AUTOMATION OF DESIGNING OF CAM-AND-LANTERN MECHANISMS IN SOLIDWORKS

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Cam mechanisms represent a large class of mechanisms that according to the corresponding profile of the cam allow one or more dwells of the output link to be obtained in certain sections, and provide a given law of movement of the output link in other sections. As known [1, 2], it is also possible to use cam-and-lantern mechanisms for this purpose, but the task of their automated design using optimization methods is not completely solved yet.

Therefore, the aim of the work is to develop a software system for automated design of optimal cam-and-lantern mechanisms with periodic dwells of the output link (Fig. 1), in accordance with the given law of motion which includes the determination of theoretical and practical profiles of the cams and the designing of a three-dimensional model of the mechanism based on the results of calculations.

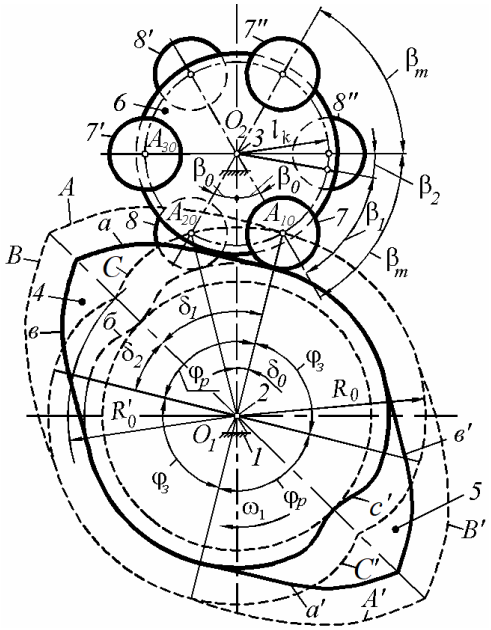

Fig. 1. The scheme of the cam-and-lantern mechanism

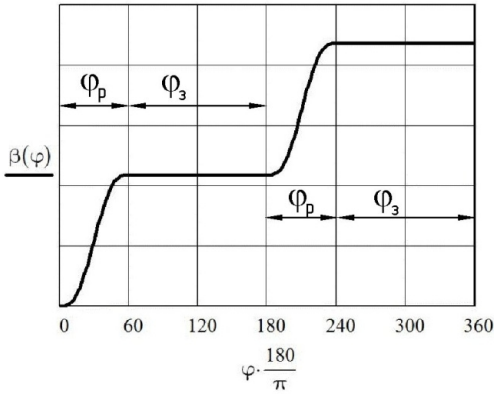

Fig. 2. Diagram of the movement of the output link

The mechanism with intermittent rotary motion of the output link is shown in the Fig. 1. The mechanism consists of a base *1*, on which shafts *2* and *3* are installed. Two paired of identical cams *4* and *5* are fixed on shaft *2*, which provide a periodic rotational movement with dwells to the output link *6*. Link *6* carries at least three pairs of evenly spaced rollers *7* and *8*. Rollers *7* are offset relative to rollers *8* by an angle β_m. Rollers *7* are in contact with cam *4*, rollers *8* are in contact with cam *5*.

With three pairs of rollers, such cam mechanism provides for one revolution of the cams two turns of the output link *6*, each by an angle $\beta_m = 60^\circ$. When designing the mechanism, it is necessary to determine the theoretical and practical profile of the cams in accordance with the given law of motion. In the Fig. 1, *b* solid lines show the practical profile, in particular the elements of the cam profile *4* – $a, c', b,$ cam *5* – $a', c, b',$ dashed lines – the theoretical profile, in particular the profile elements of the cam *4* – $A, C', B,$ cam *5* – A', C, B'. Other areas of the cams correspond to those outlined by the radii of the circles.

Initial data for calculation

1. Number of pairs of rollers $(z = 3...8)$;

2. Interaxial distance *a*;

3. The length l_k of the rocker, which is the radius of the output link *6*;

4. Angle of rotation of the cam during the movement of the output link $(\varphi_p = 90^\circ)$;

5. Permissible angle of pressure $\left(\upsilon_o = 50^\circ\right)$;

6. Radius of the roller r_p;

7. The law of movement of the output link is to be selected.

Examples of three laws are given in the Table 1, but the full list of the laws is given in [2]. The specified laws of motion are characterized by movement invariants and velocity invariants, while in the calculations we take the relative time of movement *k* in the range from 0 to 1.

Table 1

#	Name of the law	$a_k(k)$	$b_k(k)$
1	Constant acceleration	$3k^2 - 2k^3$	$6k\left(1-k\right)$
2	Shun's law	$10k^3 - 15k^4 + 6k^5$	$30\left(k^2 - 2k^3 + k^4\right)$
3	Sinusoidal law	$k - \frac{\sin 2\pi k}{2\pi}$	$1 - \cos 2\pi k$

During the design process, the following tasks are to be solved:

1. Calculation and designing of a theoretical and practical cam profile.

2. Construction of a 3D model of the cam based on the results of the practical profile calculation and construction of a parametric 3D model of the cam-and-lantern mechanism and creation of an animation of the mechanism.

