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DEVELOPMENT OF PROTO TYPE AUTOMATIC WATER LEVEL CONTROLLER DEVICE

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ABSTRACT: *Water scarcity is one of the major problems facing major cities of the country, and wastage during transmission has been identified as a major culprit. This is one of the motivations for this research, to deploy electronics techniques in creating a barrier to wastage in order to not only provide more financial gains and energy saving, but also help the environment and water cycle which in turn ensures water conservation for our future. We presented our research in embedding a control system in to an automatic water pump controller through the use of different technologies in its design, development, and implementation. The system uses microcontroller to automate the process of water pumping in an over-head tank storage system and has the ability to detect the level of water in a tank, switch on/off the pump accordingly, and displays the status on an LCD screen. We, the researchers have successfully designed and tasted the prototype form of 'Automatic plant irrigator device' in Debre Berhan University. Two main purposes of this automated water-level controller are due to the high level precision of the device, the water-level controller by itself can be used to control 'on' and 'off' conditions of the motor that delivers water to the over-head tank on the top of the building depending upon the level of water in the tank This also gives much needed rest to the farmers, as they don't have to go and turn the pump on/off manually. More generally this research project represents developing prototype form of automatic water-level controller device by using embedded system Arduino microcontroller.*

KEYWORDS- *Arduino UNO, Sensor Unit, Water-Pump, Relay, microcontroller AT89C51,LM 324, NE 555-timer.*

INTRODUCTION

Automatic water pump controller is a series of functions to control the Automatic Water Pump Controller Circuit in a reservoir or water storage. The water level sensor is made with a metal plate mounted on the reservoir or water tank, with a sensor in the short to create the top level and a detection sensor for detecting long again made for the lower level and ground lines connected to the bottom of reservoirs or reservoir.

In everyday life, there must be some physical elements that need to be controlled in order for them to perform their expected behavior. A control system therefore can be defined as a device, or set of devices, that manages, commands, directs or regulates the behavior of other device(s) or system(s). Consequently, automatic controlling involves designing a control system to function with minimal or no human interference.

In one of the research works, Ebere and Francisca (2013) designed a microcontroller based water level control system for the purpose of starting and stopping a pump, as well as display the level of the water in the tank. The system has the same objective as this design but differs in the type of sensor and display units. While they used comparators as sensors and LCD as display units, this design used metallic sensors and seven-segment ICs as display units. Furthermore, this design used PIC microcontroller embedded with C language while the other design used ATMEGA microcontroller embedded with assembly language.

Very recently, Teo and Tiew (2015) embarked on a similar venture where the Water Level Automated Management System was introduced. The information to top-up water from a reservoir tank when the water level in the main tank falls below half of the tank; was sent through SMS to the user. The module used an ultra sound sensor (ping sensor) to transmit and receive signal between the position of the sensor and the water (Abdullah et al, 2014; Viswanathet al, 2015). The microcontroller used was ATMEGA and the output device was LED and LCD. The technicality behind this module is different from that of this design in the type of sensor and the output device. However, they produce the same result of detecting water level. It is generally obvious that microcontroller has got a significant role to play in level control (Patil and Abrar, 2014). It is on this note that Chakraborty et al (2014) also worked on a water level control system using PIC microcontroller. This design is similar to this work in that it was meant for a residential building. The design used USART interface to communicate the water level status to a computer.

Sustainability of water resource in many areas of the world is now a dominant issue. This problem is quietly related to poor water allocation, inefficient use, and lack of adequate and integrated water management. Therefore, efficient use and monitoring of water is potential constraint for home or office water management system. Measuring water level is an essential task for government and residence perspective. Therefore, water controlling system implementation makes potential significance in home applications. The existing automated method of level detection is described and that can be used to make a device on/off. Such programmatic approach entails microcontroller based automated water level sensing and controlling.

