric equation enables rapid computation of points on the surface, and the implicit equation provides a simple point classification test - is a point inside, outside, or on the surface. To organize a point on a deformed quadric, one must first compute its s,t,u coordinates and substitute them into the implicit equation. The s,t,u coordinates can be created by subdividing the control point lattice, or by trivariate Newton iteration [8]. This inverse mapping necessitates significant computation, and can be a foundation of robustness problems, especially if the Jacobian of the FFD changes sign.

IV. Algorithm Pipeline of Interactive Shape Editing Design

In this project, the Sederberg Algorithm is used to simulate interactive shape editing design in 3D domain with an object is deformed to the Free-Form sense. The project consists of three main parts, Sederberg Engine, the M-file Reader, and the user input. The Sederberg Engine which is used to compute the control point on the image comprises the transformation from x,y,z, to s,t,u domain and reverse transformation step, and the output is the transformation image by Free-Form sense which is used in the real-time interactive shape editing design. The real-time interactive shape editing design simulation consists of Sederberg Engine and M-file reader step, which in every time step the image will deform to its neighboring region in the Sederberg Engine step and will be advocated according to the control point allocation in the M-file reader step. The user can interact both with the Sederberg Engine and the real-time interactive shape editing simulation. For example, the user can add external images which are used as input to the control point allocation step in the Sederberg Engine step. Another source of the external images is the movement of the object as the object movement can disturb

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the shape editing. When the user transforms the image, the specified location and orientation of the image boundary will be updated and will be used as input to the control point allocation step in Sederberg Engine and to the real-time interactive shape editing simulation. The information from the image boundary is necessary since the real-time interactive shape editing cannot move past through the image boundary. The information from updating the Free-Form sense such as the MATLAB m file and the boundary information can be obtained by doing the deformation process since the simulation is done on the grid consisting of geometry domain. The overview of the program flow is shown on the Fig.2 on the same page.The simulation is implemented in C++ language by using Microsoft Visual C++ 2008 Express Edition. As for the graphics API we use OpenGL together with Cg for the GPU programming.

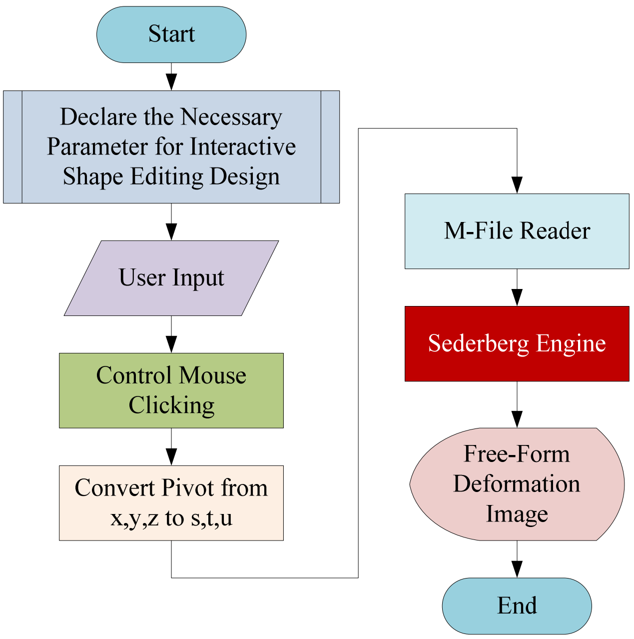

Figure.2. Program Flow

V. Interactive Shape Editing Method

The Sederberg Engine we choose to implement is the Free-Form Deformation which is the three dimensional shape editing image. The reason we chose this Engine was that the Sederberg has too high deformation for solid modeling which may cause the simulation to be a high actuate. On the other hand, the Sederberg might give a very accurate result; however, due to large number of deformation will make the implementation become very high. The Sederberg Engine section as shown on the above Fig.2 consists of convert pivot x,y,z. The result of the Sederberg Engine is the evolution of the shape editing which will be used to advent the Free-Form Deformation in the sections following the shape editing method.

A. M-File Reader

In the M-file reader step the three dimensional image is read by MATLAB m file to the same original image. Before the simulation is started with the M-filer reader, this 3D image is initialized with the graphic plane, which is the deformation image for Sederberg Engine. As the result, the total deformed images are evaluated when read from M file reader. In the M-file reader the program visits each original 3D image and transforms the deformation images. The M-file reader is given on the following Algorithm.1.

Algorithm.1 M-File Reader.

```
MFileReader = MFileReader() //using namespace standard
MFileReader = ObtainNextVertex()//Obtains next vertex
 indexCh1←indexCh1+ 7 //Move 7 character right to the 44
vector's number.
  indexCh2←find(indexCh1)
  array1← 0 // Empty the array
  array1←new char[array Size]
// copy the value out
 vertexNum←atoi(array1)
VertexPt→vertPt
 vertPt.ptNumber= vertexNum//assign number of e vertex
  indexCh1←indexCh2 + 1
// Obtain Coords
 for i = 0 to 2
indexCh1←indexCh1+ 1//Move 1 character right to the
// next coordinate (skips spaces)
   array1← 0 // Empty the array
   array Size←indexCh2 - indexCh1
// copy the value out
   switch (i)
 case 0→ vertex point position x = vertex Coordinate
 case 1→ vertex point position y = vertex Coordinate
case 2→ vertex point position z = vertex Coordinate
indexCh1 = indexCh2; // Update start pointer with end
 indexCh1←indexCh1+9 // Obtain normal
 end
for i = 0 to 2
indexCh1←indexCh1+ 1//Move1 character right to the next
array1← 0// Empty the array
array Size←indexCh2 - indexCh1
// copy the value out
switch (i)
case 0→ vertex point normal x = vertex Coordinate
case 1→ vertex point normal y = vertex Coordinate
case 2→ vertex point normal z = vertex Coordinate
   indexCh1←indexCh2; // Update start pointer with end
// Save the vertex (Account for non-zero start)
// Obtains next face in the file
 end
   MFileReader=ObtainNextFace()
   indexCh1←find(cstrFace)
 if indexCh1≠ npos string // Found a face
   indexCh1←indexCh1+5//Move 5 character right to the
// face's number
   indexCh2←find(indexCh1)
array1← 0// Empty the array
array Size←indexCh2 - indexCh1
 end // copy the value out
 thisFace.faceNumber=vertexNum//assign number of e
// vertex
   indexCh1←indexCh2 + 1 // "Face X  _<-"
   for i = 0 to 2 // Obtain coordinates
   indexCh2←find(indexCh1)
   if indexCh2= npos string // Finished
   indexCh2 = line.length()
array1← 0// Empty the array
array Size = indexCh2 - indexCh1
 end // copy the value out
   vertexPts + vertexNum – 1
  indexCh1←indexCh2 // Update start pnter with end
// Executes the read and obtaining procedure
   MFileReader=Read(string filename, MObject *mObj)
   ifstream=readFile //MObject mObj;
   throw 0 //readFile.close();
   if indexCh1≠ npos string // Found a vertex
   mObj.ObjFaces = faces
   mObj.ObjVertexPts = vertexPts
   vertexPts.clear()
   readFile close()//return mObj
```

B. Sederberg Engine

In the Sederberg Engine step in every vertex is transferred to the same direction vertex in the neighboring control point

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which is in the direction of the vertex. Before the simulation is started with the Sederberg Engine, every vertex is initialized with the equilibrium value, which is the domain of s,t,u corresponding to the domain of x,y,z. As the result, the total particle distribution of each vertex in the beginning of the vertex is $\mathbf{ISD_0}$. In the Sederberg Engine the program visits each vertex and copies the value of distribution function of every vertex. The Sederberg Engine is given on the following Algorithm .2.

Algorithm.2 Sederberg Engine.

```
SederbergEngine
Convert xyz To stu(Vector xyz)// Assign
Results←xyz.x-origin.x,xyz.y-origin.y,xyz.z-origin.z
Convert stu To xyz(Vector stu)// Assign
Results←stu.x+origin.x,stu.y+origin.y,stu.z+origin.z
Copy From Vertexes(vector<VertexPt>inputVectors)
stu point ← 0
for i = 0 to input Vectors size
   stu Points push back(SederbergAlgorithm)
end // end for
end // Copy From Vertexes
Copy To Vertexes(vector<VertexPt> inputVectors)
vector<VertexPt> = result
for i = 0 to input Vectors size
   stu Points push back(SederbergAlgorithm)
end // end for
end // Copy To Vertexes
Initialize(Vector stuOrigin, Vector lmnInput)
// float sGran, float tGran, float uGran
origin = stu_Origin
lmn = lmn_Input
UpdatePoint(Vector point,Vector originalCP,Vector
  changedCP,Vector ijk)
Vector stu
stu.x = point.x - origin.x
stu.y = point.y - origin.y
stu.z = point.z - origin.z
ComputeWeight(stu, lmn, ijk)
point.x=point.x+(changedCP.x-originalCP.x)*weight
point.y=point.y+(changedCP.y-originalCP.y)*weight
point.z=point.z+(changedCP.z-originalCP.z)*weight
end // end UpdatePoint()
Factorial(int number)
if number is less than or equal 1  then return 1
   temp = number * Factorial(number - 1)
end // end if
 return
  end // end of Factorial
Factorial(int upper, int lower)
   int temp = Factorial(upper)
   temp = temp / Factorial(lower)
   temp = temp / Factorial(upper - lower)
return temp
   end // end of Factorial
ComputeWeight(Vector stu, Vector lmn, Vector ijk)
result=Factorial((int)lmn.x(int)ijk.x)*pow(stu.x,ijk.x)*
pow(1 - stu.x, lmn.x - ijk.x);
 result*=Factorial((int)lmn.y,(int)ijk.y)*pow(stu.y,
ijk.y)*pow(1 - stu.y, lmn.y - ijk.y);
 result*= Factorial((int)lmn.z,(int)ijk.z)*pow(stu.z,
ijk.z)*pow(1 - stu.z, lmn.z - ijk.z);
end // end SederbergAlgorithm
```

Thus, the applied algorithm is as follows:

Step 1. The vertices are converted in bulk to a corresponding array of stu-space coordinates. For simplicity, this project assumes or forces the axes of the stu-space as the same as that of xyz-space, though the origin need not be similar. This eliminates costly rotational translation per vertex into the stu-space.

Step 2. The Control Points (CPs) are initialized from the object's stu-space bounding box (in this case, each boundary line divided into four sections of five CPs). They are saved in an array.

Step 3. The engine is initialized: The stu-vertices are passed into the engine for storage, as well as the co-ordinates for its origin.

Step 4. The image is displayed with the CPs, and the user selects and moves one point.

Step 5. The corresponding CP's new and initial point are passed into the engine, which calculates and re-saves the new stu-coordinates of each vertex. These vertices are then converted back *en masse* into the xyz-space.

Step 6. The newly-modified vertices and CP are refreshed onscreen.

Step 7. The step 4-6 is repeated as necessary.

VI. IMPLEMENTATION

In this section, we present some results of the FFD simulation using the implementation discussed in previous section.We conducted six simulations with different settings to in order test certain features of the simulation. The first simulation was the bunny simulation. The Free-Form Deformation essentially does not depend on the any m files. However, if the m file input is active, the FFD will not only shapes and sizes of image, but also get campaigner according to the deformation which will make it difficult to observe the interactive shape editing.The control points for deforming the image are specified by identifying the two main steps for point grid and point selection.

A. Point Grid

For our Interactive Shape Editing with Free Form Deformation program, we will use a control mesh derived from the bounding box of the model. This mesh will be a 3D grid of 4x4x4 which gives us 64 control points.

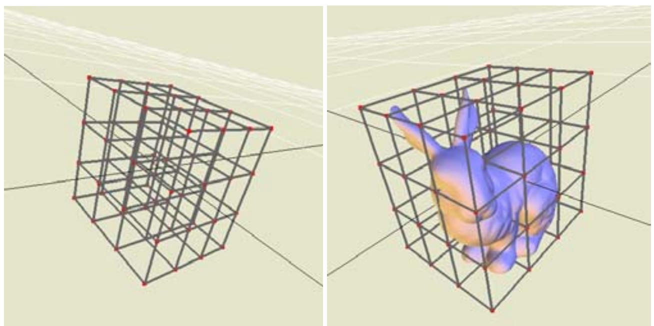

Fig.3.Point Grid

B. Point Selection

OpenGL provides a mechanism to select objects in a 3D scene. This is done by making use of the **Name Stack**. The idea is simple, we can enter *selection mode* (GL_SELECT) and render a small area around the mouse. For each selectable object that we render, we push and pop a unique name (the name is actually an integer number) into the name stack. When each selectable object is rendered, if it intersects the viewing volume a new *hit record* (with its corresponding depth information) is created. After we go back to the normal rendering mode, we can retrieve the *hit records* and select the hitted object that is closer to the camera. The function calls for the name stack are ignored if not in *selection mode*. This means that we could use a single rendering function with the name stack calls inside, but since only the control points are selectable in our program, we chose to enter selection mode and only render these points (using their position in the array

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as the name) when the user clicks on the screen. The user will then be able to move the selected point around while the mouse button is still pressed. Since the normal rendering and the rendering for the selection function will be different, it is very important to use the same projection matrix, otherwise the selection would not work properly since the points would be projected on a different position in the projection plane.

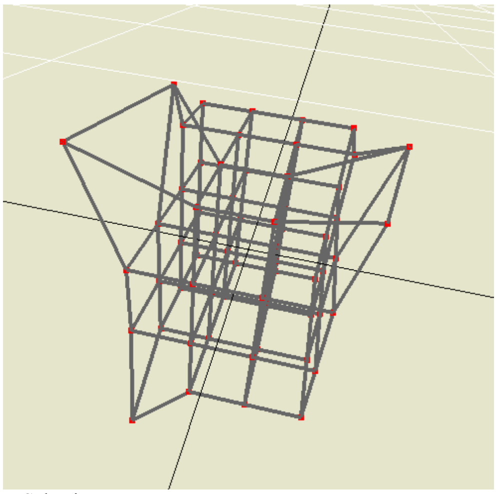
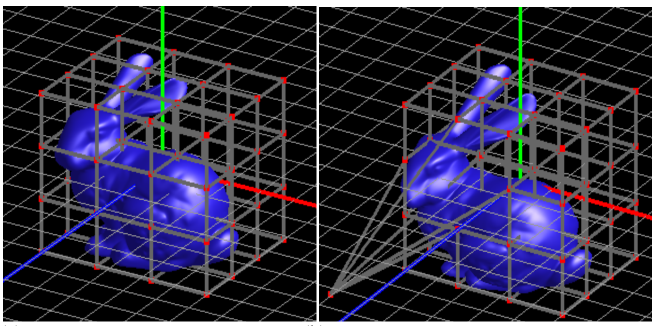


Fig.4. Point Selection

VII. EXPERIMENTAL RESULTS

A. Experimental Results for Bunny Image

The following Fig.5(a) shows the screenshot of the simulation with the Pre-Deformed bunny image. The screenshots were taken in 4×4×4 frame. We can see from the bunny image that lies inside the Sederberg boundary for Free-Form Deformation process. The screenshot results of post-deformed bunny image with (s=2, t=1, u=0) is illustrated in Fig.5(b).

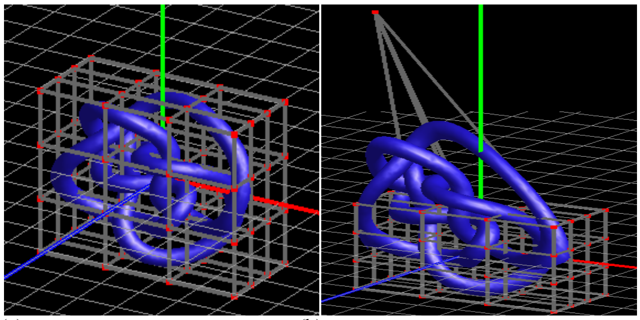


(a) (b)

Fig.5 (a) Pre-Deformed Bunny Image (b) Post-Deformed Bunny Image with (s=2, t=1, u=0)

B. Experimental Results for Knot Image

Fig.6 (a) shows the screenshot of the simulation with the Pre-Deformed knot image. The screenshots were also caught in 4×4×4 frame. We can perceive from the knot image that deceits inside the Sederberg boundary for Free-Form Deformation development. The screenshot results of post-deformed knot image with (s=2, t=3, u=2) is illustrated in Fig.6 (b).

