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COMPUTER AIDED DESIGN OF WORMS IN THE SAME AXIS

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ABSTRACT

In today's technology, it is the computer-aided or fully automated systems that take over the designing processes of products, technology and tools of production. The computer support of engineering work is the most important condition for increasing the efficiency of production and enhancing the quality of the products.
The automated technical development of the production, and the abstract of the production geometry by projective geometry in case of a few special worms, so spiroid, the mathematical description and the realisation show an advance.
The programmed mathematical model is suitable to the discussion of the production geometry problems of various types of cylindrical and conical worm surfaces – with an exact mathematical solution – that it can be applied for many purposes in engineering practice and the elaboration of the uniform concept of the implementation for the purposes of geometrically proper design.

Keywords: Programmed mathematical model, production geometry, worm surfaces

1. INTRODUCTION

The first mathematical model to analysis of the worm gear driving and it's manufacturing was created by professor Dudás [4]. The forward improved mathematical and kinematical model was worked out in the common research work managed by professor Dudás in [7]. Many employments exist with that aim to increase the accuracy of worm's manufacturing in the now days [2,3,5,8]. In the new worked out mathematical model [6] ensure attempt to enhance the accuracy of the manufacturing by grinding wheel in case the cylindrical and conical worm on the same axe with line and arc profile to eliminate the caused error of elliptical relation between the conical worm rotated with half cone angle, and the grinding wheel. The error eliminate is causing the aspect of projective geometry, in which the cylinder and the cone is in one category of the surfaces.

This paper presents the worms modelling in the main program with variety geometrical parameters, which have made in the forward improved mathematical model to enhancement accuracy processing of the pieces of the conical and helicodical worm gear drives. The last chapter containing an introduction of the one possible solution to calculate the curvature function of the cone.

2. ABOUT THE PROGRAMME

This paper shows a mathematical simulation of cylindrical and conical worms, which is made in C programme language in the foreword developed mathematical and kinematical model in theorem in projective geometry.

C programme language was designed for implementing system software, it is also widely used for developing portable application software. C is one of the most widely used

programming languages of all time. C has greatly influenced many other popular programming languages, most notably C++, which began as an extension to C.
The C programming language uses libraries as its primary method of extension. In C, a library is a set of functions contained within a single "archive" file. Each library typically has a header file, which contains the prototypes of the functions contained within the library that may be used by a program, and declarations of special data types and macro symbols used with these functions. In order for a program to use a library, it must include the library's header file, and the library must be linked with the program, which in many cases requires compiler flags.
The connected functions will can be any production process or any driving pairs model in the future.

3. THE MODELING OF HELICODICAL SURFACE ELEMENTS OF WORM GEAR DRIVES

The helicodical surfaces are generated in our programme using straight or arched curve. The size causes cannot be allowing detailing it. It can be read in [4]. The developed theory [1] is illustrated with numerical examples on the next.

3.1 THE CYLINDRICAL WORMS

The relative position of the general line to the cylindrical surface will determine the type of the helicoidally surface.
The straight generated worm surface can be Archimedean, having a line edge in axial section (Figure 1.), or a convolute one having a line edge in intersection with a parallel plane to the worm axis (Figure 2.).