Since, we researchers have successfully designed and tasted the prototype form of 'Automatic Plant Irrigator Device' in Debre Berhan University. But the device has limitation on sensing the water-level in the water-tank, and also this water-tank by itself was not automated to fill water in to it. It is so because there was no bulletin water-level sensor that has been integrated with that automatic irrigator device. Therefore, in order to regularly water the plant, the automatic plant irrigator device water-tanker must always hold water. To do so, this research project includes water level sensor to control the water level in the water tank. This water level sensor by itself can be used to monitor the water level of overhead thank on the top of our country cities building. As water scarcity is one of the major problems facing major cities of the country and wastage during transmission has been identified as a major culprit. This is one of the motivations for this research, to deploy electronics hardware and software techniques in creating a barrier to wastage in order to not only provide more financial gains and energy saving, but also helps the environment and water cycle which in turn ensures water conservation for our future. More generally this project represents developing prototype form of electronic water-level controller device.

1.METHODOLOGY AND TECHNICAL DISCUSSION

1.1.Water-Level Sensor Circuit Description- I:

This part is a about a fully functional water level controller using AT89C51 microcontroller. Fig. 1 shows the circuit of the microcontroller-based water-level controller- cum-motor protector. It comprises operational amplifier LM324, microcontroller AT89C51, optocoupler PC817, regulator 7805, LCD module and a few discreet components.

The AT89C51 (IC2) is an 8-bit microcontroller with four ports (32 I/O lines), two 16-bit timers/counters, on-chip oscillator and clock circuitry. Eight pins of port-1 and three pins of port-3 are interfaced with data and control lines of the LCD module. Pins P3.0, P3.1 and P3.6 are connected to RS (pin 4), R/W (pin 5) and E (pin 6) of the LCD, respectively. Pin EA (pin 31) is strapped to Vcc for internal program executions. Switch S2 is used for backlight of the LCD module. Power-on-reset is achieved by connecting capacitor C8 and resistor R14 to pin 9 of the microcontroller. Switch S1 is used for manual reset.

