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DESIGN AND IMPLEMENTATION OF A VACUUM PLANT FOR THE SIMULATION OF THE SYSTEM PICK AND PLACE FOR LABORATORY CONTROL OF SURCOLOMBIANA UNIVERSITY

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ABSTRACT

This work provides a tool to enhance the practical and theoretical knowledge of the students in the program of electronic engineering in the Surcolombiana university, specifically for the areas of control, automation and industrial instrumentation, proposing the development of a vacuum plant for the simulation of a pick and place system. It is also implemented an ON/OFF control for the plant, and a friendly graphic interface for the user. Finally, it is delivered a laboratory guide, as well as the recommendations and conclusions from the process of design and development of the project.

Keywords: ON/OFF control, graphic interface, pick and place, vacuum plant.

1. INTRODUCTION

It is work of engineers achieve a good analysis and automation of industrial processes, so this work is to develop a solution and an alternative for students Surcolombiana University, to design a vacuum plant for its laboratories, taking into account the management control issues has become essential for the development and growth factor production companies.

Vacuum control will be used specifically for the application of pick and place systems, used in a variety of industries for transport and handling of different elements, due to the ease of installation and ease of operation, which allows it not compromised the integrity of the parts and that these can be accurately located along a production line or any other process.

The development of this project also allows applying the knowledge in electronics, control and instrumentation, providing a timely solution to students and to those who require experience with this plant. The leadership program in previous years has acquired plants to control variables such as temperature, level, speed, position and more. Given that there is currently a vacuum plant was seen as a possible graduation project implementation thereof for subsequent donation to the university, benefiting generations of students and facilitating learning tools.

2. PICK AND PLACE SYSTEM

The pick and place system are purpose-designed devices for handling objects, which usually tend to have few degrees of freedom and movement in fixed sequences. The pick and place process (pick and place), consists of a sequence complementary movements each other, through which a device is attached and raises then take a piece and place it in a certain place.

Basic elements of a pick and place system:

- A pick and place system basically consists of four elements: sensor, servo motors, actuator and controller.
- The sensor is detecting the presence of an object in the initial position to begin the process of handling and transfer it.
- The servomotors are responsible for the vertical and horizontal movement of the actuator to perform the process of moving test objects.
- The actuator is the end device is responsible for collecting the piece from the initial position. This element can be a clamp or a vacuum through vacuum actuated.
- The controller is the intelligent part of the system. In it the acquisition of the variables obtained through the sensors and actuators is performed as needed are operated system.

3. APPLICATION

The implementation of a pick and place system can meet the following expectations:

- Allowing the automation of industrial processes object manipulation improving system efficiency;
- work in environments with limited space, programming the system to move in the established limits;
- adapt to multiple applications with single exchange system tools; Y

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- control the process of manipulation of objects through a graphical interface;

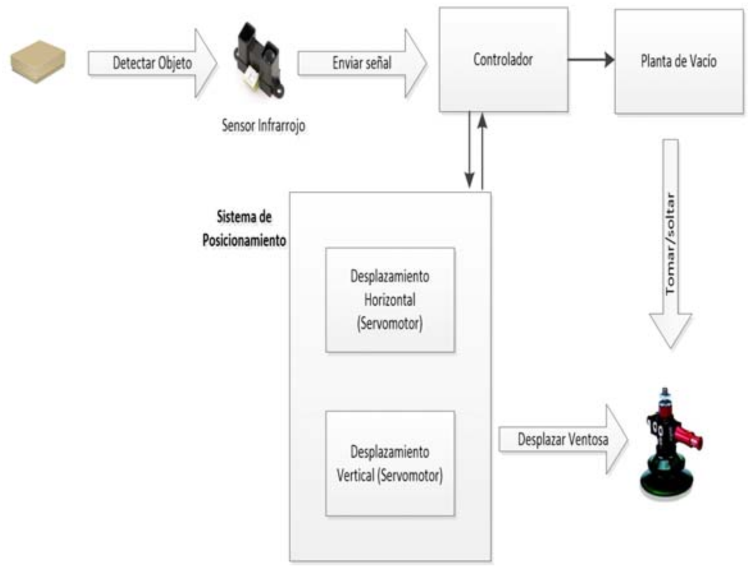

Figure-1. General scheme of the prototype.