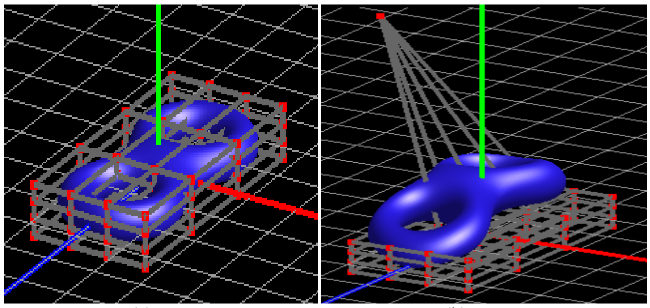


(a) (b)

Fig.6 (a) Pre-Deformed Knot Image (b) Post-Deformed Knot Image with (s=2, t=3, u=2)

C. Experimental Results for Eight Image

The following Fig.7 (a) demonstrates the screenshot of the simulation with the Pre-Deformed eight image. The screenshots were held in 4×4×4 frame. We can see from the eight image that deceptions within the Sederberg boundary for Free-Form Deformation procedure.The screenshot results of post-deformed eight image with (s=2, t=2, u=2) is illustrated in Fig.7 (b).

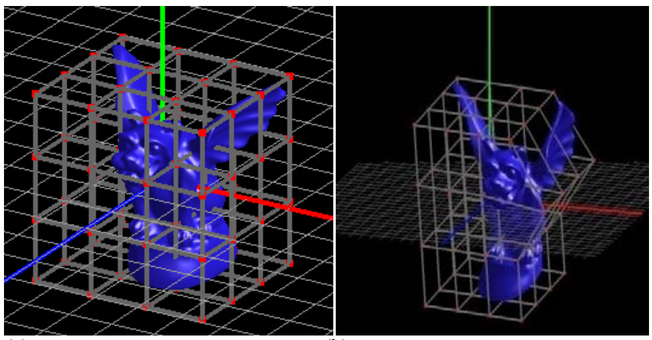


(a) (b)

Fig.7 (a) Pre-Deformed Eight Image (b) Post-Deformed Eight Image with (s=2, t=2, u=2)

D. Experimental Results for Gargoyle Image

Fig.8 (a) proves the screenshot of the simulation with the Pre-Deformed gargoyle image. The screenshots were also trapped in 4×4×4 frame. We can recognize from the gargoyle image that shams surrounded by the Sederberg boundary for Free-Form Deformation expansion.The screenshot results of post-deformed gargoyle image with (Movement of Four Points) is illustrated in Fig.8 (b).

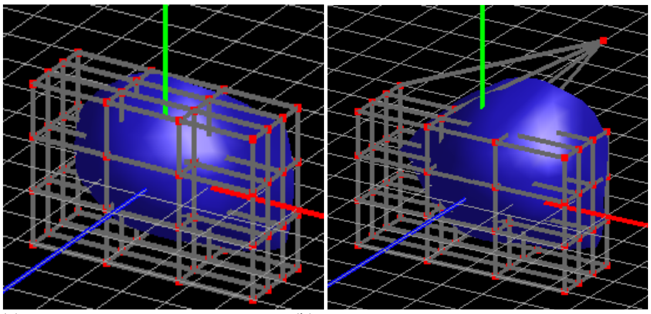


(a) (b)

Fig.8 (a) Pre-Deformed Gargoyle Image (b) Post-Deformed Gargoyle (Movement of Four Points)

E. Experimental Result for Cap Image

Fig.9 (a) confirms the screenshot of the simulation with the Pre-Deformed cap image. The screenshots were also fascinated in 4×4×4 frame. We can distinguish from the cap image that shams surrounded by the Sederberg boundary for Free-Form Deformation expansion. The screenshot results of post-deformed cap image with (s=2, t=2, u=2) is demonstrated in Fig.9 (b). In proportion to this simulation result, the cap image is distorted the shape by particular coordinate on the image.

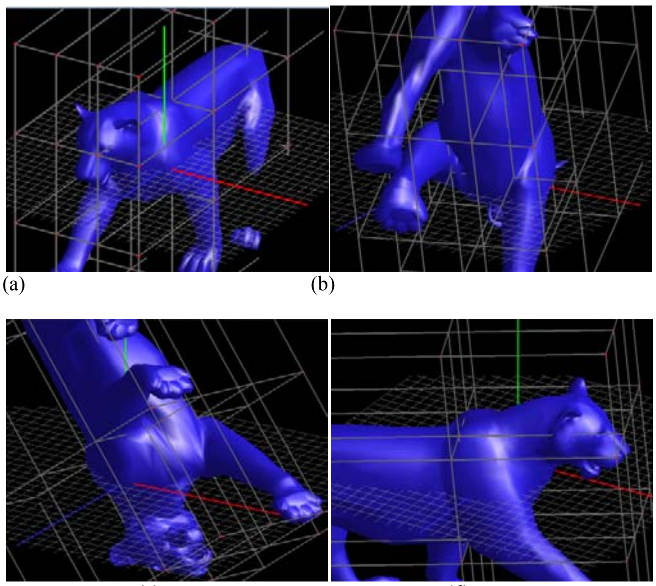


(a) (b)

Fig.9 (a) Pre-Deformed Cap Image(b) Post-Deformed Cap with (s=2, t=2, u=2)

F. Experimental Result for Lion Image

Fig.10 (a) corroborates the screenshot of the simulation with the Pre-Deformed lion image. The screenshots were also enthralled in 4×4×4 frame. We can discriminate from the lion image that shams surrounded by the Sederberg boundary for Free-Form Deformation expansion. The screenshot results of post-deformed lion image by rotating down position s,t,u axis is demonstrated in Fig.10 (b). In proportion to this simulation result, the lion image is rotated the shape by particular coordinate on the image. The screenshot results of post-deformed lion image by rotating up and right position s,t,u axis is demonstrated in Fig.10(c) and (d).



(a) (b)

(c) (d)

Fig.10 (a) Pre-Deformed Lion Image(b) Post-Deformed Lion with s,t,u Axis Rotation (Down)(c) Post-Deformed Lion with s,t,u Axis Rotation (Up) (d) Post-Deformed Lion with s,t,u Axis Rotation (Right)

VIII. STATISTIC TABLE FOR SIMULATION RESULTS

The statistic table for the deformation of several models is given in Table.1. In this table, the deformation time for Eight image is the lowest deformation time than other models. The deformation time for Lion image is the highest deformation time with the same vertices. The deformation time of Knot image and Gargoyle image is approximately the same. According to this statistic table from the simulation results, the Sederberg Engine is applied to deform the several images and the several amounts of vertices.

TABLE I
STATISTIC TABLE

Model	Vertices	Frame Size	Algorithm	Deformation Times (Seconds)
Bunny Image	40002	4×4×4	Sederberg	0.1-0.2
Knot Image	5000	4×4×4	Sederberg	0.3-0.4
Eight Image	3070	4×4×4	Sederberg	0.05-0.15
Gargoyle Image	20002	4×4×4	Sederberg	0.3-0.5
Cap Image	186	4×4×4	Sederberg	0.2-0.4
Lion Image	5000	4×4×4	Sederberg	0.35-0.6

IX. CONCLUSION

We experienced clipping, especially when the picture was deformed in several unnatural ways e.g. trying to 'push' back a CP that had been 'pulled'. There are also cases where the object stretched out of the bounding box as in Fig.3, which was not expected. However, in casual cases e.g. game models that favor improved game performance over full accuracy of the models, the performance of these deformations, if applied over modest CP movement, is well worth the loss in accuracy, especially since the deformed transformations of objects are not truly intuitive processes.As the only value to change per calculation pass is the value of the single manipulated control point CP_{IJK}, to CP_{IJK}' at point I-J-K. All other ijk- and stu-values are unchanged per vertex. The rational here is that the weight of all other vertices and Control Points on the vertex v are the same as before CP_{IJK}'s shift: instead of a summation of all points each pass, a difference between the current and initial states is added or subtracted proportional to the Control Point IJK's shift. With this assumption in place, the calculation is greatly simplified. The six summations are eliminated, while the only values that need to be stored in memory are the co-ordinates of each vertex and Control Point in the stu-space.

ACKNOWLEDGMENT

I would wish to acknowledge the many colleagues at Mandalay Technological University who have contributed to the development of this paper. In particular, I would like to thank Myat Su Nwe, my wife, ThetHtarSwe, my daughter, and ZayYarTun, my son, for their complete support.

REFERENCES

[1] Sederberg et al., "Free-Form Deformation of Solid Geometric Models", *Proceedings of SIGGRAPH 1986,* pp. 151-160, 1986.

[2] Battle et al., "Three-Dimensional Attenuation Map Reconstruction Using Geometrical Models and Free Form Deformations",IEEE Transactions on Medical Imaging, pp.404-411, 2000.

[3] Borrel, and Rappoport et al., "Simple constrained deformations for geometric modeling and interactive design", *ACM Transactions on Graphics, 13(2):*pp. 137–155, 1994.
[4] Chunyan, Jin and. Bin, et al, "Shape Edit Distance on Contour based Shapes", *Proceedings of the Sixth International Conference on Intelligent Systems Design and Applications (ISDA'06)*, 2006.
[5] Difei, Ying, and Xiuzi, "A New Method of Interactive Marker-Driven Free form Mesh Deformation", *Proceedings of the Geometric Modeling and Imaging— New Trends (GMAI'06)*, 2006.
[6] Edward et al., "Interactive Computer Graphics A Top-Down Approach Using OpenGL", 2003.
[7] Masamichi et al., "Free-Form Deformation for Implicit Surfaces", *MSc Dissertation*, 2009.
[8] Petros et al ., "Dynamic Free-Form Deformations for Animation Synthesis", IEEE Transaction on Visualization and Computer Graphic, 1997.

Exact Tonal Analysis on Polynomials (ETAP) for Computational Harmonic Analysis

Nay Oo

Abstract:

A computational harmonic analysis technique, ETAP is developed from the first principle. A closed-form formula for harmonics addition is presented in this paper as the Harmonic Addition Theorem (HAT). Power of cosine formula is applied with mathematical pattern such as checker box triangle (CBT) to exactly compute the amplitude and phase of the harmonics at the output of a polynomial nonlinearity.

Index Terms: Computational Harmonic Analysis, Harmonic Addition Theorem, Polynomials, and Harmonic Distortions.

I. INTRODUCTION

Let us define a polynomial nonlinearity as

$$f(x) = \sum_{n=0}^{Q} h_n x^n, \tag{1}$$

where h_n, and Q denote the polynomial coefficient of the nth term, and the highest degree, respectively. Let us define the input single tone with arbitrary amplitude A and phase in φ radian as

$$x(t) = A\cos(\omega t + \varphi), \tag{2}$$

where ω is the angular frequency in radian per second and t is the time in seconds.

When the sinusoidal signal in (2) is applied to the polynomial nonlinearity in (1), the output can be represented as

$$y(t) = DC_0 + \sum_{k=1} B_k \cos\left(k\omega t + \psi_k\right), \tag{3}$$

where DC_0 is the DC component; B_k and ψ_k are the amplitude and phase of the kth harmonic, respectively.

The research problem is defined as follows: given (1) and (2), to compute (3).

II. HARMONIC ADDITION THEOREM (HAT)

The HAT is the key ingredient to solve the problem.

Theorem: $\sum_{i=1}^{L} A_i \cos(\omega t + \varphi_i) = B\cos(\omega t + \psi)$, where

$$B = \sqrt{\sum_{i=1}^{L} A_i^2 + 2\sum_{i=1}^{L-1}\sum_{j=i+1}^{L} A_i A_j \cos(\varphi_i - \varphi_j)}, \tag{4}$$

$$\psi = \operatorname{atan2}\left(\frac{\sum_{i=1}^{L} A_i \sin\varphi_i}{\sum_{i=1}^{L} A_i \cos\varphi_i}\right), -\pi < \psi \le \pi. \tag{5}$$

Proof: Let $x_e(t)$ be denoted as a complex exponential function that is given by

$$x_e(t) = \sum_{i=1}^{L} A_i \exp(j\varphi_i) = B\exp(j\psi), \tag{6}$$

where B and ψ can be presented in terms of A_i and φ_i as shown in (4) and (5), respectively. For the computation of ψ, *atan2* function [1] is used to exactly locate the angle in any of the four quadrants in the complex plane. The ordinary *atan* function range is, however, $-\pi/2 < \psi \le \pi/2$ in contrast to the *atan2* function range of $-\pi < \psi \le \pi$. For the both cases of positive and negative angles in (6), let us define

$$x_{e^-}(t) = \sum_{i=1}^{L} A_i \exp(-j\varphi_i) = B\exp(-j\psi), \tag{7}$$

$$x_{e^+}(t) = \sum_{i=1}^{L} A_i \exp(j\varphi_i) = B\exp(j\psi). \tag{8}$$

Using (7), (8), and Euler's formula,

$$\begin{aligned}
&\sum_{i=1}^{L} A_i \cos(\omega t + \varphi_i) \\
&= \frac{1}{2}\exp(j\omega t)\underbrace{\sum_{i=1}^{L} A_i \exp(j\varphi_i)}_{x_{e^+}(t)} + \frac{1}{2}\exp(-j\omega t)\underbrace{\sum_{i=1}^{L} A_i \exp(-j\varphi_i)}_{x_{e^-}(t)} \\
&= \frac{1}{2}\exp(j\omega t)\underbrace{B\exp(j\psi)}_{x_{e^+}(t)} + \frac{1}{2}\exp(-j\omega t)\underbrace{B\exp(-j\psi)}_{x_{e^-}(t)} \\
&= \frac{B}{2}\left[\exp\{j(\omega t + \psi)\} + \exp\{-j(\omega t + \psi)\}\right] \\
&= B\cos(\omega t + \psi). \qquad \textit{Q.E.D.}
\end{aligned}$$

III. EXACT TONAL ANALYSIS ON POLYNOMIALS (ETAP)

By Demoivre's formula, the following power of cosine trigonometric identity has been derived [2, 3].

$$\cos^n\theta = \begin{cases} \dfrac{2}{2^n}\displaystyle\sum_{j=0}^{\frac{n-1}{2}}\binom{n}{j}\cos\left[(n-2j)\theta\right] & (n = \text{odd}), \\ \dfrac{1}{2^n}\dbinom{n}{n/2} + \dfrac{2}{2^n}\displaystyle\sum_{j=0}^{\frac{n}{2}-1}\binom{n}{j}\cos\left[(n-2j)\theta\right] & (n = \text{even}). \end{cases} \tag{9}$$

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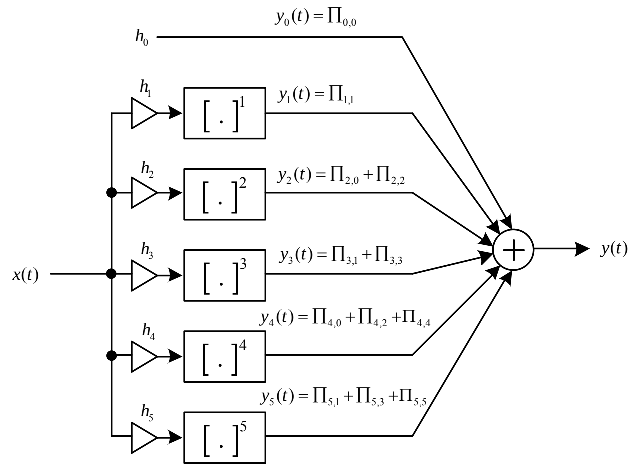

Fig. 1. Block diagram representation of (1) for the case of $Q = 5$. Each branch represents (10), where their respective algebraic expansions are described in (11) and (12).

