Advantages of the CCD camera measurements for profile and wear of cutting tools

2005 J. Phys.: Conf. Ser. 13 159

(http://iopscience.iop.org/1742-6596/13/1/037)

Institute of Physics Publishing Journal of Physics: Conference Series **13** (2005) 159–162
doi:10.1088/1742-6596/13/1/037 7th International Symposium on Measurement Technology and Intelligent Instruments

Advantages of the CCD Camera Measurements for Profile and Wear of Cutting Tools

G Varga [1], Z Balajti [2] and I Dudás [3]

[1, 3]Department of Production Engineering, University of Miskolc, Egyetemvaros, Miskolc, H-3515, Hungary

[2]Department of Descriptive Geometry, University of Miskolc, Egyetemvaros, Miskolc, H-3515, Hungary

E-mail: gyulavarga@uni-miskolc.hu

Abstract: In our paper we prepared an evaluating study of which conclusions draw mainly two directions for our fields of research. On the one hand, this means the measuring of fix, standing workpieces, on the other hand this means geometrical measurement of moving tools. The first case seems to be solved in many respects (in general cases), but the second one is not completely worked out according to the relevant literature. The monitoring of tool wear, the determination of geometrical parameters (this is mainly in case of gear-generating tools) is not really widespread yet, mainly, if optical parameters have influence on the evaluating procedure (e.g. examination of profiles of grinding wheels).
We show the elaboration of a process for the practical application of measuring techniques performed by image processing CCD cameras on the basis of wearing criteria of different cutting tools (drilling tool, turning tool). We have made a profile and cutting tool wear measuring program.

1. Introduction

The researches were done in the frame of the OTKA research project (No.: T 042843) titled "Modelling and Examination of Machine Industrial Environmentally Conscious Manufacturing Procedures". At first we are introducing the computer image processing, later how the CCD cameras can be used for measurement of the profile of a special grinding wheel. We have developed a measurement programme by the use of a LabView software for the measurements of flank wear of single point cutting tools. In the frame of this paper we would like to introduce some segment of the results achieved so far.

2. Computer image processing

Computer image processing systems first were used in the 1960s in space research and in the evaluation of pictures made from the surface of the Earth. The increase of capacity of computers made possible the wider and wider spread of computer image processing. The goal and essence of computer image processing is that the image information can be gained from our environment by the application of computers and that is processed and evaluated. The results can be intervened into certain processes.
The subject of computer image processing covers a wide number of techniques used for a wide variety of purposes. They can be broadly categorised as methods of image transformation and analysis [1].

Methods of image processing are applied in wide range at the fields of industry as well. Application of microscopic image analysis used in material examining laboratories, or the geological fracture line examination performed by remote sensing methods which can give useful help for quest of deposit of minerals can be considered as an industrial application. But usually, as industrial image processing, we mean quality control during manufacturing or process control of the systems. Hereunder there will be reviewed two one-camera-methods.

3. Profile inspection by using CCD cameras

In case of cylindrical worms the geometrically exact finishing, grinding, leads to great problems.
It is generally known that the dressing - because of the wear - of the grinding wheel changes the diameter of the wheel. It results the changes of the ratio of the diameters and the centre distance during the enveloping of the tool and workpiece (worm) [2]. These two factors have significant effects on the geometrical accuracy of the manufactured worm profile in case of a given tool profile. In case of tapered worms (spiroid worms) this problem arises even to a greater extent, because independently of the wear of the grinding wheel the centre distance and the diameter ratio are gradually changing along the axe of the tapered worm. This is the most essential production geometrical problem of grinding of tapered worms.

For the purpose of dressing the grinding wheel profile a CNC grinding wheel dressing equipment was developed [2], which continuously can dress the grinding wheel during machining. To decide whether dressing is necessary or not it requires the measurement of the deviation from the ideal profile which measurement can be done by use of CCD camera.
Contact measurement cannot be used because the abrasive object (grinding wheel) to be measured rotates very fast. The non-contact measurement using laser would be the theoretically ideal method. Practically it cannot be used because the crystal grains of the grinding wheel reflect the laser beam irregularly. The measuring by use of CCD camera seems the most appropriate measuring method for the inspection and measurement of grinding wheel profile.

3.1. Possibility of resolution of the problem

When making measurements not the whole grinding wheel is examined but a part only (figure 1). The change of the profile point belonging to the greatest diameter of the working part of the wheel is examined and evaluated. From a production geometrical point of view the change of this point is the largest. In case of grinding wheels of different profiles it is essential that the optical axis of the CCD camera be perpendicular to the profile section examined. Thus the camera should be set in a plane perpendicular to the plane examined. The optical axis of the camera is aimed at the corner point of the grinding wheel because the maximum value of the wear will be there [3].

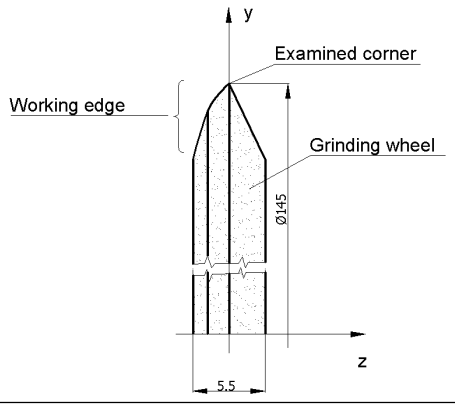

Figure 1. Featuring data of the grinding wheel

The starting state stored in the memory of the computer is compared with the worn state. When the wear in the **x** or **y** direction is greater than a prescribed value, then the controller gives the order to dress the grinding wheel and to adjust it to a suitable position. After dressing the corner points all the other wheel points are well within the tolerance zone [4].

