OFFICE AUTOMATION AND POWER CONSUMPTION ANALYSIS

PROJECT REPORT

Submitted to the

MAHATMA GANDHI UNIVERSITY

in partial fulfillment of the requirements
for the award of the Degree of

BACHELOR OF TECHNOLOGY
in
ELECTRONICS AND COMMUNICATION ENGINEERING

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the project titled **“OFFICE AUTOMATION AND POWER CONSUMPTION ANALYSIS”**, submitted to the Mahatma Gandhi University, in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Electronics and Communication Engineering, is a record of project presented by the candidate **ARAVIND S (Reg.No.15001315)** Department of Electronics & Communication Engineering, University College of Engineering, Muttom, Thodupuzha – 685 587.

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STATEMENT

The dissertation titled **“OFFICE AUTOMATION AND POWER CONSUMPTION ANALYSIS”**, submitted by **Mr. ARAVIND S (Reg. No. 15001315)**, to the M. G. University, in partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Electronics and Communication Engineering, is the original and independent work carried out by him in **KOCHI MERTO RAIL LIMITED**, under my supervision and guidance during the period from 14.1.2019 to 30.4.2019.

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Certified that the dissertation titled **“OFFICE AUTOMATION AND POWER CONSUMPTION ANALYSIS”**,is a bonafide record of independent work done by me and my group members at **KOCHI METRO RAIL LIMITED**, under the supervision and guidance of **Mr.VIJAYAKUMAR T.T, Manager (IT/COM) Kochi Metro Rail Limited** along with **Mr.ANSAR M.M, Assistant Professor, University College of Engineering, Muttom** and **Ms.ASHALATHA P T., Head of the Dept. of Electronics & Communication Engineering, University College of Engineering, Muttom.** I also certify that the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred earlier.

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ABSTRACT

The more the technology advances into the future, the more it makes thelife of people depending on it easier and one of such technologies is Automation.The term Automation can be coupled with- no effort, ease of performing a task and less human involvement means to control the appliances via a device with wireless access. The key component of this system are a pocket sized microprocessor-Raspberry Pi. The data provided by the Raspberry Pi and also to send, receive and process the requests. The Raspberry Pi acts as the brain of this system, processingthe requests, responding to the requests made by the Android application. All the sensors and actuators are connected wirelessly to the Pi using a Wi-Fi modules employed in the sensor and actuator sides of the system. Our main objective of developing this model is to create a home/industrial automation system which interacts with the user through various push notifications based on concerned parameters and full control over those electrical loads.

ABOUT THE ORGANISATION

To enrich the quality of life for everyone in Kochi by facilitating better connectivity between people, between people and places, and between people and prosperity.To make Kochi a more liveable and pleasant city for residents and visitors alike, where public transportation would be used by all – connecting people and places safely, seamlessly, reliably and comfortably. Five years ago, Kochi Metro Rail Limited was started with the objective of building and running a metro line, but later we decided to use KMRL as an opportunity to migrate citizens from personal vehicles to public transport and change the face of transportation and mobility in the process. KMRL is trying to build itself as Kerala's urban transport solutions provider. By being the first metro system in the country with an integrated multimodal transport system, Kochi Metro will not only give the city a much-required face-lift but also provide an end-to-end connectivity.

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LIST OF FIGURES

LIST OF ABBREVATIONS

EDA	-	EXPLORATORY DATA ANALYSIS
CDA	-	CONFIRMATORY DATA ANALYSIS
SN	-	SENSOR NODES
CPU	-	CENTRAL PROCESSING UNIT
TX	-	TRANSMIT
RX	-	RECEIVE
HDMI	-	HIGH DEFINITION MULTIMEDIA INTERFACE
PIR	-	PASSIVE INFRARED
UART	-	UNIVERSAL ASYNCHRONOUS RECEIVE OR TRANSMIT
ZCD	-	ZERO CROSSING DETECTOR
PWM	-	PULSE WIDTH MODULATION
GPU	-	GRAPHICS PROCESSING UNIT
GPIO	-	GENERAL PURPOSE INPUT OUTPUT
SPDT	-	SINGLE POLE DOUBLE THROW
SQL	-	STRUCTURED QUERY LANGUAGE
SPI	-	SERIAL PERIPHERAL INTERFACE

CHAPTER 1

INTRODUCTION

Automation is the technology by which a process or procedure is performed with minimal human assistance. Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention. Some processes have been completely automated.

