Arduino Uno based Smart Home Automation System

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Abstract - This paper outlines the development and implementation of an Arduino based smart home automation system. The system consists of two main parts: The Bluetooth-controlled home automation system and the automatic water level detection system. The Bluetooth-controlled home automation system is used to control electrical appliances in the house, such as air conditioners, lights, and fans. The automatic water level detection system is used to measure and monitor the water level in water tanks. Both systems are powered by an Arduino microcontroller, and are designed to be integrated and used together. The Arduino microcontroller is connected to a computer running a graphical user interface (GUI) software to enable users to control the home automation and water level detection systems. The GUI software also displays real-time data from the systems. The Bluetooth-controlled home automation system and the automatic water level detection system both have been tested for their accuracy, reliability, and efficiency. The results show that the system functions as desired and can be used to replace manual operations and provide a better user experience.

Keywords—Bluetooth Control, Sensor System, Automated Monitoring, Home Automation, Automatic Water Level Detection.

I. INTRODUCTION

1.1 Background study and motivation

Smart home automation is a type of home automation system that uses modern technology to provide a secure, convenient, and energy-efficient home environment. The project utilizes Bluetooth technology and sensors to control home appliances and detect water levels in order to provide a more efficient and comfortable living space. Domestic automation has come a long way in recent years, and the integration of Bluetooth technology has made it easier than ever to control domestic appliances remotely. [1] Bluetooth-enabled devices allow users to control home appliances and automate certain functions without having to be in the same room. This technology is particularly useful in home automation and automatic water level control, where it is possible to monitor and adjust levels from a distance. [6] The primary motivation behind this project is to develop a system that leverages the power of Bluetooth technology to provide users with a convenient and efficient way to control home appliances and automate the process of water level control. By leveraging Bluetooth technology, users will be able to monitor and adjust water levels remotely, without having to be in the same room. This will reduce the amount of time spent manually adjusting water levels and will allow for quicker and more efficient management of water levels.

1.2 Project Objectives

The objective of this project is to create a system that uses Bluetooth technology to enable users to control home appliances and automate the process of water level control. This system will be designed to provide users with a convenient and efficient way to monitor and adjust water levels automatically, and will allow for quicker and more efficient management of water levels.

1.3 Brief Outline of the report

The project will involve designing and developing a Bluetooth-enabled home automation system that is capable of monitoring and controlling water levels and other automated features. The system will allow users to easily monitor and control their home's water levels and other automated features from the comfort of their mobile device or Bluetooth control. The project will involve researching and developing a prototype of the system, as well as testing and evaluating the system to ensure that it meets the desired requirements. Finally, the project will involve deploying the system in a real-world environment for further testing and evaluation.

II. LITERATURE REVIEW

Home automation is the concept of controlling a home's lighting, heating, and other electronic devices through a centralised control system. The use of Bluetooth technology to control home automation systems is becoming increasingly popular due to its low cost and convenience. This literature review will discuss the current state of Bluetooth home automation and automatic water level control projects. The first use of Bluetooth for home automation was in 2003, when a Bluetooth-enabled thermostat was developed for a smart home project. [1] This was followed by the development of Bluetooth-enabled door locks and lighting systems, with the first commercial product being released in 2005. [1] Since then, Bluetooth has been used for a wide range of home automation tasks, including controlling lights, thermostats, security systems, and air conditioning. Recent advances in Bluetooth technology have made it possible to control home automation systems from a variety of different devices, such as smartphones, tablets, and computers. (3) This has made it easier to control home automation systems remotely, as well as enabling the automation of tasks such as scheduling and energy management. [4] Bluetooth-enabled home automation systems are becoming increasingly popular due to their convenience and cost-effectiveness. [5]

The use of technology for automatic water level control has also been investigated. In particular, the use of sensors to measure and monitor water levels in tanks and reservoirs has been studied. [6] This technology has the potential to automate water management tasks, such as scheduling irrigation and controlling water flow. [6] In addition, the use of sensors for monitoring and controlling water levels in dams and other water bodies has been explored. [2]

Overall, the use of Bluetooth to control home automation and automatic water level control projects can provide a convenient, secure, and energy-efficient way to manage various home devices.Moreover, the use of some sensors can enable users to monitor and control their devices automatically, making it a convenient and user-friendly solution for a smart home automation system.