3. Kinematic analysis of the movement of the output link of the mechanism, and, in particular, the construction of diagrams of displacements, velocities and accelerations of the output link.

4. Optimization studies of the cam-and-lantern mechanism according to the initial data, with the aim of determining the optimal mechanism according to various criteria.

To solve the given problem, a software program in the Visual Studio was developed, by means of Visual C# with SOLIDWORKS API functions included.

In the process of calculations, the theoretical and practical profiles of the cams are determined and 3D models of the cams are formed, corresponding examples are shown in Fig. 3.

Based on the results of calculations and modeling, you can also get a 3D model of the developed mechanism, for which you can generate the necessary design documentation.

In fig. 5 shows an example of two obtained options – for the number of rollers *z* = 3 and *z* = 8.

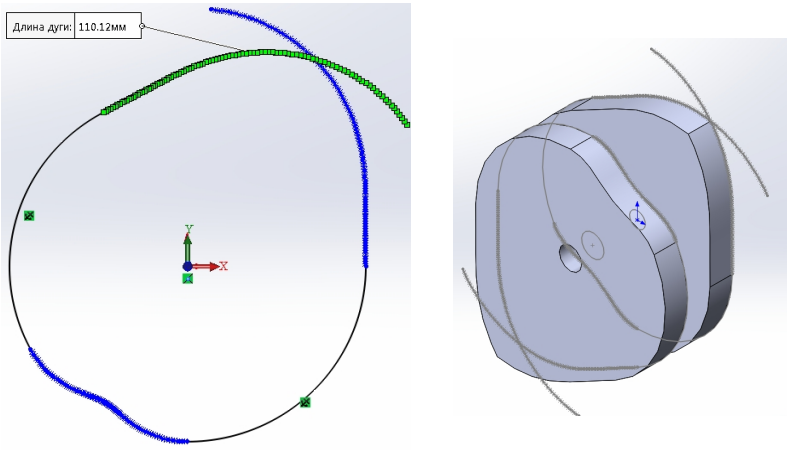

Fig. 3. An example of building a theoretical and practical profile and a 3D cam model

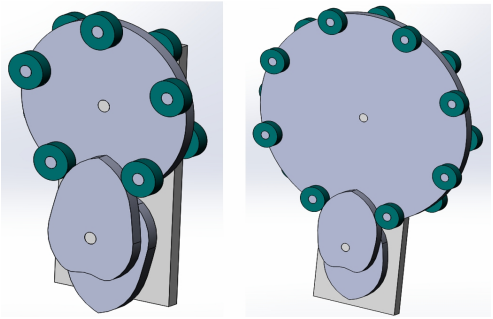

Fig. 4. An example of automated modeling of mechanisms with different initial data for synthesis

To determine the kinematic parameters of the output link (spindle wheel), in particular, to construct diagrams of displacements, velocities and accelerations, you can use the SOLIDWORKS built-in module for calculating kinematics and dynamics – SOLIDWORKS Motion, which allows you to easily create an animation of the mechanism and determine any kinematic parameters his link. In particular, in Fig. 6 shows examples of constructed diagrams of displacements and velocities of the output link.

Thus, the developed system of automated design of cam-and-lantern mechanisms allows to carry out analysis and synthesis of such mechanisms according to various criteria.

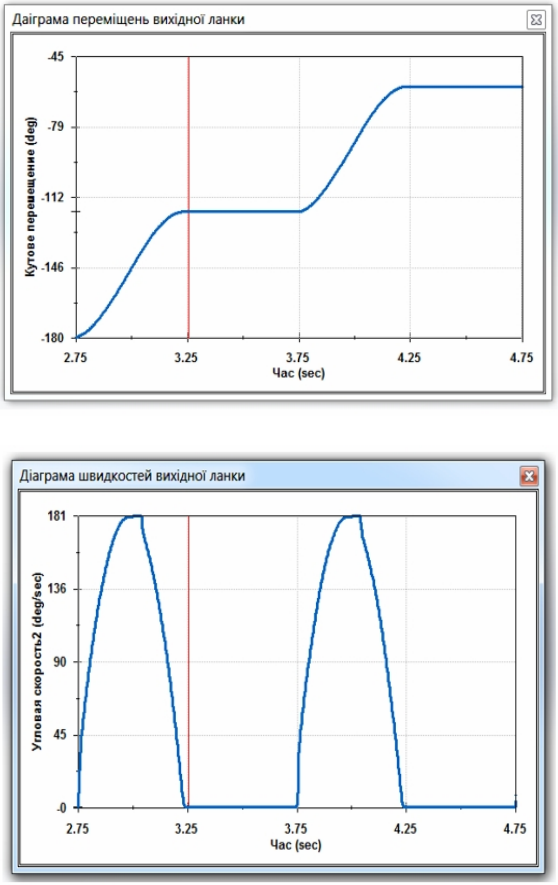

Fig. 5. Examples of obtained results kinematic analysis of the mechanism

References

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2. Kinytskyi Y. T. Theory of mechanisms and machines. K. : Naukova Dumka, 2002. 660 p.