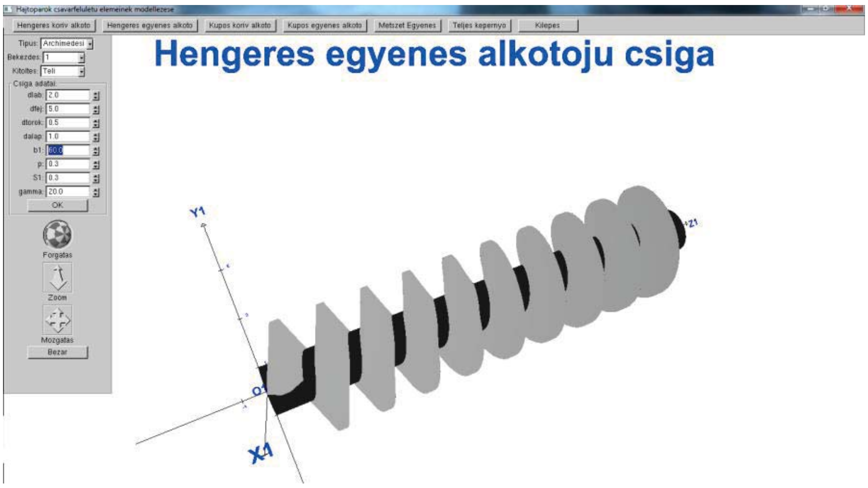

Figure 1.The cylindrical Archimedean worm

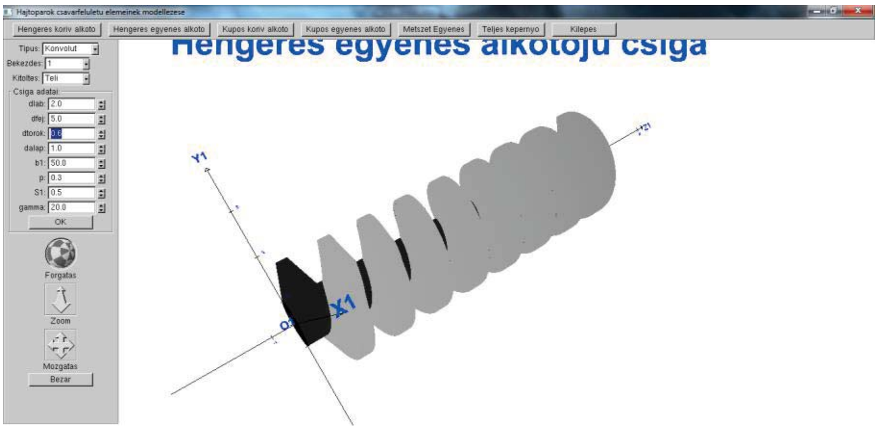

Figure 2. The cylindrical convolute worm

The involute worm surface is a special case of convolute worm surface, because of having a line edge section in a parallel plane to the worm axis and tangential to the base cylinder. On Figure 3. the number of starts is two on the involute worm.

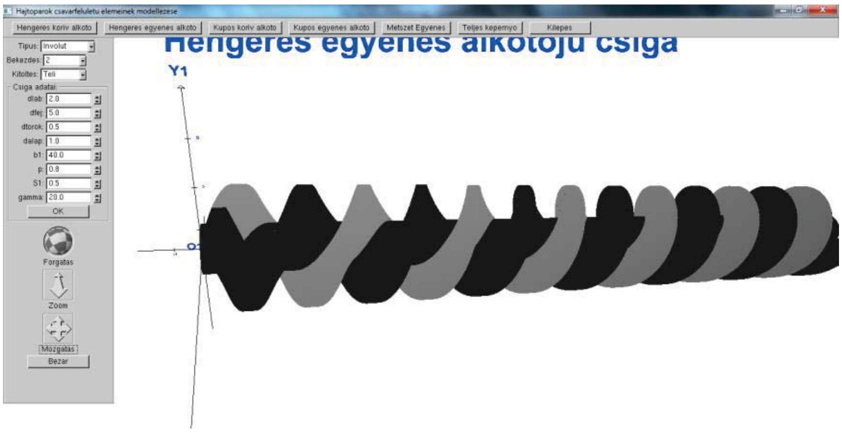

Figure 3. The cylindrical involute worm

One of the most modern types of cylindrical helicoidal surfaces is the worm generated using a different profile tool. Depending on the kinematical conditions between worm and tool, the arched profile can appear directly on the worm active surface, in axial or normal section. On the Figure 4. the arched profile of worm is circle in axial section with the given geometrical parameters.

