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Electronics Skills With Arduino and Raspberry In Undergraduate Research Course

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Abstract— This paper outlines the benefits of incorporating the Raspberry PI and Arduino into an undergraduate research course for bachelor's degree students. In this course, students work in several projects that provide an experience in research and development. In specific it works with electronics components and realized analysis with a variety of instruments. Explanations are made about three small projects implemented during Fall 2019. Our goal and motivation is to provide a hands-on building component and develop of professional and technical skills.

Keywords—Arduino, Raspberry, projects, ms power bi, microcontrollers

I. INTRODUCTION

The Raspberry Pi is a low-cost single board computer [1]. For this work, it was configured as a portable web server that can remotely acquire and show data. In the Raspberry Pi microcomputer, a Raspbian OS has been installed as the official supported operating system, which is Linux based and it allows the writing of Python codes. It is possible to interface different kinds of sensors with this microcomputer through GPIO. Temperature, humidity and motion among other sensors have been tested for further implementation. The system must measure the remote signals, store the data in a database, and allow the users to remotely access through a web server. For database management, SQLite was configured. The main objective of this project is to provide a monitoring mechanism through a web server that can control an action depending on the sensor's outcome.

The development of Communication and Information Technologies has provoked changes in the way people access information. In the last decade mobile devices have propelled the access to the internet, making it fast and easy; permitting the user an instant access to resources and applications.

Monitoring certain parameters of the climate can be limited due to the cost of the different sensors. Their costs are based on quality, precision, and their ability to connect wirelessly. The microcomputer Raspberry Pi has multiple advantages that make it great for this project. At first, it is a low-cost single board computer (SBC). It utilizes the operating system (OS) Raspbian which is Linux based and allows writing code in Python programming language being this, one of the most used programming languages for application development. With an internet connection the Raspberry Pi can monitor different weather sensors in real time and display them in a webpage. The prime objective of this project is to deliver a monitoring mechanism across a web server, therefore controlling an action based on a sensor's output.

II. RELATED WORK

The educational use of Arduino and Raspberry PI allows the configuration of adaptable systems in which students can test their skills. Other study shows that using the Arduino exposes students to sufficient complexity and challenges for an embedded system course [2]. Configure a webserver in Raspberry Pi microcomputer provides single portal which readily contributed to acquire and control the real time data [3].

III. METHODOLOGY

We provide the students all materials, components and instruments necessary for these projects. Additionally, a laboratory space is reserved. Weekly and monthly milestones are established to ensure progress and complete understanding of the tasks.

The students use C language in the Arduino. Also, the Integrated Development Environment (IDE) provides a graphical interface in which the students can write the code, debug it, compile it, and upload it, basically [4].

From the developer's website you can obtain the data of the Raspberry PI specifications. The Raspberry Pi is a low-cost single board computer (SBC). The Raspberry Pi 3 B+, which is the model used in this project consists of 40 General Purpose Input Output pins (GPIO pins).
Specifications:

- SoC: Broadcom BCM2837
- CPU: 4× ARM Cortex-A53, 1.2GHz
- GPU: Broadcom Video Core IV
- RAM: 1GB LPDDR2 (900 MHz)
- Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless
- Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy
- Storage: microSD
- GPIO: 40-pin header, populated
- Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

IV. RESULTS AND DISCUSSION

Project 1. Raspberry PI Weather Sensor Monitoring

The design of this project required the configuration of a web server on the Raspberry Pi. We used Apache services for this task. A web page was configured, to eventually display the acquire data, as shown in figure 1. In this configuration, the user can access the data with any device with an Internet connection. The sensor used for this project was a temperature and humidity sensor, this one was wired directly to the GPIO pins of the microcomputer. This microcomputer support Wi-Fi connection, we decided to connect via ethernet cable to give it access to the Internet.

Temperature, humidity, and movement sensors have been tested for later implementation. This system should measure the data, capture and store it in a database, and finally give the user access to it through a web server. We are using SQLite to configure the database for future access to the data through the webserver.

This is a low-cost solution for capturing information related to atmospheric conditions. The prime objective of this project is to deliver a monitoring mechanism through a web server, therefore controlling an action dependent on a sensor's output. We performed various tests for sensor connection, data capture, and displaying the data through an LCD 16x2 serial interface. In the future, we'll be integrating a database connection and a web interface for ease of use and give access to the student community. This experiment shows us that it is feasible from the implementation, and the economic point of view. Eventually, this system will have a variety of sensors such as wind speed and a rain gauge, that will allow us to control the sensors remotely. Time was a limitation for the conclusion of all the steps of this project.

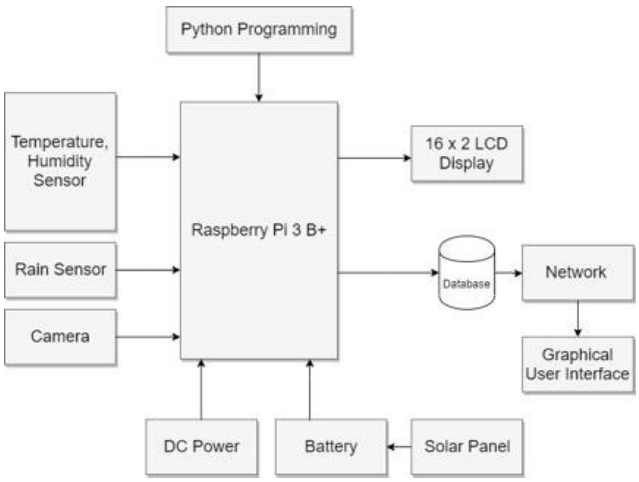

Figure 1. Block Diagram: Using a Raspberry Pi 3 B+ for Weather Sensor Monitoring

Project 2. Arduino Water Sensor

In this project, we used a water level sensor to activate a servo motor after a certain level previously established. To this servo motor we can connect the cover of a valve, and an electronic key among others. This type of configuration can work as an anti-flood system for a specific area. The materials used were:

