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A Human Machine Interface for monitoring a winding machine

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ABSTRACT

The monitoring function that we are developing is part of an overall monitoring process. It aims, on the basis of the information available on its operating modes, to detect, locate and diagnose failures that may affect its performance and operational safety. The purpose of this paper is to carry out a method for monitoring an automated system based on a Human Machine Interface (HMI). The purpose of monitoring task is the detection and the rapid localization of faults in order to minimize the average system downtime. Finally, we illustrate the implementation of the proposed supervision approach on a winding machine in order to monitor the bobbins quality.

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1. INTRODUCTION

Monitoring represents all the means implemented (manual or automatic operations, steps, functions and mechanisms) intended to observe the state of an entity (online, in real time) in order to deal with system failures over the operational phase. As the manufacturing industry evolved, monitoring equipment became crucial. Production disturbances due to equipment failure were no longer acceptable due to the growing demand. There is a relatively small amount of literature on manufacturing system monitoring problems which considers the issues associated with production quality.

The aim of this paper is the study and the design of a monitoring module based on Human Machine Interface for textile machinery. In this context, we propose a new method for supervision the wires quality and the coil geometrical form obtained by a winding machine. The HMI is an excellent choice for supervision manufacturing system. This tool enjoys wide applications in fields such as monitoring [1-3], maintenance [4] and decision making [5-7].

This paper is organized as follows. The second section begins by the presentation of the coil winding unit and its quality defected.. The third section presents a HMI allowing monitoring the bobbins defects. Finally, the conclusion and extensions to this method are outlined in Section 4.

2. THE COIL WINDING MACHINE

2.1 Presentation

This section is dedicated to the presentation of the winding machine as well as its various components. This machine is used frequently in textile manufacturing in order to manufacture bobbins that will be exploited for the construction of fishing nets, figure 1.

