Design and Implementation of a Pressure Control and Detection System for Possible Damage to the EMAPA-I Drinking Water Network in the Juana Atabalipa Sector in the City of Ibarra

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Abstract - The present work consists in the development of a pressure control system and detection of possible damages in potable water pipes, consisting of a data visualization screen (LCD), a remote data acquisition device, and a system Wireless communication, based on GSM / GPRS transmission technology; To make timely decisions regarding the variation of the water pressure in the pipes, by the operators closing or opening valves; Providing a more economical and reliable alternative to the system currently implemented.

I. INTRODUCTION

This chapter will describe each of the concepts involved in the development of the design of a water pressure control system, will begin by describing the main problem in the city's drinking water pipes, a study will be carried out on the situation Current on the area of detection of damage to water pipes potable water in the city center, causes fundamental loss of pressure and major tools such as sensors, alarm display systems, types of software, electronic devices, among others; Which will be used for the development of the project, concepts such as tools, protocols, equipment, architectures and others.

This project concludes in a versatile device that easily adapts to the needs of the EMAPA-I, and that can be adapted to any other system of control of the variation of water pressures

II. CURRENT SITUATION METHOD OF OBTAINING PRESSURE INFORMATION IN PIPES

At present in the province of Imbabura there is no device that generates some type of remote alert to me, to be able to act in time against the variations of pressure in the pipes, especially when the

Pressure level is high, which are very damaging to the pipes since many of these can cause damage to the pipes. This inexistence of a pressure control device, produces a loss in the company's economy, since not knowing in time about these damages, does not perform a timely maintenance to the pipes, which when broken cause the unnecessary waste of much liquid vital.

Currently, the only way to know about these damages is in a visual way, when water flows on the exterior of the roadway, or because of the low water pressure, which causes discomfort in the users of this resource, who opt for Notify of this damage to the public company of EMAPA-I. As a result, it is possible to demonstrate the lack of hydraulic equipment that can help and notify in a timely manner the damages in the pipes, so that we can act in time to avoid all these inconveniences to the users of the resource and to avoid wasting water.

For this purpose, this pressure sensing system was developed that promptly warns of pipeline damage in a remote way, in real time so that these problems can be solved on time, and avoid water losses and inconvenience of users.

III. DESIGN OF THE PRESSURE CONTROL SYSTEM

Once the standards, devices (pressure sensors) are clear, fundamental concepts described in chapter two on the pressure control devices in potable water networks, as well as the levels of flow, supply per block and level Of pressure; Will begin with the design of the leak control system based on the control of water pressure in the city's drinking water networks.

A. Pressure control system requirements

This system is designed to help control the pressures of the EMAPA-I drinking water pipeline, this control will be carried out in the macro measurement chamber of Juana Atabalipa Street; Once the control data has been obtained in this main valve measurement chamber, it sends the data wirelessly to the central EMAPA-I, showing these data in a 16x2 display, indicating the state that is monitoring either state , Low or Critical), according to the field of pressure that is. For the development of this system requires

- Hydraulic pressure sensor
- Two Microcontrollers
- Two Wireless Transmission Modules
- One 16x2 Display

B. Block Diagram of Pressure Control System

The leak detector has been developed in different modules according to the function they perform, this allows us a more detailed analysis besides a better operation verification, as shown in figure 1, the criteria of approach of the modules of the System of pressure control was obtained based on the thesis already developed by Henry Cervantes (Cervantes, 2012)

