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E-Lab Access using Wireless Sensor Technology

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Abstract: Now a days Laboratory experiments are integral part of science and engineering education. Automation is changing the nature of these laboratories, and the focus of the system designer is on the availability of various interfacing tools to access the laboratory hardware remotely with the integration of computer-supported learning environment.This paper presents the novel design techniques of hardware system that develops a remote/wireless Electronics Lab. The approach we employed is to use the GSM to provide students with remote access to physical laboratory apparatus. An Application is created with the help of JAVA, to handle the hardware. Systems of this type are synchronous, giving students a sense of actual involvement in the experiment. A PC is used with Dotnet programming to interface webcam option. The PC will be interfaced with MICROCONTROLLER for controlling different units. The PC uses an Internet service to E-mail Video clippings of Hardware setup and its working to the students E-mail Id.

Keywords*: Remote lab, Android, PIR Sensor, Slotted OptoIsolator.*

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1. INTRODUCTION

In engineering, laboratories have had a central role in the education of engineers, the first distance education graduate programs were intended, primarily, if not solely, for part-time students who were employed full time. Since most graduate programs do not include a laboratory component, the question of how to deliver laboratory experiences did not arise. As an undergraduate distance learning programs started to develop, this problem demanded a solution.

In this paper "E-lab access using wireless sensor technology", we use PIR sensors, Renesas controller, android, GSM, DC motors, and LCD for display. Renesas controller is the heart of the paper. All process controlled by this controller only, it is a 16-bit controller, and it consumes low power. Here we use a two line LCD for display purpose, it consists of two lines for display and its operating voltage is 5V DC. PIR sensor is a type of sensor which senses infrared rays emitted by the human body. The speed of the DC motor is measured by Slotted Opto Isolator. Driver circuit L293D is used to drive DC motors. Here we use GSM for communication purpose whose frequency is 900MHz.

2. HARDWARE DESIGN OF REMOTE LAB

In this paper the students are notified when the laboratory is available to use through GSM service using PIR sensor and are facilitated to login in the server with the given username and password through an Android application. Whenever they log in, the LAB setup will be given to them, they can conduct any experiments of their choice take numbers of iteration. The facility to change input according to results is given. The advantage is that some of the experiments take more than a day so to monitor such experiments this is very helpful as shown in figure1.

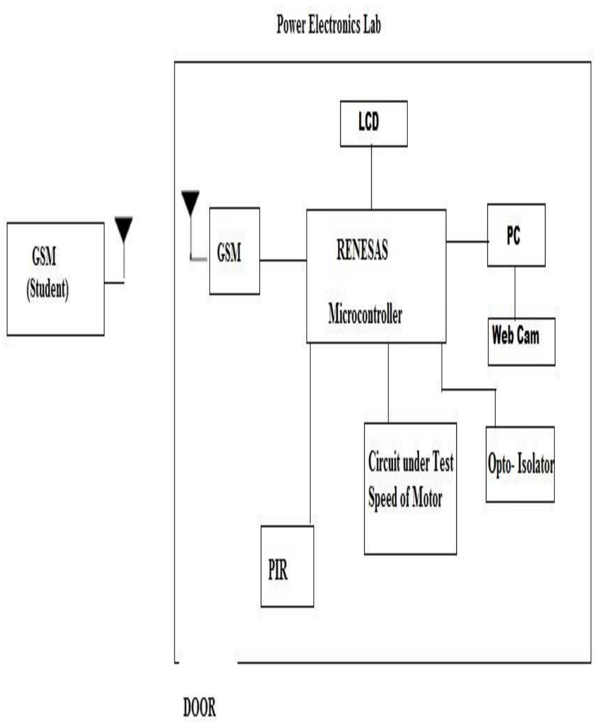

Figure 1- Block Diagram of the Research work

The GSM module is provided in such a way that it keeps on sending the results of experiments according to the time scheduled by user. Some safety measures can also be taken if there is any fluctuation in voltage levels the user can shut down the LAB system or it can be done automatically. The Web cam is provided to the user where he/she can monitor the waveforms, voltage levels, etc. A PC is used with Dot net programming to interface webcam option. The PC will be interfaced with MICROCONTROLLER for controlling different units. The PC uses an Internet service to E-mail students of Video clippings of Hardware setup and its working.

