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# USE OF 3D SCANNER FOR DIAGNOSTIC OF ELECTRICAL MACHINES DESIGN

**Abstract:** This paper deals with 3D scanning in power electrical engineering. Specifically, using a scanner company Z800 Z-Corporation. This scanner was used to diagnose the structure of the electric machine coil. After taking all necessary steps to create 3D models from scanned data the model was obtained. This model was compared with the model that was created in one of modern CAD systems. This model made for the primary model for the production of measured coil. The variations in the construction of a coil were identified. Subsequent analysis identified the causes of changes in dimensions.

## 1. Introduction

3D scanners are nowadays mainly used to create digital models of artistic and architectural objects. Gradually, they found the path to use in technical areas of human activity. Features and options 3D scanners are beginning to use in the automotive industry and mechanical machining. Application for the use of scanner can be found even in heavy electrical engineering, specifically in the process of design, modification and optimization of electrical machines.
In addition, these models can be used for diagnostics of the construction of parts of electrical machines. Using digital models can be detected deflections between the proposal and actually realized object (e.g. prototype). These variations may arise in a process of manufacture or errors in the manufacturing process. Application of 3D scanner enables a relatively rapid diagnostics and evaluation of design variations. This can help to find the removal of problems in production.

## 2. 3D Scanners

In the markets a large number of 3D scanners appear - they can be used in heavy-current electrical engineering. The various types are different in principle of scan, mobility and especially accuracy.

### 2.1 Principles

3D scanners use large number of physical principles for function. The basic ideas are the same for all scanners. It is necessary to measure as accurately as possible the distance between the scanner and digitalized object. Some scanners are based on the contact methods, others on contactless. Contact methods are based on direct contact with the measured object. Among the most frequently used methods include:

**Flight time measurements of light** – a scanner measures the time between sending the light beam and the adoption of the beam reflected from the surface of the scanned object. Base on the known speed of light then it is possible to calculate the distance from the object scanner.

**Holography method -** laser source generates a light ray on the scanned object. That ray is defused on the surface of the object scatter in all directions. Part of the reflected light is captured by sensor lens and strikes the prism. This will ensure the distribution of light rays to sub-rays. There is creates an interference pattern, and it is recorded by the sensor. Interference pattern provides information about the angle of incoming light beam and is stored in memory.

**The method of structured light** - light scanner reflects the pattern of the measured object. Sensor records how the projected pattern is changed on the object. Observed deflection model using complex algorithms are converted into distance.

**Triangulation method** - light source (e.g. laser) transmitted light ray on the scanned object. Camera scanner will capture his reflection. Scanner is based on the deflection of the light ray from the centre of the camera lens. Upon distance between the camera and light source it is possible to calculate how far away the object is from the scanner.

### 2.2 Parameters of 3D scanner Z 800

The measurements were realized by 3D scanner of Z-Corporation marked ZScanner ® 800. It is a universal mobile scanner. This device operates on the principle of triangulation. The scanner is equipped with a laser that shines on the scanned object. Scanned place is also recorded by the camera. Based on the knowledge of difference between reflected laser ray from centre of the camera lens and knowledge of the distance between laser and camera, the distance is determined from the scanned object. Z800 is equipped with three cameras for increase accuracy and speed of scanning. This makes it possible with this scanner to make the measurement with an accuracy of 0.8 mm. This accuracy is sufficient for most uses.
Together with the scanner the special software is supplied. This software allows fast transfer of data and save data in one the normally used exchange graphic formats (e.g. SAT, IGES). Such model can be transferred to modern CAD systems or to other specialized programs.

*Tab. 1 – Parameters of 3D scanner Z800*

| | |
|---|---|
| Laser: | Class II (eye safe) |
| Number of Cameras: | 3 |
| XY Accuracy: | Up to 40 microns |
| Resolution: | 0.050 mm in XYZ |
| Weight: | 1.25 kg |
| Dimensions: | 171 x 260 x 216 mm |
| Data Transfer: | FireWire |
| Power Source: | FireWire |

## 3. Diagnostic of coil construction from electric machines

For diagnostic of construction there was chosen part of coil of big electric machine. When designing the coil there is placed great accent on the shaping. Model of coil is very exact in modern CAD systems, but real components have always different dimensions.

These variations are caused by the technical possibilities of production machines and technological processes.

### 3.1 Scanning of coil

Scan of the coil part is only a first step that is needed to be done in the diagnostics of the construction. The basic information obtained with scanning are in the form of coordinates field of scanned points (Fig. 1). These data need further modification to be able to use for diagnostics of construction.

*Fig. 1. Results from scanning - Cloud of point part*

After reading the field of coordinates by specialized software it is possible to create a generalized model of the surface coil. Surface model can be generated directly using a scanning program (STL format). Then the user has very limited options for modifying the model.

The next step is fix model. There is never scanned the entire object without a single blemish, indeed. In some areas may set in certain inequalities and holes. This is due not only to use 3D scanner, but also a mathematical algorithm. This algorithm ensures the transition from the field points into the surface model. Modification of the model must be done very sensitively. Injudicious check on the model could mean adding errors into the measurement and thus the degradation of diagnostics of scanned coil.

The last step after adjustment model is then 3D model creating of the coil (Fig. 2).