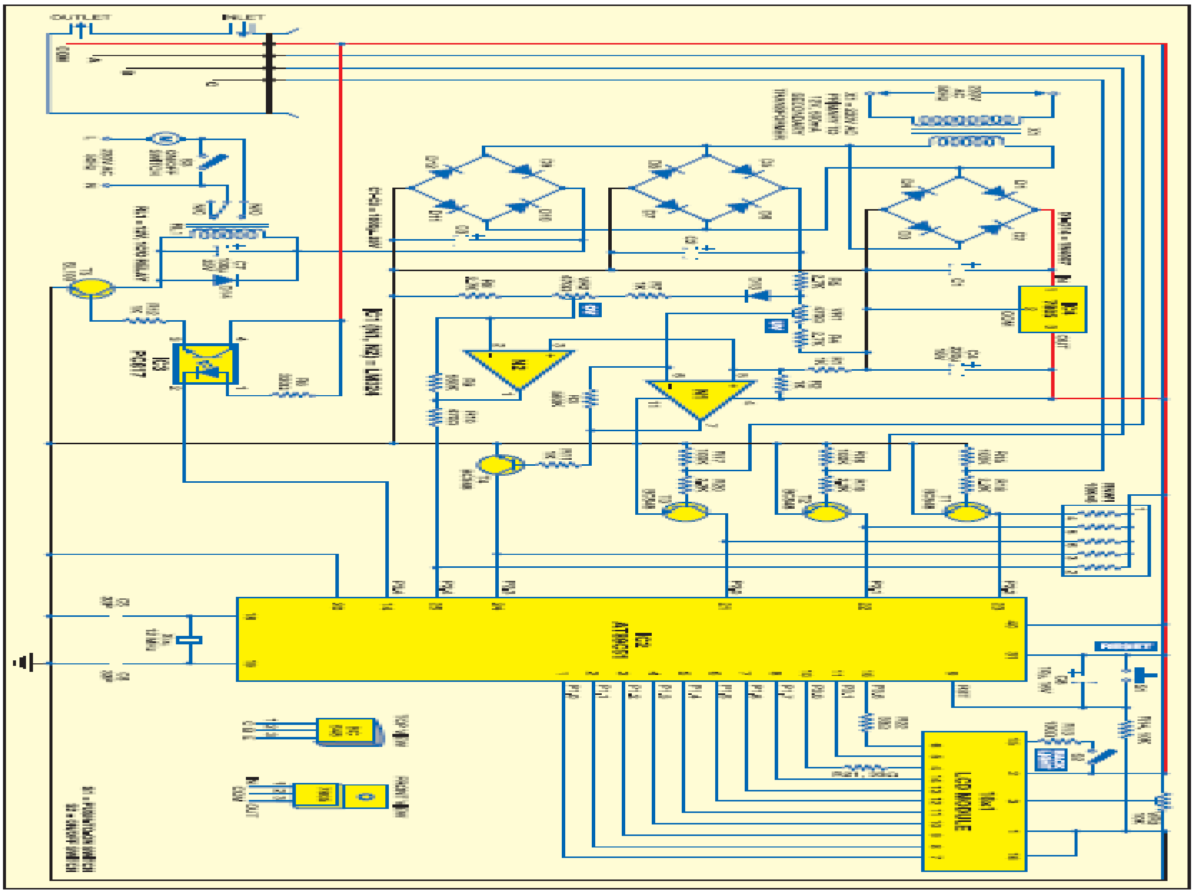

Figure 1: Water-Level Sensor Circuit Description (From where)

The microcontroller is operated with a 12MHz crystal. Port pins P2.0 through P2.2 are used to sense the water level, while pins P2.3 and P2.4 are used to sense the under-voltage and over-voltage, respectively. Pin P3.4 is used to control relay RL1 with the help of optocoupler IC3 and transistor T5 in the case of under-voltage, over-voltage and different water- level conditions. Relay RL1 operates off a 12V supply. Using switch S3, you can manually switch on the motor.

The LM324 (IC1) is a quad operational amplifier (op-amp). Two of its op-amps are used as comparators to detect under- and over voltage. In normal condition, output pin 7 of IC1 is low, making pin P2.3 of IC2 high. When the voltage at pin 6 of N1 goes below the set reference voltage at pin 5 (say, 170 volts), output pin 7 of N1 goes high. This high output makes pin P2.3 of IC2 low, which is sensed by the microcontroller and the LCD module shows 'low voltage.'

In normal condition, pin 1 of N2 is high. When the voltage at pin 2 of N2 goes above the set voltage at pin 3, output pin 1 of N2 goes low. This low signal is sensed by the microcontroller and the LCD module shows 'high voltage.' Presets VR1 and VR2 are used for calibrating the circuit for under- and over-voltage, respectively.

The AC main is stepped down by transformer X1 to deliver a secondary output of 12V at 500 mA. The transformer output is rectified by a full-wave bridge rectifier comprising diodes D5 through D8, filtered by capacitor C2, and used for the under and over-voltage detection circuitry.

The transformer output is also rectified by a full-wave bridge rectifier comprising diodes D1 through D4, filtered by capacitor C1 and regulated by IC4 to deliver regulated 5V for the circuit.

When water in the tank rises to come in contact with the sensor, the base of transistor BC548 goes high. This high signal drives transistor BC548 into saturation and its collector goes low. The low signal is sensed by port pins of microcontroller IC2 to detect empty tank, dry sump and full tank, respectively.

1.1 Circuit Operation -I:

When water in the tank is below sensor A, the motor will switch on to fill water in the tank. The LCD module will show 'motor on.' The controller is programmed for a 10- minute time interval to check the dry-run condition of the motor. If water reaches sensor B within 10 minutes, the microcontroller comes out of the dry-run condition and allows the motor to keep pushing water in the tank.

The motor will remain 'on' until water reaches sensor C. Then it will stop automatically and the microcontroller will go into the standby mode. The LCD module will show 'tank full' followed by 'standby mode' after a few seconds. The 'standby mode' message is displayed until water and if the dry-run condition still persists, the display will show 'drysump3' and the microcontroller will not start the motor automatically. Now you have to check the line for water and manually reset the microcontroller to start operation.