III. METHODOLOGY AND MODELING

3.1 Introduction

The aim of this project is to control home automation and automatic water level control using Bluetooth. Some design and implementation were required in order to run the system. Figure-1 shows the block diagram of our project where everything is controlled by Arduino Uno (Atmega328).

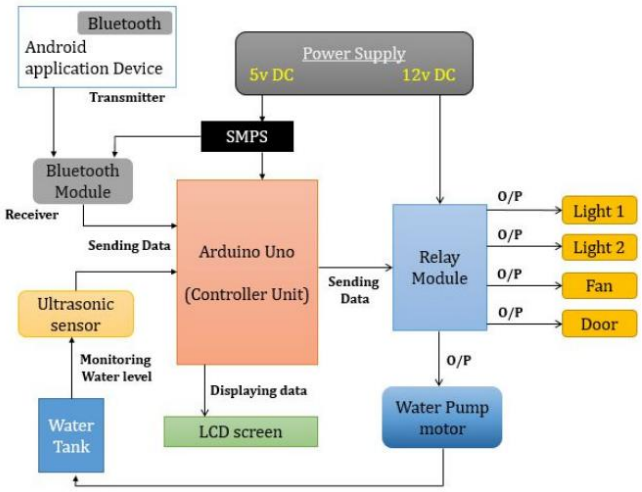

Figure – 1: Block diagram of the system

3.2 Working principle

In this project a Bluetooth module used to control the home automation system. The module will be connected to a microcontroller, which will be used to control the various components of the home automation system. The microcontroller also connected to a relay module, which will be used to control the components of the Home Automation system. The project involves the use of a water level sensor to detect the water level in a tank or water reservoir. The water level sensor is connected to the home automation system which is programmed to receive and interpret signals from the water level sensor. When the water level reaches a predetermined level, the home automation system will send a signal to a pump or valve to turn it on or off. This will allow the user to control the water level in the tank or water reservoir automatically.

3.2.1 Process of the work

The first step towards implementing the Bluetooth control home automation and automatic water level control project is to define the specific requirements. This includes the scope of the project, the desired outcome, the timeline, the budget, and the resources

available. The next step is to create a design for the project. This includes designing the hardware and software components required for the project, writing algorithms for the automation, and creating a user interface. Once the design is ready, the next step is to build the hardware and software components. This includes building the Bluetooth module, the sensors, and the actuators. After the hardware and software components are built, the next step is to test the system. This includes testing the hardware components, testing the software components, and testing the user interface. After the system is tested and is functioning correctly, the next step is to implement the system. This includes integrating the hardware and software components, setting up the system, and training users on how to use the system. The final step is to monitor and maintain the system. This includes monitoring the system for any issues, troubleshooting any issues, and updating the system when necessary.

3.3 Components used

3.3.1 Arduino Uno R3

Arduino Uno is a microcontroller board with digital and analog pins. It is open-source hardware. There are a few variants of this component. Here, Arduino Uno R3 was used. It is the central unit of a system. It uses a programming language to communicate with machines. Using Arduino, here, we have sent and received information.

Figure – 2: Arduino Uno R3

3.3.2 Bluetooth Module

Using Serial Communication (USART), it communicates with the Arduino board. The HC05 module has an internal 3.3V regulator so it can be connected to a 5V power supply. Arduino provides the power here from the LI-PO battery.

Figure 3: Bluetooth Module

3.3.3 Relay Module

Relay module is an electrical switch that is used to turn on or off devices using an electrical current. It is essentially a remote control switch that uses low voltage signals to control higher voltage devices. It is commonly used in automation and robotics applications, such as allowing a low-voltage microcontroller to control a high-voltage motor.

Figure 4: Relay Module

3.3.4 Ultrasonic Sensor

The HC-SR04 Ultrasonic Distance Sensor is a sonar-based sensor for measuring distances to objects. The ultrasonic sensor, like dolphins, uses an echo sounder to measure the distance to an object. The sensor starts working when ultrasonic waves are generated from the transmitter in the sensor, which spreads the waves in a specific direction. The ultrasonic waves spread throughout the air and once it comes into contact with an object in its path, the waves are immediately returned. It is used to measure the obstacle in the system.

Figure – 5: Ultrasonic sensor

3.3.5 DC Mini Water Pump

It is a water pumping motor that is cost efficient and can be operated using 2.5 volts to 6 volts. In our project, when the Ultrasonic sensor detects the water level of the tank it gives the update to Arduino and then Arduino sends input to the pump to release water.

