# MICROCONTROLLER'S USING IN MONITORING THE MAINTENANCE SYSTEM OF FLEXIBLE MANUFACTURING LINES

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**Abstract: The paper presents a way of improving the interventions of the maintenance department made on the continuous manufacturing lines. The main purpose is represented by decreasing the times of stationaries of the machines and eliminating the loss of production. Using this system, the spent time for each planned reparation will also be decreased.**

***Keywords:*** *microcontrollers, industrial communications, databases, electronic system for maintenance, management of defects.*

## I. INTRODUCTION

At the moment, every manufacturing machine has a proper maintenance sheet which is used to track the last revisions and interventions made on the machine. This monitoring is made in a manual mode, that sheet being handwritten by the maintenance personnel after every procedure. This paper is about realizing a new monitoring system of the maintenance processes in an automatic mode using an electronic device which communicates with a database.

## II. THE MAIN TYPES OF MAINTENANCE OPERATIONS

The main types of maintenance operations are: [1] [2] [3]

*A. Preventive maintenance*

This type of maintenance consists of two components:

*1. Monitoring situation*

This includes actions that detects defects - for example: visual, olfactory or ultrasound inspections.

*2. Preventive maintenance*

This includes actions that prevents defects – for example: adjustments, greasing, alignments and so on.

*B. Predictive maintenance*

This type of maintenance determines the status of the equipment in order to predict the frequency and the way that maintenance should be performed. This approach offers cost savings both in terms of energy consumption, spare parts and the costs generated by the downtimes of the equipment. Most predictive maintenance inspections are performed while the equipment is running (daily routine), minimizing disruptions during the normal operations of the system.

*C. Proactive maintenance*

An efficient proactive maintenance program leads to an precise action plan and it's implementation in the right time. Proactive maintenance is an effective way to reduce machine intervention times by increasing the reliability of the equipment and its time of proper operation.

*D. Corrective maintenance*

This type of maintenance is made when a fault appears on the equipment in order to restore it to the normal operating conditions. [4].

## III. THE CLASSIC SYSTEM OF MONITORING THE MAINTENANCE PROCESSES

The classic system used by maintenance department to track the specific processes is represented in the following block diagram:

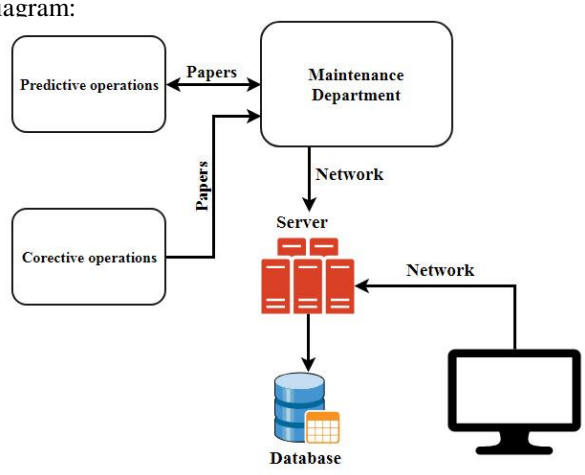


*Figure 1. The block diagram of the classic monitoring system.*

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As represented in the picture above, the classic system of monitoring the maintenance processes contains the following components:

- server
- database
- PC
- maintenance sheets

The server is used to store necessary documents for maintenance, like documentations of the machines, monitoring of the spare parts, maintenance specific procedures and lists for tracking all the maintenance operations that have been done on each equipment.

The database contains all the specific details of every type of maintenance for each industrial machine. This database could contains the following informations: the line number, the equipment number, the name of the industrial process, the maintenance department (electrical, mechanical) the name of the maintenance operation (for example: changing filters, checking the electrical connections, different types of measurements) , the frequency of doing each operation (daily, weekly, once per month, after 1000 hours of running), the time that is necessary for each operation, the status of the machine (turned on or off), the name of the person who made the operation, the spent time for each operation (could take more time than is planned if there appears other difficulties), the solution used for the defect, a special column for suggestions and many other details that could be useful for the maintenance.

The PC is used to access the database using the network to get the details of a specific equipment or to insert new data into it.

The maintenance sheets include all the details that are found in the database, and there is a specific sheet for each type of maintenance. Every industrial machine has a proper folder to store all the maintenance sheets.

The classic system of monitoring the maintenance processes is based on the following steps:

- checking on the database or the specific sheet of the machine if there is needed any predictive/preventive operation
- after every maintenance process made on one of the machines, the responsible of the process have to complete the sheet with all the details
- after completing the sheet of paper, the details of the process must be inserted once again, but this time into the database

## IV. THE NEW SYSTEM OF MONITORING THE MAINTENANCE PROCESSES

The new system of monitoring the maintenance processes is based on the following block diagram(Figure 2).