In the whole procedure, the microcontroller checks for high and low voltages. For example, when the voltage is high, it will scan for about two seconds to check whether it is a fluctuation. If the voltage remains high after two seconds, the microcontroller will halt running of the motor. Now it will wait for the voltage to settle down. After the voltage becomes normal, it will still check for 90 seconds whether the voltage is normal or not. After normal condition, it will go in the standby mode and start the aforementioned procedure.

1.1.Water-Level Sensor Circuit Description- II:

This part is a about a fully functional water level controller using Arduino UNO. The circuit displays the level of water in the tank and switches the motor ON when the water level goes below a predetermined level. The circuit automatically switches the motor OFF when the tank is full. The water level and other important data are displayed on a 16×2 LCD display. The circuit also monitors the level of water in the sump tank (source tank). If the level inside the sump tank is low, the motor will not be switched ON and this protects the motor from dry running. A beep sound is generated when the level in the sump tank is low or if there is any fault with the sensors.

1.1. Circuit Operation- II:

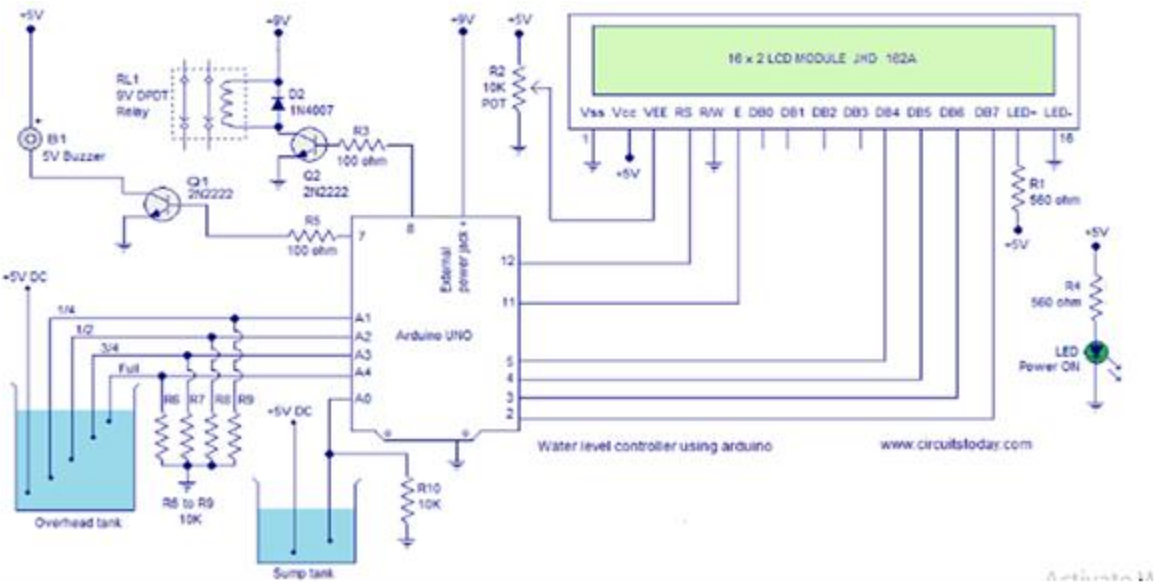

Figure 2: The circuit diagram of the water level controller using Arduino.

Conductive method is used to measure the level. The sensor assembly consists of four aluminium wires arranged at 1/4, 1/2, 3/4 and full levels in the tank. The dry ends of these wires are connected to analog input pins A1, A2, A3 and A4 of the Arduino respectively. A fifth wire is positioned at the bottom of the tank. Resistors R6 to R9 are pull down resistors.

The dry end of this wire is connected to +5V DC. When the water touches a particular probe, electrical connection is established between that probe and the +5V probe because water has slight conductivity. As a result current flows through that probe and this current is converted into a proportional voltage by the pull down resistor. Arduino reads the voltage dropped across each pull down resistor for sensing the level of water in the tank. Same method is used for measuring the level of water in the sump tank.

Digital pin 7 of the Arduino controls the buzzer and digital pin 8 controls the motor. Transistor Q1 drives the buzzer and resistor R5 limits the base current of Q1. Transistor Q2 drives the relay. Resistor R3 limits the base current of Q2. D2 is a freewheeling diode. POT R2 is used to adjust the contrast of the LCD. Resistor R1 limits the current through the back light LED. Resistor R4 limits the current through the power ON LED. Complete program for the water level controller using Arduino is given on the appendix.