Automation covers applications ranging from a household thermostat controlling a boiler, to a large industrial control system with tens of thousands of input measurements and output control signals. In control complexity it can range from simple on-off control to multi-variable high level algorithms.

In the simplest type of an automatic control loop, a controller compares a measured value of a process with a desired set value, and processes the resulting error signal to change some input to the process, in such a way that the process stays at its set point despite disturbances. This closed-loop control is an application of negative feedback to a system. The mathematical basis of control theory was begun in the 18th century, and advanced rapidly in the 20th.

Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques. The benefit of automation include labour savings, savings in electricity costs, savings in material costs, and improvements to quality, accuracy and precision

Office automation refers to the varied computer machinery and software used to digitally create, collect, store, manipulate, and relay office information needed for accomplishing basic tasks. Raw data storage, electronic transfer, and the management of electronic business information comprise the basic activities of an office automation system. Office automation helps in optimizing or automating existing office procedures.

1.1 BIG DATA ANALYSIS: ROLE OF AUTOMATION

The emergence of big data largely changed the digital landscape and organizational operations. the disparity of data was effectively mitigated by its intensified analytics. with the evolution of newer trends in this realm, the technologies are getting polished. automation of big data is the most disruptive technology changing its dominion completely. the power of big data lies in finding the patterns having some predictive values. it is further enhanced by automated processes that help in identification of some specific ‘data features’. these features help in making a predictive analysis of the database.

The automation of Big Data Analysis. depending on the technology applied, it can take only a few weeks to process, analyze, and understand any amount of Big Data. In all these regards, automation has added benefits like reducing the operational costs, improving operational efficiency, enhanced self-service modules, and increased the scalability of Big Data technologies. For instance, it can function as a numerical identifier thriving across the data tables in e-commerce business. Also, it looks for categorical data to generate the set of features having interrelated values.

1.2 ANALYSIS OF TIME-VARYING BIG DATA

The automated Analytics should ideally focus on a basic framework for analyzing any volume of data over a period of time. The categorization of Analytics into different segments reflects a pragmatic approach. These segments are labeling of data, its division according to the relevant time periods, and identification of data features to be addressed.

1.3ROLE IN DATA PREPARATION

This automation should reduce the time taken for Predictive Analytics. It is a complex challenge faced by the Data Scientists working on such projects. Hence, it requires a robust language that simplifies the identification of prediction problems and streamlines the analysis process. Also, it entails a tailored framework that can automatically work with varied specifications for analogous acts of categorization and labeling of the data.

1.4 DETECTING PREDICTION FEATURES AND REPRESENTING THEM

The representation of data in a measurable format is the key role to be played by automation. It can work as a big leap towards enablement of analysts in identifying the main prediction problems in a standardized format. This will facilitate its sharing and analysis. As a result, collaborations between Data Analysts and domain experts will increase. The experts will be enabled to learn and use the language used for automated predictive analysis for specification of their problems. It will bring more precision in the process.

The automation of Big Data Analytics is a huge step in the direction of improving Data Science in the imminent times. The self-service model has facilitated the business owners in leveraging its various factors without digging deeper into its complexities. The Big Data has become more accessible and cost-effective. Moreover, it allows the Data Scientists to concentrate on their core competencies instead of indulging in time-consuming acts of data analysis.

1.5 TYPES OF AUTOMATION SYSTEMS

- Fixed automation,
- Programmable automation
- Flexible automation.

1.5.1 FIXED AUTOMATION

It is a system in which the sequence of processing (or assembly) operations is fixed by the equipment configuration. The operations in the sequence are usually simple. It is the integration and coordination of many such operations into one piece of equipment that makes the system complex. The typical features of fixed automation are:

- High initial investment for custom–Engineered equipment;
- High production rates
- Relatively inflexible in accommodating product changes.