4. SYSTEM ARCHITECTURE

In the detection step, the system has three infrared sensors and a vacuum sensor (vacuum switch). The first sensor transmits a signal to the controller when it detects the presence of an object in the loading area. The other two sensors send readings positioning of the crane along the path. The vacuum switch sends a signal to the controller when the detected object is held by the suction cup.

Transportation stage composed of the structure of the bridge crane, two DC motors and the final element of suction (suction cup), allows vertical and horizontal scrolling of objects.

In the step of generating vacuum, through a compressor, a filter, a solenoid valve and an ejector negative pressure suction lift allow the objects to be transported is generated.

Finally, at the stage of the control system it has a device driver that is responsible for receiving the sensor signals of the detection step. When the first infrared sensor detects the presence of an object in the loading zone, the controller sends an activation signal to the DC motor manager vertical displacement of the transport system to bring the cup to the object. Then, the controller sends a signal to the conditioning circuit to enable the solenoid valve that allows the suction cup. Then, the controller receives the signal sent by the vacuum switch when the object is held by the suction cup and the motor is activated again to perform the upward movement. Following this, the controller receives readings from two infrared sensors to determine the position manager crane allowing the horizontal movement of the transport system to reach the discharge area. Additionally, the controller allows communication via USB with a graphical user interface for the development of laboratory practices using the system.

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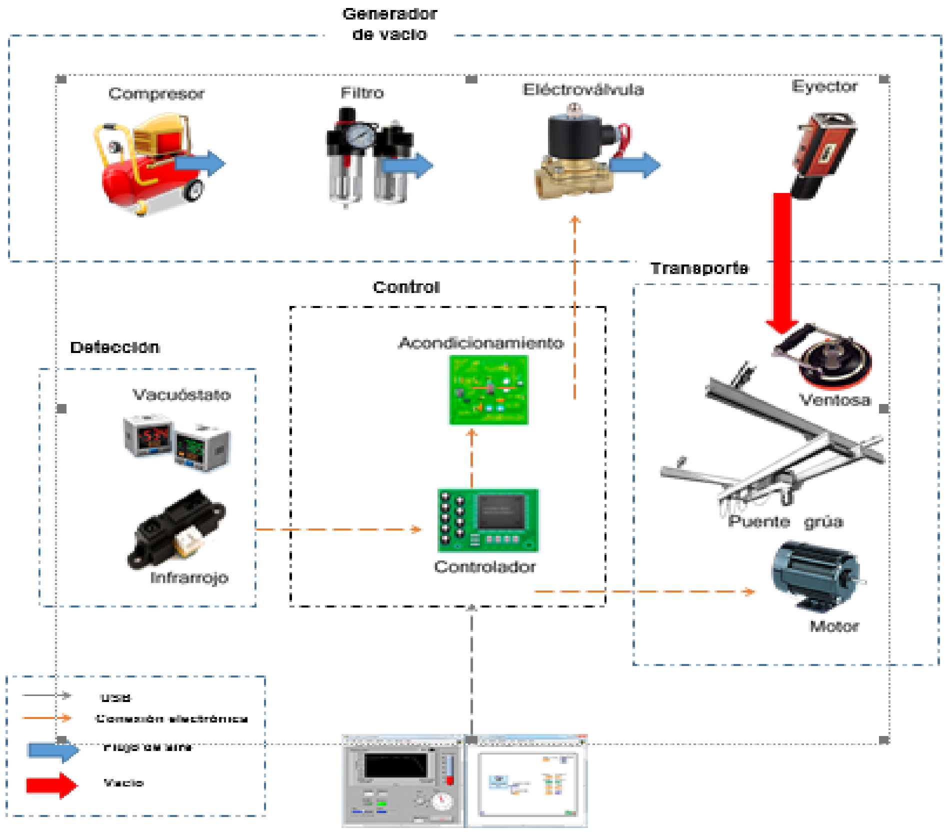

Figure-2. System architecture.

4.1 Controller

Responsible for administering the system and conditioning circuit, responsible for adapting the signal levels needed to operate the solenoid valve.

For the controller, development card 430 Launchpad MSP430 from Texas Instruments (Figure-4) was used. The card has an internal oscillator 16Mhz, with 16KB Flash, 512B RAM, peripherals such as AD converter of 10 bits, timers, serial communication (UART, I2C and SPI) and a host of digital inputs and outputs, which allow easy system expansion. In addition, programming of the card is very simple, because the integrated development environment (IDE) is based on C language and does not require any additional interface for programming.

For the conditioning step signal the MSP430 card to activate the solenoid valve, based on a transistor and a relay circuit was implemented.