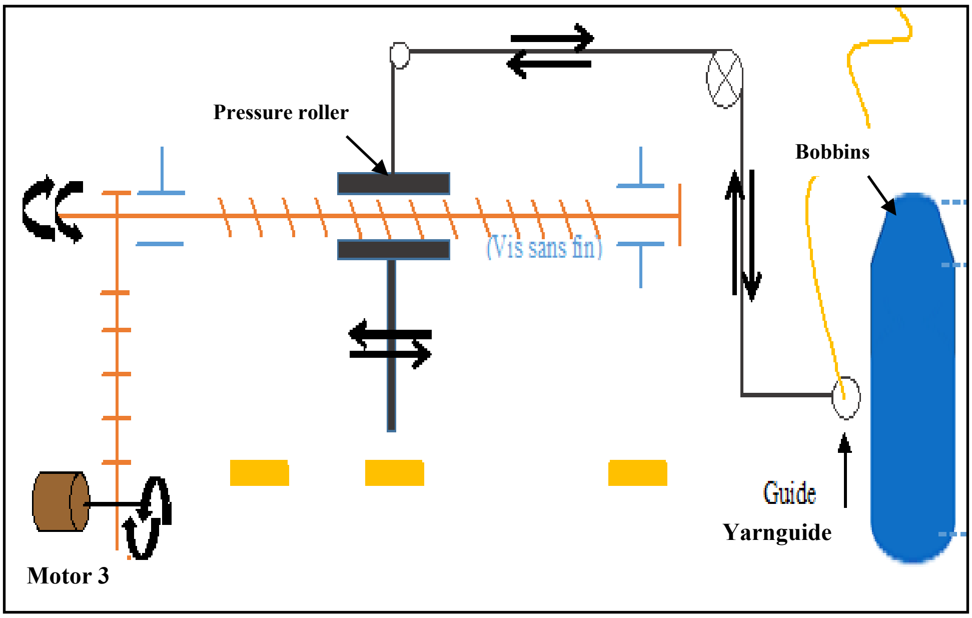


Figure1. Winding machine

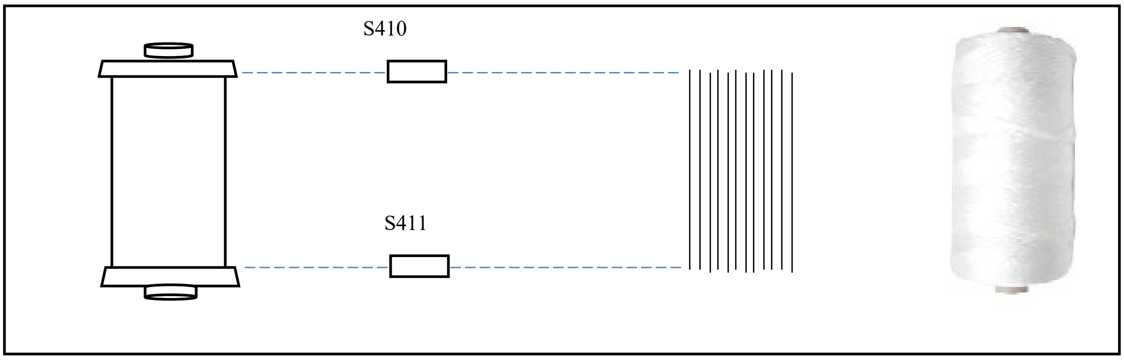
2.2 Bobbins defects

The main purpose of this paper is to monitor the wires quality and the coil geometrical form. Figure 2 shows the difference between conforming or non conforming bobbins conical shapes. In the studied system, four sensors are involved to check the geometrical form of bobbins.

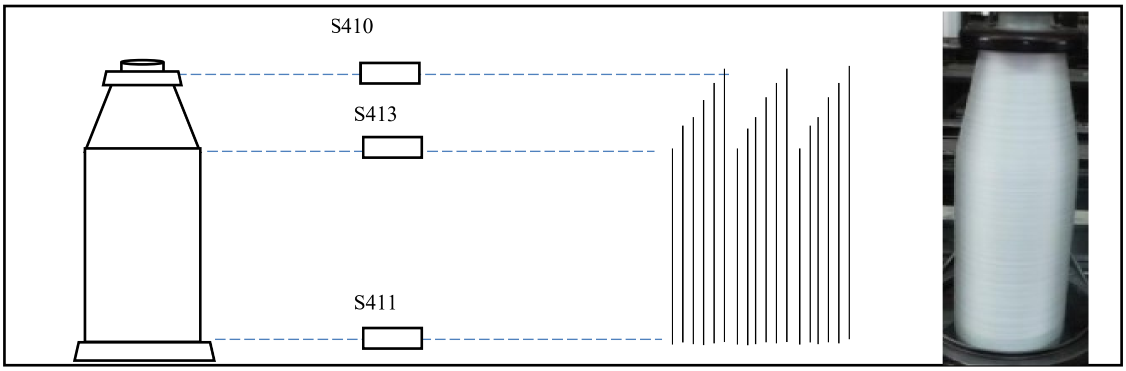
- S411: sensor indicating the coil low level to be filled,
- S410: sensor indicating the coil high level,
- S413: sensor indicating the conical level,
- S432: upper conical level sensor (other shape of the conical coil)

Given these defects, it is imperative to detect, locate and diagnose failures that may affect the coil winding performance and operational safety.

In this context, our contribution consists in developing a monitoring system based on a HMI in order to improve the availability system factor and to minimize the system average downtime.



(a) Conforming form



(b) Unconforming form

Figure 2. Conical shapes

3. HMI FOR MONITORING THE WINDING MACHINE

For monitoring the quality of bobbins obtained by a winding machine a HMI is developed. This interface is created on C # and allows monitoring the coil geometrical form produced by the rolling up machine. The proposed HMI has several windows and allow access to the different menus and views, figure 3.

The main view, figure 3, allows the supervision of the studied manufacturing unit by entering the desired set point (frequency). It also allows viewing the measured motors and variable drives speeds.

The starting of the two motors is triggered by pressing the start button in the main view of the system, in order to reach the desired setpoint, figure 3. V1 (resp. V2) represented the motor speed associated to M1 (resp. M2). Vm represent the average motor speed. A good quality of wires torsion is expressed by a speed ratio “Rv” (Rv = Vm1 / Vm2). The wires quality is qualified as good if the speed ratio “Rv” belongs to the range [1.4, ..., 1.6]. Otherwise an alrm is generated and an immediate stop of the machine is claimed. In this case there is poor wires quality.

3.1 Supervsion of of the bobbins geometric shape

The monitoring of the coil geometrical form is structured on the variation of the yarn guide motor speed “M3”.