Hardware Design:

The system performs the sensing level and control activities without the manual observation and attention in the site. Being an automatic system unavailing man power and providing information for long period of time. The automatic water level control system has the following main components.

Sensor Unit:

The sensor assembly consists of four Aluminium wires arranged at 1/4, 1/2, 3/4 and full levels in the tank. The dry ends of these wires are connected to analog input pins A1, A2, A3 and A4 of the Arduino respectively. A fifth wire is positioned at the bottom of the tank.

Control Unit:

The basic operation of control unit is the controlling water pump by arduino which is programmed by particular program. Water pump are connected with an output pin of arduino via a relay circuit which is connected with a transistor.

Liquid Crystal Display (LCD):

LCD is the most common message display device used to display ASCII character. LCDs have become a cheap and easy way to get text display for embedded system. The Common displays are set up as 16 to 20 characters by 1 to 4 lines.

Buzzer:

It is an electronic used to give alarm sound as it is programmed.

Power Supply:

Power supply circuit, the name itself indicates that this circuit is used to supply the power to other electrical and electronic circuits or devices. There are different types of power supply circuits based on the power they are used to provide for devices.

ARDUINO:

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

RELAY:

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. A relay switch can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. Commonly used relays are available in different configuration of operating voltages like 6V, 9V, 12V, 24V etc.

Arduino C Language:

Complete program for the water level controller is written using Arduino software (IDE). The Arduino reads the sensor output through the analog input pins using analog Read function. For example q=analogRead(qut); converts the voltage (in the range 0 to 5V) at the "quarter" probe into a number (in the range 0 to 1023) and saves it into the variable "q". This way the voltage at each probe is scanned to corresponding variables. These variables are compared to a fixed number (100 here) for identifying the current condition. Actually 100 is the equivalent of 0.48 volts and if the voltage at a particular sensor is greater than this, it is considered as an electrical continuity and water is assumed to be touching the probe. The "vale" of the fixed number (comparison variable"v") needs some adjustment because the resistivity of water changes from place to place and the gap between the sensor probes will be different in different tanks.

1.Result and Discussion

1.1 SIMULATION:

Using PROTEUS software, now it is possible to draw a complete circuit for arduino based system and then tests it interactively. With PCB layout the software now also offering automation of both component placement and track routing, getting the design into the computer can often be the most time consuming element of the exercise. And if you use circuit simulation to develop your ideas, you are going to spend even more time working on the schematic. So when we simulate our program which had written in arduino c language, and as we wrote before that we will always show the water level on the LCD and we will turn - on and off- the pump unit according to this value.