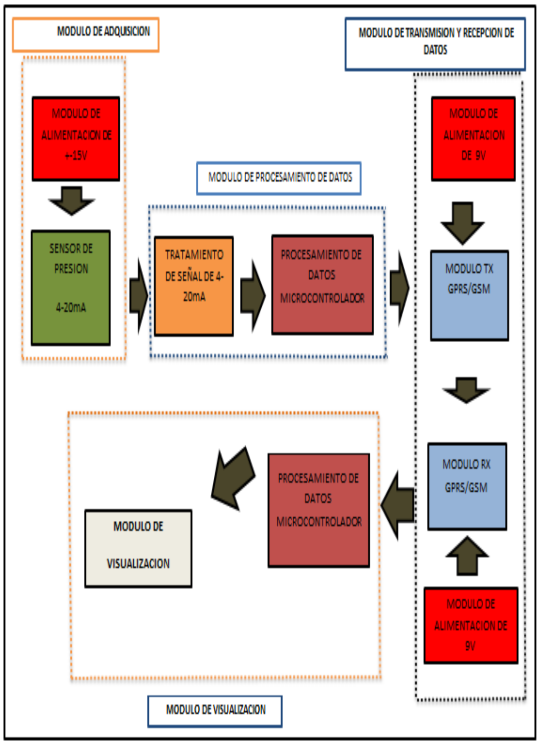

Figure 1. Division of leak detector system modules.

The pressure sensor is fed by a source of +/- 15v, this sends the received data to a signal processing module, so that it can be understood and configured through the microcontroller, it sends the instructions to the GSM module of transmission, Which will be linked and sent to another GSM reception module, which will capture the sensor data, and through a microcontroller will translate this information to finally be displayed and can show us the required information

IV. SCHEMATIC DESIGN IN PROTEUS OF SOURCES OF FEEDING

Para poder determinar el correcto funcionamiento y conexión de cada elemento electrónico así como su correcta configuración se desarrolla los diagramas de funcionamiento en el software proteus, para después proceder a armarlos en forma física una vez conociendo su correcta elaboración de los circuitos.

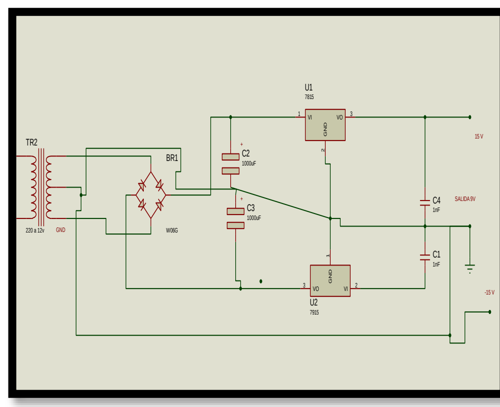

Figure 2. Electronic circuit of pressure sensor power supply Obtained from: (Cervantes, 2012)

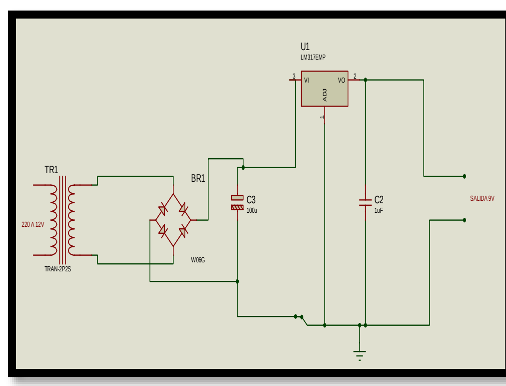

Figure 3. Schematic diagram of the variable voltage source. Obtained from: ISIS Proteus

V. DESIGN OF PRINTES CIRCUIT CARDS

After checking the operation of the electronic circuits by means of tests of operation in the program Proteus, the printed circuit boards are manufactured from the schematic designs, these are made with the help of the software PCB Wizard, all the cards are realized in Bakelite on one side so you can choose the bakelite that we like both in shape and design