As represented in the picture the new system of monitoring the maintenance processes contains the following components:

- server
- database
- PC
- RFID tag for each equipment
- the monitoring device

The server, the database and the PC are used in the same way that are used on the old monitoring system.

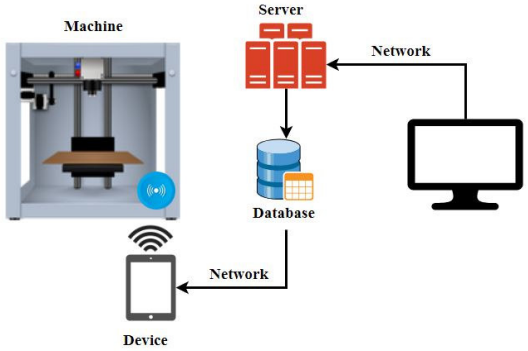


*Figure 2. The block diagram of the new monitoring system.*

The RFID tags are used to identify every equipment by an unique ID that is written on the internal memory of each tag.

The monitoring device is used to scan the RFID tag of an equipment to get all the necessary details about it. When scanning the RFID tag of an equipment, on the display of the monitoring device appears a menu which allow the users to select what information needs about the scanned equipment, the informations being received using the network, for example: the documentation of the machine, the database with all the operations that have been done in the past, the specific procedures for that equipment, every type of maintenance and its specific operations and their history.

Additional functions could be implemented like reminder functions on the beginning of the shift for every predictive/preventive operation that must be done during that day or week, depends on every type of operation and the eventual spare part that is needed. Regarding the corrective maintenance, there could be implemented functions to send an alert to the monitoring device when a fault appears on any of the machines.

The main advantage of the new system of monitoring the maintenance processes is represented by simplifying the way that the maintenance personnel gets the specific information about the equipment which leads to saving time.

## V. THE USED COMPONENTS FOR IMPLEMENTATION

The main used components to realize the project are the following:

- Microcontroller board
- RFID module
- Touchscreen display
- Communication module

### *A. Microcontroller board*

The microcontroller board used to realize the project is Arduino MEGA 2560 which is a development board based on ATmega2560 microcontroller and it has the following features:

TABLE I. ARDUINO MEGA 2560 FEATURES[5]

| | |
|---|---|
| Microcontroller | ATmega2560 |
| Operating voltage | 5V |
| Input voltage | 7-12V |

| | |
|---|---|
| (recommended) | |
| Input voltage (limit) | 6-20V |
| Digital I/O pins | 54 (15 of them provides PWM output) |
| Analog Input pins | 16 |
| DC current per I/O pin | 20mA |
| DC current for 3.3V pin | 50mA |
| Flash memory | 256KB (8KB are used by bootloader) |
| SRAM | 8KB |
| EEPROM | 4KB |
| Clock speed | 16MHz |

*B. RFID module*

The RFID module used is called MFRC522 which is a highly integrated reader/writer IC for contactless communication at 13.56 MHz frequency. [6]


*Figure 3. The MFRC522 module [7].*

A system based on the RFID technology is composed by the following main parts: [8]

- a reader/writer: which is made up of transmitting/receiving elements necessary to communicate with the RFID tag, a microprocessor required to decode the received signals, a memory for data recording, and an integrated or separate antenna.
- RFID tag: it also contains an electronic circuit for communicating with the reader/writer and a memory section for storing the identification code.
- data processing system

An RFID system operates on the basis of an electromagnetic field emitted by the reader, the field coverage being variable depending on the frequency of the system and the size of the antenna. When a card is detected in the field, the information stored in the tag memory is transmitted to the reader. When the card is powered from either an external source or the reader's field, the tag passes a sequence of steps to address specific memory locations, which are transmitted to the reader. Once the data transmitted by the tag is received, the reader decodes the received data, which is going through a test validation called the CRC (check the redundancy cycle), and if the data is valid, it is forwarded to a data processing system.

The principle of the RFID technology is presented in the image below:

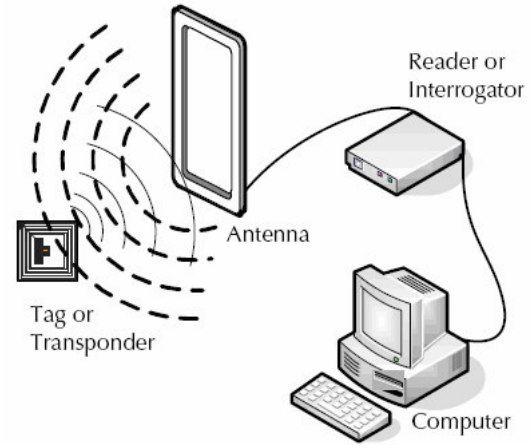


*Figure 4. The principle of the RFID technology[9].*

*C. Touchscreen display*

The touchscreen display is used for accessing the documentations, the database, to select the operation language and all the other functions available for the maintenance personnel.