Figure – 5: DC Mini Water Pump

3.3.6 LCD Display

16*2 LCD display is a liquid crystal display (LCD) that has 16 columns and 2 rows of pixels or characters. It used to monitor the water level and water pump condition.

Figure – 6: LCD display

3.3.7 Mini Servo Motor

Mini servo SG90 is small and lightweight with high output power. It is used to make the door of the smart home.

Figure 7: Mini Servo SG90

3.3.8 Light and Fan

Used as home appliances.

Figure 8: Light and Fan

3.3.9 DC battery

A DC battery is a type of battery that produces electricity from the chemical reaction between two dissimilar metals and an electrolyte. It used to provide the power to the whole system.

Figure – 9: DC battery

3.3.10 10k potentiometer

10k potentiometer is a type of variable resistor that has a resistance range of 10,000 ohms (10k). It used to control water pump speed.

Figure – 10: 10k potentiometer

3.4 Implementation

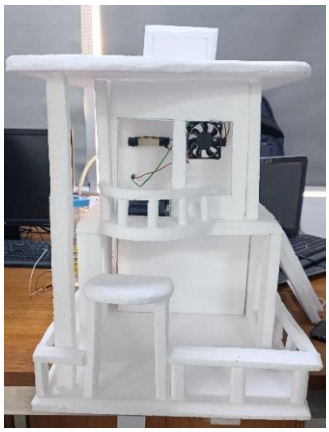

Figure – 11: Implementation of the project

Software Implementation

Arduino IDE is used to code for this. C++ programming language was used.

- Figure (2-10) was taken from the website https://store.arduino.cc/ (accessed on December 07, 2022)