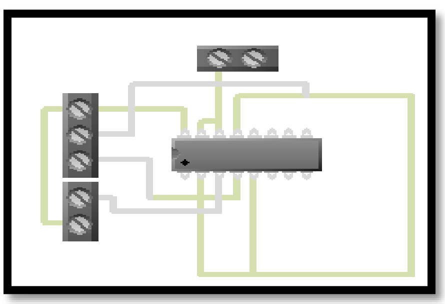

Figure 4. Printed Circuit of Digital Analogue Converter RCV 420

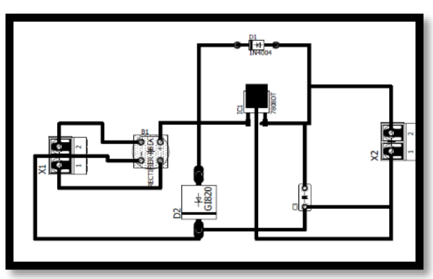

Figure 5. Printed Circuit of 9v Fixed Source

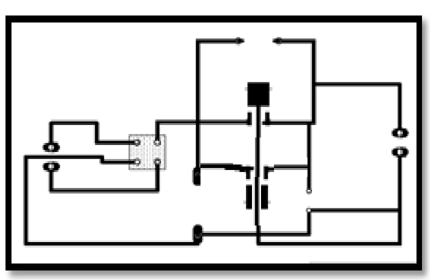

Figure 6. Printed Circuit Source of +15 and -15v

VI. CONSTRUCTION OF ELECTRONIC CARDS

For the development of electronic cards: firstly the design obtained in PCB Wizard is printed on couché paper, which must be printed on a laser printer, the bakelite of the defined size is cut out, then the design is transferred by contact applying heat on The paper to the plate, the plate is washed to remove the excess of paper leaving in the bakelite only the traces drawn, then the bakelite is immersed in water mixed with ferric chloride, where the unprinted copper is corroded. Once the solution has done its job, the plate is washed, the tracks are checked for continuity and the electronic components are drilled and soldered.

The cards manufactured are:

Figure 7. Variable voltage supply for SIM900 module Transmission and reception

Figure 8. 9v fixed voltage source for the Arduino module

Figure 9. + -15 v voltage source for the pressure sensor

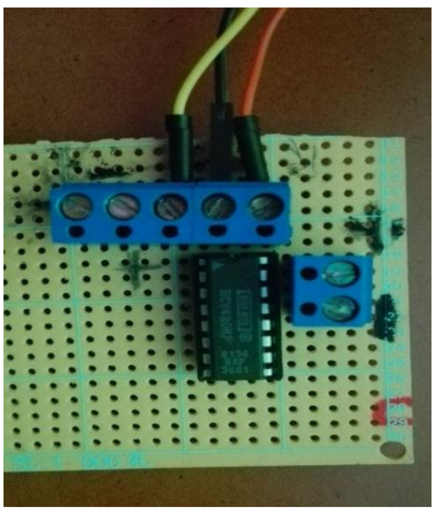

Figure 10. Circuit for current conversion with RCV420

The respective cards at each station were mounted in an industrial metal box in which electronic boards of the communication system, the power supply and the GPRS / GSM modules and Arduino module were added (see Figure 10 and Figure 11).

Figure 11. Industrial panel # 1 reception system

Figure 12. Industrial Board # 2 Transmission System

Figure 13. Industrial panel # 3 current-to-voltage transformation system

VII. SYSTEM FLOW DIAGRAM RECEPTION AND VISUALIZATION

In these diagrams the logic part of the pressure control system is realized, the programming part is done in C ++ language, which will be recorded in the microcontroller housed in the Arduino UNO platform.