1.1Model: The sump tank is low and reservoir is empty the buzzer generates sound

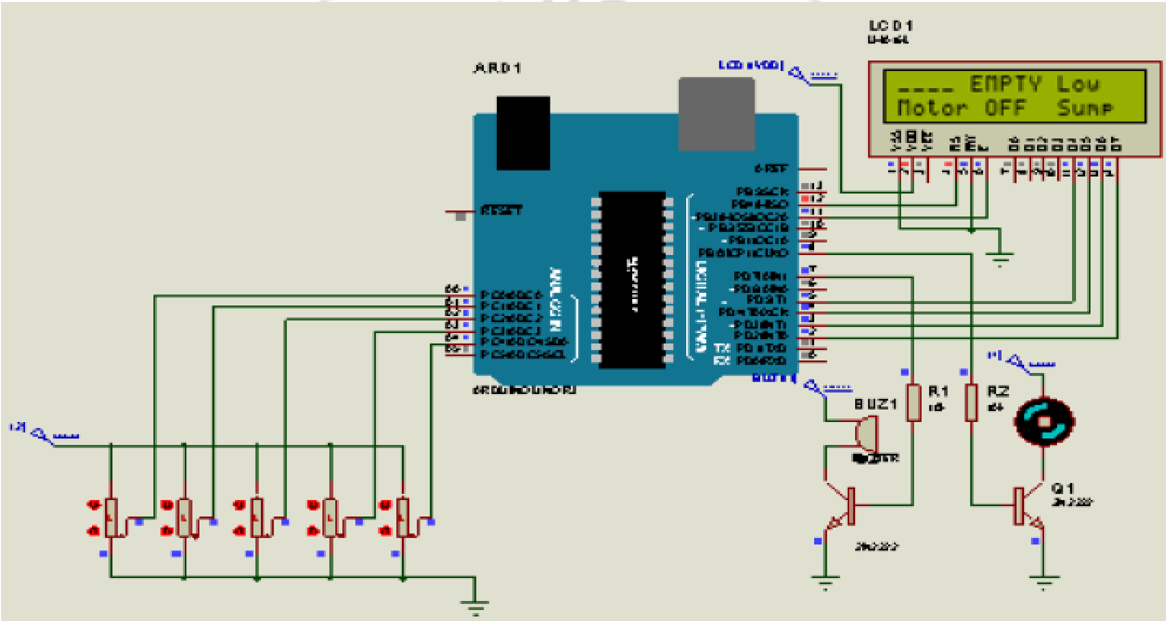

Figure 3: The sump tank is low and reservoir is empty the buzzer generates sound**.**

1.1. Model: The 25% water level display

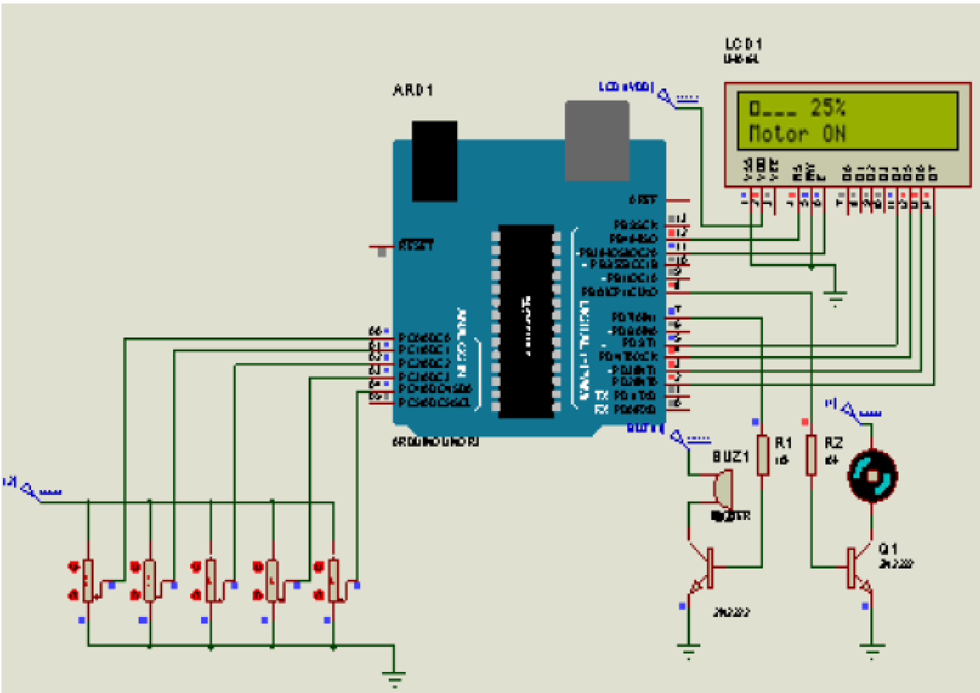

Figure 4: The 25% level display.