The economic justification for fixed automation is found in products with very high demand rates and volumes. The high initial cost of the equipment can be spread over a very large number of units, thus making the unit cost attractive compared to alternative methods of production. Examples of fixed automation include mechanized assembly and machining transfer lines.

1.5.2 PROGRAMMABLE AUTOMATION

In this the production equipment is designed with the capability to change the sequence of operations to accommodate different product configurations. The operation sequence is controlled by a program, which is a set of instructions coded so that the system can read and interpret them. New programs can be prepared and entered into the equipment to produce new products. Some of the features that characterize programmable automation are:

- High investment in general-purpose equipment;
- Low production rates relative to fixed automation;
- Flexibility to deal with changes in product configuration; and
- Most suitable for batch production.

Automated production systems that are programmable are used in low and medium volume production. The parts or products are typically made in batches. To produce each new batch of a different product, the system must be reprogrammed with the set of machine instructions that correspond to the new product. The physical setup of the machine must also be changed over: Tools must be loaded, fixtures must be attached to the machine table also be changed machine settings must be entered. This changeover procedure takes time. Consequently, the typical cycle for given product includes a period during which the setup and reprogramming takes place, followed by a period in which the batch is produced. Examples of programmed automation include numerically controlled machine tools and industrial robots.

1.5.3 FLEXIBLE AUTOMATION

It is an extension of programmable automation. A flexible automated system is one that is capable of producing a variety of products (or parts) with virtually no time lost for changeovers from one product to the next. There is no production time lost while reprogramming the system and altering the physical setup (tooling, fixtures, and machine setting). Consequently, the system can produce various combinations and schedules of products instead of requiring that they be made in separate batches. The features of flexible automation can be summarized as follows:

- High investment for a custom-engineered system.
- Continuous production of variable mixtures of products.
- Medium production rates.
- Flexibility to deal with product design variations.

The essential features that distinguish flexible automation from programmable automation are:

- The capacity to change part programs with no lost production time; and
- The capability to changeover the physical setup, again with no lost production time.

These features allow the automated production system to continue production without the downtime between batches that is characteristic of programmable automation. Changing the part programs is generally accomplished by preparing the programs off-line on a computer system and electronically transmitting the programs to the automated production system. Therefore, the time required to do the programming for the next job does not interrupt production on the current job. Advances in computer systems technology are largely responsible for this programming capability in flexible automation. Changing the physical setup between parts is accomplished by making the changeover off-line and then moving it into place simultaneously as the next part comes into position for processing. The use of pallet fixtures that hold the parts and transfer into position at the workplace is one way of implementing this approach. For these approaches to be successful; the variety of parts that can be made on a flexible automated production system is usually more limited than a system controlled by programmable automation.

CHAPTER 2

DATA ANALYSIS

Data analysis is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, and is used in different business, science, and social science domains. In today's business world, data analysis plays a role in making decisions more scientific and helping businesses operate more effectively.

Data mining is a particular data analysis technique that focuses on modeling and knowledge discovery for predictive rather than purely descriptive purposes, while business intelligence covers data analysis that relies heavily on aggregation, focusing mainly on business information. In statistical applications, data analysis can be divided into descriptive statistics, exploratory data analysis (EDA), and confirmatory data analysis (CDA). EDA focuses on discovering new features in the data while CDA focuses on confirming or falsifying existing hypotheses. Predictive analytics focuses on application of statistical models for predictive forecasting or classification, while text analytics applies statistical, linguistic, and structural techniques to extract and classify information from textual sources, a species of unstructured data.

2.1 THE PROCESS OF DATA ANALYSIS

Analysis refers to breaking a whole into its separate components for individual examination. Data analysis is a process for obtaining raw data and converting it into information useful for decision-making by users. Data are collected and analyzed to answer questions, test hypotheses or disprove theories.

2.1.1 PHASES OF DATA ANALYSIS

- Data requirements

The data are necessary as inputs to the analysis, which is specified based upon the requirements of those directing the analysis or customers (who will use the finished product of the analysis). The general type of entity upon which the data will be collected is referred to as an experimental unit (e.g., a person or population of people). Specific variables regarding a population may be specified and obtained. Data may be numerical or categorical (i.e., a text label for numbers).

