Implementation of an Automated System in the Measurement of Temperature in Broken Dynamic Equipment

José Luis Hernández Corona, Ernesto Mendoza Vázquez, Alejandra Ortiz Castro, Amador Arroyo López, Moisés Martínez Aguirre

Abstract: ***This article presents a titration project describing the implementation in the rotodynamic equipment of an economical automated temperature module, as a preventive solution for future failures caused by the lack of analysis in the increase or decrease in temperature. The project is currently contextualized in the area of industry, first, providing background to frame the importance of temperature control and measurement and also know what its evolution has been like. Immediately focuses on explaining the theoretical basis for giving context to the reader. For the purpose of detecting the increase or decrease of heat in machinery by implementing a monitoring system. The development of the project is based on the use of an LM35 transistor that connected to an Arduino Uno through various cables, will display the temperature measurement and make interface of the obtained results that will be reflected in a 2x16 LCD screen. The project is applied in a prototype bench in three key parts of the pulley, and in the two bearings to make the simulations, then perform corresponding tests and check that theory. A simple and lower cost system, but above all efficient that meets the expectations of the problem presented.***

Keywords: ***Control, automation, electromechanical failures, Signals, Simulation.***

I. INTRODUCTION

A machine element or set of elements is considered to have failed when they cease to operate satisfactorily or when continuing to use them may cause further major damage [1]. Typically, a failure analysis is performed to find its causes, establish responsibilities, and most importantly: "Take Corrective Measures to Prevent Recurrence in the Future" (Albañil & Espejo Mora, 2002). Furthermore, it is known that increasing the temperature of a metal or alloy decreases both its resistance and its fatigue life. There are two failure mechanisms related to temperature; (a) Thermo creep and (b) Thermal Fatigue, cyclical changes in temperature favor failure due to thermal fatigue, when the material is heated unevenly, some parts of the structure will expand more than others [2]. Since previous times, the importance of having a temperature measurement system has been framed and thermographic cameras have generally been implemented that quickly detect anomalies and potential errors in industrial maintenance and production control, detecting problem areas before they are produce a failure and, in the same way, to detect hot spots in electrical panels, motors and machinery of any kind, which allow observing interruption of service or accidents [3].Higher than normal operating temperatures, either caused by environmental conditions or generated within the motor, can damage the bearings. Normal operating temperatures vary by application. Maintenance technicians must be aware of these differences and must know the common causes and solutions for their overheating.

It should be emphasized that some of the most common problems are: badly placed parts, which can cause a constant and unforeseen rubbing, causing excessive heating, another aspect to take into account is the cleaning of the machinery because the dirt makes the parts not run and stop mid-process or overheat. This should be avoided because in the least case it can cause a part to rupture, a production stoppage, or a major breakdown involving leaks and costly repairs [4]. In accordance with the provisions of NOM-004-STPS-199, Protection Systems and Safety Devices in Machinery and Equipment Used in Work Centers, it establishes in its point number 7.2.1. "The periodicity and the procedure to carry out the preventive maintenance, and in its case the corrective one, in order to guarantee that all the components of the machinery and equipment are in safe operating conditions." [5]. Validates the implementation of an automated temperature module that will have the operating temperature variable and the ambient temperature variable displayed so that, according to this parameter, a certain output value can be identified and the appropriate measures taken. Furthermore, not to mention that in the general procedure for fault location among the most important potential problems is the electrical-temperature and ambient temperature combination [6]. That is why the implementation of this project is of great relevance since, as mentioned, the temperature measurement in machinery is a key part to guarantee a good operation, here is the importance of detecting these variations in a timely manner."Nothing is indestructible in this life. Neither tools, there are several types of maintenance for the industry, on the one hand, preventive, consisting of analyzing the most vulnerable parts of machinery and planning maintenance in time.

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Another is the predictive one, according to which a more complete analysis of the entire industrial process is made and the machines are connected to calibrate vibrations, temperatures and other types of factors [7] ”. (Moran, 2020)

II. MATERIALS AND METHODS

A. Elements and components

The implementation of this project involves the use of the following elements.

Table- I: List of materials for the construction of the prototype.

Material
1 Arduino Uno board 3 LM35 temperature sensors 1 LCD 16x2 Various cables (Jumper, interface) 1 breadboard 1 x 10K potentiometer 1 computer

B. Test bench description

A test bench was built to simulate the malfunctions that can occur during temperature variations.

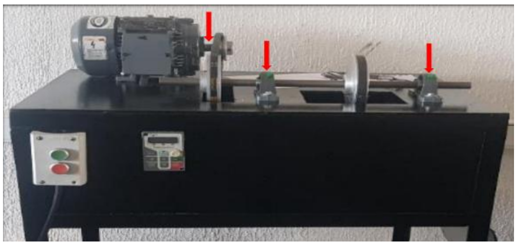

Fig. 1. Dynamic Broken Model Composition

The prototype bench has 7 main parts: Motor, Pulleys, Belt, 2 bearings, 1 balancing disc, 1 speed variator, of which only 3 will be subsequently tested with the sensors superimposed on: Pulley, and the two Bearings, which are indicated with red arrows.

For the implementation of the circuit, initially the selection of a correct sensor that captures the temperature signal is made, in this case it is proposed to use an LM35 in which, for each degree centigrade measured, it would output a voltage value of 10 mV [8].

