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PREDICTIVE MAINTENANCE OF THE AUTOMATED SEWING MACHINES IN TEXTILE INDUSTRY

ŞUTEU Marius Darius[1], BABAN Calin Florin[2], BABAN Marius[2], DRAGOMIR George[2], TOTH (Kiss) Edit[3]

[1]University of Oradea, Faculty of Energy Engineering and Industrial Management, Department Textiles, Leather and Industrial Management, 410058, Oradea, România, E-Mail: suteu_marius@yahoo.com

[2] University of Oradea, Faculty of Managerial and Technological Engineering, Department Industrial Engineering, 410087, Oradea, România, E-Mail: imt@uoradea.ro

[3] Doctoral School of Engineering Sciences, University of Oradea, România.

Corresponding author: Marius Darius, Șuteu, E-mail: suteu_marius@yahoo.com

Abstract: *One of the most used approaches to schedule maintenance is condition-based maintenance. The automated sewing machines are state-of-the-art complex machines that operate at high speeds, where vibrations and noises are generated by their moving parts. The levels of vibrations and noises increase at the high-speed working regime and when some components are worn out. Within this context, the aim of this paper was the development of a software product based on fuzzy logic to schedule the replacement of the needles of the automated sewing machines based on their condition monitoring. The research was carried out on an automated sewing machine that operated at the recommended working speed of 3500 stitches/minute. The sewing material was polyester and NM 80 sewing needles were used. Vibration measurement was performed using the Top Lab-GBDT-L device, while the Center 322 sonometer was employed to measure the level of noise. The integrated software environment R was employed to develop the software product. This software allows the establishment of the time when the replacement of these needles should be done taking into account their noise level and vibrations amplitude. An example demonstrates the effectiveness of the software product for the replacement of the needles of automated sewing machines.*

Key words: *needles, noise, vibrations, fuzzy, software.*

1. INTRODUCTION

Condition-based maintenance is one of the most used approaches to schedule maintenance in different industries [1]. In condition-based maintenance, different measures can be employed to monitor the degradation state of analyzed equipment or machines [2]. In the case of textile machines, their condition has been monitored through vibration sensors [3], resistive strain gages [4], thermographic camera [5] or sonometers [6]. Then, a prediction of their time-to-failure can be performed based on the monitoring process.

The automated sewing machines are state-of-the-art complex machines that operate at high speeds (5000-7000 stitches/minute). During operation, vibrations and noises are generated by the moving parts of automated sewing machines. The levels of vibrations and noises increase at the high-speed working regime and when some components are worn out [7].

Within this framework, the purpose of this paper was to develop a decision system based on fuzzy logic for predicting the failure of needles of automated sewing machines, considering their vibrations amplitude and noise level.

2. EXPERIMENTAL PART

The research was carried out on an automated sewing machine that operated at the recommended working speed of 3500 stitches/minute. The sewing material was polyester and NM 80 sewing needles were used. Vibration measurement was performed using the Top Lab-GBDT-L device with the vibration sensor placed on the OZ axis (Figure 1). The Center 322 sonometer was employed to measure the level of noise.

