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NEW TREND IN EDUCATION – VIRTUAL MODEL OF ELECTRICAL MACHINES

Abstract: The aim of the article is to describe the virtual laboratory of power electrical, which has been created on UVEE FEKT within project EDIPE or within some student thesis. The paper contains descriptions of possibilities creating virtual laboratory, the model for them and next evolution too. Virtual laboratory would be used either as supplement in daily studies or as the replace in combined form of study.

1. Introduction

At the Department of Power Electrical and Electronic Engineering of the Faculty of Electrical Engineering and Communication at the Brno University of Technology, there is also a combined study in the bachelor and master studies for which it is necessary to prepare, within e-learning, virtual laboratories and for these mainly models of electric direct current, asynchronous and synchronous machines. In our new PC classroom, we have the latest versions of parametric CAD systems – Autodesk Inventor and 3ds max. We use them for projects and both bachelor and diploma theses to create models of individual machines or at least their parts for application in virtual laboratories.

The basis of a virtual laboratory consists in simulation of the measurement of a motor. The aim of this contribution is to describe creation of a complete model of a machine for such laboratory – an induction single-phase motor with external rotor. The model will be comprised of electrical, mechanical and thermal parts. All these parts will be finally assembled to make a single complete model which will be used within the virtual laboratory program.

We can divide CAD systems by various aspects. If we ignore division to 2D and 3D modeling (the capability to create simple 3D models is currently provided by any better CAD system), the largest difference is between parametric and non-parametric modeling. We create motor models for the virtual laboratory in parametric CAD systems.

2. Parametric modeling

We consider a parametric model to be a model that is described mathematically by means of parameters. On such a model, the characteristics of its geometric parts are defined including mutual relations with other parts, if it is

in a system. In the model created in this way, dimensions and other characteristics are not defined by specific values, but by variables, expressions and formulas which relate to one another. After substituting several basic specific values, the actual dimensions of a part are calculated.

3. Systems using parametric modeling

3.1. Autodesk Inventor

This software is supplied in two variants – Series and Professional. Autodesk Inventor is a volumetric 3D modeler enabling modeling in the way a designer is used to thinking. The system supports parallel cooperation within a wider team of designers with reliable data sharing. It is characterized, in particular, by three basic features. These include a one-day productivity, high performance in working with large assemblies and adaptive technology.

3.2. 3ds max

If it is necessary to create a model in which high demands are placed on the visual aspect of design or on quality animation, the 3ds max program is an ideal tool. This parametric 3D system enables to create 3D objects from preset shapes and subsequently to change them at the designer's or animator's discretion. Owing to a generous offer of movements, distortions and mutual interconnection among individual 3D objects, 3d max is a highly creative tool for 3D modeling. For visualization and animation, there are numerous abilities for working with lights, body surfaces, and many other effects. The advantage of this system is also a fully customizable and open architecture, which along with a library of additional plug-in applications, provides users with the absolute creative freedom.

4. The creation of animation

The abilities of modeling in parametric 3D CAD systems are incomparable with drawing in 2D CAD systems. The greatest advantage for designers is a perfect overview of the three-dimensional shape of a part in the entire course of designing, an easy modification of any part in any moment and plenty of other functions which are simply learnt during designing thanks to intuitive operation and tuition-oriented help.

Animation or presentation is created in Inventor based on a gradual breakdown of a part to individual parts, by defining movement trajectories and a view of the part. For its visual presentation in the form of a gradual assembly of individual parts into a structural unit this tool is ideal for animation.
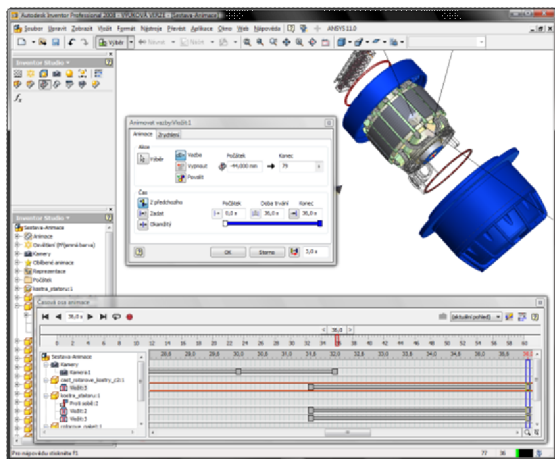