Let us denote the output signal at the nth degree polynomial branch in Fig. 1 as follows:

$$y_n(t) = h_n\left[x(t)\right]^n = h_n\left[A\cos\left(\omega t+\varphi\right)\right]^n = \begin{cases} \sum_{k=1}^{n} \Pi_{n,k} & (n,k = \text{odd}), \\ \Pi_{n,0} + \sum_{k=2}^{n} \Pi_{n,k} & (n,k = \text{even}), \end{cases} \tag{10}$$

where

$$\Pi_{n,k} = \begin{cases} A_{n,k}\cos\left(k\omega t+\varphi_{n,k}\right), & \text{for } k \neq 0, \\ DC_{n,0}, & \text{for } k = 0, \end{cases} \tag{11}$$

By (9),

$$A_{n,k} = 2\left(A/2\right)^2 h_n \binom{n}{(n-k)/2}, \text{ and } \varphi_{n,k} = k\varphi \tag{12}$$

are amplitude and phase of the kth harmonic at the nth term of the polynomial, respectively. By (1) and (10),

$$y(t) = \sum_{n=0}^{Q} y_n(t) = \sum_{n=0}^{Q} \sum_{\substack{k\in\{1,3,\ldots,n\},n=\text{odd} \\ k\in\{0,2,\ldots,n\},n=\text{even}}} \Pi_{n,k}, \tag{13}$$

where $\Pi_{n,k}$ in (11) and (13) denotes the component generated at the n degree polynomial branch and k harmonic as illustrated in Fig. 1. When $\Pi_{n,k}$ s are placed in the checker box, as shown in Fig. 2, the checker-box triangle (CBT) pattern is emerged. By (13),

$$y(t) = \sum_{n}\sum_{k} \Pi_{n,k} = \sum_{k}\sum_{n} \Pi_{n,k}. \tag{14}$$

Thus, the component having the same frequency can be added together using (4) and (5). In pictorial representation (see Fig. 2), the components in CBT are added vertically using HAT. In symbolic representation,

$$\begin{aligned} y(t) &= \sum_{n=\text{even}} DC_{n,0} + \sum_{k>0}\sum_{n} A_{n,k}\cos\left(k\omega t+\varphi_{n,k}\right) \\ &= DC_0 + \sum_{k>0} B_k\cos\left(k\omega t+\psi_k\right). \end{aligned} \tag{15}$$

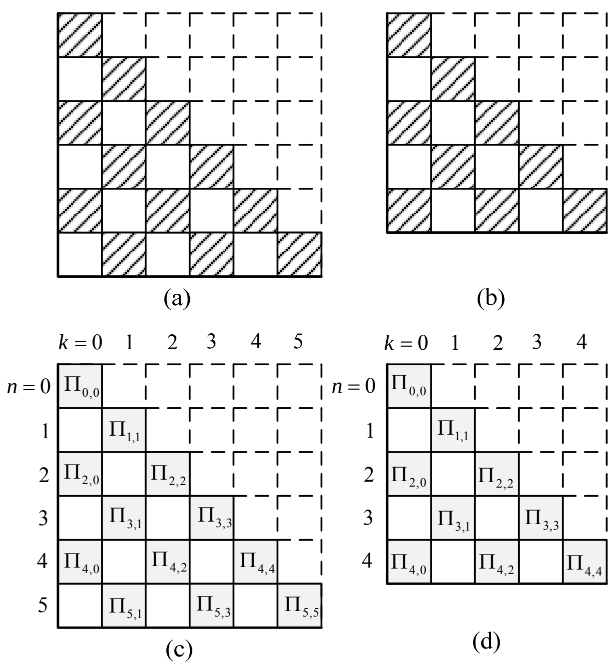

Fig. 2. Checker-box Triangle Pattern where each row and each column represent the component outputs from $y_n(t)$ and the generated harmonics with the exception of DC at $k = 0$, respectively. Sub-figures (a), and (c) illustrates the generated component fill-ups for the case of $Q = 5$, whereas (b), and (d) for $Q = 4$. The indices n and k denote the index of the coefficient of polynomial, which is equivalent to the index of $y_n(t)$ and harmonic number respectively. Note that the component is DC when $k = 0$.

As a computational example, let (2) with $A = 1$ and $\varphi = \pi/2$ is applied into $f(x) = 1.4214x - 0.7409x^3 + 0.3313x^5$. The output signal in (3) or (15) is obtained as

$$\begin{aligned} y(t) &= 1.7541\cos(\omega t+\pi/2) + 0.2590\cos(3\omega t-\pi/2) \\ &\quad + 0.0888\cos(5\omega t+\pi/2). \end{aligned}$$

IV. CONCLUSION

A technique to compute the harmonic amplitudes, phases, and DC components at the output of polynomial nonlinearity was developed.

REFERENCES

[1] S. Moritsugu and M. Matsumoto, “A note on the numerical evaluation of arctangent function,” *ACM SIGSAM Bulletin*, vol. 23, pp. 8-12, Jul. 1989.

[2] J. Wiener, “Integrals of $\cos^{2n} x$ and $\sin^{2n} x$,” *The College Mathematics Journal*, vol. 31, pp. 60-61, Jan. 2000.

[3] B. Wiener and J. Wiener, “Demoivre’s formula to the rescue,” *Missouri Journal of Mathematical Sciences*, vol. 13, pp. 1-9, Fall 2001.

Cloud QoS, High Availability & Service Security Issues with Solutions

Muhammad Zakarya, Izaz ur Rahman *and* Mukhtaj Khan

ABSTRACT:

Cloud Computing is a most recent and hottest buzzword nowadays, emerges as a key service of the Utility or On-demand computing [1] which builds on decade of research in the ground of computer networking, World Wide Web and software services. It put forwards a service oriented architecture, reduced information technology overhead for the end-user, enormous and huge flexibility and reduced total cost of ownership. Recent attacks on the clouds especially DDoS poses as a potential intimidation and danger to this key technology of the expectations and future. In this paper we are going to present a new Cloud Environment and Architecture and an Entropy based ADS approach to mitigate the DDoS attack which further improves network performance in terms of computation time, QoS and HA under Cloud computing environment SaaS, PaaS, IaaS and IT Foundation are four basic types of Cloud Computing [30, 31, 32].

Index Terms: Anomaly Detection System, Distributed, Denial of Service, High Availability, Quality of Service, Software as a Service, Platform as a Service, Infrastructure as a Service, Intrusion Detection System, Authentication Serve, Group Leader, Geographic Node, Internet Protocol, Geographical Authentication & Authorization Server,Load Balancing, Cloud Site

I. INTRODUCTION & CONCEPTS:

Computing is being changed and altered to a new model consisting of services that are commoditized and delivered in a style similar to conventional utilities such as water, gas, electricity, and telephony service. In such a model, customers access services based on their requirements without gaze at to where the services are hosted or how they are delivered. *Cloud computing* denotes the infrastructure as a "Cloud" from which businesses and customers are competent and capable to access applications from anywhere in the world using on demand techniques. CISCO Cloud architecture is shown in Fig 1. Depending on the category and kind of resources provided by the Cloud, different layers can be defined as IaaS, SaaS, PaaS and IT Foundation [1, 30]. All of these layers come with the promise to reduce first of all capital expenditures (CapEx) as well as operational expenditures (OpEx) in terms of reduced hardware, certificate & license and area management. In contrast, along with these benefits, Cloud Computing also raises rigorous and harsh concerns especially on the subject of the security of the cloud Computing Environment [30, 31].

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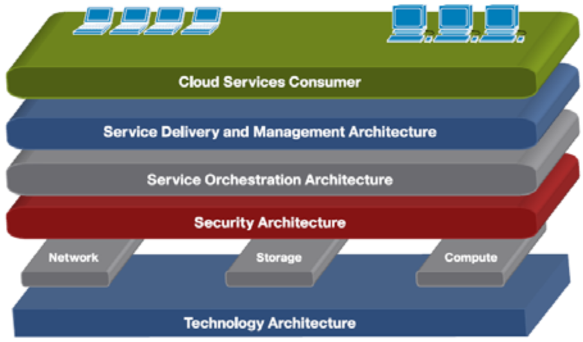

Fig.1. CISCO Cloud Architecture *[31]*

A. *High Availability in Cloud Systems*

Any system which is always available to its customers is HA. High availability of cloud system can be achieved, through implementing a lot of architectures. For example reduce congestion. It is difficult to achieve HA in today's global village because more services are required to customers. The more congested the network, more systems are offline to its customers. Considering TCP congestion scenario, where TCP drops all extra packets resulting in increased queuing delays. Therefore using traditional TCP congestion detection, avoidance mechanisms are not to achieve HA.

B. *QoS in Cloud computing environment*

We are trying to study different service level security issues in Cloud computing especially in wireless Cloud, and will try to propose new solutions to their security improvements. As service level security issues like DoS Attacks & Network Congestion, are most important. Solving these issues results in High Availability as well as. In high available systems, QoS services are expected from service providers.

C. *Security Issues & Problems*

As networks are coming common to layperson in computer technology, the need to provide good services to its customers at any time is essential. Cloud computing provides its services to its customers on need basis, means whenever, what is required must be provided. Therefore managing QoS and making the systems available, each and every time, to provide its services to Cloud users and customers, is a must. Although there is a obvious stipulate for in-depth conversation of security issues in Cloud Computing, the in progress surveys on Cloud security issues focus principally on data confidentiality, data protection and data privacy and discuss frequently organizational means to conquer these issues. Fig 2 shows security model for distributed environment.

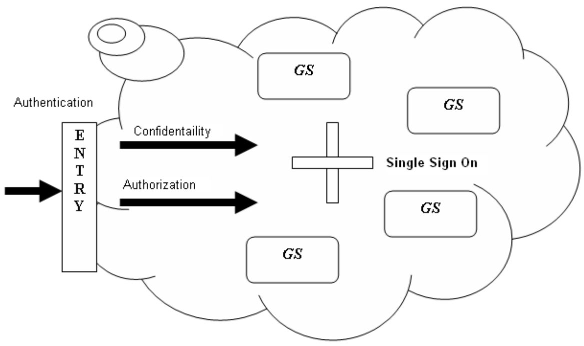

Fig. 2. Security model for Cloud Computing environment *[32]*

D. Distributed DoS Attack

DDoS attacks are launched by sending a large volume of packets to a target machine, using simultaneous cooperation of multiple hosts which are distributed throughout the Cloud computing environment. DDoS attacks on the Internet & especially on Cloud Computing has become an immediate problem in computer networks terminology. Gossip based DDoS attacks detection mechanism is used to detect such types of attacks in network, by exchanging traffic over line i.e. communication medium information. Mostly DDoS attacks are considered as congestion control problem. DDoS attacks are two phases attack. In first phase the attacker finds some vulnerable systems in the network. The attacker install some DDoS tools on these systems, also called zombies or agents. In second phase all zombies create the actual attack on the victim, as shown in figure 3 below [2].

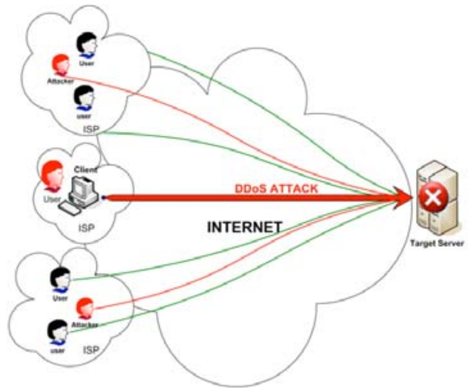

Fig .3. Attacker, Zombies and Victims *[29]*

E. IP Spoofing

Change of source address in the header of an IP packet is called IP Spoofing. It requires privileged access to network stack (raw socket access). A partial solution to IP Spoofing is to associate a fixed MAC address with each IP address in a subnet to detect spoofing.

The rest of paper is organized as follows. In section I we give some introduction, II is about related work. Section III, IV and V is about existing problem and proposed solution. IV describes statistical and simulation results. VII is about performance evaluation. We conclude in section VIII with challenges and future directions.

II. RELATED WORK & EXISTING TECHNIQUES:

In this section we discuss some existing mechanisms and techniques.

A. Ingress & Egress Filtering

Ingress & Egress filtering mechanism is shown diagrammatically in Fig 4 [10]. The firewall can easily drop that packet that is addressed for a node which is not present in its network. Similarly it has a check on those packets leaving the network. If source address is altered the firewall will drop the attack flow.

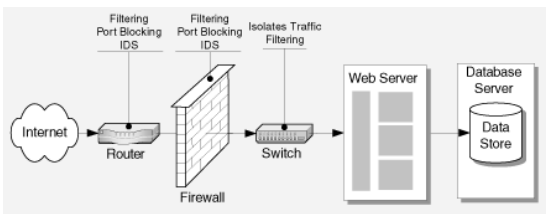

Fig.4. Ingress & egress filtering *[10]*

B. IP trace-back mechanism

In this technique the attacker is traced, by location. Actually without any mobility, it is some what easy, but when mobility is involved, the attacker cannot be traced easily.

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C. Moving Target Defense technique

A Band-Aid solution to a DDoS attack is to change the IP address of the victim computer, thereby invalidating the old address. The technique may work in some cases but administrators must make a series of changes to DNS entries, routing table entries etc.

D. Rate Limiting mechanism

Rate-limiting mechanisms compel a rate limit on a set of packets that have been characterized as nasty by the detection mechanism. It is a moderate response technique that is usually deployed when the detection mechanism has many false positives or cannot accurately illustrate the attack flow.

E. Traffic Shaping

A number of routers available in the bazaar today have features that permit you to limit the amount of bandwidth that some specific type of traffic can consume. This is occasionally referred to as "traffic shaping" technique [10].

F. Internet Protocol Version 6 (IPv6)

IPv.4 does not have any check or methods to authenticate whether the IP address i.e. source address, that the sender puts into an IPv.4 packet header field, is justifiable or not. As a result, the authentication of source IP address is to be anticipated to enhance and improve an Internet Security against current DoS attacks as shown in Fig 5 [10].

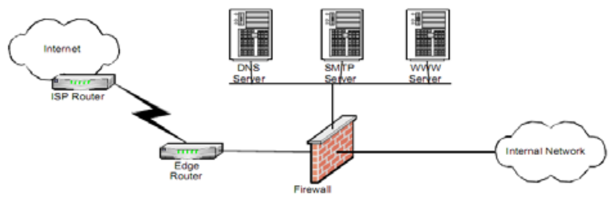

Fig.5. IP Version 6

G. Mutually Guarded Approach

In wireless communication medium, if a node-A (attacker) (masquerade itself as node-B), sends packets to node-C, where nodes A & B are in the same coverage area, then that packet will also be received by node-B. Therefore node-B will easily catch the attack. But if nodes B & C are in different coverage area or both nodes B & C are out of range to each other, in that scenario the attacker will successfully launch its attack, as shown in Fig 6.

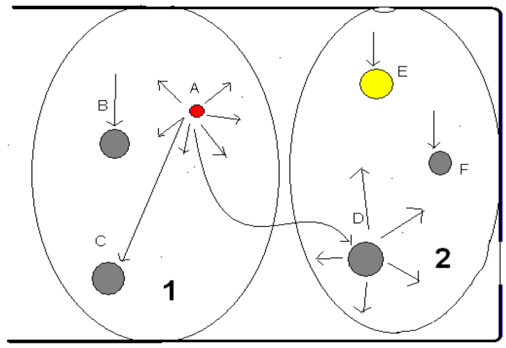

Fig.6. Mutually guarded approach *[32]*

III. EXISTING PROBLEM:

We are going to propose a DDoS detection and prevention mechanism, that has the beauty of being easy to adapt and more reliable than existing counterparts. As, in service level security issues DoS Attacks, DDoS & Network Congestion, are most important. Solving the issue of DDoS also results in High Availability as well as good QoS.

IV. PROPOSED SOLUTION:

After a deep study of available techniques, we are going to introduce new IDS, which can be implemented on our own proposed architecture, resulting in DDoS detection and prevention mechanism. We are giving the proposed solution and architecture to private clouds.