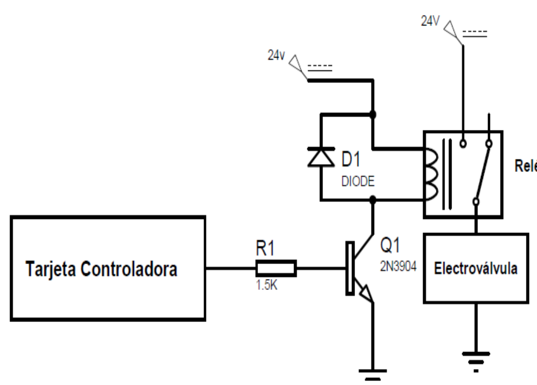

Figure-3. Electronic control diagram.

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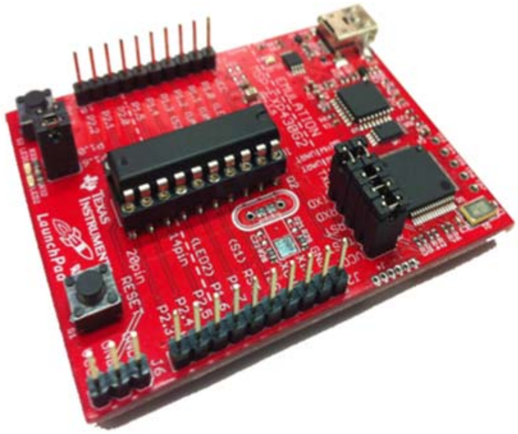

Figure-4. MSP430 Launchpad 430.

4.2 Multistage circuit

This circuit unifies each of the steps used to control the movement of the bridge crane and enable elements and instruments used in the final project. Among those we need for H bridge motor control digital sensors, solenoid, infrared sensors, and voltage regulators.

The first step is to enable the solenoid, a switch circuit. Followed by regulators 12v, 9v, 5v and 3.3 for feeding different teams. There is also the H bridge with diode configuration shown below. Finally easy connections for communication card Launch Pad control and all the PCB.

Figure-5. Multistage circuit.

4.3 Programming

Energy has been used. Programming the MSP430 Launch pad card 430 is performed through the Energy program, based on the C language programming it was made taking into account the flow chart shown in Figure-6.

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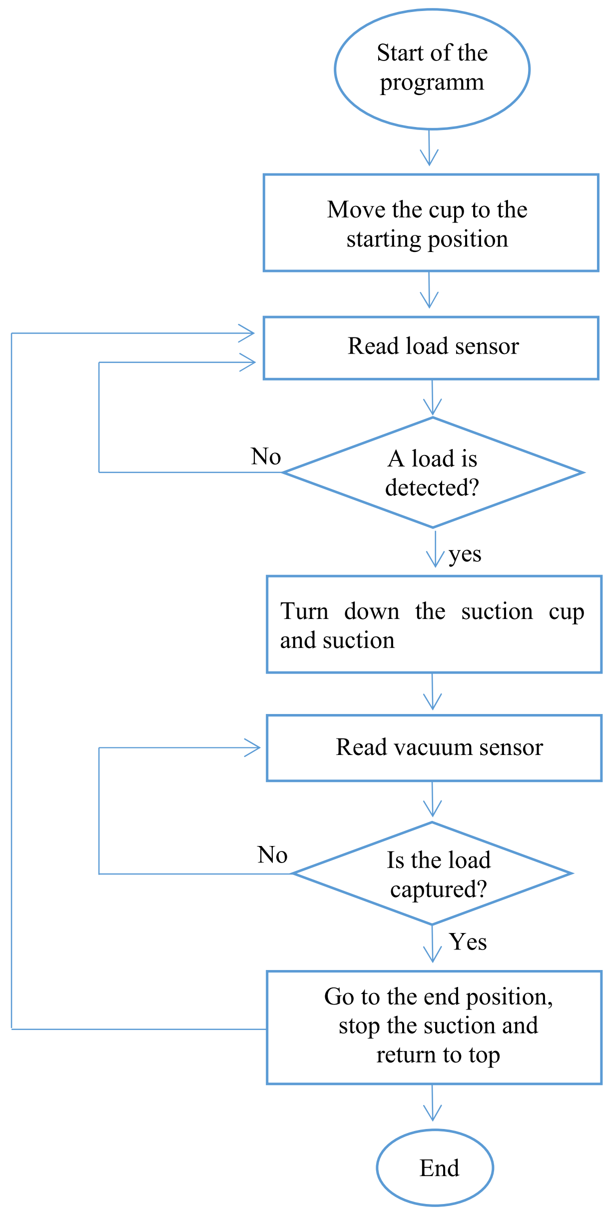

Figure-6. Flowchart programming.