- Data collection

Data are collected from a variety of sources. The requirements may be communicated by analysts to custodians of the data, such as information technology personnel within an organization. The data may also be collected from sensors in the environment, such as traffic cameras, satellites, recording devices, etc. It may also be obtained through interviews, downloads from online sources, or reading documentation.

- Data processing

The phases of the intelligence cycle used to convert raw information into actionable intelligence or knowledge are conceptually similar to the phases in data analysis.Data initially obtained must be processed or organised for analysis. For instance, these may involve placing data into rows and columns in a table format (i.e., structured data) for further analysis, such as within a spreadsheet or statistical software.

- Data cleaning

Once processed and organised, the data may be incomplete, contain duplicates, or contain errors. The need for data cleaning will arise from problems in the way that data are entered and stored. Data cleaning is the process of preventing and correcting these errors. Common tasks include record matching, identifying inaccuracy of data, overall quality of existing data, deduplication, and column segmentation. Such data problems can also be identified through a variety of analytical techniques. For example, with financial information, the totals for particular variables may be compared against separately published numbers believed to be reliable. Unusual amounts above or below pre-determined thresholds may also be reviewed. There are several types of data cleaning that depend on the type of data such as phone numbers, email addresses, employers etc. Quantitative data methods for outlier detection can be used to get rid of likely incorrectly entered data. Textual data spell checkers can be used to lessen the amount of mistyped words, but it is harder to tell if the words themselves are correct.

- Exploratory data analysis

Once the data are cleaned, it can be analyzed. Analysts may apply a variety of techniques referred to as exploratory data analysis to begin understanding the messages contained in the data. The process of exploration may result in additional data cleaning or additional requests for data, so these activities may be iterative in nature. Descriptive statistics, such as the average or median, may be generated to help understand the data. Data visualization may also be used to examine the data in graphical format, to obtain additional insight regarding the messages within the data.

- Modeling and algorithms

Mathematical formulas or models called algorithms may be applied to the data to identify relationships among the variables, such as correlation or causation. In general terms, models may be developed to evaluate a particular variable in the data based on other variable(s) in the data, with some residual error depending on model accuracy.

2.2 SENSOR DATA ANALYSIS

Sensor Nodes (SN) have received considerable attention recently, as the benefits from using them are manifold. Not only are they a means for data acquisition and monitoring of unexplored or inaccessible areas, they are also a low-cost alternative for sensing the environment, which greatly aids to better understand our surroundings or inaccessible areas. Sensor network techniques have to effectively deal with the constraints inherent in the domain:

- The limited power available to the sensor nodes
- The cost of wireless communication
- The processing and storage limitations of the nodes.

To address these problems, exchanged messages must be minimized as much as possible, especially since communication is more resource consuming than processing However, we should not simply place strong constraints on communication, rather we should adopt and employ efficient communication algorithms and protocols to provide the desired functionality efficiently and with acceptable quality.

A vast amount of data has been generated by developing information technology and wireless internet. Most electronic devices include sensors which generate various data. These data can be used to provide useful information in real-time. Furthermore, we can obtain useful knowledge by analyzing accumulated sensor data. The weather center is a representative case. Development and dissemination of device control boards provide an environment to collect sensor data. By using a device control board and database tool, we can construct a database which includes various sensor data. These accumulated sensor data can be used for data mining. However, these tools are difficult and complicated to utilize by beginners. Furthermore, data analysis needs hard coding to implement various algorithms. To consider these issues, our goal is constructing a library to collect and analyze sensor data.

In the case of sensor data collection, a module is built up for each sensor, and after simple pin setting, sensor data collection is made possible by selecting the desired sensor. In addition, sensor data stored in real time is managed through a database, and an exceptional data value is processed to further improve reliability of data. It also provides a method for analyzing the collected data.

CHAPTER 3

PROPOSED SYSTEM

Automation systems is becoming more and more popular. People want to live in intelligent living spaces equipped with automation systems, these systems not only provide them convenience, comport, security but also reduce their daily living cost by energy saving solutions .The demand for automation products has been increased rapidly, which promise a potential market trend in near future.