1.2. Model: The 50% water level display

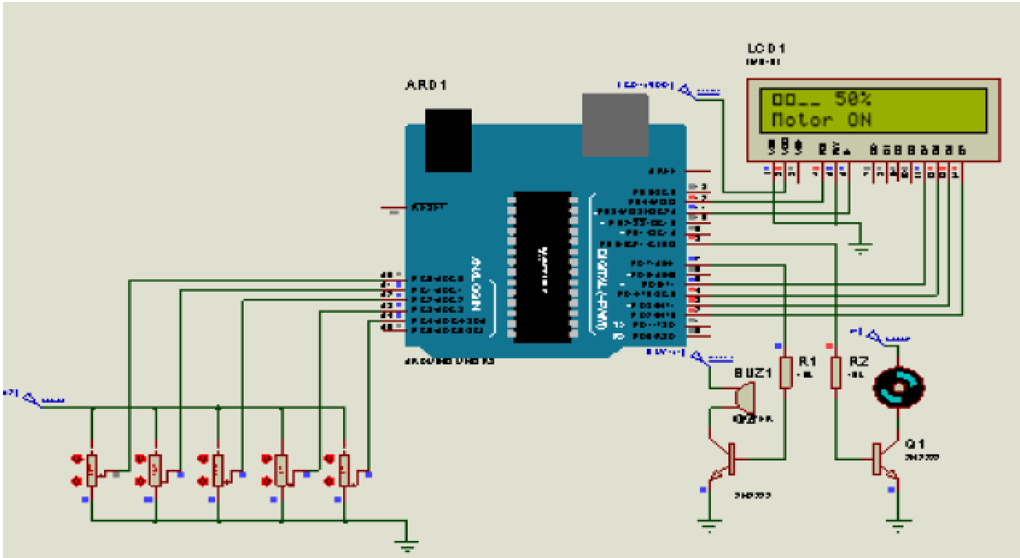

Figure 5: The50% level display.

1.3. Model: The 75% water level display

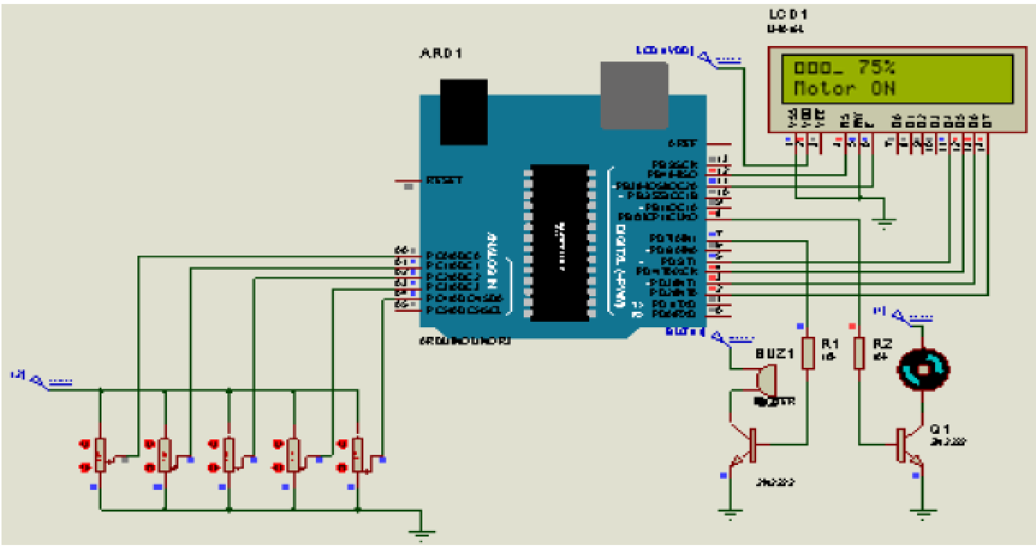

Figure 6: The 75% level display.