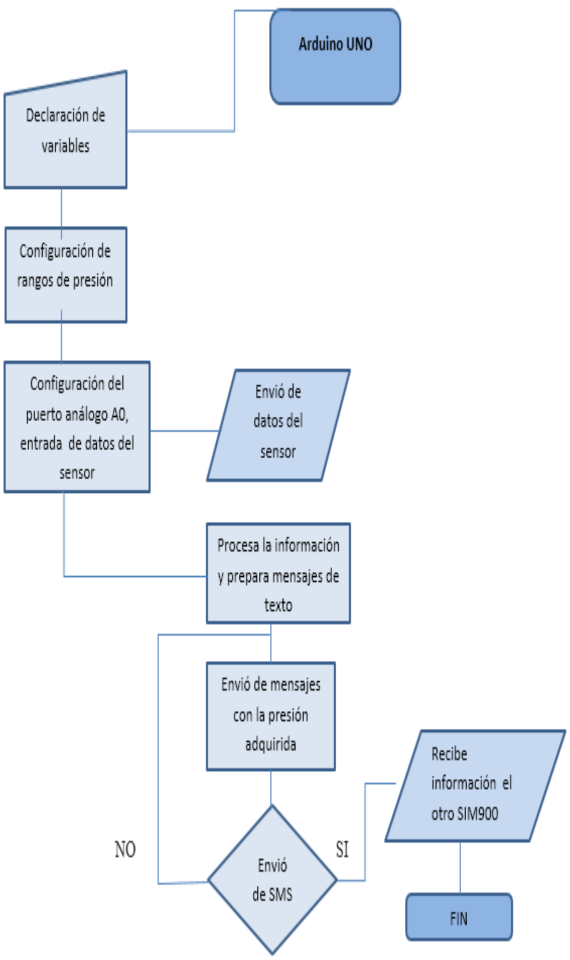

Figure 14. Flow diagram of the transmission system

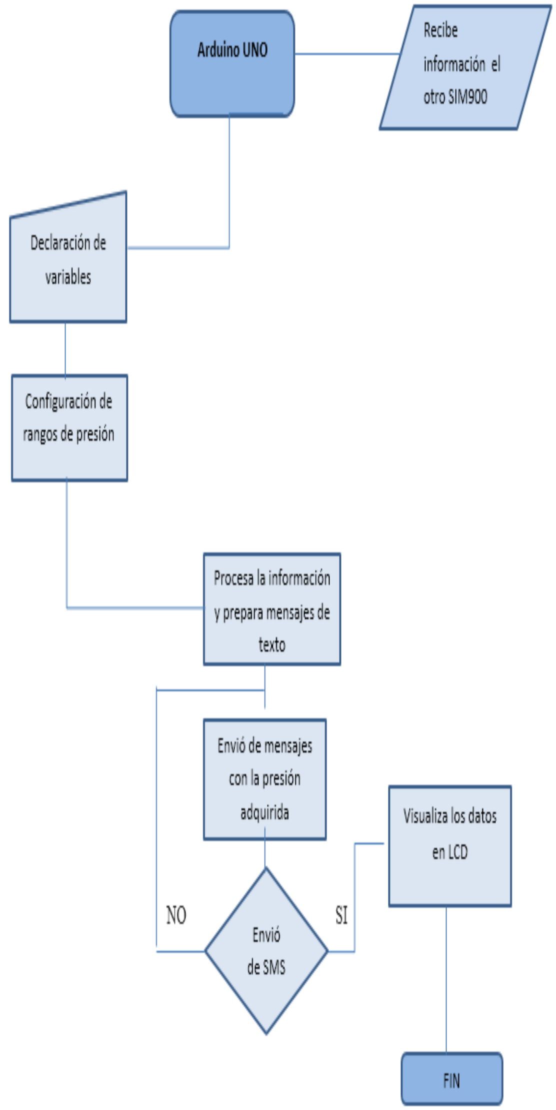

Figure 15. Reception system flowchart

VIII. TESTING THE ELECTRONIC SYSTEM

For the operation of the Arduino during these tests the original program of the leak detection device was recorded. Once assembled, it is proceeded to energize the board and simulate necessary conditions obtaining the following data.