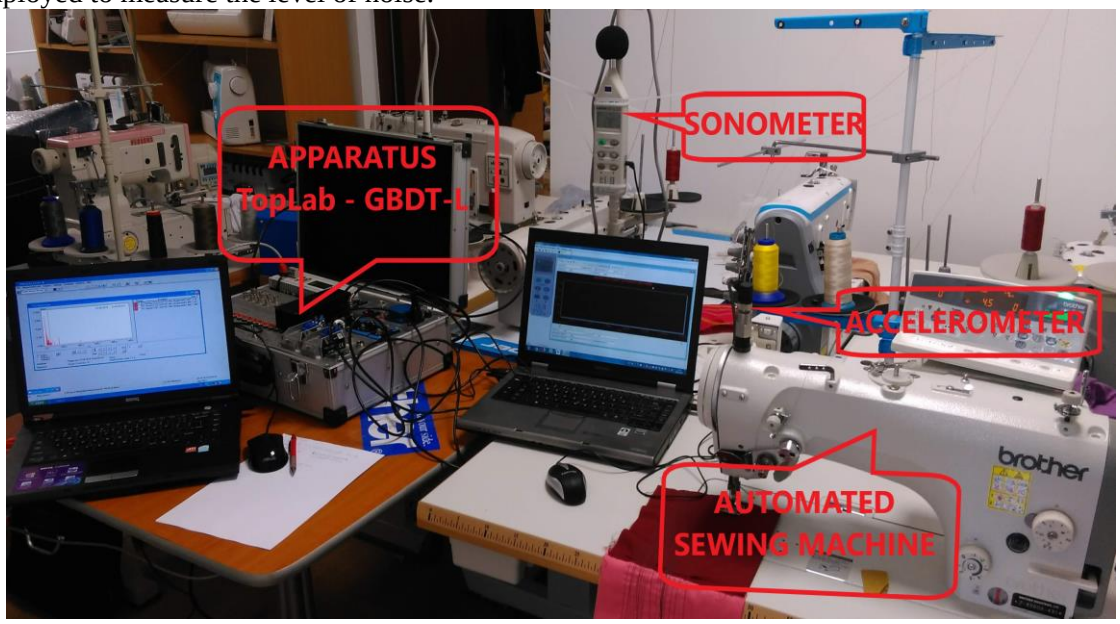
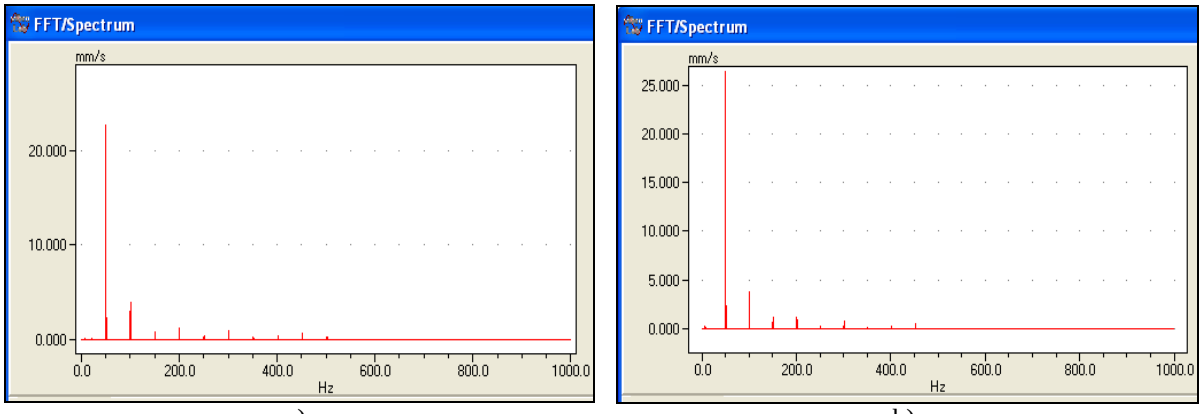


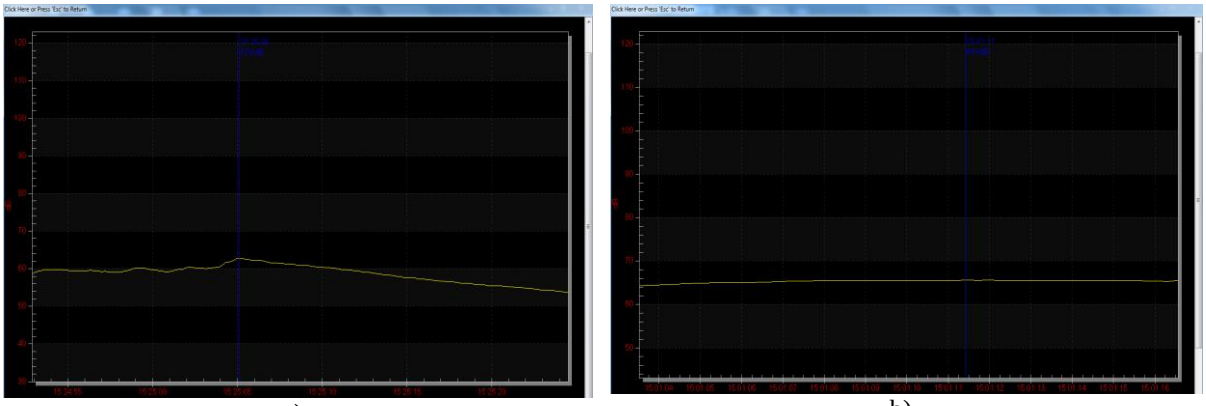
Fig. 1: *Measurement of vibration and noise level for the analyzed automated sewing machine*

The amplitude of vibrations and noise level were measured for a new needle and a defective needle. Figure 2 depicts the amplitude of vibrations for the employed needles, while figure 3 shows the noise level for the same needles.



a) b)

Fig. 2: *The amplitude of vibrations for a) new needle and b) defective needle*



a) b)

Fig. 3: *The noise level for a) new needle and b) defective needle*

3. A SOFTWARE PRODUCT BASED ON FUZZY LOGIC FOR MAINTENANCE SCHEDULING OF THE NEEDLE OF AUTOMATED SEWING MACHINE

A software product based on fuzzy logic was developed to schedule the replacement of the needles. The software determines when the needle should be replaced, depending on the vibration amplitude and the noise level. The development of this software product was achieved through the integrated software environment R.