Renesas architecture based R5F100LEA microcontroller is used to implement this paper. It contains 32k RAM, 12- bit internal Timer, 1 external interrupt, 2 UART, programming support, etc. Renesas Flash is used to program the microcontroller and the coding will be done using Embedded C.

2.1. PIR Sensor

PIR sensors are often used in the construction of *PIR-based motion detectors*. These sensors measure infrared radiation emanating from objects in the field of view. All objects emit what is known as black body radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The Detection range is about 2-3 meters, it needs settling time of 60 seconds so that it can adjust it to the surrounding temperature.

The supply voltage is DC 3V-5V, a pyroelectric sensor has an infrared filter window that admits IR within the 5 to 15 micrometer wavelength range. One end of the two series-connected elements in an analog sensor are connected to pin 3 that is normally grounded. The other end connects internally to the gate of a Field Effect Transistor and to a very high value pulldown resistor. Power is applied to FET drain pin 1 and the output signal comes from FET source pin 2 which is usually connected through an external pulldown resistor to ground and to an amplifier. A digital sensor, includes internal processing circuits and output digital pulses

2.2. Slotted Opto Isolator

In electronics, an Opto-**isolator**, also called an **Optocoupler**, **photocopier** or **optical isolator**, is a component that transfers electrical signals between two isolated circuits by using light. Opto-Isolators prevent high voltages from affecting the system receiving the signal. Commercially available Opto-Isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 10 kV/μs. A common type of Opto-isolator consists of an LED and a phototransistor in the same opaque package.

MOC7811 is a slotted Opto isolator module, with an IR transmitter & a photodiode mounted on it. Performs Non-Contact Object Sensing. This is normally used as a position sensor switch (limit switch) or as Position Encoder sensors used to find the position of the wheel. It consists of IR LED and Photodiode mounted facing each other, enclosed in a plastic body. When the light emitted by the IR LED is blocked because of alternating slots of the encoder disc logic level of the photo diode changes. This change in the logic level can be sensed by the microcontroller or by discrete hardware. This sensor is used to give position feedback to the dc motor.

2.3.Microcontroller

RL78 is Renesas Electronics' new-generation microcontroller family, combining advanced features from both the 78K and R8C families to deliver low power consumption and high performance. RL78 is based upon 16 bit CISC architecture with analogue rich functionality. The platform line up will include general purpose, LCD and ASSPs including lighting and automotive microcontrollers. RL78 is designed specifically for ultra-low power applications, enabling customers to build compact and energy-efficient systems at lower cost.

Here we are using the Renesas, based R5F100LEA microcontroller. This belongs to the Renesas microcontroller family with 8 KB flash memory and 32k of data RAM. It has 2 UART'S which is used in our paper.

2.4. GSM Modem

It is used to send the text message to the authorized person's mobile as soon as the information is sent from microcontroller. The GSM module is provided in such a way that it keeps on sending the results of experiments according to the time scheduled by user. We are using SIM300 GSM Module in our Paper. SIM300 is a Tri-band GSM/GPRS engine from SIMCOM Ltd that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz.

3. RESULTS AND DISCUSSION

The necessary steps for conducting and performing the experiment are explained ahead. Students or users can conduct any laboratory experiments without being physically present in the lab. The hardware setup is previously made ready to be used in the laboratory for all the experiments to be conducted. For demo purpose, we are conducting the experiment "speed control of DC motor" in the power electronics lab. The following is the circuitry set-up made in the lab for the DC motor control experiment as shown in figure 2

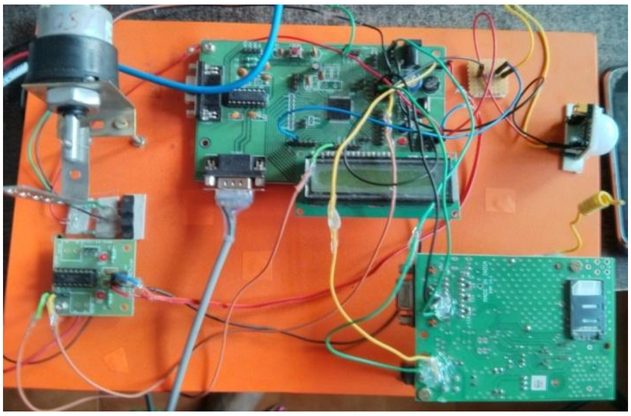

Figure 2- Hardware setup

A laptop PC with Webcam is dumped with Dot net coding for data transmission and is placed near the hardware setup; which is also connected to the same by ports.