Figure 4. The cylindrical worm with arched profile

3.2. THE CONICAL WORMS

The type of the generator curve and it's placing to the axis determine the helicodical surfaces, from that give us the worms. The geometrical parameters of the conical worms give us the type of the spiroid worm [4]. The interpretation of Archimedean, involute and convolute worms in conical case can be similarly in cylindrical helicodical surfaces [2]. The simulation of these case can be seen in Figure 5., 6.and 7.

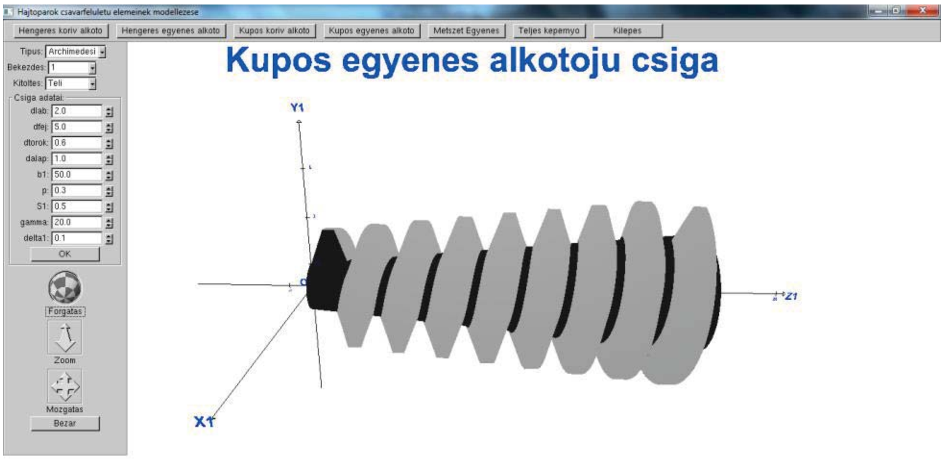

Figure 5. The Archimedean conical worm

The convolute conical worm is modelling with two starts.

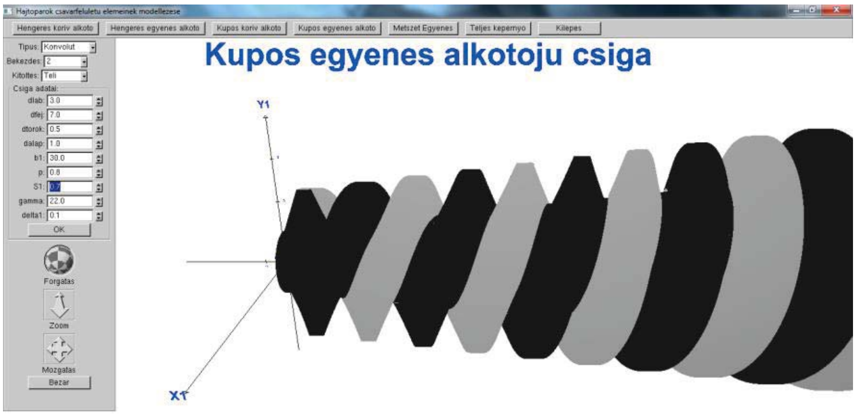

Figure 6. The convolute conical worm

The conical involute worms are the special case of the convolute conical worm. The geometrical parameters were discharge suitable, as it can be seen in Figure 7.

