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COMPUTER VISION FOR THE 3D COILS TRANSPONDER QUALITY MONITORING

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***Abstract*- Evaluating the electrical 3D coil quality has always been difficult task. Currently, the inspection is performed manually by the operators. The detection of appearance and geometry's defects for the small 3D coils requires the implementation of a robust and fast control system.**
In this paper, we propose a complete solution of 3D transponder's coils quality monitoring, based on artificial vision. This approach is based on image processing techniques using digital vision algorithms. It relies in the first step on the detection of the existing defects in the controlled part, and to quantify the density of their presence in the second step, before evaluating its conformity in the final stage.
A prototype has been designed and set up in reel production line to check the eventual damages of transponder coils, and allows the detection of their references. The latter has shown via experimental results how the vision systems can improve strongly the reliability and improve the accuracy of the inspection tasks.

Keywords:Artificial vision –Non destructive inspection – Image processing – defect identification

I. INTRODUCTION

Nowadays, industrial companies operating in an environment in constant competition, suffer a high pressure, while they try to get the balance between ensuring customer satisfactions, maximum financial income and conserving the ethical responsibilities. In order to deal with all these challenges and achieve their smart objectives, the finish good must be subjected to specific tests in order to ensure the conformity with the required specifications.

3D transponders manufacturing is a very demanding industry in terms of quality and performance. Besides of the automotive industry, 3D transponders are used in many other applications as: access control, logistics, animal identification, traceability of products, etc. In the specific applications in automotive, the transponders are used in the identification or the acceptance of a key by the vehicle immobilization system by means of radio-frequency (RF) signals. The isotropy is frequently looked for in the RF antenna, with a keyless entry system. This functionality was attained by the combination of 3 simple coils oriented in the 3 space's axes, with the objective of covering the maximum space orientation. This small 3D coil offers the possibility of mounting simple 3-coil components (see figure 1) with full functionality, reducing costs, saving PCB space and increasing circuit reliability.

This paper presents an automated contactless solution for the control of the coil damages and the legs of the transducer axis based on artificial vision. This approach makes it possible to identify and ensure the real-time control of the aspect identification, helping to respect production rate and emergencies.

The idea of this solution was initiated following the technology evolution in the artificial vision which has grown strongly in recent decades. It is one of the areas that are experiencing growing demand from companies in various industries. It is used to determine the quality of certain products such as LCD [1], leather [2], apple quality [3], wood [4], steel [5] [6], printed circuit board [7] and Ceramic tiles [8], etc. Nowadays, artificial vision is used in industry in a variety of applications: product quality control, automation, video surveillance, etc.

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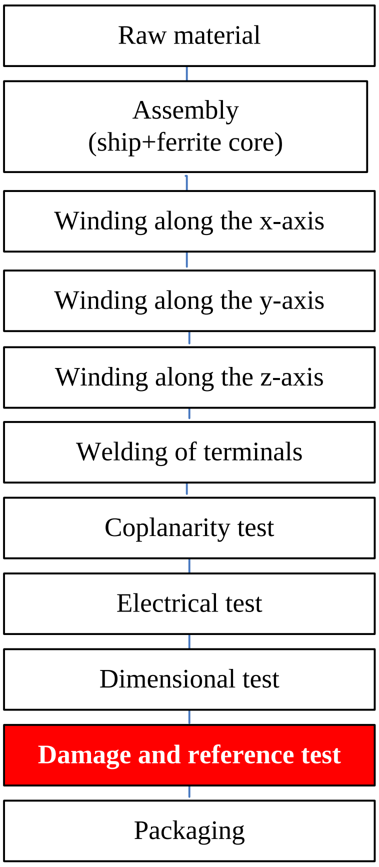

Fig. 1 Manufacturing process of transponders

II –BROACHED PROBLEMATIC

The quality control of transponder coils have to follow reliable tests, considering the safety impacts that can be generated by the eventual damages.

Currently this control is carried out visually using an optical microscope to detect the damage. However fatigue, uncertainty of the human eye and measuring equipment, high production rate, time pressure, etc., generates a degradation of the small defects detection reliability. Assessment of their conformity is consequently very subjective and delicate.