A lab in charge enters the laboratory and turns on the main power supply. A PIR sensor is assumed to be placed at the entrance of the lab. This sensor senses the person entering the laboratory and sends signal to the GSM set-up present at the laboratory. This GSM in-turn notifies previously registered (data stored by faculty) students that the lab is ready to use

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1338 – 1342

with the regular SMS service. This is also displayed on the LCD display at the hardware setup shown in figure 3.

Figure 3- LCD display

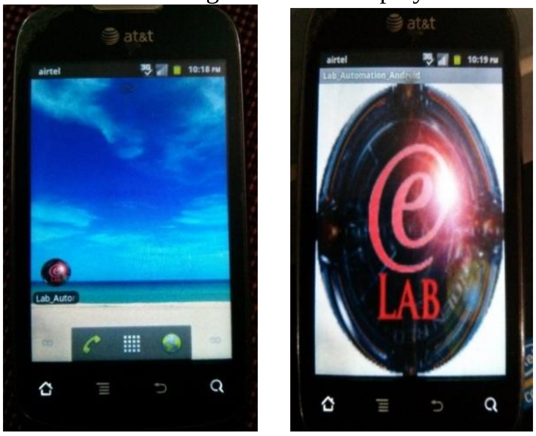

Figure 4- E-lab mobile application

SMS is received by all the registered students on their android mobile phones that has the laboratory application previously installed shown in figure 4.

Students are required to login to their ID's; which can be in-turn notified as attendance to the faculty as shown in figure 5. These details are also previously stored by the faculty in coding.

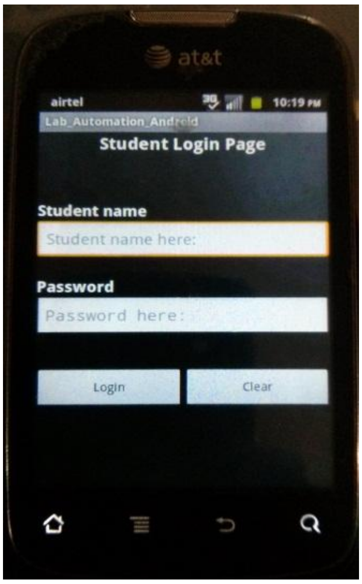

Figure 5- Application login page

Figure 6- List of experiments

After logging in, the student is connected to the laboratory through wireless GSM service. Students can select the experiment to be conducted from the list of experiments available/ displayed in the application as shown in figure 6.

After selecting "speed control of DC motor" experiment, Students are ready to learn and conduct.

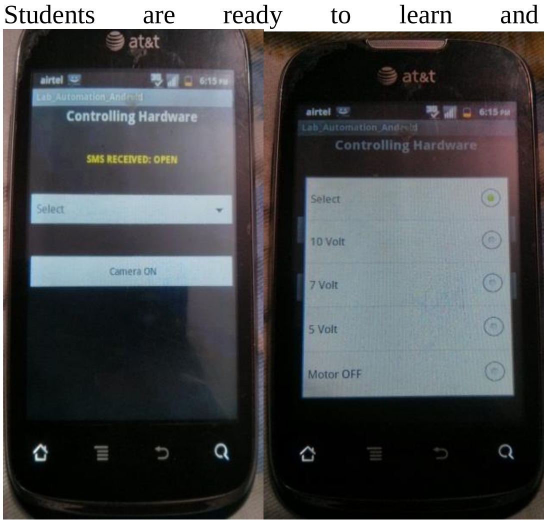

Figure 7- Application voltage control option

The corresponding voltages selected one after the other and sent to the hardware through GSM service as shown in figure 7. GSM at the hardware which is connected to the Renesas microcontroller is used to control the DC motor set-up. Speed in RPM is calculated by the number of rotations made by the DC motor with the help of the Opto-Isolator in the hardware set-up. This result is displayed on the LCD screen at the laboratory as shown in figure 9 and is also sent to the students through GSM service and is received in the application.