1.4. Model: The 100% water level display

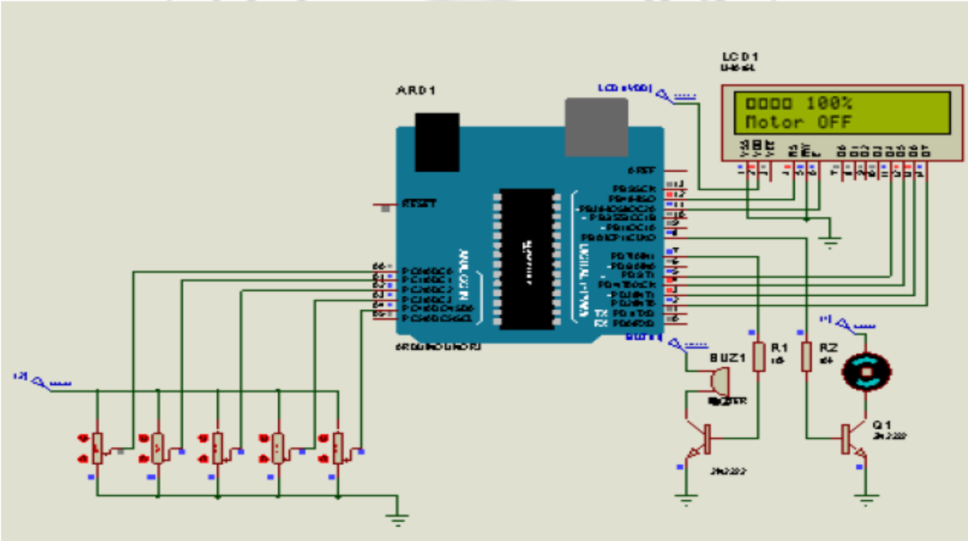

Figure 7: The 100% level display.

1.5. Prototype Electronic Water-Level Controller Device:

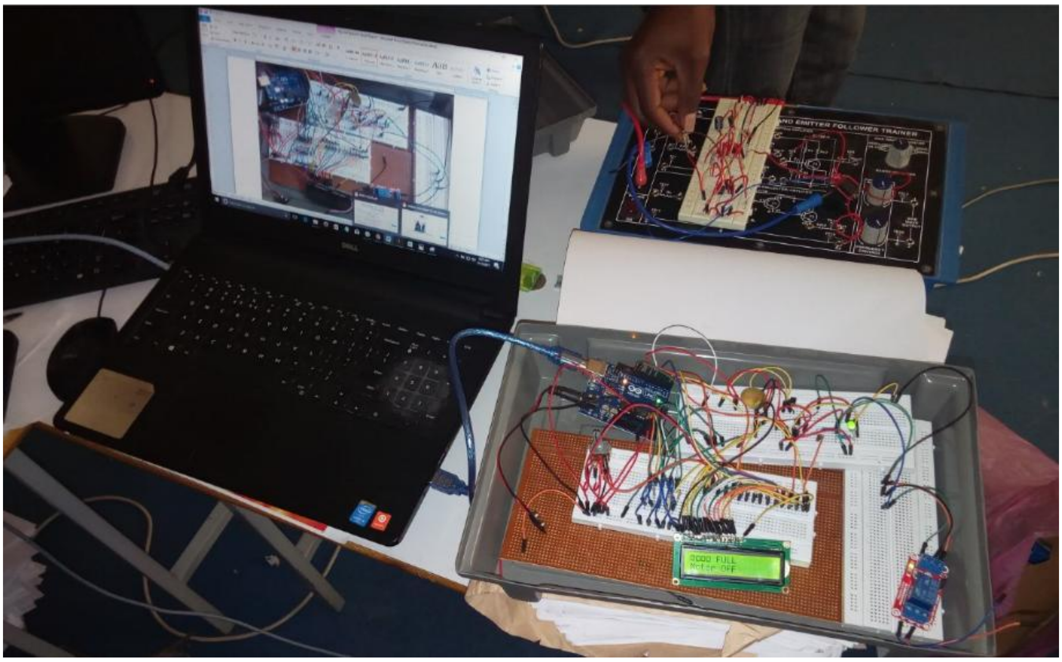

Figure8: Prototype Electronic Water-Level Controller Device, designed in Debre Berhan University Applied Physics, Electronics LAB.

2.CONCLUSION

This research project has achieved the main objectives. Moreover, this project involved designing and development of automatic water level control system had exposed to the better way of software and hardware architecture that blends together for the interfacing purposes. The system employs the use of advance sensing technology to detect the water level.

- This system is very beneficial in rural as well as urban areas.
- It helps in the efficient utilization of available water sources.
- If used on a large scale, it can provide a major contribution in the conservation of water for us and the future generations.

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