Fig. 1. The creation of animation - assembling of motor

Compared to the other 3D parametric systems, the animation abilities in the 3d max system are at a higher level. Using this program it is therefore possible to create complicated animations for which Inventor is not sufficient. Conversely, creating and designing structural parts is quite impractical in this system. Very advantageous is cooperation of the Inventor and 3ds max systems via the data format *.igs supported by both systems. Designing a part in Inventor and its subsequent animation in 3ds max is the most efficient way of creating an effective animation with the ability to use all advantages provided by parametric 3D modeling and a professional animation studio. The only considerable disadvantage of this cooperation is the necessary knowledge of both parametric systems.

5. The design of a modeled single-phase asynchronous motor

As every rotating machine, also this one is comprised of a stator and rotor. It is a motor which has a less common construction where the stator is located inside the rotor that rotates around it. The stator frame is comprised of stampings that are insulated from one another and they make up a part of the magnetic circuit of the machine. These stampings have cut out slots in which there is a winding and its starts and ends are brought to a terminal box. This motor has dual winding: auxiliary and main. The rotor is comprised of a short-circuited aluminium winding. Rotor stampings are pressed on a shaft which rotates in bearings. Between the stator and rotor there is an air gap which should be as small as possible to prevent unnecessary losses in air from occurring. In the rotor slots there is the winding which is short-circuited on sides. In single-phase motors of lower powers, the winding is cast together with ventilating blades out of aluminum using casting under pressure. Such winding is called a cage. These motors are used most often as fans, where individual blades are mounted onto the outer construction of the rotor. The rated speed of these motors ranges between 300 and 800 rpm.
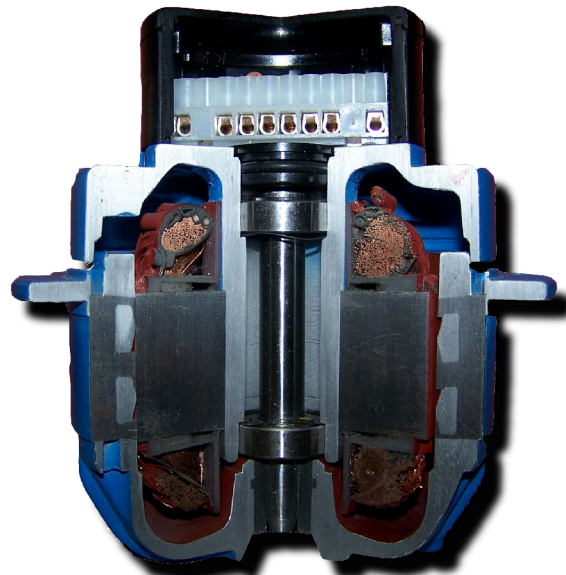

Fig. 2. The construction of modeled motor – the section of stator and rotor

When creating the animation, we took as the base a complete asynchronous motor which was modeled completely in Inventor. The file Sestava.iam was used for animation and it was fur-

ther adjusted in the auxiliary application Inventor studio. This part of Inventor is designed directly for creating moving visualizations.
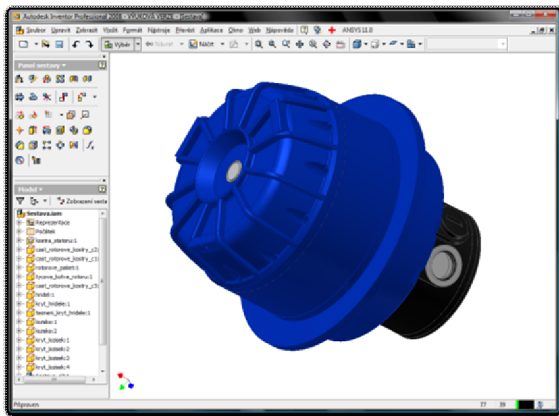