A. Proposed Architecture

In our proposed architecture, we have divided the whole Cloud System into regional areas i.e. GS, where each GS is protected by an AS /GL. Our developed ADS is installed on two places i.e. every Cloud Node & AS or on their respective routers. A packet which is detected as cruel once at AS, is marked out, so that Client node can be informed. In our proposed architecture (for future direction), DDoS source is detected for future prevention. A tree is maintained at every router, by marking every packet with path modification strategy, so that the victim is able to trace the sender of the packet. Any packet which was detected as malicious flow, can be confirmed in a second try i.e. confirmation process at GN i.e. victim node. In phase 1 we detect malicious flow, while in phase 2 we have a confirmation algorithm so either to drop the attack flow, or to pass it otherwise. In the given scenario, we consider that AS is configured properly for policed address i.e. the attacker node address or victim IP address.

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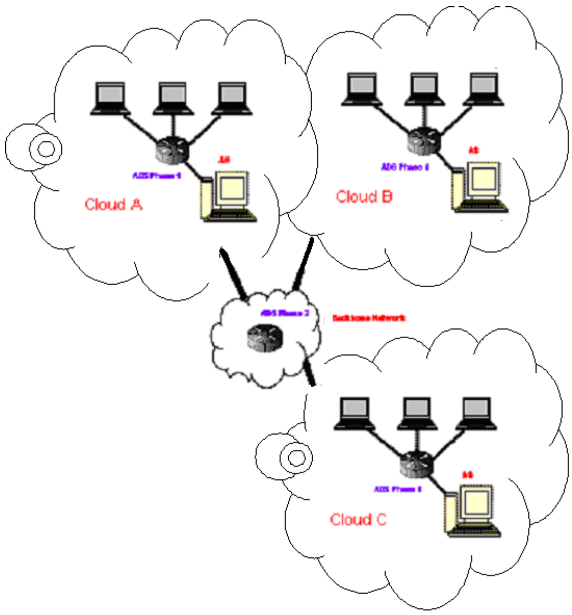

Fig.7. Proposed Cloud Architecture

- AS or GAS is responsible for controlling the geographical area where defined.
- Locally phase 1 is executed & at the core router phase 2 takes place.

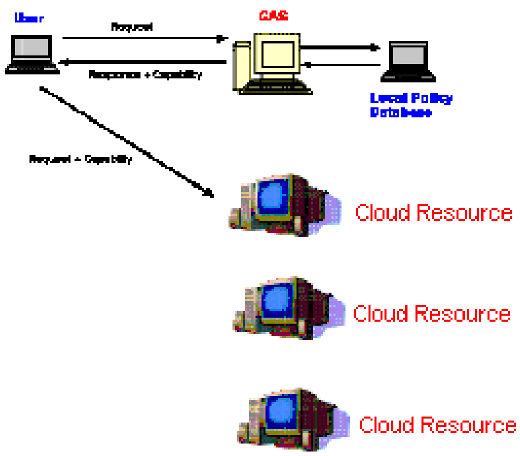

Fig.8. Working diagram of Proposed Cloud Architecture

PROS & CONS

- Local Security Policy
- Little computation involved as compared to Global security policy
- No overhead of extra packet
- User accesses GAS, hence fully authenticated & authorization check & balance
- Performance Scalability + LB + QoS
- No need for resources to check the user identity
- Local & Quick allocation of resources by GAS
- No Single point of failure, affects only a or some part of the Cloud environment
- GAS are required to inform all corresponding GAS in case of new node to any geographical society
- GAS is attacked by DDoS, not possible here
- Near to the source detection facility

B. *Intrusion Detection System*

IDS may be in software form and/or in hardware form, that will monitor the network for disbelieving activity and alerts the network administrator to take a particular action accordingly. Signature based IDS will observe packets on the network and judge against them to a database maintained with well-known threats. On the other hand, using an ADS, if deviation of user activity is exterior a certain threshold value, it is marked as nasty and a reaction is triggered. After a deep survey of DDoS detection & prevention mechanism we reach to the point that Entropy may be used as DDoS detection metric [32].

C. *Information Theory &Entropy based ADS*

According to [14], any statements that have some surprise and meaning are called information. Some consider that information theory is to be a subset of communication theory, but we consider it much more. The word entropy is rented from physics, in which entropy is a measure of the chaos of a group of particles i.e. 2^{nd} law of thermodynamics. If there are a number of possible messages, then each one can be expected to occur after certain fraction of time. This fraction is called the probability of the message. In [23], [24] Shannon proved that information content of a message is inversely related to its probability of occurrence. To summarize, the more unlikely a message is, the more information it contains. *In* [15], Entropy H(X) is given by

$$H(X) = -\sum_{x\in\mathcal{X}}^{n} p(x)\log p(x) \qquad (1)$$

The log is to the base 2 and entropy is expressed in bits. To say randomness is directly proportional to entropy i.e. more random they are, more entropy is there. The value of sample entropy lies between 0 and log(n). The entropy value is smaller when the class distribution belongs to only one & same class while entropy value is larger when the class distribution is more even. Therefore, comparing entropy values of some traffic feature to that of another traffic feature provides a mechanism for detecting changes in the randomness. We use traffic distribution like IP Address & application Port Number i.e. (IP address, Port). If we wants to calculate entropy of packets at a single or unique source i.e. destination, then maximum value of n must be 2^{32} for IPV4 address. Similarly if we want to gauge entropy at multiple application ports then value of n is the total number of ports [16]. In similar way, p(x) where x є X, is the probability that X takes the value x. We randomly examine X for a fix time window (w), then $p(x) = m_i/m$ Where, m_i is the total number we examine that X takes value x i.e

$$m = \sum_{i=1}^{n} mi \quad (2)$$

Putting these values in entropy equation 1, we get

$$H(X) = -\sum_{i=1}^{n} (m_i/m)\log(m_i/m) \quad (3)$$

Similarly, if we want to calculate the probability p(x), then m is the entire number of packets, but m_i is the number of packets with value x at destination as source [26]. Mathematically given as

$$P(x) = \frac{\text{Number of packets with } x_i \text{ as source (destination) address}}{\text{Total number of packets}} \quad (4)$$

Again if we want to calculate probability p(x) for each destination port, then

$$P(x) = \frac{\text{Number of packets with x as source (destination) port}}{\text{Total number of packets}} \quad (5)$$

Remember that total number of packets is the number of packets observed in a specific time slot (w). When this calculation finishes, normalized entropy is calculated to get the overall probability of the captured flow in a specific time window (w). Normalized Entropy is given by

$$\text{Normalized entropy} = (H / \log n_0) \quad (6)$$

Where n_o is the number of dissimilar values of x, in a specific time slot (w). During the attack, the attack flow dominates the whole traffic, resulting in decreased normalized entropy. To confirm our attack detection, again we have to calculate the entropy rate i.e. growth of entropy values for random variables, provided that the limit exists, and is given by

$$H(\chi) = \lim_{n\to\infty} \frac{1}{n} H(x_1, x_2 \ldots x_n) \quad (7)$$

V. PROPOSED ALGORITHMS:

DETECTION

- *Decide a threshold value δ_1*
- *On edge routers collect traffic flows for a specific time window (w)*
- *Find probability P(X) for each node packets*
- *Calculate link entropy of all active nodes separately*
- *Calculate H(X) for routers using Equation (1)*
- *Find normalized entropy using Equation (6)*

If normalized entropy < δ_1, identify malicious attack flow

CONFIRMATION

- *Decide a threshold value δ_2*
- *Calculate entropy rate on edge router using Equation (7)*
- *Compare entropy rates on that router, if =< δ_2, DDoS confirmed*
- *Drop the attack flow*

In this paper we have not considered confirmation algorithm for our mathematical & simulations study, as that is our next target. In Fig 9, the flow diagram for our proposed scheme is given.

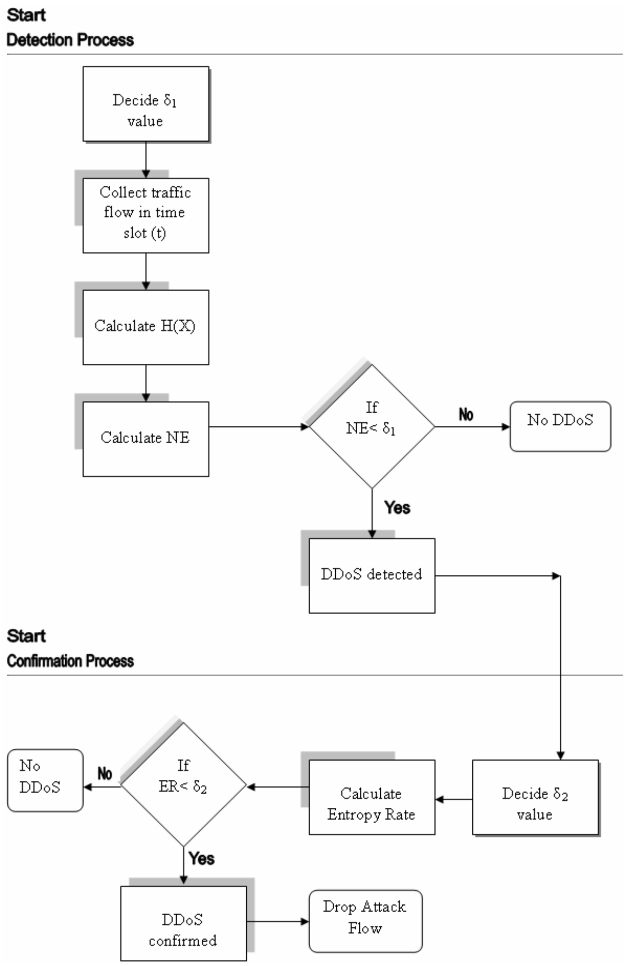

Fig 9 Flow / Transition Diagram *[32]*

VI. IMPLEMENTATION, SIMULATION & RESULTS:

In this section we describe that how to mathematically or statically implement our proposed scheme, while in section coming after that we have shown our simulation results along with charts form with a practical environment. We have used a Cloud Simulator i.e. CloudSim for testing our solutions. We run our proposed algorithms several time on the same system, on the basis of which we derived performance evaluation results. Here in this article we have shown only case 1.

A. Mathematical Proof

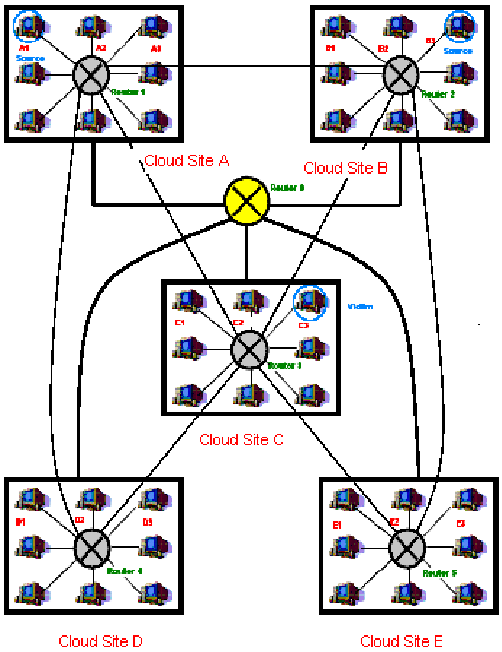

Fig.10. Environment for statistical study

Consider Fig 9, A1 and B3 are attack sources at different Cloud Sites, while C3 is the target victim machine. Router 1 will capture traffic flow coming from A1 and Router 2 will capture attack flow thrown by B3, for a specified time window (w). Suppose that we capture the following traffic flow at Router 1 and Router 2, shown in table 1 and table 2, table 3 and table 4 respectively.

TABLE 1: TRAFFIC AT ROUTER 1

Source node	Destination node	No of packets	Entropy
A1	C3	2	0.40
A2	B1	2	0.40
A3	B3	3	0.47
A4	E1	7	0.50

Therefore Router Entropy for Router 1 is 0.40 + 0.40 + 0.47 + 0.50 = 1.77 & as $\log_2 4 = \log 4/\log 2 = 2$ Hence NE is $1.77/\log_2 4 = 0.88$

TABLE 2: TRAFFIC AT ROUTER 2

Source node	Destination node	No of packets	Entropy
B1	D1	2	0.44
B2	A3	6	0.47
B3	C3	1	0.31
B4	E2	2	0.44

Therefore Router Entropy for Router 2 is 0.44 + 0.47 + 0.31 + 0.44 = 1.66 & as $\log_2 4 = \log 4/\log 2 = 2$ Hence NE is $1.66/\log_2 4 = 0.83$

TABLE 3: TRAFFIC AT ROUTER 4

Source node	Destination node	No of packets	Entropy
D1	A1	2	0.46
D2	A3	3	0.52
D3	E3	2	0.46
D4	C2	3	0.52

Therefore Router Entropy for Router 1 is 0.46 + 0.52 + 0.46 + 0.52 = 1.96 & as $\log_2 4 = \log 4/\log 2 = 2$ Hence NE is $1.96/\log_2 4 = 0.98$

TABLE 4: TRAFFIC AT ROUTER 5

Source node	Destination node	No of packets	Entropy
D1	C3	1	0.43
D2	C1	1	0.43
D3	D1	2	0.52
D4	A4	2	0.52

Therefore Router Entropy for Router 2 is 0.43 + 0.43 + 0.52 + 0.52 = 1.90 & as $\log_2 4 = \log 4/\log 2 = 2$ Hence NE is $1.90/\log_2 4 = 0.95$

We can see that as at both routers i.e. Router 1 and Router 2, routers entropy is lesser as only one flow conquered the whole bandwidth. As an outcome NE decreases. If we have a perfect threshold value δ, suppose 0.94 then our proposed ADS will consider flows coming from A1 (CS A) and B3 (CS B) as malicious flows, while Cloud Site D & Cloud Site E have entropy value greater than our considered threshold value 0.94, no attack is detected at these sites.

B. Simulations Study

1) Simulation Environment

CloudSim was used as a simulation environment, for testing the results of our proposed Idea. To simulate our proposed idea we have 5 users with 2 posers of DDoS attack, 3 routers and 3 resources containing any single victim node on the same time, as shown in Fig 11.

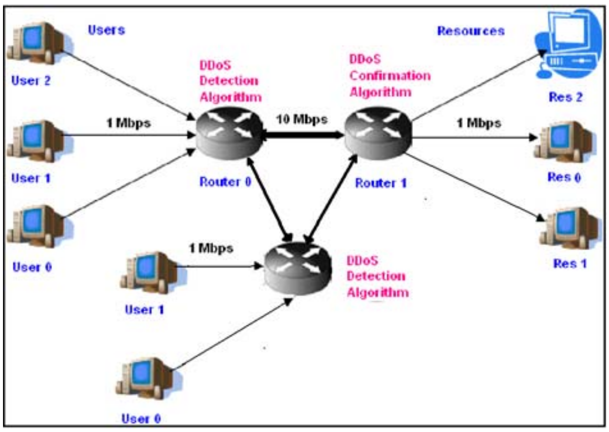

Fig.11. Environment for simulation study

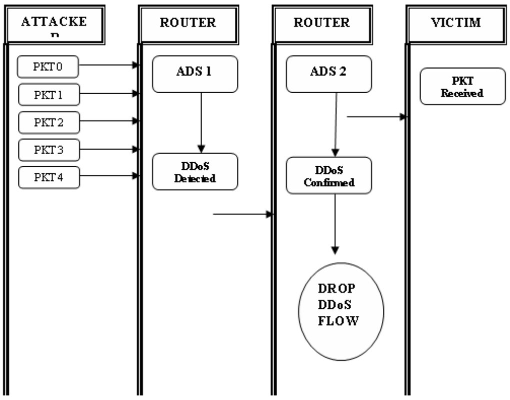

Fig.12. Transition Diagram [32]

Both routers are connected to each other over a 10 Mbps link, while all other connections are made at 1 Mbps link. Detection algorithm is implemented on router 0, while confirmation is supposed to be implemented on router 1. The process is show in state transition diagram given in Fig 12.

2) Simulation Results

In this section we consider only DDoS detection algorithm on router 0, not to confirm attack.