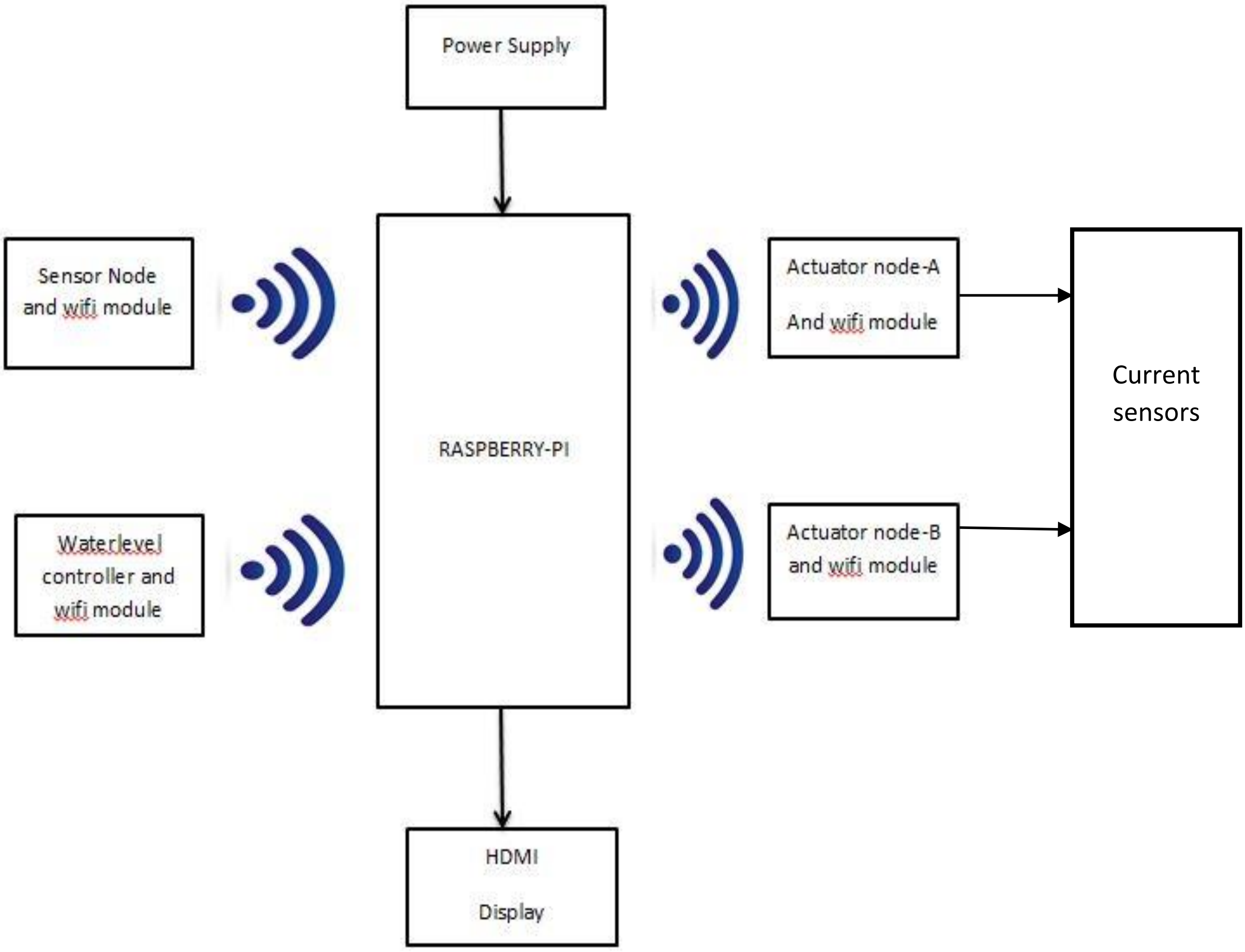


Figure 3.1: General block diagram

A Wi-Fi wireless platform with embedded Linux web server and its integration into a network of sensor nodes for building automation and industrial automation is implemented here. In this system focus is on developing an ESP8266 based Low cost Wi-Fi based wireless sensor network, the IEEE 802.11nprotocol is used for system. In most of the existing wireless sensor network are designed based on wifi modules. The pecking order of the system is such that the lowest level is that of the sensors, the in-between level is the controllers, and the highest level is a supervisory node. The supervisor can be react as an active or passive. The system is shown to permit all achievable controller failure scenarios. The supervisor can handle the entire control load of all controllers, should the need arise. An integrated system platform which can provide Linux web server, database, and PHP run-time environment was built by using Raspberry-pi with Apache+PHP+MySQL. Various Internet accesses were offered by using Wi-Fi wireless networks communication technology. Raspberry Pi use as a main server in the system and which connects the sensor nodes via WiFi in the wireless sensor network and collects sensors data from different sensors, and supply multi-clients services including data display through an Embedded Linux based Web-Server.

In this proposed design, the event of a Wi-Fi based Wireless Sensor Network management exploitation using Linux board Raspberry pi and Internet of Things technology using ESP8266 Wi-Fi module. The system is suitable for real time Wireless sensors monitoring and for remotely controlling the Sensor network and improve the latency compare to ZigBee and RF based sensor network. The proposed system may be employed in many fields like home and Building automation and Industrial automation. Now a days Wi-Fi network is easily available in all fields like Office Building and Industrial Building so proposed wireless sensor network easily controlled using any Wi-Fi network.it is not possible to overcome all the current issues in a single system, but proposed system can avoid any type of failure in node to server communication.

CHAPTER 4

COMPONENTS USED

This system is based on wireless controlling over a wifi network with minimum requirements of hardware. The system consists of:

- Data Acquisition section
- Database (Raspberry-pi)
- Control section
- Display section

4.1 DATA ACQUISITION SECTION