3.1.1 Phase1: Command change

The time required for brooch changing is estimated at 500 ms. Exceeding this time, a wires defaults is claimed, figure 4b.

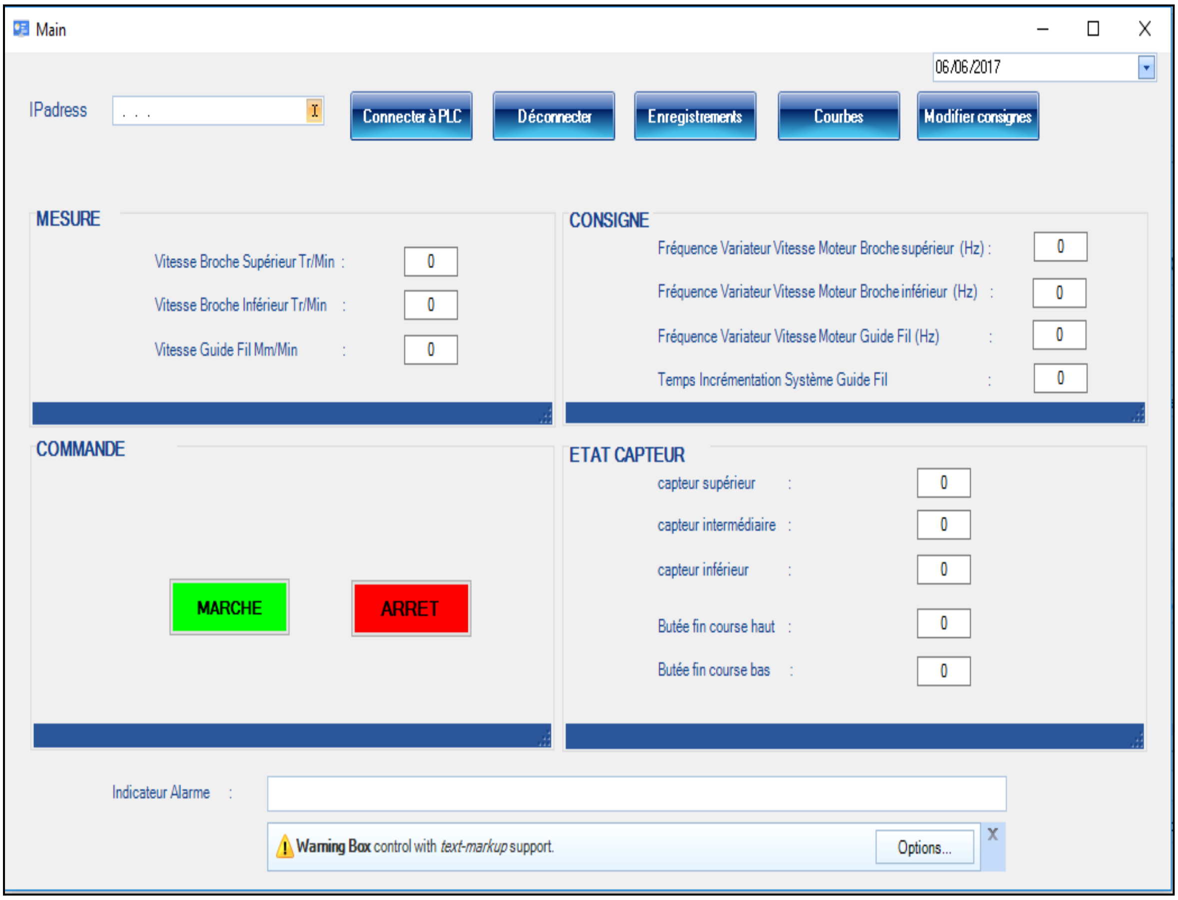
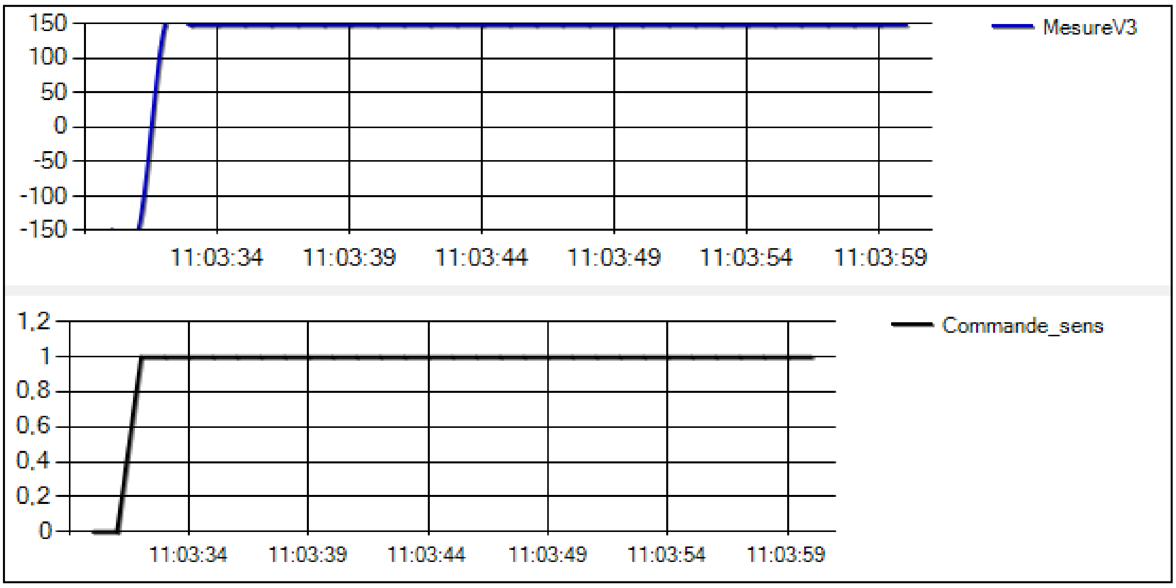
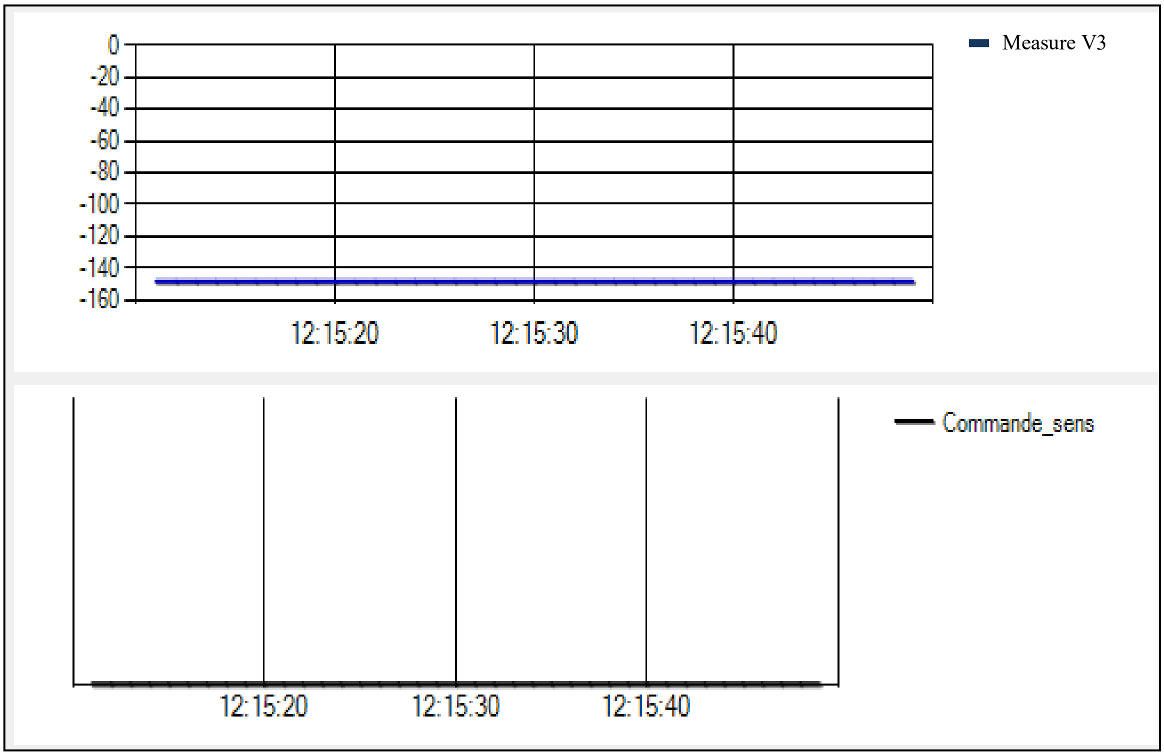