Fig. 3. The model of single-phase asynchronous motor

6. Data formats for storing 3D body representations

6.1. What does a data format means?

The data exchange format is important for creating a model and for transferring data between individual CAD systems. The term "data format" means a certain organization of data stored in a file. Basically, data are information of a certain type. It can be a simple text, an image, sound, video or anything else. However, to give data some sense, it must be defined what these data actually mean and how they are organized.

So the data format clearly defines how data are stored or how to store them to be able to use them effectively.

6.2. Basic data for 3D body representation

In the field of computer technology, a 3D body is defined not by its volume, as in the real environment in which we live, but by its surface. Although objects are divided in programs to surface objects and volume objects, also these volume objects are comprised of a surface. The only difference between them is that volume objects have a "closed" surface.

It is a general surface which can be converted, with a certain loss in accuracy, to a certain number of plane surfaces. The plane surface usually means a bounded surface lying in a certain plane. The plane is defined clearly by three points. These three points can also serve for bounding the surface lying on the plane that the points define. This creates a triangle in the 3D space. And the triangle is the most elemen-

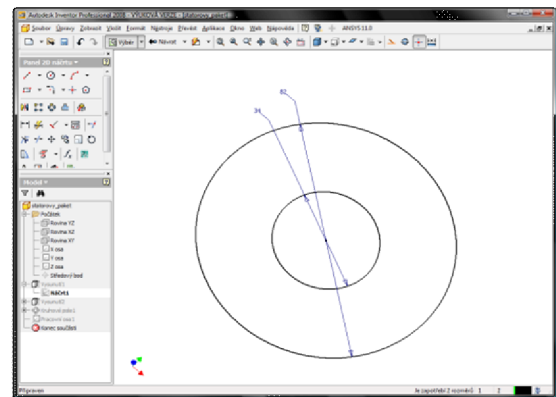tary graphic object which is processed by graphical interfaces.

Fig. 4. The sketch of model

So the basic data representing a 3D body are the points making up the apexes of a triangle. Then surfaces representing a 3D body are created out of the triangles. Other data that specify a 3D object more closely can be the color of the object surface or even the color texture.
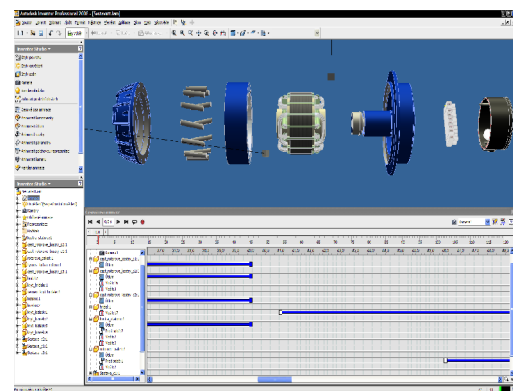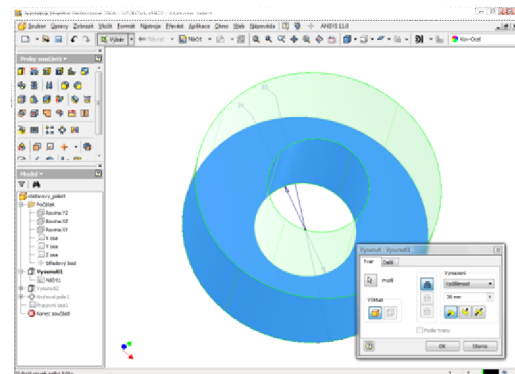

Fig. 5. The creation of solid

Fig. 6. The environment for design of animation at Inventor Studio

7. Conclusion

This aim calls for principally new modern methods of education. There is necessary to prepare many models with application of 2D and 3D modeling to principal parts of electric machines and apparatus. This model is one of the first outputs.

Acknowledgments

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