ISSN: 2321-8169
1338 – 1342

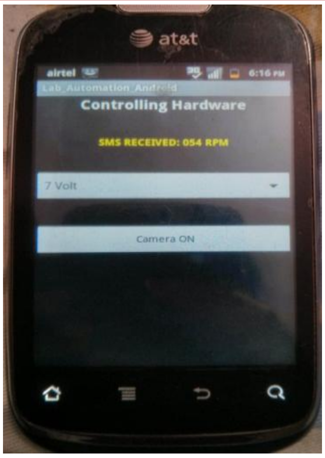

Figure 8 – Speed in RPM displayed in application

In order to enhance learning, a laptop PC with a web cam is placed on the hardware set-up, the "camera on" option is selected in the Android application by the student. When the hardware receives this request through the GSM service as shown in figure 10, a small video clipping of the hardware set-up is recorded through the webcam as shown in figure 11. This video has been sent to the students via E-mail services.

Figure 9 – Speed in RPM displayed on LCD diaplay

Figure 10 – Camera on message received and displayed on LCD display

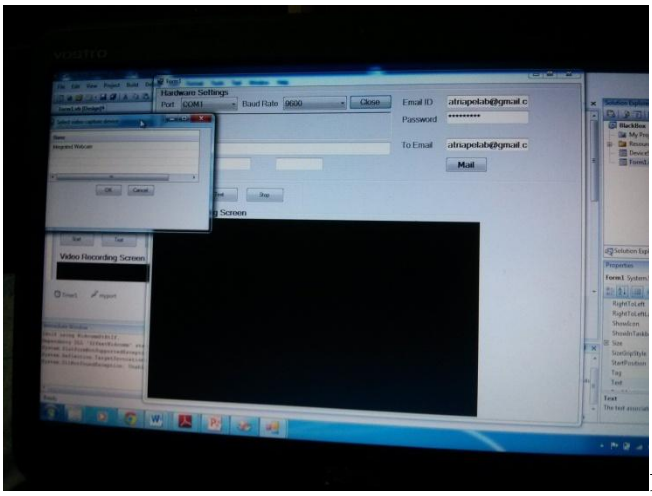

Figure 11 – Camera properties on Laptop PC

The voltage and speed reading is shown in table 1. The graph of the results of this paper for the speed control of DC motor is shown in figure12. Voltage vs speed characteristics are noted.

Voltage in Volts	Speed in RPM
0	0
5	24
7	36
10	54

Table 1 : DC motor characteristics

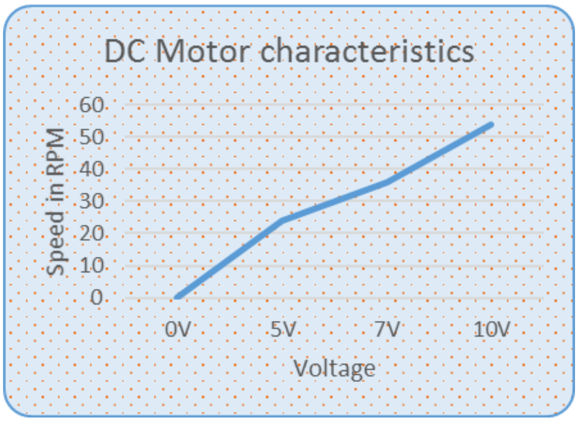

Figure 12 – Speed VS voltage characteristics of DC motor

IV. CONCLUSION

There are fundamental differences between hands-on and remote labs, beyond the mere format of their interfaces, which result in differences in the learning experience and for this reason remote labs should not be directly substituted like-for-like for hands-on Laboratory Work.

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Nevertheless, the only necessary difference between hands-on and remote-labs is the physical separation of student and apparatus. Other differences and similarities in the student's learning experience can be controllable factors, to greater or lesser extents. Remote labs have the potential to offer some valuable educational advantages if, like any other teaching technique, they are used appropriately within the curriculum.

We proposed an intelligent laboratory and system utilizes multi sensors and wireless communication technology in order to control devices, according to user requirements and surroundings. A Live lab camera which allows panning, tilting, zooming, showing, hiding, refresh. The integration of a kind of user scheduling for organizing the access according to a time table. This remote laboratory can be used not only in the field of education, but also for doing any measurement-task with real laboratory instruments.

In future power can be generated by the rotating motion of the DC motor. Power can be stored in turn from the mechanical rotation and the stored energy can be in-turn re-used for the experimental setup.

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