3.5 Experimental setup

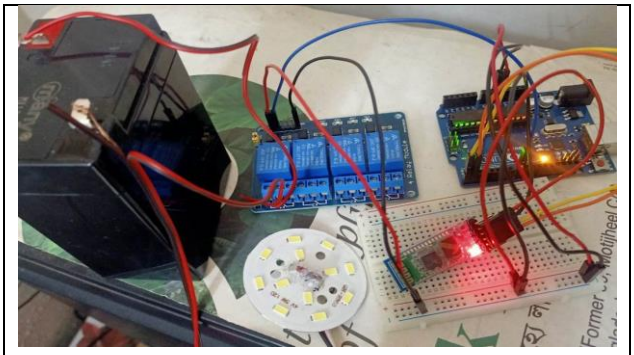

Figure – 12: Bluetooth control home automation

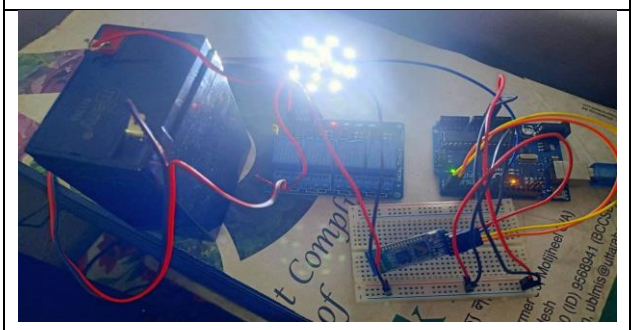

Figure – 13: Bluetooth control home automation

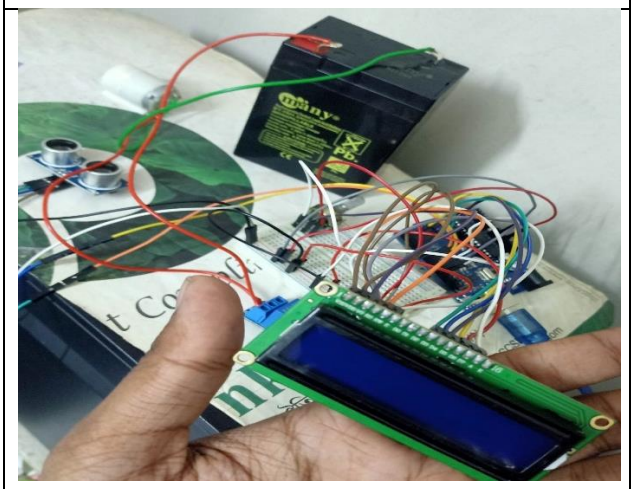

Figure – 14: Automatic water level control

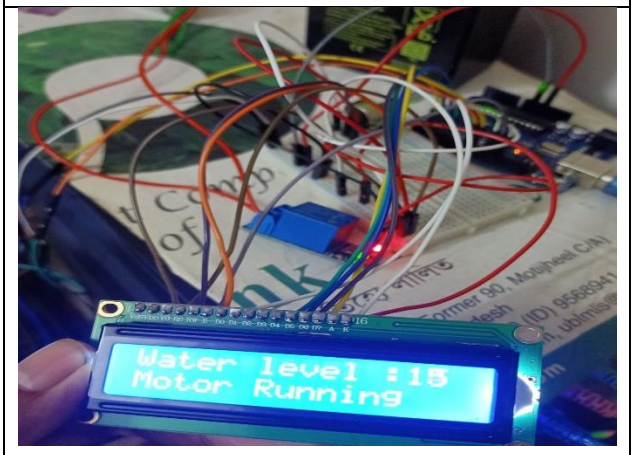

Figure – 15: Automatic water level control

IV. COST ANALYSIS

4.1 Hardware Cost:

1. Arduino Uno – 1000tk
2. Bluetooth Module – 450tk
3. Servo Motor and pumps - 400
4. Ultrasonic sensor and Display – 500tk
5. Relay Module – 350tk
6. DC Power Source – 1000tk
7. Other components and wires- 500tk
8. Installation and Setup: 300tk

Total Cost of Arduino based Smart Home Automation system project = 4500tk

V. RESULT AND DISCUSSION

5.1 Simulation

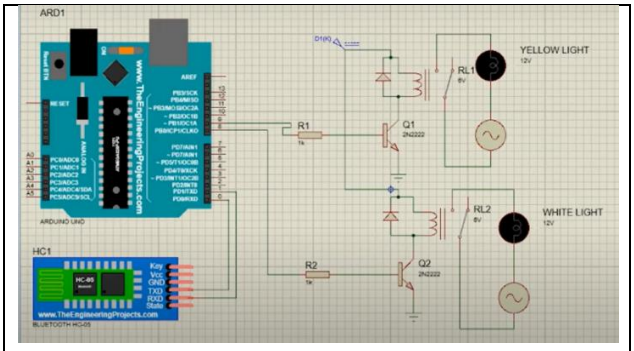

Figure – 16: Bluetooth control home automation (All Lights OFF)

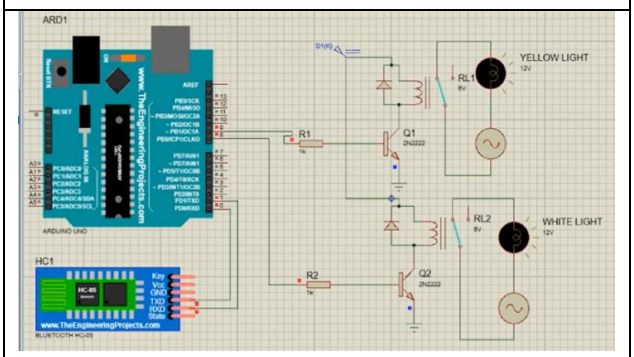

Figure – 17: Bluetooth control home automation (Both Lights ON)

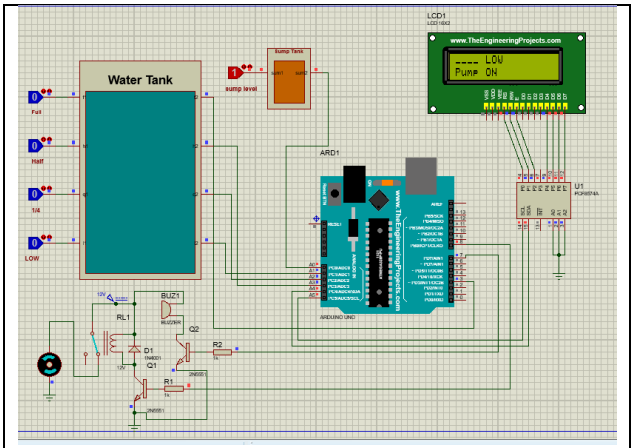

Figure – 18: Automatic water level control

(Low water level and pump will be on)