Figure 3. HMI main view



(a) Normal brooch changing



(b) Anomalous brooch changing

Figure 4. Control of the rotation direction of the thread guide system motor M3

3.1.2 Phase2: Monitoring of motor speed V3

We can have a defect in the shape quality if there is a considerable variation of the motor speed “V3” associated to yarn guide engine“M3”. In our study, the motor speed “V3” is estimated at 148 rpm.. The non respect of this motor speed value causes the non-conformity of the coil geometric shape l and the immediate stopping of the machine to remedy this fault, figure 5.

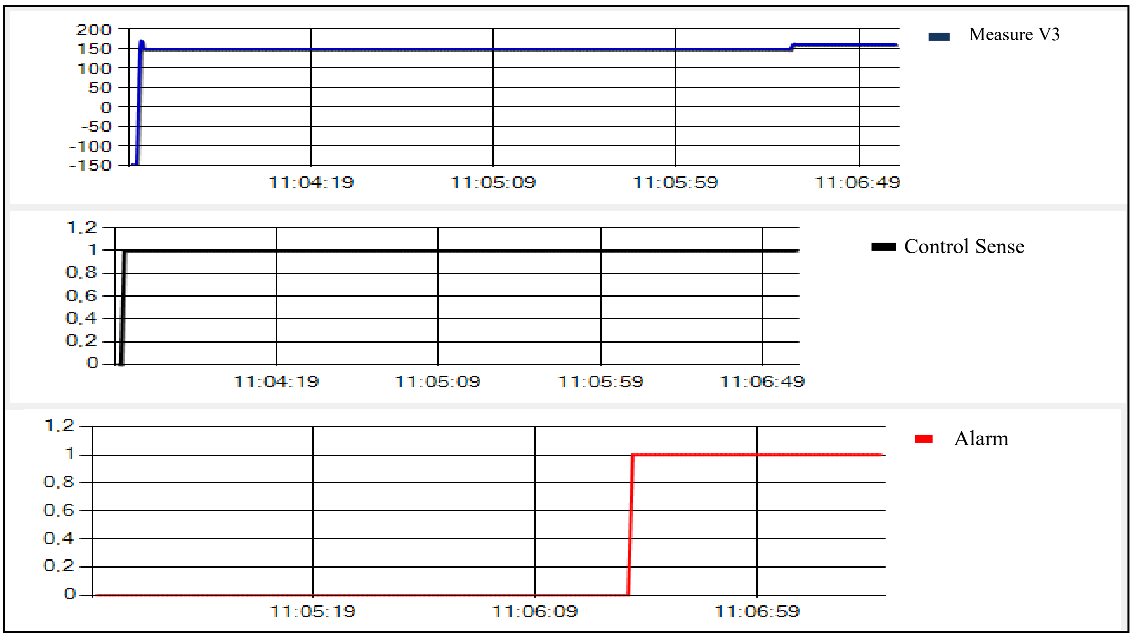


Figure 5. Monitoring of motor speed V3

■ **Wires twisting quality**

The main causes of wires default are:

- Exceeded motors speeds V1 or V2: **t**he main causes are as friction, drive belt failure, …etc.
- Sensor fault

If the motor speeds ratio "Rv" belongs to the intervals [1.4, ..., 1.6] in this case the torsion quality is good and the system operation is qualified as normal (good wires quality), figure 6, 7