In this context, the implementation of a robust and efficient fault detection model remains essential in the mass production industries.

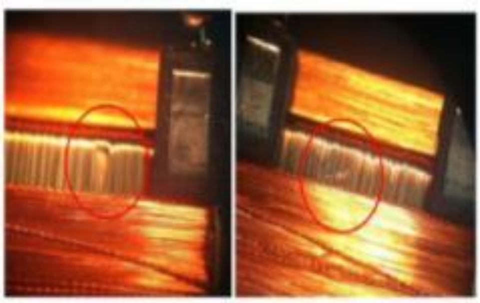

Figure 2 Example of coil damage

III- EQUIPMENT AND METHODOLOGY

In order to scrutinize the problematic described above, in the objective of changing the coil damages detection from manual control to automated one, we adopted a computerized approach based on the digital images processing using an HD camera, and a developed algorithm in C# environment using OpenCV library.

The camera provides a high quality image and color reproduction, and it is equipped with a 5-megapixel sensor and several special functions such as Flexible LED Control (FLC), Automatic Magnification Playback (AMR).

The image capture obviously requires a high level of illumination, in order to better identify the quality defects on the controlled part. This functionality is ensured by a torch lamp that provides continuous illumination in a parallel direction of the coil wires and perpendicular with the camera (see figure 2).

Fig. 3 Position of the controlled part, camera and light

IV –ARTIFICIAL VISION SOFTWARE

Two modules were elaborated in the C# environment, to suit the studied problematic (see figures 4 and 5).

- The first one includes four blocks to ensure the exactitude of the finish reference label
- The second one includes ten different blocks to identify the electrical coil damages

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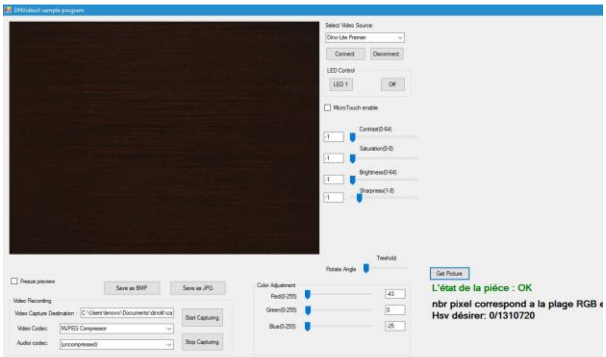

Fig. 4 General view of the test system screen

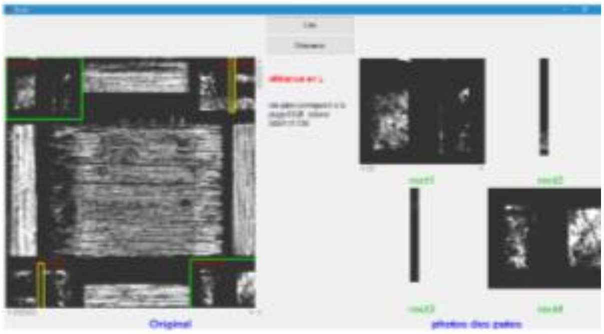

Fig. 5 General view of the reference system screen

V – RESULTS AND DISCUSSION

A–Reference test system

1) block I : It is used to display the recorded video by placing a rectangle on the areas to be tested (see figure 6).

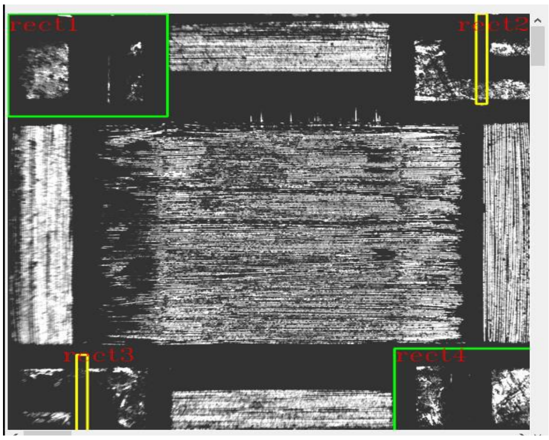

Fig.6tested areas.