4.4 Interface

This equipment can be controlled and monitored via computer, so using Labview graphical interface, in order to make easy the user management team therefore two buttons, automatic and manual were designed was designed. The manual button allows movement of individual parts of the system at the time desired by the user, while the automatic button allows detection and motion according to the number of loads without manipulating each of the parties.

Besides this allows to visualize the movements in real time through LEDs, which indicate the position of the object in the system. Thereby allowing the user to view their movements.

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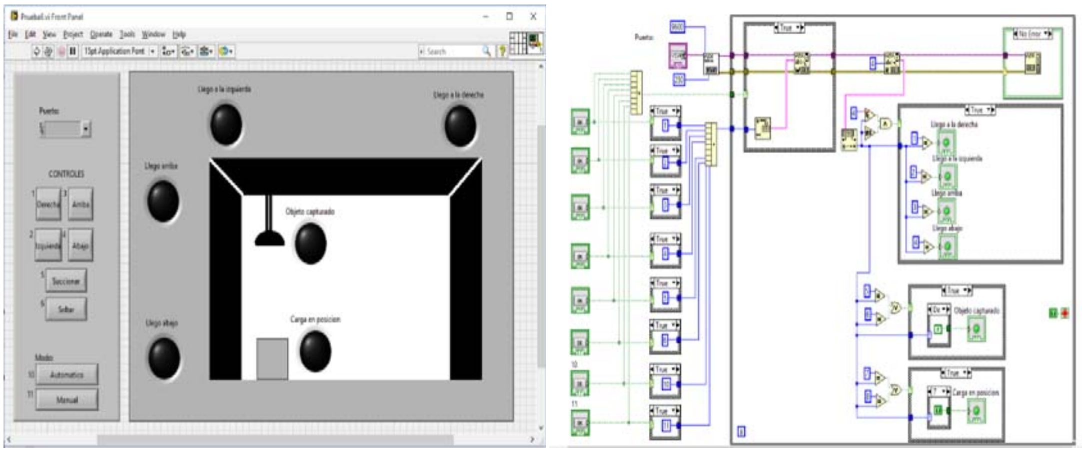

Figure-7. GUI Screenshots.

5. RESULTS

5.1 Implementation of the vacuum system and application

The implemented control system is done via a PC using an interface in Labview, this allows an ON / OFF control for the items individually or in automatic mode. It is shown below in Figure-8, its composition and structure. Including mechanical systems such as the compressor, the ejector, the suction cup, filter and hoses safety; and between electronic elements are motors, sensors, and control card launchpad circuits designed to system operation.

Figure-8. Final control system.

In the photograph the vacuum sensor that allows real-time readings of vacuum level needed to load the prototype objects are displayed according to their weight. The form is also shown as the screen indicating a mobile user's position in real time allowing this to the "STOP" at any time of manual or automatic mode looks.

6. CONCLUSIONS

Initially a thorough analysis of possible tools and / or technologies that could improve infrastructure technology control laboratories and the idea of designing and implementing a robotic test module such as "pick and place" was performed, bridge type crane thus filling a gap of this type of equipment in the laboratory.

Subsequently, identification of mechanical elements performed using essential to ensure the operation of the system. And this form to strike a balance in the cost and time benefits.

After testing for circuit design system requirements, on the part of handlers corresponding to the movement of the horizontal and vertical axes of the bridge current they are performed. Including solenoid actuated and each of the control stage feed stages. Including engine types used and the construction and design of all prototype.

Upon completion of this step, programming tests were performed on Launch Pad, making reading sensors and responses thereto. The software used was ENERGIA, free and available to every user. In this way it was possible to make an ON / OFF control before reading the medium.

The system will be made periodic tests, ensuring that both the mechanical components such as electronic functioned properly and as was raised in the project objectives.

Tests were conducted with different weights and load sizes. Thanks to these tests it was concluded that the system works successful way, and therefore the implementation can be done in the laboratory of control.

It added that it meets the general objective and thanks to the construction of this module is achieved improved technological infrastructure control laboratory; thus improving the performance of students in the experiments with industrial prototype and serving as a tool for teachers.

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