CASE 1:

TABLE 5: TRAFFIC AT ROUTER FOR USER_0

Destination node	Total No of packets	Probability	Entropy
Res_0	3	0.5	0.52
Res_1	2	0.2	0.46
Res_2	5	0.3	0.5

Therefore Router Entropy for Router 2 is 0.52 + 0.46 + 0.5 = 1.48 & as $\log_2 3 = \log 3/\log 2 = 1.58$

Hence Normalized Entropy is $1.48/\log_2 3 = 0.93$

TABLE 6: TRAFFIC AT ROUTER FOR USER_1

Source node	Total No of packets	Probability	Entropy
Res_0	3	0.3	0.52
Res_1	4	0.4	0.52
Res_2	3	0.3	0.52

Therefore Router Entropy for Router 2 is 0.52 + 0.52 + 0.52 = 1.57 & as $\log_2 3 = \log 3/\log 2 = 1.58$

Hence Normalized Entropy is $1.57/\log_2 3 = 0.99$

TABLE 7: TRAFFIC AT ROUTER FOR USER_2

Source node	Total No of packets	Probability	Entropy
Res_0	0	0.0	0.0
Res_1	3	0.3	0.52
Res_2	7	0.7	0.36

Therefore Router Entropy for Router 2 is 0.0 + 0.52 + 0.36 = 0.88 & as $\log_2 2 = \log 2/\log 2 = 1$

Hence Normalized Entropy is $0.88/\log_2 2 = 0.88$

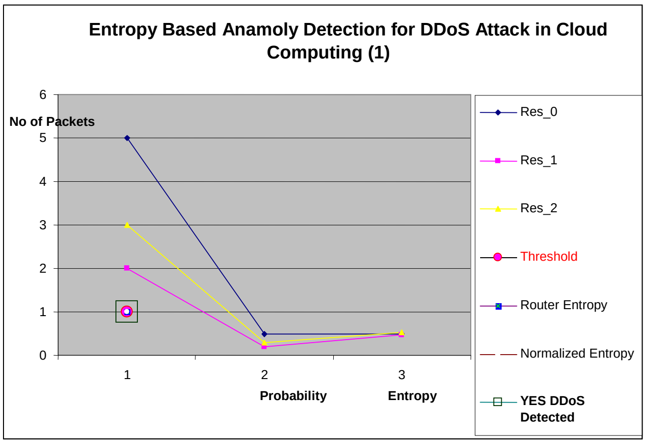

Fig.13. Simulation results (Case 1)

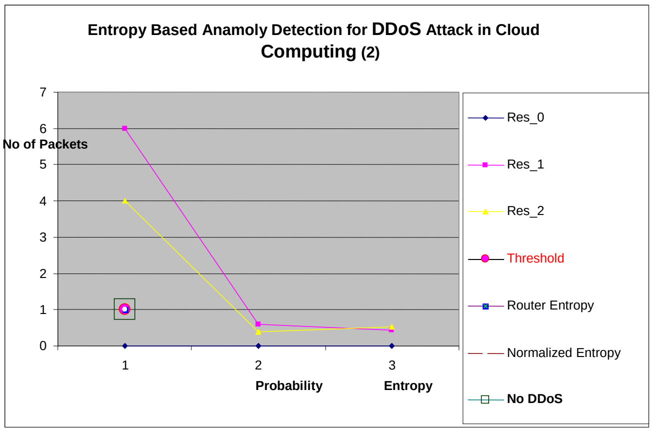

Fig.14. Simulation results (Case 2)

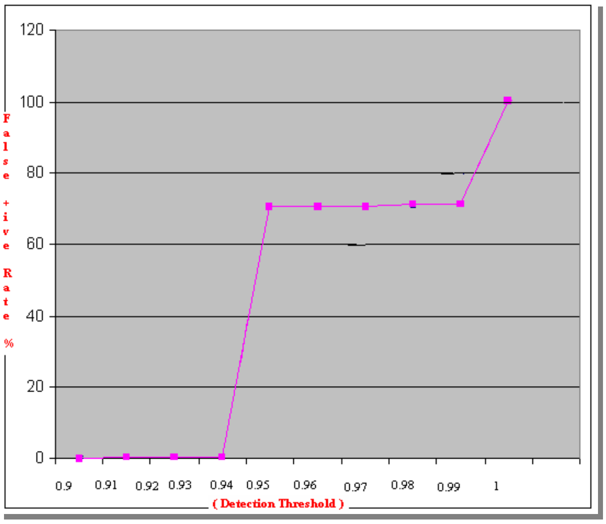

Fig.16. DDoS false positive rate

VII. PERFORMANCE EVALUATION:

Our ADS can detect 100% DDoS attack only in case of good threshold value, which is one of the most challenging tasks in developing any ADS. We conclude our story that a threshold value of 0.94 results in good detection rate. A value greater than 0.94, results in good detection rate i.e. 100 % DDoS detection but generate more false positive alarms, as the value is increased from 0.94 to 1.0. The reports are shown in figure 14 and figure 15, are self explanatory.

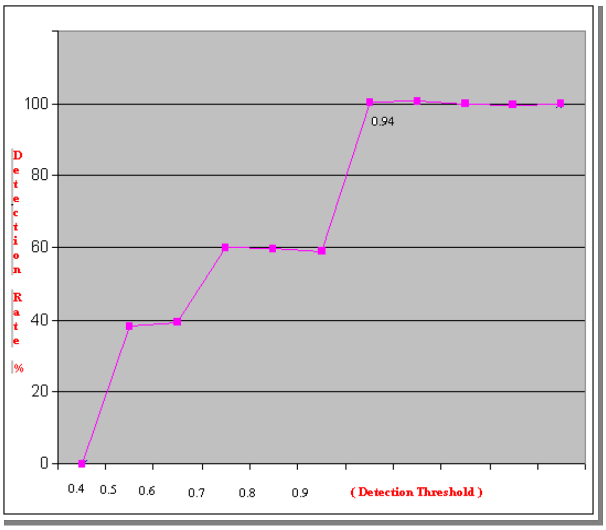

Fig. 15. DDoS detection rate

VIII. CONCLUSION

In this paper, we have proposed a new architecture for Cloud On-Demand Computing platform, where the whole Cloud System is divided into numerous administrative domains, which are controlled independently by its own Authentication & Certification Authority i.e. AS. We also introduced an ADS for detection & early prevention of DDoS attacks in our proposed architecture. In future the proposed design and suggestion may be actually implemented over Cloud computing platform to precisely detect DDoS attacks. The idea may also be extended for recovery mechanism for DDoS attacks. Following are some major challenges which might be addressed for further enhancement by researchers and scholars.

- *In case of huge network access separating legitimate flows from attack flows is a challenging task; our next task is to confirm the dropping of only attack packet.*
- *what about different mathematical functions when used for creating attack packets*
- *In case of Huge network access separating legitimate flows from attack flows is a challenging task*

ACKNOWLEDGMENT

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REFERENCES

[1] B. Jacob, Michael Brown, Kentaro Fukui, Nihar Trivedi, "Introduction to Grid Computing", 2005

[2] K. Samad, Ejaz Ahmed, Riaz A. Shaikh, Ahmad Ali Iqbal, "Analysis of DDoS attacks & defence mechanisms", 2005

[3] Hang Chau, "Network Security – Mydoom, Doomjuice, Win32/Doomjuice Worms and DoS/DDoS Attacks", USA

[4] Puneet Zaroo, "A Survey of DDoS attacks and some DDoS defence mechanisms", Advanced Information Assurance (CS 626).

[5] S. M. Specht, Ruby B. Lee, "Distributed Denial of Service : Taxonomies of Attacks, Tools and Countermeasures", September 2004

[6] Yu Chen, Kai Hwang, Wei-Shinn Ku, "Distributed Change point Detection of DDoS Attacks: Experimental Results on DETER Testbed", 2007

[7] Preeti, Yogesh Chaba, Yudhvir Singh, "Review of Detection and Prevention Policies for Distributed Denial of Service Attack in MANET", March 2008

[8] S. Meenakshi, Dr.S.K.Srivatsa, "A Comprehensive Mechanism to reduce the detection time of SYN Flooding Attack", 2009

[9] Bryan Parno, Zongwei Zhou, Adrian Perrig, "Don't Talk to Zombies: Mitigating DDoS Attacks via Attestation", June 2009

[10] K. Meintanis, Brian Bedingfield, Hyoseon Kim, "The Detection & Defense of DDoS Attack", University of Texas

[11] A. Lakhina, M. Crovella, and C. Diot., "Diagnosing Network-Wide Traffic Anomalies, ACM SIGCOMM Computer Communication Review", Portland, 2004

[12] L. Feinstein, D. Schnackenberg, R. Balupari, and D. Kindred, "Statistical approaches to DDoS attack detection and response", 2003

[13] W. Lee, D. Xiang, "Information-theoretic measures for anomaly Detection", IEEE, 2001

[14] David Applebaum, "Probability and Information (An Integrated Approach)", Cambridge University Press, 2008

[15] M. Thomas Cover, Joy A. Thomas, "Elements of Information Theory", Second Edition, 2006

[16] Dennis Arturo Ludeña Romaña, Yasuo Musashi, "Entropy Based Analysis of DNS Query Traffic in the Campus Network", Japan

[17] R. Buyya, Manzur Murshed, "GridSim: a toolkit for the modeling and simulation of distributed resource management and scheduling for Grid computing", 2002

[18] Anthony Sulistio, Gokul Poduval, Rajkumar Buyya, Chen-Kong Tham, "Constructing A Grid Simulation with Differentiated Network Service using GridSim", University of Melbourne, Australia

[19] M. Murshed, Rajkumar Buyya, "Using the GridSim Toolkit for Enabling Grid Computing Education", Monash University, Australia

[20] Anthony Sulistio, Uros Cibej, Srikumar Venugopal, Borut Robic, Rajkumar Buyya, "A toolkit for modelling and simulating data Grids: an extension to GridSim", March 2008

[21] Anthony Sulistio, Chee Shin Yeo, Rajkumar Buyya, "Visual Modeler for Grid Modeling and Simulation (GridSim) Toolkit", 2003

[22] Microsoft Encarta Encyclopedia, 2009

[23] E. Claude Shannon, "A Mathematical Theory of Communication", 1948

[24] E. Claude Shannon, "Communication Theory of Secrecy Systems", 1949

[25] Yi-Chi Wu, Wuu Yang, Rong-Horg Jan, "DDoS Detection and Trace-back with Decision Tree and Gray Relational Analysis", National Chiao Tung University, Taiwan.

[26] George Nychis, "An Empirical Evaluation of Entropy-based Anomaly Detection", May 2007

[27] Point of View White Paper for U.S. Public Sector, "Cisco Cloud Computing Data Center Strategy, Architecture, and Solutions", 1st Edition

[28] CloudSim documentation for programming and simulations

[29] D. Angelos Keromytis, "Denial of Service Attacks and Resilient Overlay Networks", Columbia University

[30] R. Buyya, CheeShinYeo, SrikumarVenugopal, JamesBroberg, IvonaBrandic, "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility", 2008 Elsevier B.V. All rights reserved

[31] R. Buyya, Suraj Pandey and Christian Vecchiola, "Cloudbus Toolkit for Market-Oriented Cloud Computing", M.G. Jaatun, G. Zhao, and C. Rong (Eds.): CloudCom 2009, LNCS 5931, pp. 24–44, 2009. © Springer-Verlag Berlin Heidelberg 2009

[32] Muhammad Zakarya, Ayaz Ali Khan, Hameed Hussain, "Grid High Availability & Service Security Issues with Solutions", ICIIT 2010, 978-1-4244-813 8-5/10 / $ 26.00 C 2010 IEEE

ERROR CONFIGURATIONS IN BIT PATTERNS OF COMPRESSED DIGITAL SPEECH BASED ON CASCADED APPROACH

Nazish Nawaz Hussaini , Asadullah Shah , Abdul Wahab Ansari

Abstract :
The research challenges in digital speech processing remain in the traditionally identified area like speech compression. The main purpose to compress speech is to reduce the load of voice traffic for transmission, maintaining the quality of speech. In the initial stage of proposed research a cascaded approach is designed to reduce the bit rate and to the maintain speech quality. This coding technique is developed upon a PCM coded speech by dropping few of the least significant bits (LSB) of every byte and randomly substituting these dropped bits at the decoding end from their respective fixed Codebooks. To analyze the speech quality Mean Opinion Score is conducted, which is a subjective quality analysis. Experiments are conducted to refine the strategy by configuring the LSB bits after substitutions from their respective fixed codebooks but of reduced sizes. It is observed that as the codebooks containing the less number of bit patterns with lesser numeric values like 0 and 1, when substituted, their bytes have no changes in the valuable least significant bits.

Index Terms: Least Significant Bits, Bit Configurations, Fixed Codebook, Mean opinion Score

I. INTRODUCTION

Compression techniques are developed to cope with the problems of limited memory, and deal with bandwidth requirements. A telephonic speech is specified in International Telecommunication Union as standard G.711, producing 64Kbps speech [1]. G.711 is pulse code modulation (PCM) standard produces output at 64 kilobits per second (Kbps) [2]. Differential PCM encodes the differences of PCM values; this type of encoding reduces to the number of bits required to store a sample of about 25% lesser as compared to PCM [3]. Adaptive Differential PCM (ADPCM) is defined in ITU−T G.726 standard. ADPCM sets the level for quantization to the size of the input difference signal at a bit rate reduced to 32 kbps for voice transmission [4]. Most widely used speech coding algorithm proposed yet is Code Excited Linear Prediction and its variations, these are providing significantly better quality of speech than other low bit-rate algorithms [5].

CELP coding scheme is described in federal standard 1016, providing good quality, at 4.8 Kbits per second, some of its variants are like G. 723.1 CELP based, at 5.3 and 6.4 Kbits/sec and G.729 CELP based, at 8 Kbps [6].

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II. LITERATURE REVIEW

The progress of multimedia depends on the solution of technical problems of encoding, storage, transmission, distribution, security and privacy, recognition, understanding, indexing and searching, also subjective quality analysis of multimedia material. An appropriate model of source produces effective transformation of an input stream to an output stream. Performance evaluation of compression algorithms includes metrics like efficiency, compression ratio, bit rate achieved after compression, percentage of compression, scale of perception like MOS and others. Speech can be compressed in telephones with A-law or u-law, with a reduced bit rate of 64kbps. Speech compression can be achieved through parametric or source method like CELP, Waveform method like ADPCM, producing compression rates above 32 kbps. Wavelet and fractal coding are examples of transform method, producing compression rates 2.4kbps or even lower. Code Excited Linear Predictive (CELP) is one of the better compression schemes belonging to parametric scheme and compress speech to 4.8 kbps [8].

Compression systems like CELP, VSELP, GSM 06.10 and Artificial Neural Networks ANN, focus on the fact of voiced and unvoiced sounds. The main cause is the speaker dependency that hinders the standardization of new voice compression systems [9]. Another proposed technique uses lossy compression algorithm that consider perceptual and rate distortion criteria. The achiever bit rate is 54 to 64 kbps. The decoder implements this algorithm effectively in real time [10].

It is analyzed in a research on protecting real time speech signal over Internet, (based on Forward Error Correction) that the performance of G.729 decoder fails to cover up the loss of voiced and unvoiced frames at an unvoiced/voiced transition. The impact of frame loss within a speech signal on the quality and gained the knowledge that the "loss of voiced frames at the beginning segment leads to a significant degradation in speech quality while the loss of other frames covered up well by the G.729 decoder's concealment algorithm" [13]. A research on "Digitizing

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Speech Recordings for Archival Purposes", described digitizing speech recordings for archival purpose. Analyzing frequency response, dynamic range, noise, psychoacoustic and perceptual quality, spectral evaluation of recordings was used to develop digitization best practices. Digitization with sampling rate: 96KHz; on 24-bits; The WAV file format is recommended for speech recordings and are easy to process into a variety of streaming formats [5].

An approach used for the digital speech is to drop 3 least significant bits from every byte at the source end, and substitute randomly the dropped bits at the destination end, from the respective codebook. The codebook for the substitution of 3 dropped bits is of 2^3=8 bit patterns size [14].The research is also carried out on Sindhi and Urdu languages to compare the speech quality of both languages after compression [15]. The strategy [14] is then refined by reducing the codebook size or splitting the codebooks in two equal halves. Byte errors are analyzed to observe error free and error occurring bytes [16].