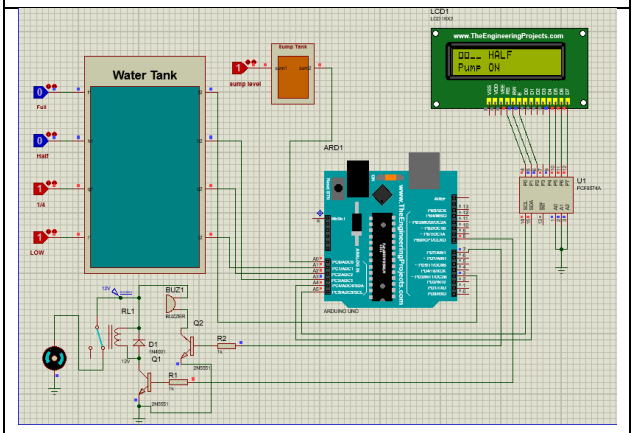

Figure – 19: Automatic water level control

(Water Half-filled and pump on)

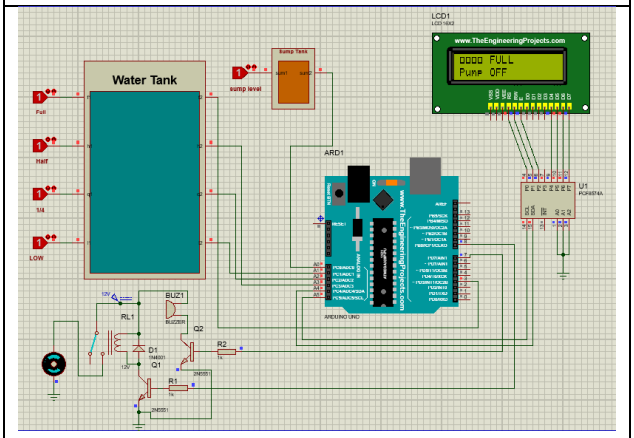

Figure – 20: Automatic water level control

(Water tank is Full and pump will be off)

5.2 Experimental results

The Arduino UNO R3 is linked to a rechargeable LI-PO battery, which serves as the system's power supply. According to the code that has been uploaded to the Arduino board, The Bluetooth home automation system was tested by connecting a HC-05 Bluetooth module to the Arduino microcontroller and then connects to a relay module. Once the connection was established, the system was able to be controlled through a Bluetooth enabled device such as a Smart Android phone. The system was able to control various home appliances such as lights, fans and Door. The system was found to be reliable and efficient in its operation. On the other hand, the automatic water level control system was tested by connecting the Ultrasonic sensor to the Arduino microcontroller and then to a relay module. Once the connection was established, the system was able to be automatically controlled by monitoring the water level.

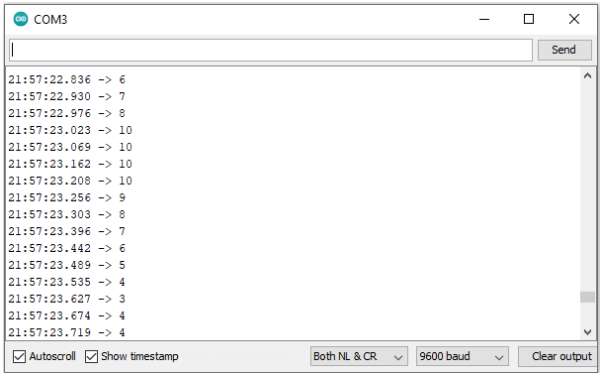

Figure 21: monitoring the distance

(Source – Arduino IDE)

The system was able to detect the presence of the water and accurately adjust the water level as needed. When the water level is low the sensor detects the situation and send signal to the Arduino board, then relay module received signal from the Arduino and water pump gets started which is connected to the relay.

Sl No	Water level range to Sensor	Pump Situation
01.	6 cm	Pump Off
02.	9 cm	Pump Off
03.	11 cm	Pump Off
04.	13 cm	Pump Off
05.	15 cm	Pump ON
06.	14 cm	Pump ON
07.	10 cm	Pump ON
08.	8 cm	Pump ON
09.	7 cm	Pump ON
10.	5 cm	Pump Off

Table-1: Output when pump is ON/Off

As seen in the table, the water pump is activated when the water level is more than or equal to 15 cm distance from the sensor. When the water distance in 5 cm the pump gets off. This cycle keeps repeating. The system was able to respond quickly to changes in the water level and maintain the desired level. Overall, the system was able to accurately and reliably control the water level in the designated area.