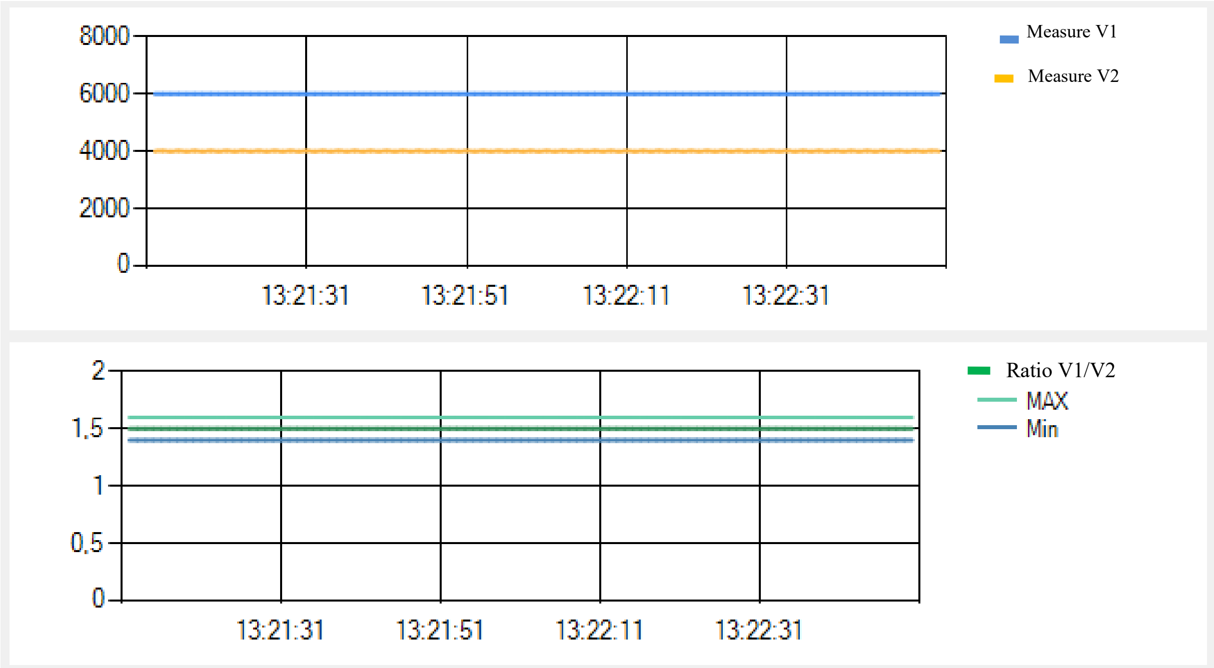


Figure 6. Motors speeds V1 and V2

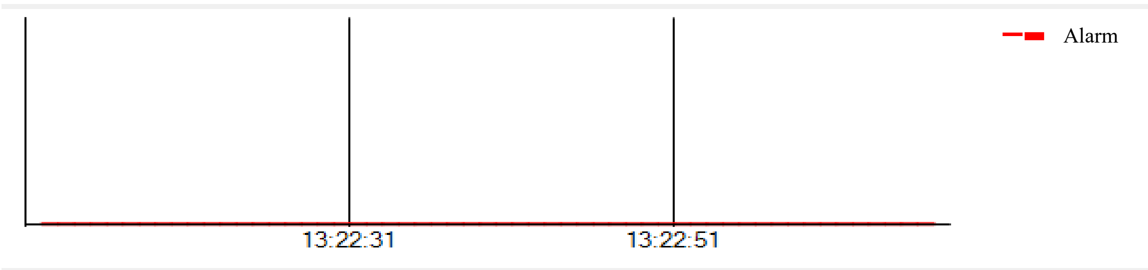


Figure 7. Normal speed ratio

A considerable variation of the motor speed V1, figure 8, causes the triggering of an alarm (non-conformity of the speed ratio) which leads to the machine stop.

Thus, the purpose of the implementation of this monitoring interface on a PLC is to explain in details what is happening on the system and to help operators identifying failures in order to preserve product quality and avoid a damage of the process.

Figure 8. Alarm generation due to wires twisting fault

4. CONCLUSION

This paper presented an approach to improve the product quality of a winding machine. Our contribution consists in developing a strategy for monitoring the wires quality and the coils geometrical shape based on HMI.

The work presented in this paper focuses on developing a Human Machine Interface, in Visual Studio. The objective is to improve the quality of the final product and to find an adequate solution allowing data management, monitoring, and control. The results obtained for the illustrative example are promising. The illustrative example shows that the supervision approach improves the prevention of temporal disruption and production rate by performing an early detection.

It will be important to extend the application aspect of the Human Machine Interface produced under Visual studio. A study of the quality defects correction through a PID corrector would make it possible to have a concrete assessment of the contributions of the developed interface.

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