3.2. Measurement of grinding wheel profile by CCD camera

Before calibration we have to assure the perpenducalirity of optical axis of CCD camera to the table of the object. The monitor picture of measurement is shown on figure 2. Measurements were done on an own build dressing equipment [5], [6].

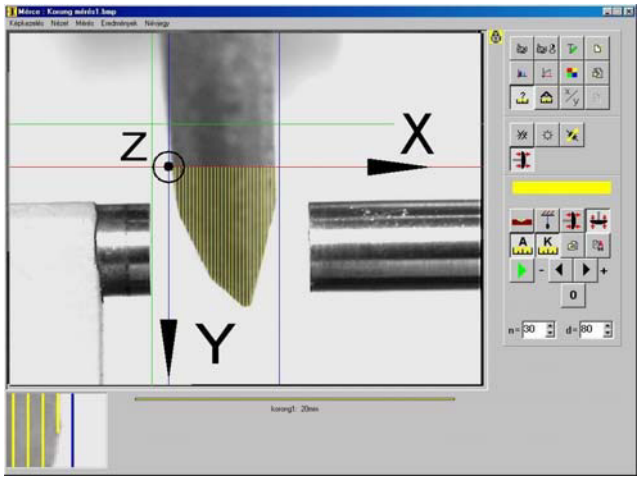

Figure 2. Measurement of grinding wheel profile

The measured X and Y values, served by the measuring program, of the profile can be seen on figure 3. The measured values can further be processed in an Excel program. In this way the pictures of the profile belonging to different wear can be compared. The dimension in vertical direction between two measurements can be set by us, e.g. in the direction of X the measured distance was divided into 30 pieces.

X	Y
p1	0.23
p2	1.69
p3	2.93
p4	3.53
p5	3.89
p6	4.40
p7	4.82
p8	5.28
p9	5.67
p10	6.10
p11	6.56
p12	6.98
p13	7.18
p14	7.37
p15	7.56

X	Y
p16	7.76
p17	7.92
p18	8.18
p19	8.37
p20	8.61
p21	8.76
p22	8.74
p23	8.72
p24	7.92
p25	7.10
p26	6.77
p27	5.44
p28	4.40
p29	3.23
p30	2.12

Figure 3. The measured and drawn values of the profile

3.3. Measurement of cutting tool wear by CCD camera

Figure 4. shows schematic of experimental setup. Drill was hold by support device. It should be noted that the edge of the twist drill was setup to be perpendicular to CCD camera. Therefore we bought high precision. CCD camera (type: FOculus FO 430C), which was connected with the computer. The

images were sent constantly, so we could see images at any time. Computer has a role to acquire an image by software and it enables to take an image.

Image acquisition was performed by C++ language by a software. G language only takes place image process. Bulb was set on an angle to illuminates the drill edge.

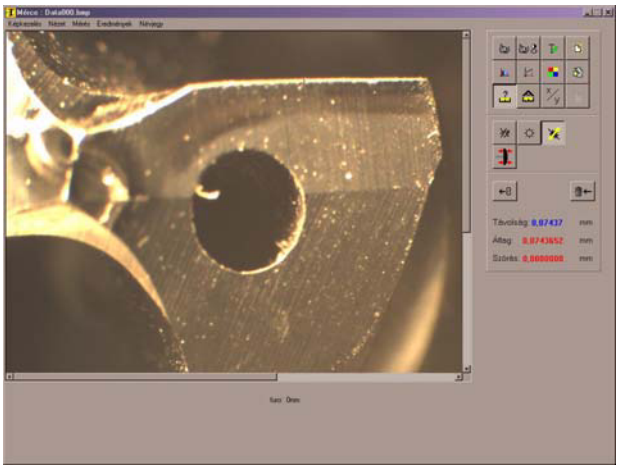

Figure 4. Screen at wear measurement of a twist drill

For example the flank wear and the corner wear of a weared twist drill can be seen on figure 4. The blue numbers in the middle on the right in figure 4. shows the value of the measured wear in mm-s.

4. Summary

With help of CCD cameras there is a new possibility for in process tool profile monitoring, dimension inspection of grinding wheel profile measurement. The automated evaluation of the measured data is a further advantage; in this way the measuring system and the production system can be assembled. This fact gives the possibility of the feedback during machining. In this way the production of helicoid surfaces in CIM systems can be solved in case of high accuracy as well.

Acknowledgements

This work was supported by **OTKA** project titled "**Modelling and Examination of Machine Industrial Environmentally Conscious Manufacturing Procedures**"

References

[1] http://www.tessella.com/literature/Supplements/compimag.htm
[2] Dudas I 2000 The Theory and Practice of Worm Gear Drives *Penton Press* London
[3] Dudas I, Varga G and Banyai K 2001 Grinding wheel profile measurement by CCD camera, *12th Int. DAAAM Symposium* Oct. 24-27 Jena, Germany **117-18**
[4] Dudas I and Varga G 2001 Metrological Use of CCD Cameras *microCAD 2001 Int. Scientific Conference* March 1-2 Univ. of Miskolc, Miskolc, Hungary **35 - 40**
[5] Varga G 2000 Examination of environmentally conscious manufacturing technologies, *Proc. of ICT-2000* September 6-8 Miskolc, Hungary **377-82**.
[6] Balajti Z and Banyai K 2004, A possible method for the solve of 3D evaluation with 2 CCD cameras *Production Processes and Systems*, Publ. of the University of Miskolc, **1**, Miskolc University Press **237–42**