This refined strategy is further explored to see the impact on each and every byte of digital speech. Bytes after substitution of 3 bits are checked to know the number of changed bits. Bits are configured to see whether out of 3 substituted bits, mostly how many bytes are having changes in their 0th bit only, or changes occurred in 1^{st} bit or 2^{nd} bit individually. Configuration of bits also evaluates the bytes having changes occurred only in 0^{th} and 1^{st} bit, 0^{th} and 2^{nd} bit, 1^{st} and 2^{nd} bit i.e., changes in consecutive bits. This strategy focuses on the bytes having no changes in their least significant bits too i.e.; before and after substitutions they remain same or the bytes after substitution changed totally i.e.; all substituted bit are change bits.

Bit errors occurred in each byte of the .pcm speech from the codebooks of original size and reduced sizes in the refined strategy are shown in Fig-2.1 shows an abstraction for the 3 bit substituted bytes:

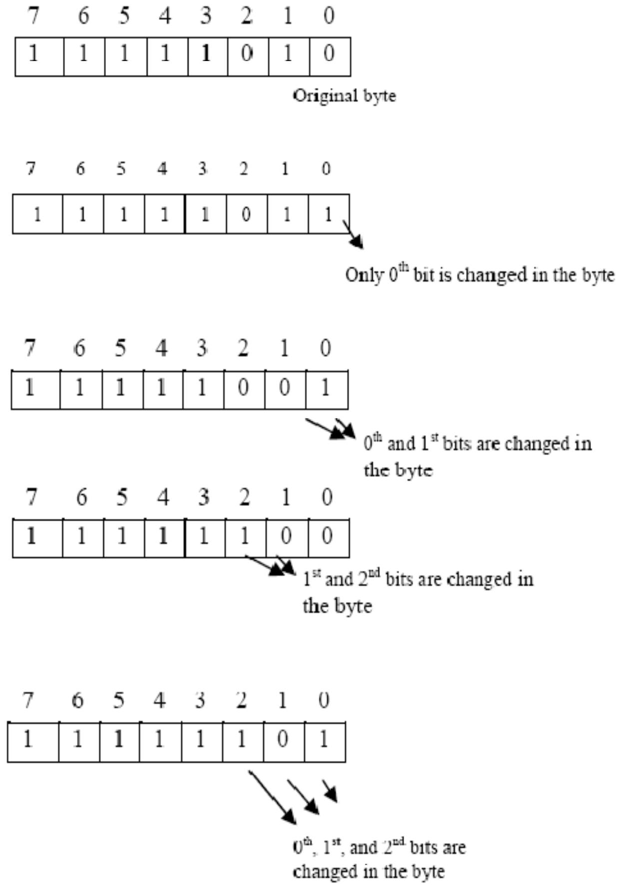

Fig: 2.1. Abstraction for the 3 bit substituted bytes

A. *Codebook containing 8 bit patterns*

The Codebook of 8 bit patterns size is used in the first experiment (with respect to 3 dropped bits) i.e., {0,1,2,3,4,5,6,7} or {000, 001, 010, 011, 100, 101, 110, 111}. When bit patterns are picked randomly from that codebook and substituted as least significant bits at the destination end, then it is observed that in all the bytes of the compressed speech file, various bytes are having 50% changes in their 0th, 1st, and 2^{nd} least significant bits respectively.

The file named as F8 (created with codebook of 8 bit patterns size), and the bit configurations are shown in table-2.1. In this experiment F8-file compressed after substituting 8 bit patterns, scored 4.22 MOS (Mean Opinion Score) out of 5.

B. *Codebooks containing 4 bit patterns*

In the second experiment the Codebook when reduced to two halves, then the first half at left hand side contains 4 bit patterns {0,1,2,3} and the second half at right hand side contains rest of other 4 bit patterns {4,5,6,7}. The compressed speech files with respect to the corresponding codebooks are named as FL48 (File substituted with codebook of 4 bit patterns from the left side values) and FR48 (File substituted with codebook of 4 bit patterns from the right side values).

After substitution of these patterns having lesser numeric values to all the bytes, various bytes are having 50% changes in their 2^{nd} least significant bits respectively i.e., 0^{th} and 1^{st} bit out of 3 least significant bits and 2^{nd} bit of these bytes remained unchanged at the decoding end. The Codebook containing rest of other 4 bit patterns {4,5,6,7}, when substituted as the 3 least significant bits, 50% various bytes found error occurring in their 0^{th} and 1^{st} least significant bit respectively while all the 100% bytes contain error in their 2^{nd} least significant bit at the decoding end. See the bit configurations in table-2.1. As the bit configuration status proceeds change in the bit causes more noticeable error.

. In this experiment FL48-file compressed with the respective 4 bit patterns at left side (lesser numeric values) scored 3.99 and FR48-file compressed with the respective 4 bit patterns at Right side (greater numeric values) scored 3.5 out of 5.

C. Codebooks containing 2 bit patterns

In the third experiment, the Codebooks containing 2 bit patterns each {0,1},{2,3},{4,5},{6,7} named as FLL28, FLR28, FRL28, and FRR28.

After substitution it is observed that from these four fixed reduced codebooks the codebook having {0,1} bit patterns gives better results to listeners and from all the bytes, 50% bytes are having changes in their 0^{th} least significant bit only and no changes found in their other bits, also rest of 50% Bytes found error free. See the bit configurations for this and rest of files in table-2.1. The codebook containing {2,3} bit patterns having 0^{th} least significant bit changes in 50% various bytes while 100% bytes found error in 1^{st} least significant bit, but the 2^{nd} least significant bit of all the bytes of the speech file remained same at the decoding end.

The codebook having {4,5} bit patterns made changes in 50% various bytes in their 0^{th} bit from all the bytes while 100% bytes found change in their 2^{nd} least significant bit, it is observed that 1^{st} bit of all the bytes of the speech file remained as they were before substitution. The codebook having {6, 7} bit patterns caused changes in all the 100% bytes in their 0^{th}, 1^{st} , and 2^{nd} bits of the speech file after substitution.

. In this experiment the files having 2 bit patterns each as codebooks to substitute are FLL28, FLR28, FRL28, and FRR28. These contains {0,1},{2,3},{4,5},{6,7} bit patterns, the MOS scored is 4.22, 4.10,4.10, 3.45 out of 5 respectively.

III. RESULTS AND DISCUSSIONS

Our proposed research work is based on simple strategy to compress data and can compete to the standard coding schemes. The approach drops 3 least significant bits in different experimentations and substitutes these bits with their respective codebooks. The refined strategy uses codebooks of reduced sizes. The strategy also focuses on the codebook sizes and

also values of the bit patterns they have. On substituting 3 least significant bits with 3 bit patterns out of 8 patterns, very good speech quality is achieved with 37.5% compression. The research work also focused on bit configurations i.e., changes in a byte with respect to their 0^{th} , 1^{st} , and 2^{nd} least significant bits for 3 bits substitutions. It is concluded that codebooks of reduced sizes having less number (values) of bit patterns with numeric values like 0 and 1, when substituted, 50% of bytes found unchanged after substitutions.

Table-2.1. Bit Error Configurations after 3 Bit Substitutions Radio recorded Speech

Compressed files (After 3 bit substitution)		**Bit Error Configurations**					
		0^{th} Bit		1^{st} Bit		2^{nd} Bit	
File Name	**Bit Patterns**	No. of Bytes	Error %	No. of Bytes	Error %	No. of Bytes	Error %
F8	{0,1,2,3,4,5, 6,7};	40018	49.80	40082	49.88	40237	50.07
FL48	{0,1,2,3};	40309	50.16	40016	49.80	0	0.00
FR48	{4,5,6,7};	40150	49.97	40257	50.10	80355	100.00
FLL28	{0,1};	40101	49.90	0	0.00	0	0.00
FLR28	{2,3};	40324	50.18	80355	100.00	0	0.00
FRL28	{4,5};	40153	49.97	0	0.00	80355	100.00
FRR28	{6,7};	40179	50.00	80355	100.00	80355	100.00

REFERENCES

[1] http://en.wikipedia.org/wiki/G.711, August 17, 2007.
[2] http://whatis.techtarget.com/definition/0,,sid9_gci1251936 00.html Apr26, 2007.
[3] http://en.wikipedia.org/wiki/Pulse-code_modulation, 19 August 2007.
[4] http://www.cisco.com/warp/public/788/signalling/ waveform_coding.html, Feb 02, 2006.
[5] http://en.wikipedia.org/wiki/CELP, 30 June 2007.
[6] http://www.otolith.com/otolith/olt/lpc.html, October 95
[7] Shijo M Joseph, Firoz Shah A, Babu Anto P, Spoken Digit Compression: A Comparative Study between Discrete Wavelet Transforms and Linear Predictive Coding, International Journal of Computer Applications (0975 – 8887), Volume 6– No.6, September 2010.
[8] W. Kinser, Compression and its Metrics for Multimedia, Proceedings of the First IEEE International Conference on Cognitive Informatics (ICCI'02).
[9] Javeir Bustos and Alejandro Bassi, Voice Compression Systems for Wireless Telephony, XXI International Conference of the Chilean Computer Science Society (SCCC'01), pp. 0041, November 2001.
[10] Rodrigo Capobianco Guido, Lucimar Sasso Vieira, Fabrycio Lopes Sanchez, Jan Frans Willem Slaets, Lyrio Onofre Almeida, Adilson Gonzaga, Marcelo Bianchi , A Matched FIR (Finite Impulse Response) Filter Bank for Audio Coding, pp. 796-801, Proceedings of the Seventh IEEE International Symposium on Multimedia (ISM'05).
[11] J Light, Performance Analysis of Audio Codecs over Real-Time Transmission Protocol (RTP) for Voice Services over Internet protocol, Proceedings of the Second Annual Conference on Communication Networks and Services Research (CNSR'04).
[12] http://whatis.techtarget.com/definition/0,,sid9_gci896692,%20% 2000.html, Apr 03, 2007.
[13] Henning Sanneck and Nguyen Tuong Long Le, Speech Property-Based FEC for Internet Telephony Applications, to appear in Proceedings of the SPIE/ACM SIGMM Multimedia Computing and Networking Conference 2000 (MMCN 2000), San Jose, CA, January 2000.
[14] Nazish nawaz Hussaini and Prof. Dr. Asadullah Shah, "Binary codebook Based Digital Speech Compression", SZABIST Journal of Independent Studies and Research, Vol. 5, No. 2, July 2007.
[15] Nazish nawaz Hussaini and Prof. Dr. Asadullah Shah, "Affects upon Urdu and Sindhi Language Perceptions Using Codebook Based Digital Speech Compression", proceedings of Shaikh Ayaz International conference on Language and Literature, Sindh University, Jamshoro, January 2007.
[16] Nazish nawaz Hussaini and Prof. Dr. Asadullah Shah, "Byte Error Analysis Based on Cascaded Approach for Digital Speech Compression", Bahria University Journal of Information and Communication Technology (BUJICT)-Karachi, Vol. 2, Issue I, ISSN 19994974, December 2009.

Microstrip Patch Antennas for Microwave S band, C band and X band Applications

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Abstract:

Advantages of Microstrip patch antennas make them solid candidate for the field of communication in Microwave application. This paper consists of Microstrip patch antennas with complete mathematical calculations, Simulation results and the relevant antenna applications on the operating frequencies. These designed antennas have frequency ranges in Microwave S band, C band and X band. S band cover the frequencies of 2 GHz, 3 GHz and 3.5 GHz. C band cover the frequencies of 6GHz, 7GHz. X band cover the frequencies of 8GHz and 9 GHz. These antenna simulations performed by using Ansoft HFSS TM V10.0. Simulation results are presented in terms of Resonant Frequency Return Loss, VSWR, Radiation Pattern and the antenna Gain. Microstrip patch antennas have wide range of applications, however here in this paper following applications are presented. WLL, WiMAX, Satellite Communication and Marine Radar Communication (SART).

Index Terms: **SART, WiMAX, Satellite Communication, Microstrip Patch Antenna**

1. Introduction:

In high performance applications like Unmanned Aircraft, Radar Systems, Satellite Communication Systems, WLAN, WiMAX, missile, Mobile Radio and Wireless Communication Systems size, cost, weight, ease of fabrication, ease of installation offer constraints. Microstrip patch antenna can perform well in Microwave applications as particular of interest like in Satellite Communication (FSS) and Marine Radar Communication (SART).

The increasing popularity of indoor wireless LAN capable of high speed transfer rate is prompting the development of efficient antennas. Due to increased usage in residential and office areas, these systems are required to be Low Profile, Aesthetically pleasing and Low Cost as well as Highly effective and efficient. Microstrip patch antennas are well suited for wireless LAN application systems due to their Versatility, Conformability, Low Cost and Low Sensitivity to manufacturing tolerances. Recently importance has been placed upon creating patch antennas that show broadband properties and capable of high speed data transfer.

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Microstrip antennas are small structures, used in external public switched network (PSTN), to collect or radiate electromagnetic wave. Most people require an antenna that can stand up to daily abuse and still keep reception when connected to the network. 3 to 3.6 GHz is the frequency band used in the WLL technology. Wireless local loop (WLL) sometimes called radio in the loop, or fixed-radio access (FRA), uses public switched telephone Network (PSTN) to connect subscribers using radio signal instead of copper wire for all or part of the connection. In rural telephony WLL uses the 3 to 3.6 frequency band.

WiMAX (Worldwide Interoperability for Microwave Access) is a wireless digital Communications System, also known as IEEE 802.16, that is intended for wireless "Metropolitan Area Networks" (MAN). WiMAX can provide Broadband Wireless Access (BWA) up to 30 miles (50 km) for fixed stations, and 3 - 10 miles (5 - 15 km) for mobile stations. WiMAX has three allocated frequency bands called low band, middle band and high band. The low band has frequency from 2.5 GHz to 2.8 GHz, the middle band has frequency from 3.2 GHz to 3.8 GHz and the high band has frequency from 5.2GHz to 5.8 GHz. Due to the advantages of Microstrip Patch Antenna such as low weight, low profile planar configuration, low fabrication costs and capability to integrate with microwave integrated circuits technology, the Microstrip Patch Antenna is very well suited for applications such as wireless communications system, cellular phones, pagers, radar systems, and satellite communications systems, so here we use middle band frequency that is 3.5GHz resonant frequency (the main reason is that in Pakistan WiMAX operates on 3.5GHz frequency), we will design Square Microstrip Patch Antenna using probe feed technique for WiMAX application.

A wideband slotted circularly polarized patch antenna is used for 5-6 GHz WLAN Applications. Circularly polarized antennas are receiving much attension these days due to their increasing importance in commercial and defense Wireless Communication Applications. These include Low-Earth-Orbit (LEO) and Medium-Earth Orbit(MEO) Satellite Communication as well as Wireless Local Area Network(WLAN)Applications.

TheUltra-WideBand (UWB) antennas have been widely adopted in communication systems of commercial and military domains. Because of the attractive feathers,such as low cost, small size, and easy fabrication.7Ghz can be used

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SART stands for "Search And Rescue Transponders" also known as "Search And Rescue radar Transponders" which used for the locating of vessels in distress or of their survival craft. A SART has a receiver that detects the signals from X-band radars (9.2 - 9.5 GHz). If the SART detects a signal it immediately transmits twelve pulses on the same frequency these pulses detected on the radar screen, by using these dots or signals location of the life boat or marine can easily detected[1], [2][3].

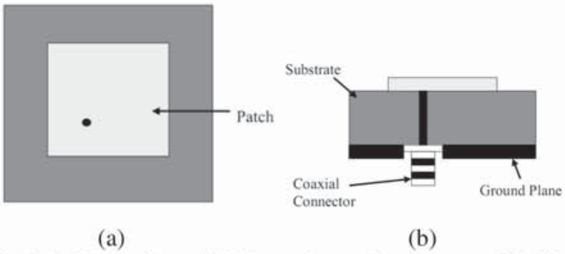
A Microstrip antenna has a dielectric substrate having a radiating patch on one side and a ground plane on the other side. The EM waves fringe off the top patch into the substrate and are radiated out into the air after reflecting off the ground plane, EM waves change their direction according to the input signal cycle. The feed of Microstrip antenna can have many configurations like Microstrip line, coaxial, aperture coupling and proximity. Of the four feeding techniques, Microstrip line and coaxial are relatively easier to fabricate. However, Microstrip line limits the bandwidth to 2 to 5% as spurious radiations increase with the increase in substrate thickness [5]. Therefore, coaxial feed is used for feeding Microstrip antenna. However, coaxial feed and antenna matching is required as antenna input differs from 50 ohm. The analysis and design of Microstrip antenna can be carried out using different techniques and models. The most popular one are transmission line, cavity and full wave [5]. The design of Microstrip antenna is carried out using transmission line model (TLM) [6] of Munson and Derneryd, as it gives good physical insight [5] and results adequate for most engineering purposes. It requires less computation [4]. However, it is difficult to model coupling using TLM.

