The automated recognition part markings algorithms

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Abstract. The development is aimed at the problem parts marking recognizing solving in mechanical engineering. Marking makes it possible to ensure the correct parts use and assemblies during assembly, to facilitate the assembly processes automation in production conditions. The algorithms and procedures presented in the article are based on a mathematical apparatus for improving the marking image quality and its recognition. The paper presents a functioning algorithm for the evaluation subsystem and improving the marking image quality based on the processing procedure "sliding window". A marking recognition algorithm has been developed, the task of which is to recognize the symbols and designations that form the marking. The marking selection procedure result example on the object is given. The proposed algorithms allow for the product markings recognition in production conditions with sufficient reliability.

1 Introduction

In the modern machine-building production conditions to ensure the parts and assembly units identification is widely used their marking. Marking allows ensure the parts and assemblies correct use during assembly, to facilitate the assembly processes automation in the in-line production conditions, to increase the production flexibility by using in assembly processes exactly those parts that are necessary for the product a particular modification.

Marking is important for the product quality control system organization, as well as the automated CAQ system use. Marking allows identify performers throughout the entire technological process, encode specific product characteristics, and ensure product tracking throughout their entire life cycle. The marking is carried out in the numeric, alphabetic and other signs form that uniquely identifies this product and its manufacturer. In mechanical engineering, alphabetic signs, digital signs, barcodes and these coding methods combinations are most often used.

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2 Materials and methods

The marking methods and these methods application results differ significantly. This is explained not only by the various application technologies peculiarities, but also by the materials from which the parts are made and their condition at the application time. It is also necessary to take into account the change in the marking state during the transportation and parts operation.

The systems used for reading must ensure the marking applied to the part or assembly an error-free reading, regardless of its application method the symbols and signs used for identification. It is also necessary to take into account the organizational restrictions imposed on the reading process related to the various production type's peculiarities. In the in-line production conditions, it is unacceptable that the marking identification process affects the technological process duration. The best solution in this case is to perform the marking reading process at the input control stage or transportation to the technological process next operation, which requires the process automation [1].

In mechanical engineering, the marking following types are most often used for marking parts and assemblies: laser marking, drop-jet marking, impact marking, electrolytic marking method, micrograving with a milling cutter [2].

After analyzing the existing marking recognition systems, we come to the following conclusions: the marking recognition system should be contactless, provide reading of any markings regardless of the application method, have a high automation degree, have good performance, be able to read slightly damaged marking images, be noise-resistant, provide quick reconfiguration to read a new marking type, have a simple design. In modern conditions, the most promising is the creation of an automated marking recognition system based on an electronic optical module and a personal computer.

3 Results and discussion

One of the main requirements for automated recognition systems is to ensure the automation of the process. To do this, it is necessary to develop appropriate algorithms for the various subsystems functioning. Based on the reading systems analysis, it was decided to design a system based on an electronic optical module and a personal computer. Based on this, it follows that recognition will be based on a digital image [3]. Processing a real digital image in order to solve the detecting and recognizing an object on it problem requires at least solving two problems. Firstly, it is the image quality assessment and improvement and secondly, it is the object direct recognition, which in our case is the marking. We will develop algorithms for the subsystems functioning subsystems aimed at solving these problems.

The subsystem evaluation and image quality improvement functioning algorithm is shown in Figure 1. The main task of this algorithm is to determine the presence of a suitable marking presence for recognition and to improve the resulting image the quality.

The algorithm functions as follows.

An image obtained from a digital camera or other imaging device undergoes primary processing, which consists in obtaining from the image its necessary characteristics for further processing [4, 5]. Next, the marking is searched and highlighted in the image [6, 7]. After completing this step, the system must determine the presence of markings on the image.

If the marking is not detected, a message about the marriage in the marking is issued. If the presence of the marking presence is fixed, the next step is performed, aimed at improving the marking image quality.