Data acquisition begins with the physical phenomenon or physical property to be measured. Examples of this include temperature, light intensity, gas pressure, fluid flow, and force. Regardless of the type of physical property to be measured, the physical state that is to be measured must first be transformed into a unified form that can be sampled by a data acquisition system. The task of performing such transformations falls on devices called sensors. A data acquisition system is a collection of software and hardware that allows one to measure or control physical characteristics of something in the real world. The data acquisition section consists of different sensors and processing boards the are:

- Sensor Node
- PIR sensor
- Temperature sensor
- Humidity sensor
- Air Quality sensor
- Arduino nano
- Esp8266 wifi module
- Water level controller

4.1.1 SENSOR NODE

Sensors are used by wireless sensor nodes to capture data from their environment. They are hardware devices that produce a measurable response to a change in a physical condition like temperature or pressure. Sensors measure physical data of the parameter to be monitored and have specific characteristics such as accuracy, sensitivity etc. The continual analog signal produced by the sensors is digitized by an analog-to-digital converter and sent to controllers for further processing. Some sensors contain the necessary electronics to convert the raw signals into readings which can be retrieved via a digital link (e.g. I2C, SPI) and many convert to units such as °C. Most sensor nodes are small in size, consume little energy, operate in high volumetric densities, be autonomous and operate unattended, and be adaptive to the environment. As wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts. Sensors are classified into three categories: passive, omnidirectional sensors; passive, narrow-beam sensors; and active sensors. Passive sensors sense the data without actually manipulating the environment by active probing. They are self powered; that is, energy is needed only to amplify their analog signal. Active sensors actively probe the environment, for example, a sonar or radar sensor, and they require continuous energy from a power source. Narrow-beam sensors have a well-defined notion of direction of measurement, similar to a camera. Omnidirectional sensors have no notion of direction involved in their measurements. Most theoretical work on WSNs assumes the use of passive, omnidirectional sensors. Each sensor node has a certain area of coverage for which it can reliably and accurately report the particular quantity that it is observing. Several sources of power consumption in sensors are: signal sampling and conversion of physical signals to electrical ones, signal conditioning, and analog-to-digital conversion.