The processing cycle starts when the image is taken, then the system draws rectangles on the legs of the part. The image is transformed into a bitmap format, in order to scan all the pixels. The algorithm tests then, the RGB and V (brightness) values on each pixel of the 1st tile. This cycle proceeds to the treatment of the next tile, until covering the whole piece.

The conformity of the part is pronounced by comparing the measured values with the predetermined values of the reference. If it's less than the limit, the part is reference parallel (see figure 7), if not the reference is the reference L see figure 8).

Fig.7Piece reference parallel

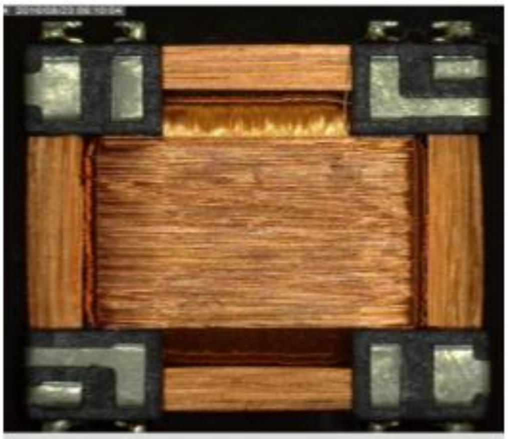

Fig. 8 Piece reference L

2) block II : Displays the rectangles encircling the tested area (the part's legs illustrating the reference type).

The thin rectangles indicate the existence of a difference between the two references (see figure 9).

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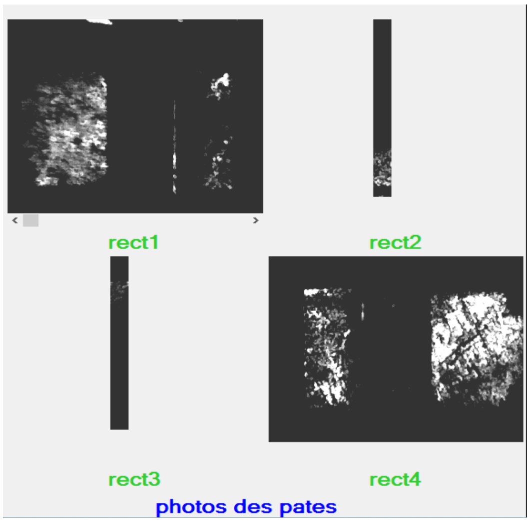

Fig.9Test unit

3) block III: Illustrates the information related to the type of reference and processing results (see figure 10).

L - reference

Number of pixels corresponding to the desired RGB range : 564/171/736

Fig. 10Reference information

B- Damages test system

The software was implemented on the production line, the capture is done automatically after detection of the part by an infrared sensor. Subsequently, the captured image is split into 16 equal rectangles to increase the sensitivity related to the defect, and store it as a bitmap to scan all pixels.

Then, we tests the RGB and V (brightness) values of each pixel for all tiles, and compares the results to the RGB and V ranges, if no defect is detected it concludes that the controlled piece is conform (see figure 11).

(a)

(b)

Fig. 11 Position of the identified damages and test results: (a) defective part (b) non-defective part

The results were satisfactory and conclusive, since the software was able to classify the image of the manufactured parts as defective / non-defective with a 100% accuracy, in addition it permit :

- Control time under 2,5 s
- The measuring system capability less than 1,33.
- The system measures without contact with the finish good. This operation will never generate any damage to the coil.

VI. Conclusions

In This paper we presented the design of an artificial vision system for the monitoring of the 3D Coils transponders damage and leg test references.

Several experiments were carried out, with different image processing algorithms, to finally adopt the suitable fault identification model based on the measurement of the RGB and HSV values of the damage. The

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implementation of the designed system proved to be robust with all the performed tests.

The illustrated approach can be applied in a various sectors and activities such as fruit sorting, preserves, etc. Substantial savings can be achieved following this strategy.

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