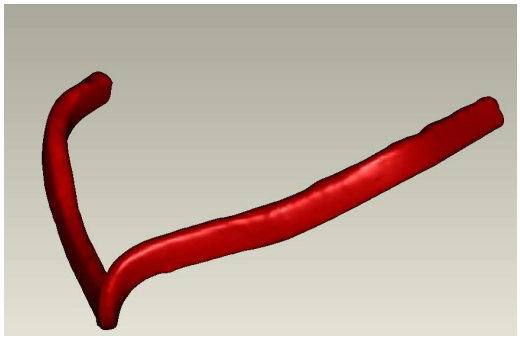

*Fig. 2. 3D model of coil part*

### 3.2 Comparation of scanned model and CAD model

To identify differences in the structure is need to have a model created in a modern CAD system (Fig. 3) and scanned model of the coil. As shown in Fig. 4, part of the model in CAD system is longer than scanning part. This difference is not significant in the diagnosis, because program will compare the variations only on the scanned model.

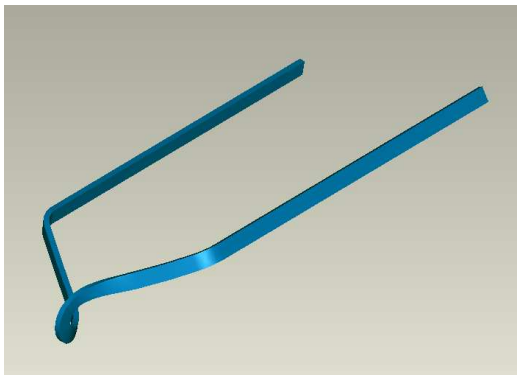

*Fig. 3. CAD model of coil part*

An important step is the placement of models on each, that the orientation of them is exactly the same (Fig. 4). If the model is created in the same plane as the scan was carried, there is no problem with it. If, however, both models are oriented differently, one must use special functions. Using these functions it can be aligned through the models themselves on the basis of identical edges or points.

As shown on Fig. 4, it is possible to see variances in the structure already in optical comparison of models.

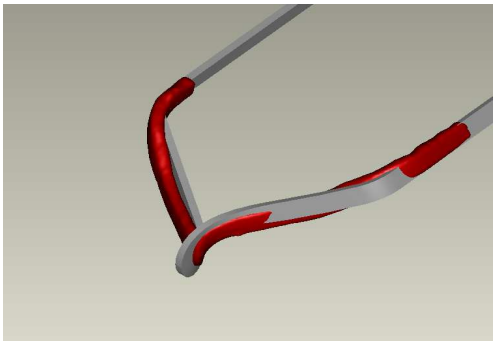

*Fig. 4. Comparison of scanned and CAD models*

### 3.3 Results of comparison

The last step is the utilization of diagnostic function of the program for comparison of models. The Fig 5 is a graphical representation of visible variations of the coil part structure created in CAD system and the scanned model.

As seen, variations in construction are sporadically very considerable. The largest deviation in the construction is about 18 mm. This deviation is very significant and shows that in the process of manufacture and storage of the coil there is not all in order.

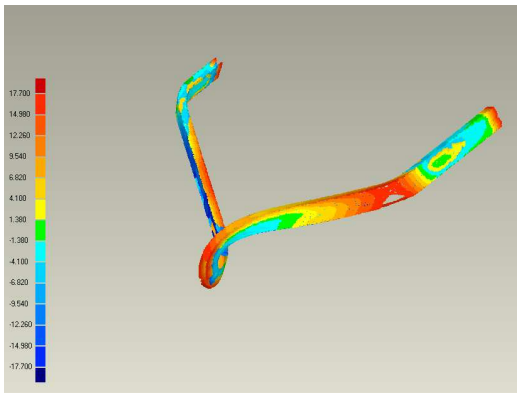


*Fig. 5. Results of comparison*

By the help of analysis of production, handling and storage there was found that variations in design were not in this case caused by a technological process. The deformation of construction was based on unprofessional handling and storage of the coil. During the handling has it comes about operation of large forces on the coil material. Given that this material is copper, there was a permanent deformation of the shape of the entire coil.

## 4. Conclusion

The use of 3D scanners has a wide field of power electronics applications. The possibility of rapid diagnosis of electrical machines design components can be useful both in the production of prototypes, and in mass production. It is in mass production where it is necessary to control the quality and compliance with production standards.

Diagnosis of the coil design showed that when it is used and then evaluate correctly it is possible to locate the weak point in the manufacturing process. This enables you to avoid needless mistakes and thereby reduce the cost of any reclamation.

It is necessary however to say that an accurate scan using the scanner of company Z800 Z-Corporation is a matter of experience and practice. If the scan and would-be modification of model made negligently or in a recorded are registered further errors, the diagnosis is inaccurate and design can be very misleading.

Nevertheless, it is possible to say that the use of 3D scanners in heavy electrical engineering will find wider application. Creating a 3D model of the fan or other parts of electrical machines can be used not only to diagnose the construction. These models can be used as a basis for calculations in programs such as Ansys or CFX. They will then create a model of physical fields and currents, which on these parts have effect. The modification and optimization of various parts of electrical machines greatly simplifies.

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