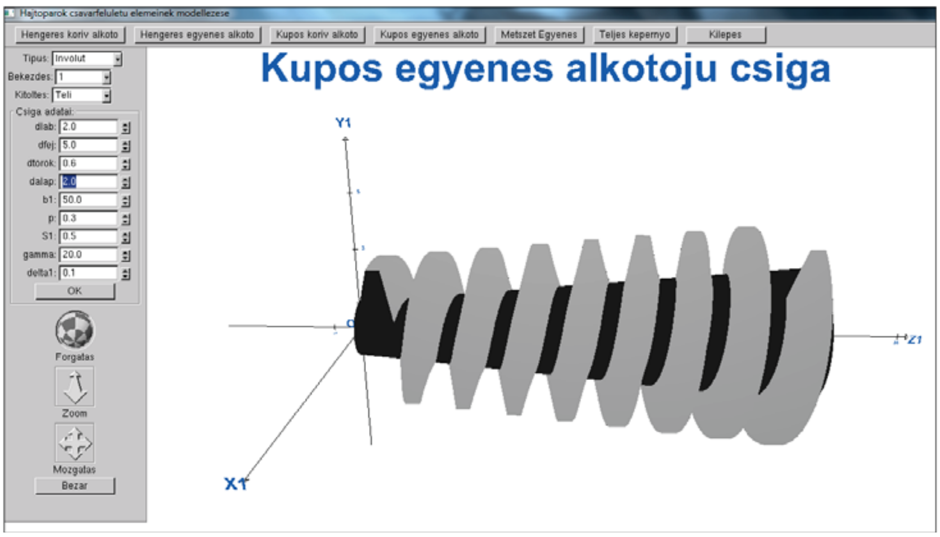

Figure 7. The involute conical worm

Conditions that are more advantageous exist for circular profile worms. The bearing pattern analysing was introducing in [1]. The new modeling can give more profitable results [1].
The conical worm with circle profile in axial section is determined the showed geometrical parameters on Figure 8.

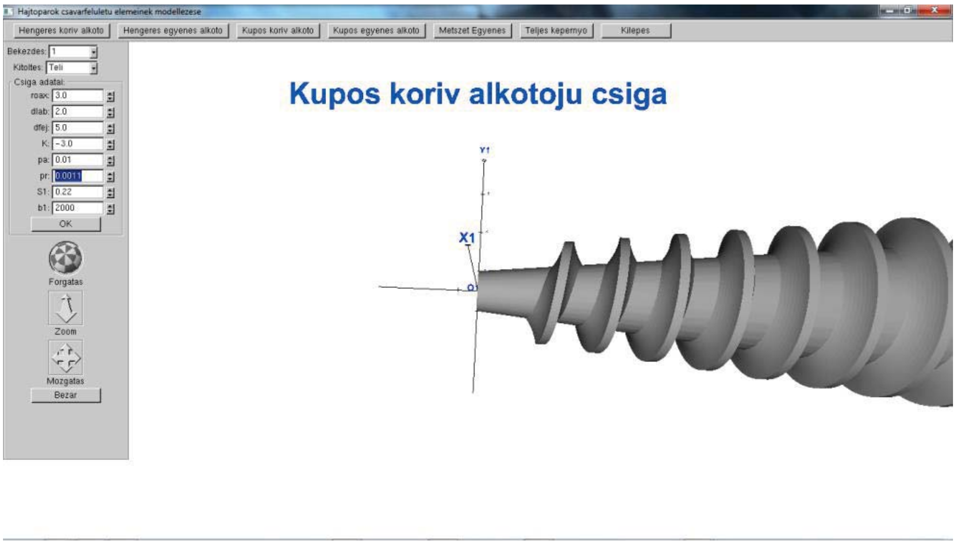

Figure 8. The conical worm with arched profile in axial section

4. THE AXIAL PROFILE CURVATURE ON CONVOLUTE WORM

The selected points on the axial section of convolute of worm are $\mathbf{p}_0$, $\mathbf{p}_1$,...$\mathbf{p}_n$, and let them parameters u_i, $i=0,1,...,n$, $u_0=0$, $u_n=1$, and they are proportional length of chord.
A curve is needed to find to the given points and parameters.
One of the solutions of the problem is the interpolated Bézier curve [7].
The $\mathbf{b}_0$, $\mathbf{b}_1$,…, $\mathbf{b}_n$, control points are wanted to determine the Bézier curve to the $\mathbf{p}_0$, $\mathbf{p}_1$,...$\mathbf{p}_n$ points.