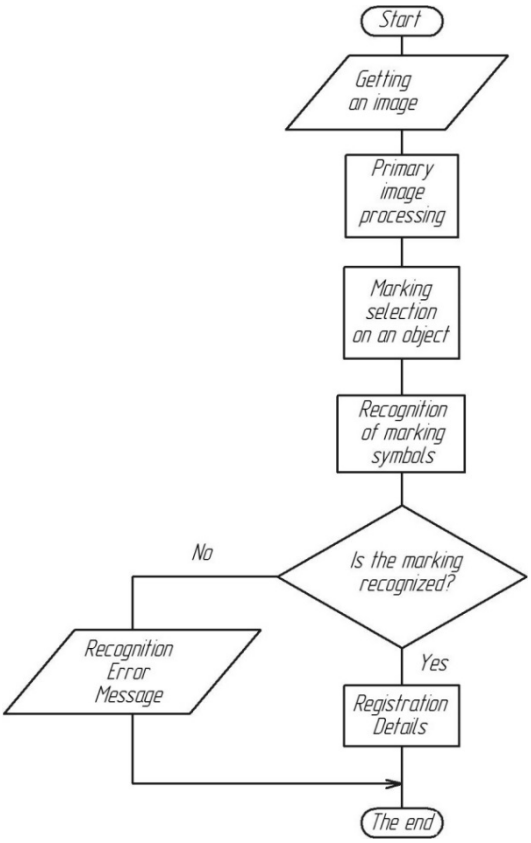

Fig. 1. The subsystem evaluation and image quality improvement functioning algorithm.

The marking recognition algorithm is shown in Figure 2.

The algorithm main task is to recognize the symbols and symbols that form the marking.

The algorithm functions as follows. The image preprocessed and improved according to the evaluation subsystem functioning and quality improvement algorithm is loaded into the proposed processing algorithm.

At the next stage, the primary image processing is performed, similar to the previous algorithm in order to obtain its characteristics. Then the marking area is highlighted in the image and the device for recognizing symbols and symbols forming the marking is launched.

At the next stage, if the marking is recognized, depending on the production task being solved, the system enters data about the part or node into the appropriate database or searches for information about it in the CAQ system of the enterprise. If the marking is not recognized, the system should issue a message about the marriage in the marking.

Next, the marking image quality with the requirements conformity re-check is performed. If the marking image quality does not meet the requirements, a message about a defect in the marking is displayed. If the marking image quality meets the requirements, then such an image is accepted for further processing and the marking recognition.

It follows from the algorithms that in order to ensure markings automated recognition, it is necessary to develop procedures for primary image processing, marking selection on the object, improving the marking image quality and marking symbols recognition.

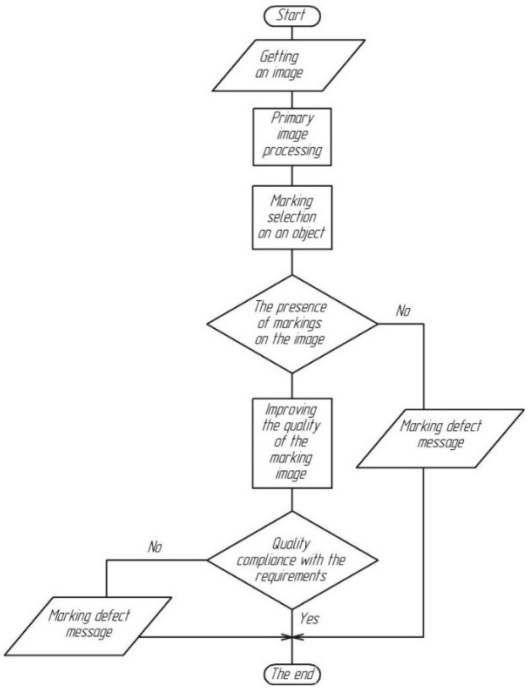

Fig. 2. The marking recognition algorithm.

Let's consider these procedures in more detail. The primary image procedure processing involves determining the noise reduction arising under the in various factors influence acting in the obtaining a digital image process. Such noises can occur due to poor image acquisition conditions, the image background presence, image sampling and quantization processes, imperfections in the image transmission and display system. Solving this problem requires an integrated approach. The noise effect reducing arising from poor image acquisition conditions can be reduced by using additional illumination when obtaining an image. However, most of the noise can be eliminated by applying well-known image processing algorithms, discussed in more detail in the literature [6].