The software product (Figure 4) contains 2 input variables (noise level expressed in db and vibration amplitude expressed in mm/s), 1 output variable (duration of operation of the needles to their replacement expressed in minutes) and 25 rules for the fuzzy rule base. Figure 5 shows the inference of the fuzzy decision system.

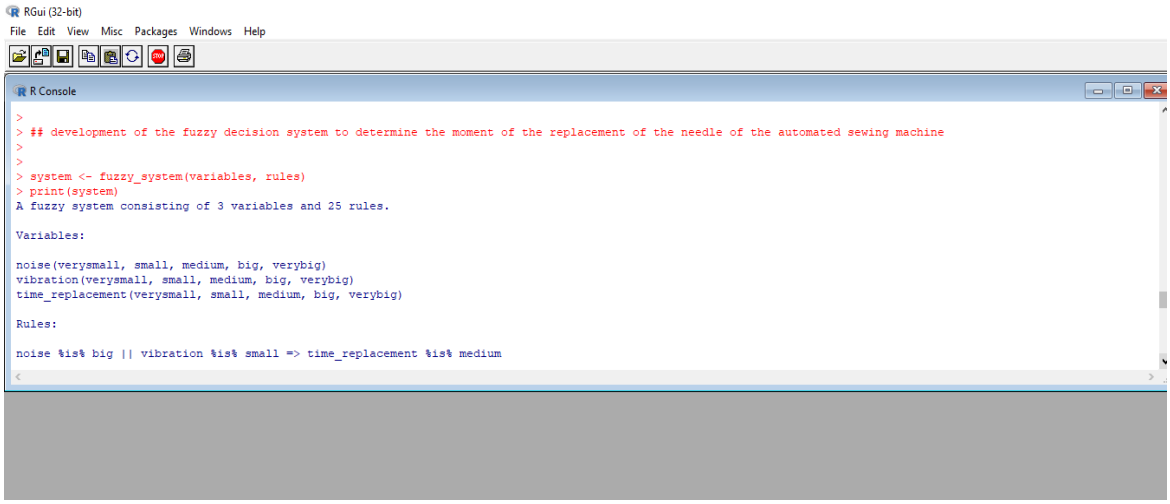


Fig. 4: *The software product for the needles replacement*

As an example, if the noise level is 64.1 dB and the vibration amplitude is 24.81 mm/s, then using the software product the replacement of the needles should be carried out after 85.49541 minutes of operation.

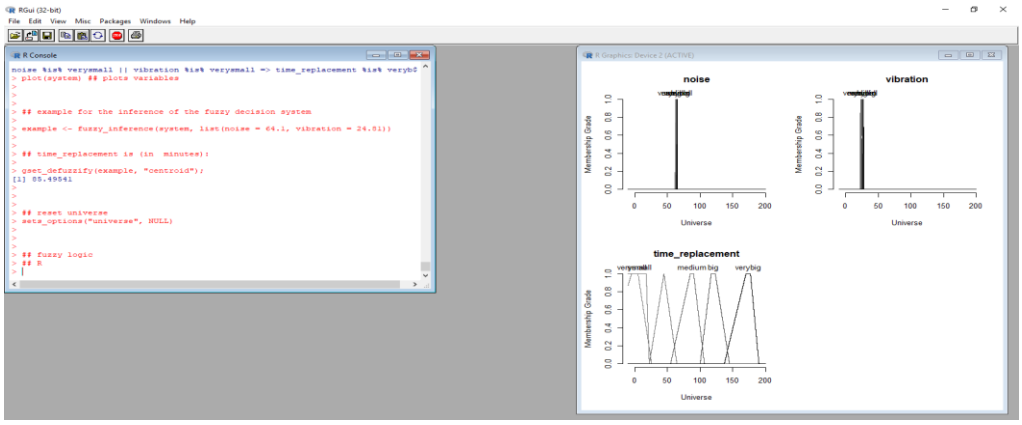


Fig. 5: *The inference rules of the fuzzy decision system for the needles replacement*

5. CONCLUSIONS

In this paper, a software product based on fuzzy logic was developed to schedule the replacement of the needles of automated sewing machines. The software product was developed using the integrated software environment R. Based on noise level and vibrations amplitude, it allows the establishment of the time when the replacement of these needles should be done. An example illustrated the employment of the software product.

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