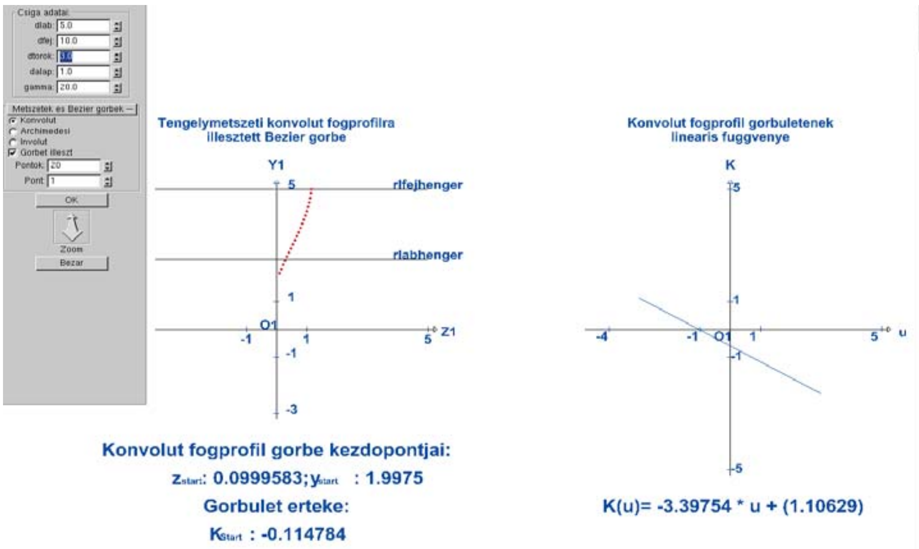

Figure 9. The interpolation Bézier curve on the convolute profile with the curvature function

The equation of the Bézier curve is determined in the next formula:

$$\mathbf{b}(u) = \sum_{j=0}^{n} B_j^n(u)\,\mathbf{b}_j \quad (i=0,1,...,n), \tag{1}$$

where $B_j^n(u)=\binom{n}{j}u^j(1-u)^{n-j}$ are Bernstein polynoms.

The next linear inhomogeneous equation systems give us the control points:

$$\begin{bmatrix}\mathbf{p}_0\\ \mathbf{p}_1\\ \vdots\\ \mathbf{p}_n\end{bmatrix}=\begin{bmatrix}B_0^n(u_0) & B_1^n(u_0) & \cdots & B_n^n(u_0)\\ B_0^n(u_1) & B_1^n(u_1) & \cdots & B_n^n(u_n)\\ \vdots & \vdots & \ddots & \vdots\\ B_0^n(u_n) & B_1^n(u_n) & \cdots & B_n^n(u_n)\end{bmatrix}\begin{bmatrix}\mathbf{b}_0\\ \mathbf{b}_1\\ \vdots\\ \mathbf{b}_n\end{bmatrix} \quad (2).$$

The $u_i \neq u_j$ condition results us the unambiguous solution to $\mathbf{b}_i$. So we receive the $\mathbf{b}_i$ control points of the interpolation Bézier curve to the are $\mathbf{p}_0$, $\mathbf{p}_1$,...$\mathbf{p}_n$ points.

In case n=4, the third degree Bézier curve fitted to the worm profile give us the κ(u) first degree function of the curvature. It can be seen in Figure 9.

5. CONCLUSION

The programmed projective geometry methodical mathematical model can be a base a new source of our research work. The new aspect of the modelling of the analysing and manufacturing can give us the more result on accuracy.

The showed programme has a few practical functions. Rotation controls allow the user to input rotations into an application by manipulating an arcball control. The control displays as a checkerboard-textured sphere, which the user manipulates directly. The current rotation of the control is passed to the application as an array of 16 floats, representing a 4´4 rotation matrix. This array can be passed to OpenGL directly to rotate an object, using the function glMultMatrix(). Rotations control deals with pure rotations only (no translation or scaling), the transpose of the 4´4 matrix is the same as its inverse. Rotation controls can optionally keep spinning once the user releases the mouse button. To enable this, use the function GLUI_Rotation::set_spin(). Note that spinning should be disabled in performance-critical applications (it is disabled by default). The simulation of these method was developed without manufacture cost. Using a suitable equation in projective geometry must be harmonized to the arched profiles and write it in a new function in the future.

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