The procedure for marking on an object is to search for the marking area, that is, to find its coordinates. The marking initial image example is shown in Figure 3, and the procedure marking selection object result is shown in Figure 4.

Fig. 3. The marking initial image example.

Fig. 4. The procedure marking selection object result.

The primary image processing procedure involves determining the noise reduction arising under the various factors influence acting in the obtaining a digital image process. Such

noises can occur due to poor image acquisition conditions, the presence of an image background, image sampling and quantization processes, imperfections in the image transmission and display system. Reducing the noise arising effect from poor image acquisition conditions can be reduced by using additional illumination when obtaining an image. However, most of the noise can be eliminated by applying well-known image processing algorithms [7].

Improving the image quality in the case of marking recognition is one of the ensuring key tasks the quality of mechanical engineering products. Procedures for improving the marking image and marking recognition symbols the quality are based on the mathematical apparatus implementation. Traditionally, various algorithms are used to solve it [8, 9]. In this case, the "sliding window" processing procedure is used to improve the image [10]. This method has the necessary versatility and gives good results regardless of the texture and other features of the images, which is important when working with markings obtained by various methods of application. A "sliding window" in this case is a limited area that moves sequentially over the image entire area. In each new position, the output image value is calculated. The processing this kind general appearance is described by the expression:

$$g(n_1,n_2)=G[\{f(n_1-m_1,n_2-m_2)\},(n_1,n_2)\in D] \quad (1)$$

Where $g(n_1,n_2)$, $f(n_1,n_2)$ – are two–dimensional sequences of the input and output images, respectively samples ; G – is the transformation operator; D – is a finite set of samples given relative to the origin and determining the processing window shape and size.

The image processing examples of markings applied by various methods in order to improve their quality are shown in Figures 5-8.

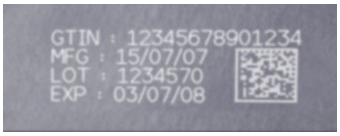

Fig. 5. Noisy image of laser marking.

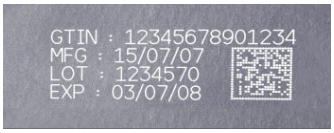

Fig. 6. Restored image of laser marking.

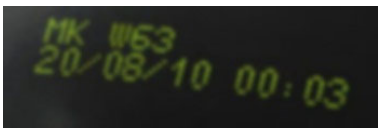

Fig. 7. Noisy image of the drip-jet marking.

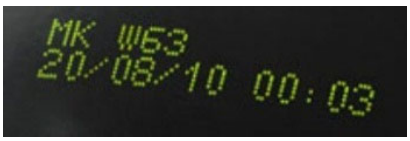

Fig. 8. Restored image of the drip-jet marking.

The recognition system should be considered from the structure of its software and the hardware part system structure view point. The marking recognition system main structural components data formation should be based on the requirements imposed on the system.

Testing of the designed automated part marking recognition system was carried out by recognizing markings applied by laser marking, drop-jet marking, impact method, electrolytic method, microgravity milling cutter. For recognition, 100 markings applied by each of the methods were taken, a total of 500 markings. 4 markings were unrecognized and recognized with errors, which is 0.08%. The operation stability was checked by the markings recognition on one sample. The recognition operation was performed 50 times; the marking was recognized without errors. The system's resistance to noise was also evaluated. To do this, noise was artificially stepwise added to the marking image. The system gave an error at a noise level of 15%. These systems testing results operation can be considered satisfactory.

4 Conclusion

The developed algorithms and procedures implementation is based on the proposed mathematical apparatus for improving the marking image the quality and the mathematical apparatus for marking recognition. The marking recognition system hardware part implementation was proposed and this system operability an assessment was carried out, which showed that the designed automated marking recognition system meets all the requirements imposed on it and allows for the product markings recognition of in production conditions with sufficient reliability.

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