The used display is a TFT (Thin Film Transistor) touchscreen and is based on ILI9341 and XPT2046 integrated circuits.

The used touchscreen display is illustrated in the picture above:


*Figure 5. The used touchscreen display [10].*

*D. Communication module*

The communication module is used to connect to the network for accessing the necessary files from the server. As a communication module may be used a Wi-Fi module, an Ethernet module or any other module which can access the local network.

For example, the Wi-Fi serial transceiver module ESP8266 may be used to connect to a local router for accessing the server.

## VI. IMPLEMENTATION

The implementation of the new monitoring system is based on the electrical diagram presented in figure 7.

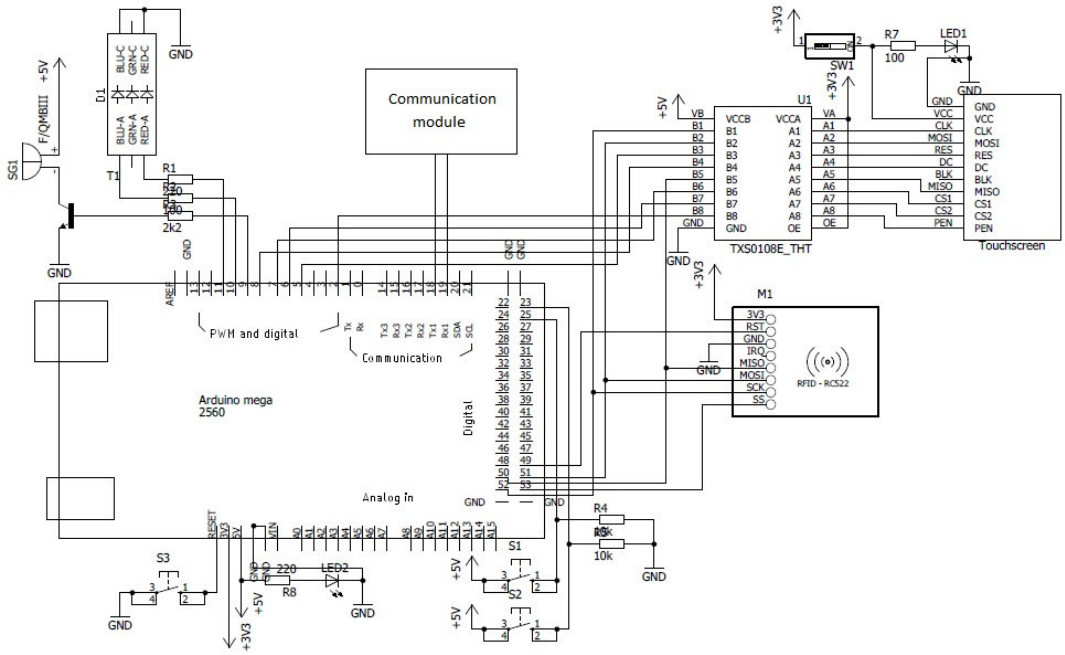


*Figure 6. The electrical diagram of the new monitoring system of the maintenance processes.*

The main electronic components used in schematic, excluding the ones described in chapter V are the following:

- SG1 – passive buzzer used to indicate if the RFID tag is known by the system or not
- T1 – NPN transistor used to amplify the sound of the buzzer
- D1 – RGB LED used for the same reason as the buzzer
- SW1 – switch for turning on/off the touchscreen display
- S3 – reset button
- LED1 – indicated the power supply for the touchscreen display
- LED2 – indicates the power supply of the module
- U1 – converter from 5V to 3.3V used for touchscreen display

The implemented user interface for the touchscreen is presented in the picture below:

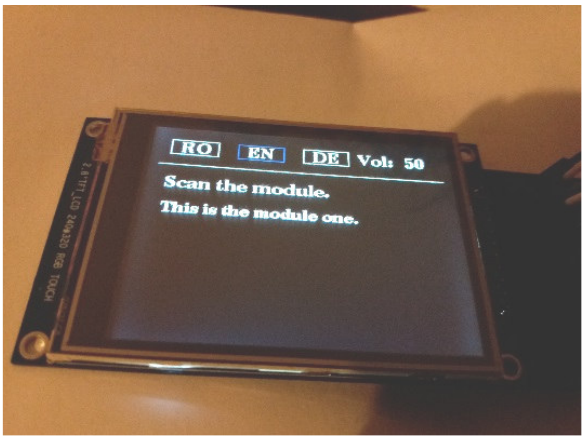


*Figure 7. The implemented interface for touchscreen.*

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