C. Signal Processing Module Test

In this test the linearity of the RCV 420 current receiver was verified, which generates signals from 4 to 20 mA, which were measured with a multimeter; Obtaining the following data as shown in Table I

Table I
Linearity test RCV 420

Entrada (mA)	Salida (V)
4	0.01
6	0.63
8	1.33
10	1.80
12	2.52
14	3.17
16	3.80
18	4.58
20	5.04

D. LCD contrast test

To verify that the processing is correct, voltage values vary from 0V to 5V measured with a multimeter and we observe the data in the LCD to know the change of state according to the water pressure exerted; Data recorded through the sensor

Table II
LCD contrast test

Entrada (V)	Lectura LCD (V)
0	0.1
1	1
2	1.99
3	2.99
4	4.00
5	4.98

E. Data display test

The output data on the LCD can be displayed according to the input voltage that was received (See Table.III data output on the LCD)

Table III
Test the data as they go to Display

Entrada (V)	Visualización LCD
0 a 0,5 V	Presión Nula
0,6 a 2.9 V	Presión Normal
3 a 5 V	Presión Critica

IX. PRESSURE TRANSMITTER TEST

The Pressure Transmitter was connected to a 15V voltage at a distance of 50cm with UTP cable, to test the transmitter, was mounted in the water line through a pressure control valve, located in the water measuring chamber Potable in the interior of the road, to test that the transmitter is sending the data is energized the electronic card to observe on the LCD the pressure value measured by the transmitter and compared to a manometer obtaining the data which are compared between Yes to be able to determine the precision of the lord, whose data are shown next in figure 16.

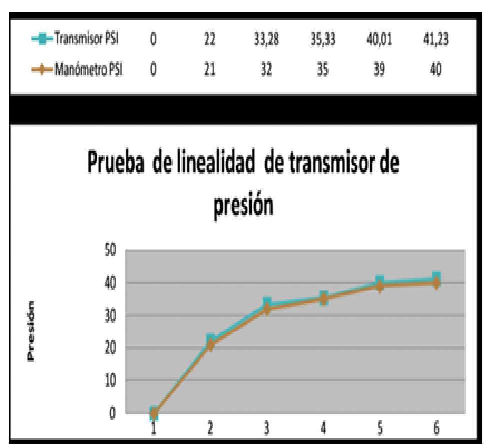

Figure 16. Pressure Transmitter Test
Earned: Excel

X. IMPLEMENTATION OF THE PRESSURE SYSTEM

The metal housing where the electronic modules of the device were located was installed in the macro-metering chamber, which was fixed to the wall with thin-threaded bolts, the pressure transmitter was installed on the water pipe, 50m Board, for which a plastic bushing adapter of ¾ "to ½" is placed, and finally the pressure transmitter, for the connection of the transmitter as already indicated in the test phase UTP cable is used which is buried through Conduit pipe.

Figure 17 shows the cast iron pipe which is located in the macro measurement chamber at the bottom of the road, where the pressure control valve and the manometer are housed. Measurement of water density.

Figura 17. Tuberíaprincipal de agua potable de la calle Juana Atabalipa

Figure 18 shows the connection form of the pressure sensor directly connected to the pipeline through which the drinking water flows. This connection serves to measure by means of this device the variation of pressure produced in this conduit by The vital liquid.

Figure 18. Connecting the pressure sensor to the main drinking water line

XI. CONCLUSIONS

There are commercial leak detection systems that can be very precise to find the place of the leak, these devices are very expensive, in addition to having to be constantly extracting the data from the place where these types of devices are; For this reason, considering the needs of EMAPA-I, this current thesis project has been developed, which is very beneficial since it is much lower cost, and does not require a visual inspection, to extract the data in case of leakage , Since this system is constantly census and in case of any type of change in pressure, send the data to the place where the technical staff is, or in turn can receive these by means of text message to the personnel cell In charge of the place.

XII. GRATITUDE

A special thanks for the collaboration given to the engineer C.Pupiales and the engineer J. Michelena for the orientation of this project, which could be successfully completed.

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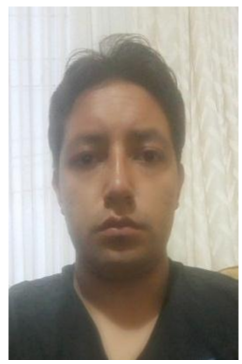
XIV. BIOGRAFIA



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