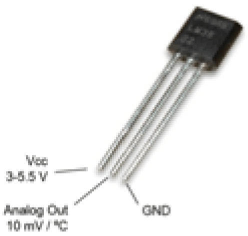

Fig. 2. LM35 temperature sensor.

Once you have the appropriate sensor, you proceed to choose a digital instrument to convert the analog signal in this case temperature, into numerical expressed in degrees Celsius, for which an Arduino Uno was implemented, which has analog inputs, digital outputs , 1 power input, voltage and ground outputs, which will be necessary to carry out the project [9].

Table- II: Arduino Uno board symbology

(pink)	Digital outputs
(green)	Power input
(purple)	Analog inputs
(yellow)	Voltage outputs (5V)
(red)	land

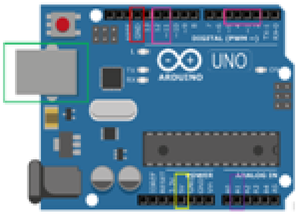

Fig. 3. Representation of the applicable Arduino Uno Board.

Later it is necessary to have a device that allows the visualization of the information in a graphic way, through the use of different characters and symbols. Therefore, a Liquid Crystal Display is chosen, a glass screen that has a minimum consumption of energy or electric current and the programming is extremely simple.

C. Measurement prototype design

Continuing with the Procedure, the LCD actuator is connected to the Arduino, making the following connections:

- LCD inputs 2,3,4,5,10,12, starting to count the LCD pins on the right, to the Arduino 2,3,4,5,11,12 digital outputs.
- Inputs 0, 11, 15 from the LCD to GND.
- LCD input 1 to VCC (5V) with a resistance and input 14 directly without resistance.
- The potentiometer 10K with data output to input 13 on the LCD.
- The LM35 sensor is mounted to the analog input (A0).

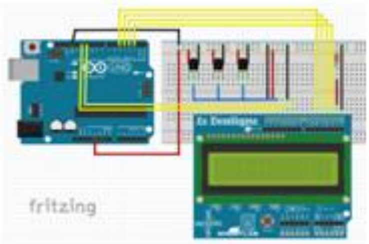

Fig. 4. Schematic of the complete assembly of the Prototype.

The device works by loading a program with the commands that we want to implement into the Arduino microprocessor, in this case the code necessary to perform the reading is simple. Only the voltage value is read through the analog input (analogRead) and the corresponding conversions are carried out.

D. Experimental design

It is proposed to create 3 temperature measurement circuits in the prototype bench that, as mentioned in the beginning, will be placed in 3 parts where the increase in heat occurs. Motor. It is intended to place the first sensor of the prototype on the upper pulley, as it is in constant rotary movement if there is misalignment in the belt, the pulley will increase its temperature.

Rowlock. It is intended to place two prototype sensors in bearings 1 and 2, since, based on the theory, the misalignment of the arrow would also cause a considerable increase in them.

To check what has been proposed above, tests will be carried out in the prototype bench where a comparative measurement of the temperature of each part when it works correctly and of the temperature with alterations in effort will be made, in order to establish a constant and base all subsequent analyzes on it. temperature measurement.

III. RESULT AND DISCUSSION

When starting the activation process of the sensors, the data will be transmitted immediately through the serial port that we can control with the «Serial Monitor».

Next, an output type is shown with the proposed measurement, the following is obtained:

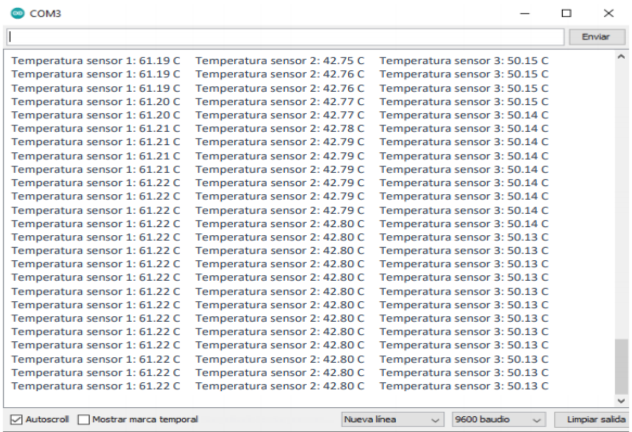

Fig. 5. Visualization of final results.

Based on the above, the temperature increase analysis is performed.

Table III. Comparative data for the interpretation of results.

Temperature	x	and
20 ºC	0.2 V	0 V
25 ºC	0.25 V	1.25 V
30 ºC	0.3 V	2.5 V
35 ºC	0.35 V	3.75 V
40 ºC	0.04V	5.0 V

IV. CONCLUSION

The benefits of measurement with this type of proposal allow us to detect the increase or decrease in temperature in broken dynamic equipment, being necessary to create a module for the study of temperature measurement such as the one proposed, as this is a key piece for detection of damage to the mechanical systems, carrying it out efficiently and accessible without generating such a high cost compared to the cost of purchasing any of the existing equipment.

V. OTHERS RECOMMENDATIONS

It is recommended to identify the variations that may occur in order to correct them in a timely manner and thus avoid further damage, in addition to recognizing the temperature as a fundamental cause in the defects that cause the deficiency or breakdown of the machinery and with all this prevent costs unnecessary caused by late maintenance on broken dynamic equipment.

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