5.3 Comparison between Simulation and experimental results

Simulation and experimental results are both important in the development and implementation of any project. Simulation results are important for predicting outcomes and for testing a system before it is deployed in the real world. Experimental results are necessary for accurately assessing and validating a system's performance in the real world.

For the Arduino based smart home automation system, simulation results can be used to evaluate the system's capability to perform the required tasks. This includes testing the system's ability to communicate with other devices, its ability to accurately collect and process data, and its ability to respond to user commands. Simulation results can also help optimize the system's performance and identify potential issues that may arise in the real world. On the other hand, experimental results are necessary to validate the system's performance in the real world. This includes testing the system's ability to communicate with other devices, its accuracy in collecting and processing data, and its response to user commands. Experimental results will also provide an indication of how the system will perform in different environments and temperatures. Additionally, experimental results will provide a clear picture of how the system will interact with other systems and its reliability in the real world. Both simulation and experimental results are important for the Bluetooth control home automation and automatic water level control project. Simulation results can help optimize the system's performance and identify potential issues before they are deployed in the real world. Experimental results are necessary to validate the system's performance in the real world and ensure that it is reliable and accurate.

5.4 Limitations in the project

- Bluetooth signals have a limited range and can be blocked by walls or other physical barriers.
- Bluetooth connections are vulnerable to security risks such as data interception and malicious attacks.
- Not all devices are compatible with each other, which can limit the scope of the project.
- Difficulty in operating the project in different types of water environments.
- Risk of failure due to technical issues or user error.

VI. CONCLUSION AND FUTURE ENDEAVORS

The Arduino based Smart Home Automation system project is a great example of how technology can be used to make life easier. By using a combination of Bluetooth, Arduino, and sensors, the project was able to successfully automate the home and water levels. The project has proven to be a great success, with the home automation system being able to control lights, fans, and other home appliances with ease. Additionally, the water level control system was able to accurately detect and monitor the water levels in the tank, allowing for greater efficiency in its use. Overall, this project has demonstrated that technology can be used to make life easier and more efficient. It is also a great example of how a combination of different technologies can be used to create a larger, more powerful system. With more research and development, similar projects can be used to automate more aspects of life, making our lives easier and more efficient.

6.1 Future endeavors

1. Further development of the project to include additional home automation features, such as voice control, temperature control and security systems.

2. Research into the use of artificial intelligence for home automation, such as for automatic scheduling of appliances.
3. Investigating the potential for integrating smart home appliances into the system, such as smart lighting and connected kitchen appliances.
4. Exploring the possibilities of incorporating machine learning algorithms into the system to improve its performance.
5. Development of a user-friendly mobile application to easily control and monitor the home automation system.

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American International University- Bangladesh (AIUB)
Faculty of Engineering (EEE)

Course Name:	Microprocessor and Embedded Systems	**Course Code:**	EEE 4103
Semester:	Fall 2022-2023	**Section:**	" I "
Faculty Name:	Nirjhor Tahmidur Rouf		

Capstone Project Title:	Arduino Uno based Smart Home Automation System.
Project Group No.	

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Assessment Materials and Marks Allocation:

Cos	**Assessment Materials**	**POIs**	**Marks**
CO3	Course Project report ***(Demonstrate a course project using microcontrollers, sensors, actuators, switches, display devices, etc. that can solve a complex engineering problem in the electrical and electronic engineering discipline through appropriate research)***	**P.d.1.P3**	**5**

CO	Excellent to proficient [5- 4]	Good [3]	Acceptable [2]	Unacceptable [1]	No response [0]	Secured marks
CO3 **P.d.1.P3**	The outcome of the project demonstrates a course project using microcontrollers, sensors, actuators, switches, display devices, etc. that can solve a complex engineering problem in the electrical and electronic engineering discipline through appropriate research.	The outcome of the project somewhat demonstrates a course project using microcontrollers, sensors, actuators, switches, display devices, etc., and also somewhat solves a complex engineering problem in the electrical and electronic engineering discipline through appropriate research.	The outcome of the project demonstrates a course project using microcontrollers, sensors, actuators, switches, display devices, etc. but cannot solve a complex engineering problem in the electrical and electronic engineering discipline through appropriate research.	The outcome of the project does not demonstrate a course project using microcontrollers, sensors, actuators, switches, display devices, etc. also cannot solve a complex engineering problem in the electrical and electronic engineering discipline through appropriate research.	No Response	
Comments					Total marks (5)	