Organization of the paper is as follows: Section-2 describes the complete design procedure and implementation of both Microstrip antennas. Results of simulations of designed model are presented in Section-3. Finally, conclusion has been shown in the end.

2. Design Procedure:

The coaxial line fed Microstrip antennas are designed at their respective resonant frequency and the resonant frequency of a rectangular Microstrip antenna has been designed for based on the width and length of the patch, given height and permittivity of the dielectric material between the conductive Microstrip and ground plane.

The design procedure of designed antennas carried out step by step [5], [7] is given below;



(a) (b)

Fig.1: (a) Top view of Microstrip patch antenna (b) Side view of Microstrip patch antenna (Coaxial Line feed)

2.1. Substrate Selectivity:

The first step is to select the appropriate substrate and thickness of substrate. Bandwidth and radiation efficiency increase with substrate thickness, and radiation efficiency of the Microstrip patch antenna mainly depends on the dielectric constant or permitivity of the substrate. Because permittivity of the substrate effects the transmission efficiency. [8]

In this paper, the substrate that used in the designing process is FR4 Epoxy Glass, that have relative permitivity of 4.4 and the substrate height will be 1.6mm. To manage the bandwidth of the antenna substrate height can be varied depending upon situation and the requirements of the antenna bandwidth.

Practical values can be calculated by using standard formulas.

2.2. Width of Patch:

Width of patch can be calculated by using following equation

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Here $c = 3\text{x}10^{11}$ mm/s

For 2 GHz

Width of the Patch having substrate FR4 Epoxy Glass with relative permitivity of $\epsilon_r = 4.4$ at resonant frequency of 2 GHz is,

W = 4.74 cm

For 3 GHz

Width of the Patch having substrate FR4 Epoxy Glass with relative permitivity of $\epsilon_r = 4.4$ at resonant frequency of 3 GHz is,

as patch is square so length and width will remains equal, and can be calculated by using this formula.

$$W = L = \lambda_o / 2$$

W = L = 2.38 cm

For 3.5 GHz

Width of the Patch having substrate FR4 Epoxy Glass with relative permitivity of $\epsilon_r = 4.4$ at resonant frequency 3.5 GHz is, as patch is square so length and width will remains equal, and can be calculated by using this formula.

$$W = L = \lambda_o / 2$$

W = L = 2.04 cm

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For 6 GHz

Width of the Patch having substrate FR4 Epoxy Glass with relative permitivity of $\epsilon_r = 4.4$ at resonant frequency of 6 GHz is,

as patch is square so length and width will remains equal, and can be calculated by using this formula.

$$W = L = \lambda_o / 2$$

$$\mathbf{W = L = 1.2\ cm}$$

For 7 GHz

Width of the Patch having substrate FR4 Epoxy Glass with relative permitivity of $\epsilon_r = 4.4$ at resonant frequency of 7 GHz is,

as patch is square so length and width will remains equal, and can be calculated by using this formula.

$$W = L = \lambda_o / 2$$

$$\mathbf{W = L = 1.022\ cm}$$

For 8 GHz

Width of the Patch having substrate FR4 Epoxy Glass with relative permitivity of $\epsilon_r = 4.4$ at resonant frequency of 8 GHz is,

$$\mathbf{W = 8.47\ mm}$$

But as patch is square so length and width will remains equal, and can be calculated by using this formula.

$$W = L = \lambda_o / 2$$

$$\mathbf{W = L = 8.9\ mm}$$

For 9 GHz

Width of the Patch of a Microstrip patch antenna having substrate FR4 Epoxy Glass with relative permittivity

$\epsilon_r = 4.4$ at resonant frequency f = 9 GHz is,

$$\mathbf{W = 7.53\ mm}$$

But as patch is square so length and width will remains equal, and can be calculated by using this formula.

$$W = L = \lambda_o / 2$$

$$\mathbf{W = L = 7.9\ mm}$$

2.3. Effective Dielectric Constant:

The effective dielectric constant can be calculated by using this equation,

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-0.5}$$

For 2 GHz

Patch antenna using substrate FR4 Epoxy Glass

For $\epsilon_r = 4.4$, W=4.74 cm and h = 0.0032 m,

$$\boldsymbol{\varepsilon_{eff} = 3.9}$$

For 3 GHz

Patch antenna using substrate FR4 Epoxy Glass

For $\epsilon_r = 4.4$, W=2.38 cm and h = 0.0032 m,

$$\boldsymbol{\varepsilon_{eff} = 3.75}$$

For 3.5 GHz

Patch antenna using substrate FR4 Epoxy Glass

For $\epsilon_r = 4.4$, W=2.04 cm and h = 0.0032 m,

$$\boldsymbol{\varepsilon_{eff} = 3.70}$$

For 6 GHz

Effective relative permitivity of patch having substrate FR4 Epoxy Glass of relative permitivity $\epsilon_r = 4.4$, height of substrate h = 0.16 cm and width of patch W = 1.2 cm at resonant frequency **f = 6 GHz** is,

$$\boldsymbol{\epsilon_{eff} = 3.7543}$$

For 7 GHz

Effective relative permitivity of patch having substrate FR4 Epoxy Glass of relative permitivity $\epsilon_r = 4.4$, height of substrate h = 0.16 cm and width of patch W = 1.022 cm at resonant frequency **f = 7 GHz** is,

$$\boldsymbol{\epsilon_{reff} = 3.702}$$

For 8 GHz

Effective relative permitivity of patch having substrate FR4 Epoxy Glass of relative permitivity $\epsilon_r = 4.4$, height of substrate h = 1.6 mm and width of patch W = 7.9 mm at resonant frequency **f = 8 GHz** is,

$$\boldsymbol{\epsilon_{eff} = 3.6579}$$

For 9 GHz

Effective relative permitivity of patch having substrate FR4 Epoxy Glass of relative permitivity $\epsilon_r = 4.4$, height of substrate h = 1.6 mm and width of patch W = 7.6 mm at resonant frequency f = 9 GHz is,

$$\boldsymbol{\epsilon_{reff} = 3.6195}$$

2.4. Length Extension of Patch:

Length extension of the patch can be calculated by using this equation,

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$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

For 2 GHz

Length extension of patch at frequency 2 GHz with $\epsilon_{reff}=$ 2.54, width W = 4.74 cm and height h = 0.0032 m is,

ΔL = 0.72 cm

For 3 GHz

Length extension of patch at frequency 3 GHz with $\epsilon_{eff}=$ 2.2, width W = 2.38 cm and height h = 0.0032 m is,

ΔL = 0.07 cm

For 3.5 GHz

Length extension of patch at frequency 3.5 GHz with $\epsilon_{eff}=$ 2.2, width W = 2.04 cm and height h = 0.0032 m is,

ΔL = 0.06 cm

For 6 GHz

Length extension of patch at frequency 6 GHz with $\epsilon_{eff}=$ 3.7543, width W = 1.2 cm and height h = 0.16 cm is,

ΔL = 0.069971 cm

For 7 GHz

Length extension of patch at frequency 7 GHz with $\epsilon_{eff}=$ 3.702, width W = 1.022 cm and height h = 0.16 cm is,

ΔL = 0.701 cm

For 8 GHz

Length extension of patch at frequency 8 GHz with $\epsilon_{eff}=$ 4.18, width W = 7.9 mm and height h = 1.6 mm is,

ΔL = 0.7029 mm

For 9 GHz

Length extension of patch at frequency 9 GHz with $\epsilon_{eff}=$ 4.18, width W = 7.6 mm and height h = 1.6 mm is,

ΔL = 0.6971 mm

2.5. Actual Length of Patch:

Actual length of patch can be calculated by using this equation,

$$L_{actual} = L - 2\Delta L$$

For 2 GHz

Patch antenna using substrate FR4 Epoxy

For L_{eff} = 3.8 cm and ΔL = 0.072cm

$\mathbf{L_{actual}}$ **= 3.7 cm**

For 2.5 GHz

Patch antenna using substrate Rogers RT/Duroid 5880 (tm)

For L_{eff} = 4.2008 cm and ΔL = 0.166cm

$\mathbf{L_{actual}}$ **= 3.86 cm**

For 3 GHz

Patch antenna using substrate FR4 Epoxy

For L_{eff} = 4.2008 cm and ΔL = 0.07cm

$\mathbf{L_{actual}}$ **= 2.44 cm**

For 3.5 GHz

Patch antenna using substrate FR4 Epoxy

For L_{eff} = 4.2008 cm and ΔL = 0.07cm

$\mathbf{L_{actual}}$ **= 2.09 cm**

For 6 GHz

Actual Length of Patch antenna using substrate FR4 Epoxy Glass having relative permitivity ϵ_r = 4.4, L_{eff} = 1.2903 cm and ΔL = 0.039971 cm is,

$\mathbf{L_{actual}}$ **= 1.15 cm**

For 7 GHz

Actual Length of Patch antenna using substrate FR4 Epoxy Glass having relative permitivity ϵ_r = 4.4, L_{eff} = 1.114 cm and ΔL = 0.07 cm is,

$\mathbf{L_{actual}}$ **= 0.976 cm**

For 8 GHz

Actual Length of Patch antenna using substrate FR4 Epoxy Glass having relative permitivity ϵ_r = 4.4, L_{eff} = 6.9 mm and ΔL = 1.66 mm is,

$\mathbf{L_{actual}}$ **= 7.5 mm**

For 9 GHz

Actual Length of Patch antenna using substrate FR4 Epoxy Glass having relative permitivity ϵ_r = 4.4, L_{eff} = 6.9 mm and ΔL = 1.66 mm is,

$\mathbf{L_{actual}}$ **= 6.5 mm**

2.6. Ground Plane Dimensions:

The transmission line model even though is applicable to infinite ground planes only but for practical considerations, a finite ground plane is used. However, size of ground plane should be greater than the patch dimensions by approximately six times the substrate thickness all around the periphery so that results are similar to the one using infinite ground plane. The ground plane dimensions Length and Width can be calculated by using following equations,

$$L_g = 6h + L$$

$$W_g = 6h + W$$

It can also be calculated using another formula as,

$$Lg=40h+L$$

$$Wg=40h+W$$

For 2 GHz

Patch antenna using substrate

Lg =4.3cm

Wg =5.5cm

For 3 GHz

Patch antenna using substrate

Lg = 3.2cm

Wg =4cm

For3.5 GHz

Patch antenna using substrate..

Lg = 2.8cm

Wg =3.5cm

For 6 GHz

Length and Width of antenna having substrate FR4 Epoxy Glass is,

Lg=40h+L = **7.7cm**

Wg=40h+W = **7.95cm**

For 7 GHz

Length and Width of antenna having substrate FR4 Epoxy Glass is,

Lg=40h+L = **7.376cm**

Wg=40h+W = **7.704cm**

For 8 GHz

Length and Width of antenna having substrate FR4 Epoxy Glass is,

$L_g = 6h + L =$ **71.5 mm**

$W_g = 6h + W =$ **75.4 mm**

For 9 GHz

Length and Width of antenna having substrate FR4 Epoxy Glass is,

$L_g = 6h + L =$ **70.5 mm**

$W_g = 6h + W =$ **74.1mm**

2.7. Coaxial Feed Point Location:

The inner conductor of the coax is connected to the radiation patch and the outer conductor to ground plane. The feed point should be near one of the two radiating edges [9].Parametric sweep method is applied to determine the feed point exactly.

Table 2.7.0 Feed Point Location

Antenna	Feed Point Location
2 GHz	**5.4, 4.9,0 (cm)**
3 GHz	**4.1, 4. 3,0 (cm)**
3.5 GHz	**4.71, 4.19,0 (cm)**
6 GHz	**3.8, 3.7,0 (cm)**
7 GHz	**3.79, 3.66,0 (cm)**
8 GHz	**36, 35.8,0 (mm)**
9 GHz	**35.8,35.8,0 (mm)**

Table 2.7.1 For 8 Ghz patch antenna:

Element	Calculated (mm)	Practically Used(mm)
W (Width of Patch)	W = 7.9 mm	W = 8.9 mm
L (Length of Patch)	L = 7.9 mm	L = 7.5 mm
Wg (Width of Ground)	Wg = 75.4 mm	Wg = 75.4 m
L (Length of Ground)	Lg = 71.5 mm	Lg = 71.5 mm

Table 2.7.5 For 2 GHz patch antenna:

Element	Calculated (cm)	Practically Used(cm)
W (Width of Patch)	W = 4.74	W = 3.48
L (Length of Patch)	L = 3.38	L = 3.48
Wg (Width of Ground)	Wg = 5.5	Wg = 10.9
L (Length of Ground)	Lg =4.3	Lg = 9.8

Table 2.7.6 For 3 GHz patch antenna:

Element	Calculated (cm)	Practically Used(cm)
W (Width of Patch)	W = 2.38	W = 3.1
L (Length of Patch)	L = 2.38	L = 3.5
Wg (Width of Ground)	Wg = 4	Wg = 9.4
L (Length of Ground)	Lg = 3.2	Lg = 8.5

Table 2.7.7 For 3.5 GHz patch antenna:

Element	Calculated (cm)	Practically Used(cm)
W (Width of Patch)	W = 2.04	W = 3.3
L (Length of Patch)	L = 2.04	L = 3.5
Wg (Width of Ground)	Wg = 3.5	Wg = 9
L (Length of Ground)	Lg = 2.8	Lg = 8.5

Table 2.7.3 For 6 GHz patch antenna:

Element	Calculated (cm)	Practically Used(cm)
W (Width of Patch)	W = 1.2 cm	W = 1.15 cm
L (Length of Patch)	L = 1.2 cm	L = 1.15 cm
Wg (Width of Ground)	Wg = 7.6 cm	Wg = 8 mm
L (Length of Ground)	Lg = 7. 6 cm	Lg = 8 cm

Table 2.7.4 For 7 GHz patch antenna:

Element	Calculated (cm)	Practically Used(cm)
W (Width of Patch)	W = 1.022 cm	W = 0.98 cm
L (Length of Patch)	L = 1.022 cm	L = 0.98 cm
Wg (Width of Ground)	Wg = 7.6 cm	Wg = 8 mm
L (Length of Ground)	Lg = 7. 376 cm	Lg = 7.376 cm

Table 2.7.2 For 9 GHz patch antenna:

Element	Calculated (mm)	Practically Used(mm)
W (Width of Patch)	W = 7.6 mm	W = 7.9 mm
L (Length of Patch)	L = 7.6 mm	L = 6.5 mm
Wg (Width of Ground)	Wg = 74.1 mm	Wg = 74.1 mm
L (Length of Ground)	Lg = 70. 5 mm	Lg = 70. 5 mm

3. Simulation and Results:

Simulation of the coaxial fed Microstrip antenna is carried out in Ansoft HFSS TM V 10.0. Analysis of radiation pattern and gain show that the coaxial fed Microstrip antennas have achieved the desired specifications successfully.

3.1. Simulation Results for 8 GHz:

A patch antenna model with L = W = 4.70 cm and a feed point at ~2.36 cm along the patch diagonal yielded a resonant frequency of 8 GHz, as well as an excellent resonant return loss. VSWR is less than 2.0.