- Arduino Uno
- An LED bulb.
- A resistance of 220 ohms.
- Water level detection sensor.
- Servo motor

This servo motor, model SG90, will be in a neutral position and once the water level sensor reaches the designated level, the Arduino microcontroller will send the signal to the servo motor so that it can move to the left or to the right, depending on the side that suits you best. Figure 2, shows a schematic configuration for this project.

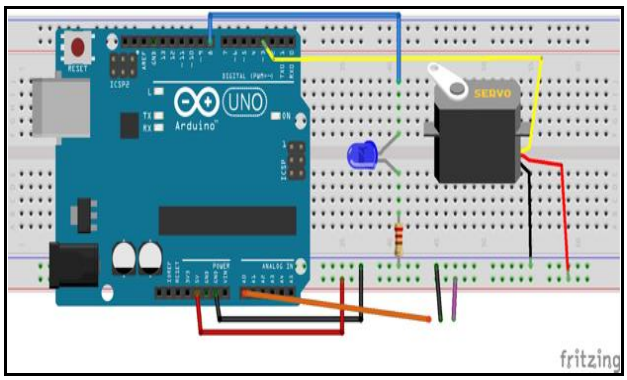

Figure 2. Arduino Water Sensor Diagram

The water level sensor has a time limit for reading accuracy. Figure 3 shows the sensor code. Experimentally, we obtained the time limit it was approximately one minute and thirty seconds, after this time the reading is not so reliable. Table 1 shows the voltage generated by the sensor.

Table 1. Voltage Generated by the Sensor

Voltage Generated by the Sensor	
1 cm	1.04V - 1.08V
2 cm	1.14V - 1.20V
3 cm	1.28V - 1.33V
4 cm	1.35V - 1.38V

The voltages measured in the previous table were measured in a seven ounce plastic cup.

Project 3. Arduino Movement Sensor

In this project, we used a DC motor for ventilation of an area as the motion sensor detects movement. Next to this, LED indicators will be used to determine the fan speed. With the help of a motion sensor used in previous practices we will change the speed of a DC motor. This DC motor will be used as a fan. While the motion sensor does not detect anything, the fan motor will be at an intermediate speed, but once the motion sensor detects something the fan will be at maximum speed. The intermediate speed will be represented by the yellow LED indicators and the maximum speed by the green one. The circuit connection is as shown in figure 4.

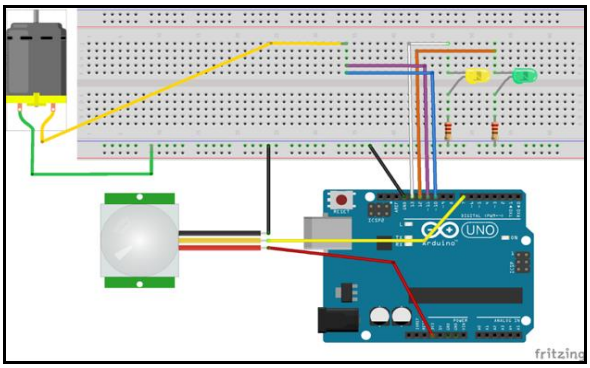

Figure 4. Arduino Movement Sensor Diagram

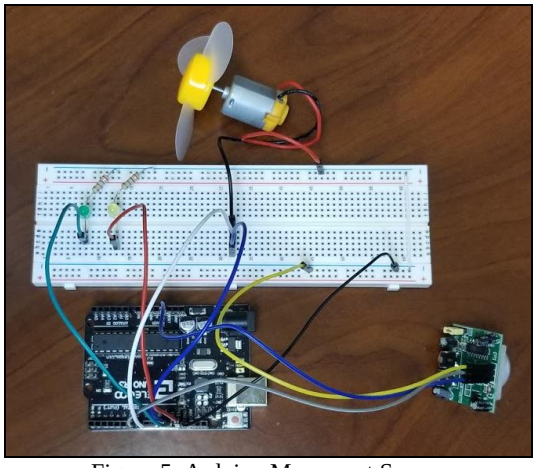

Figure 5. Arduino Movement Sensor

When building the circuit, two output pins are used for the DC motor in order to supply it with more voltage and better ventilation, otherwise the motor will not have enough speed. In the motion sensor the “repeat trigger” configuration was used, this can be changed in the lower left back side of the component. This will cause the motor to remain at high speed while the sensor detects movement and the green LED indicator stays on, when there is no movement within the sensor detection angle the engine speed decreases and the yellow LED indicator will turn on.

V. CONCLUSION AND FUTURE SCOPE

This experience helped students on the development of technical skills. The use of Raspberry PI and Arduino 3 B+ helped by providing better understanding of the concepts theoretically explained in their classes. Definitively, this experience is a great way to introduce concepts associated to computer science and information technology. All three projects were a low-cost investment, and a benefit for students handling issues related to programming or sensor communication. Future lines of work will consist of the implementation of the database for obtaining weather data.

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