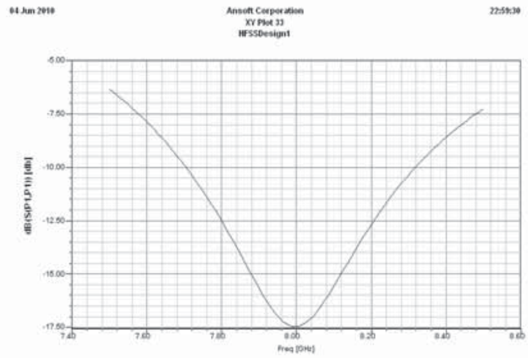

Fig.1: S11 response

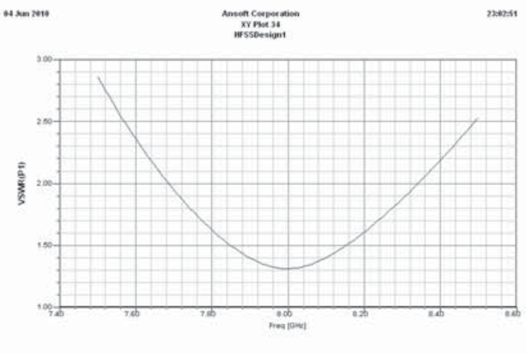

Fig.2: VSWR

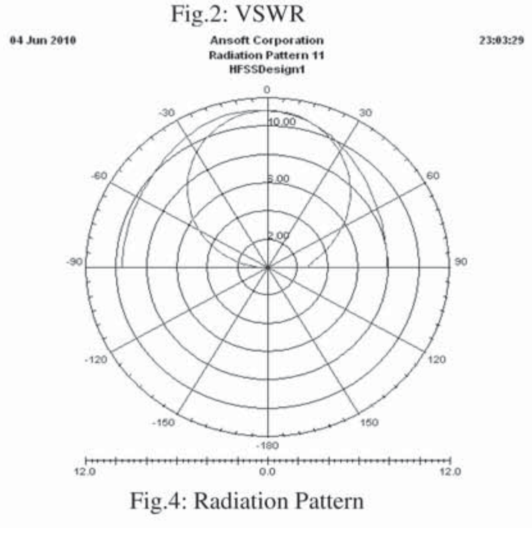

Fig.4: Radiation Pattern

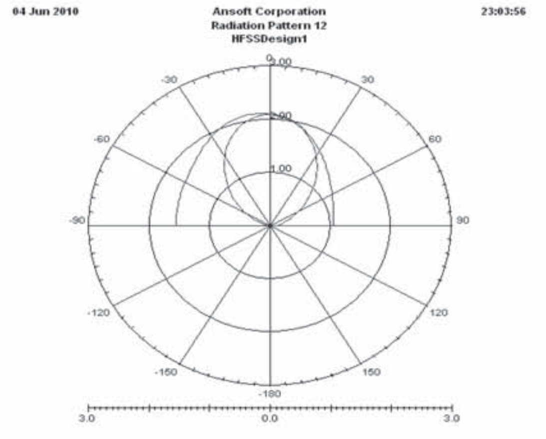

Fig.4: Antenna Gain

3.2. Simulation Results for 9 GHz:

A patch antenna model with L = W = 4.70 cm and a feed point at ~2.36 cm along the patch diagonal yielded a resonant frequency of 8 GHz, as well as an excellent resonant return loss. VSWR is less than 2.0.

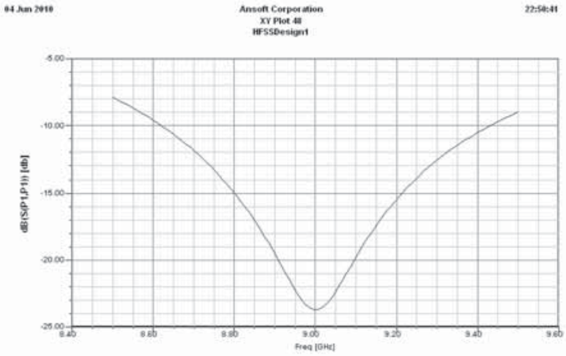

Fig.5: S11 response

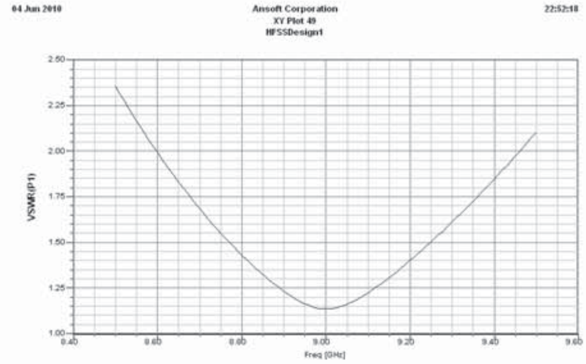

Fig.6: VSWR

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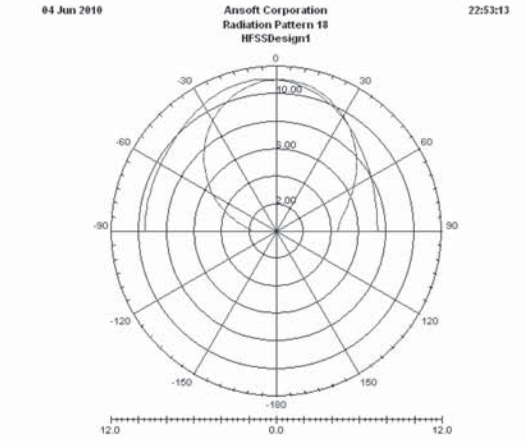

Fig.7: Radiation Pattern

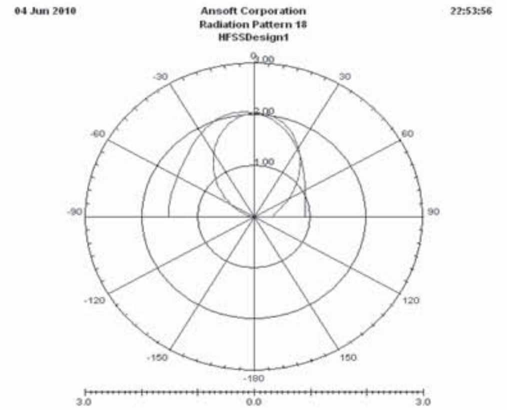

Fig.8: Antenna Gain

3.3. Simulation Results for 6 GHz:

A patch antenna model with L = W = 1.2. cm and and a

feed point of (3.8, 3.7 ,0)cm along the patch diagonal yielded a resonant frequency of 6 GHz, as well as an excellent resonant return loss. VSWR is less than 2.0

Fig.9:S11 Response for HFSS Simulation of Microstrip

Patch antenna.

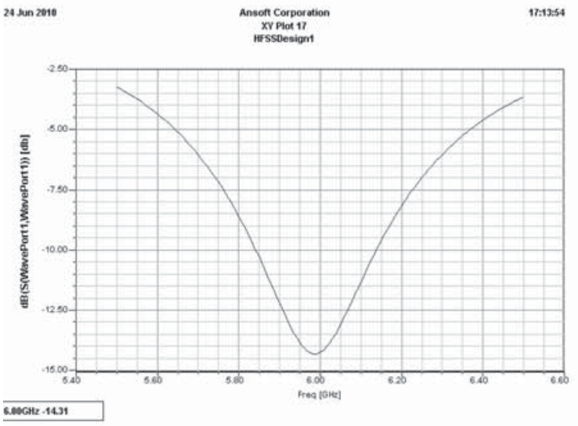

Fig. 9: S11 response

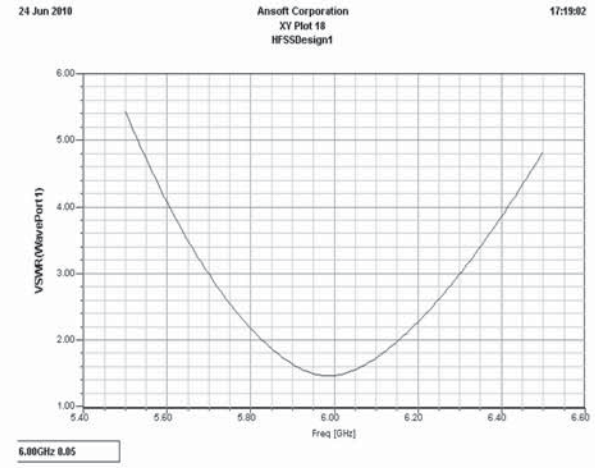

Fig.10: VSWR

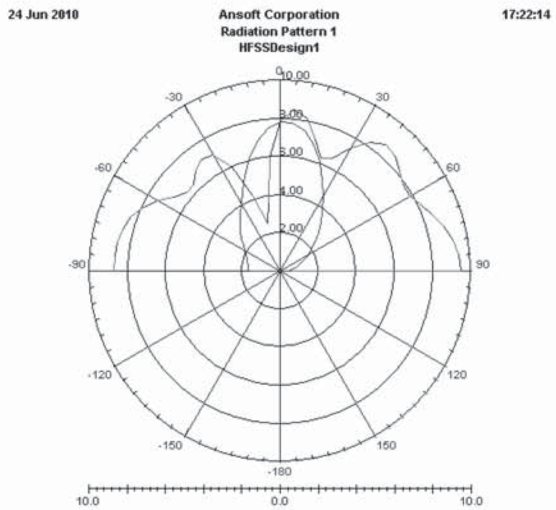

Fig.11: Radiation Pattern

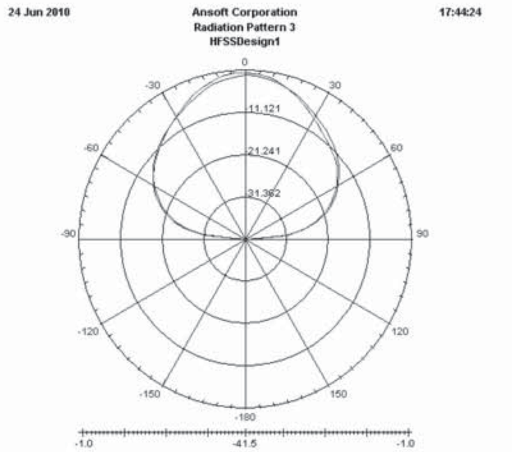

Fig.12: Antenna Gain

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3.4. Simulation Results for 7 GHz:

A patch antenna model with L = W = 1.022. cm and a feed point of (3.79, 3.66, 0) cm along the patch diagonal yielded a resonant frequency of 6 GHz, as well as an excellent resonant return loss. VSWR is less than 2.0

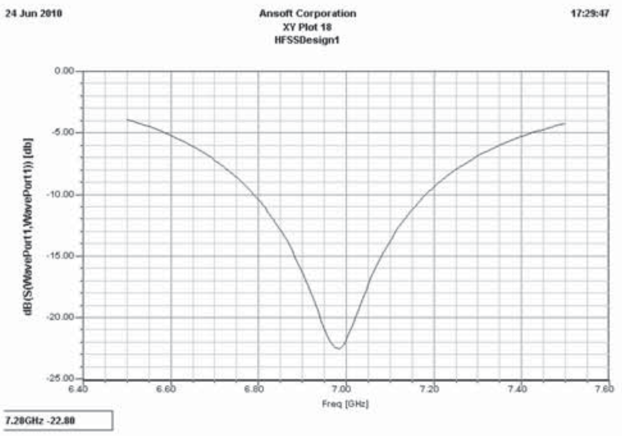

Fig.13: S11 response

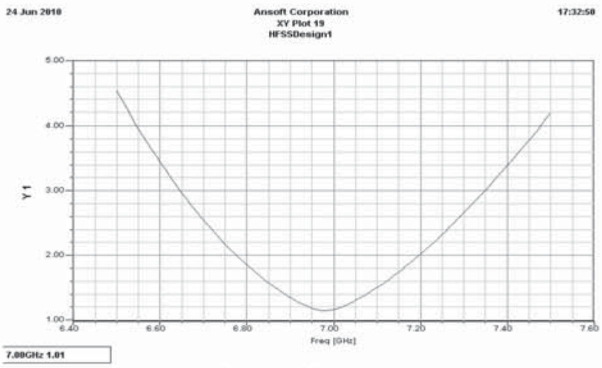

Fig.14: VSWR

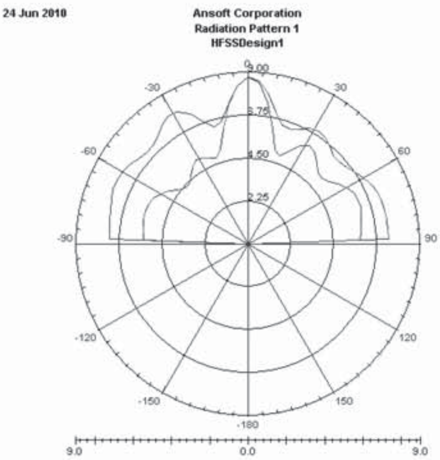

Fig.15: Radiation Pattern

For 2 GHz patch antenna

The simulation result of 2 GHz Patch antenna is shown below.

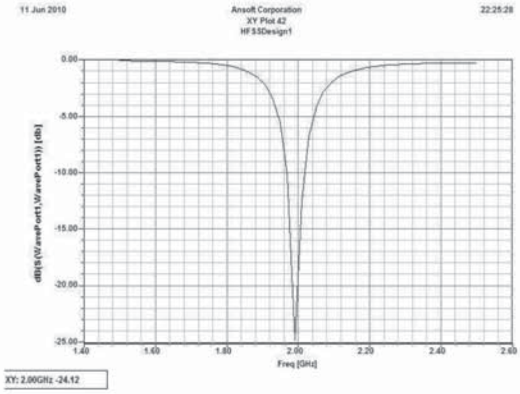

Fig16. S_{11} response

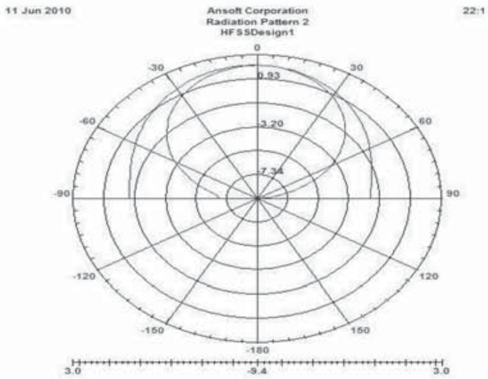

Fig 17: Radiation Pattern

Conclusion-

These antennas used for several applications specially 3 GHz to 3.6GHz for wireless local loop, 3.5 GHz for WIMAX, 5GHz to 6GHz for WLAN, 7 GHz for Ultra-Wide Band Communication, 8 GHz for transmission and 9.2-9.5 GHz for reception of SART (Search and Rescue Transponders) for signals coming from X-band radars.

REFERECES

[1] Shahid Hassan, Irfan Arshad, Muhammad Waqas Majeed, Basit Ali Anjum "*Microstrip Patch Antennas for Microwave L band & S band Applications*", Feb 18-20, 2010, ICEI 2010, Melaka Malaysia.

[2] W. D. Palmer, "Direct Antenna Modulation: Analysis, Design, and Experiment", Electronics Division, US Army Research Office, Research Proposal, pp. 1 – 11, July 2005

[3] C.A. Balanis, Antenna Theory Analysis & Design, 2ndEdition, John Wiley & Sons, New York, 1997

[4] K.R. Carver and J.W. Mink, "Microstrip Antenna Technology", IEEE Trans.Antenna Propagation, Vol. AP – 29 , No. 1, pp.2 – 24, January 1981

[5] I.J.Bahl and P. Bhartia , Microstrip Antenna, Washington 1980

[6] Nazifa Mariam, " Comparison between inset and coaxial feed excitation technique of microstrip antenna", Proceedings of Conference on information science,technology and management (CISTM2007) Hyderabad, India, July 16-18, 2007

[7] W.F. Richards, Y.T Lo, and D.D Harrison, " An Improved theory of Microstrip Antenna with Applications", IEEE Trans. Antenna Propagation, Vol. AP – 29 , No. 1, pp. 38 – 46, January 1981

[8] W.L. Stutzman, G.A. Thiele, *Antenna Theory and design*, John Wiley & Sons, 2*nd* Ed., New York, 1998.

[9] L.I William and Y. Rahmat –samii, "Novel Bi-polar Planner Near-Field Measurement Scanner at UCLA,"1991 int IEEE/AP-S Symp.Dig., London, Ontairo, Canada, June 1991.

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