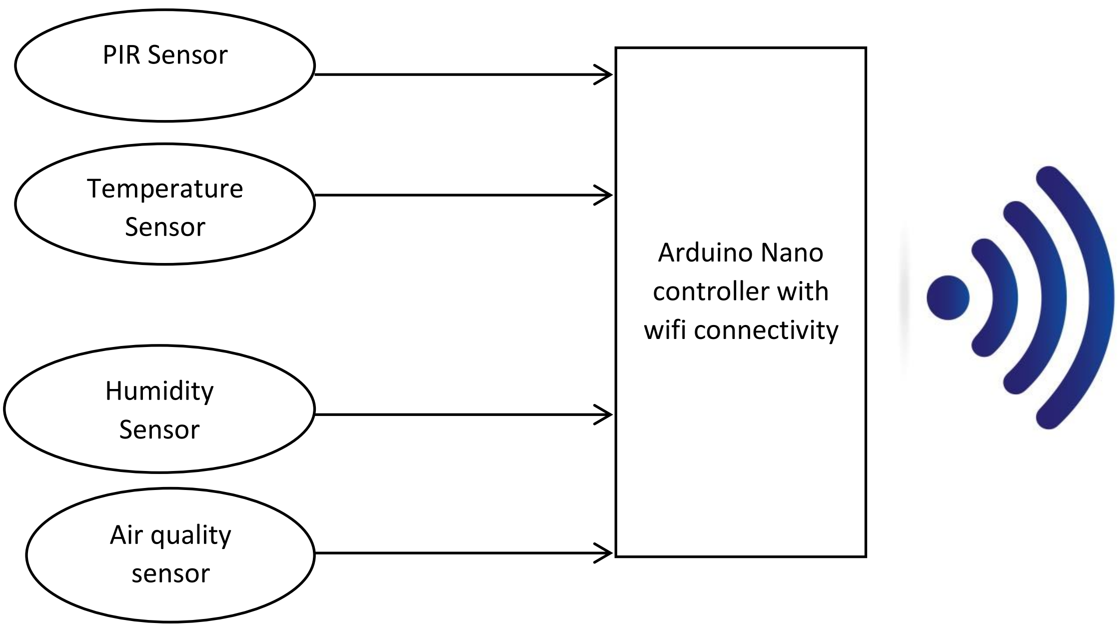


Figure 4.1 sensor node

Different sensors used are:

- **PIR Sensor**

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

Figure 4.2 PIR sensor

An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of the sensor. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. Objects of similar temperature but different surface characteristics may also have a different infrared emission pattern, and thus moving them with respect to the background may trigger the detector as well.

PIRs come in many configurations for a wide variety of applications. The most common models have numerous Fresnel lenses or mirror segments, an effective range of about ten meters (thirty feet), and a field of view less than 180 degrees. Models with wider fields of view, including 360 degrees, are available—typically designed to mount on a ceiling. Some larger PIRs are made with single segment mirrors and can sense changes in infrared energy over thirty meters (one hundred feet) away from the PIR. There are also PIRs designed with reversible orientation mirrors which allow either broad coverage (110° wide) or very narrow "curtain" coverage, or with individually selectable segments to "shape" the coverage.

The PIR sensor is typically mounted on a printed circuit board containing the necessary electronics required to interpret the signals from the sensor itself. The complete assembly is usually contained within a housing, mounted in a location where the sensor can cover area to be monitored.The housing will usually have a plastic "window" through which the infrared energy can enter. Despite often being only translucent to visible light, infrared energy is able to reach the sensor through the window because the plastic used is transparent to infrared radiation. The plastic window reduces the chance of foreign objects (dust, insects, etc.) from obscuring the sensor's field of view, damaging the mechanism, and/or causing false alarms. The window may be used as a filter, to limit the wavelengths to 8-14 micrometres, which is closest to the infrared radiation emitted by humans.

Features:

- Complete with PIR, Motion Detection.
- Dual Element Sensor with Low Noise and High Sensitivity.
- Supply Voltage – 5V.
- Delay Time Adjustable.
- Standard TTL Output.

- **Temperature and Humidity sensor(DH-22)**

DHT22 is a digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin.(no analog input pins needed).DHT22 capacitive humidity sensing digital temperature and humidity module is one that contains the compound has been calibrated digital signal output of the temperature and humidity sensors. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability.

.The sensor includes a capacitive sensor wet components and a high-precision temperature measurement devices, and connected with a high-performance 8-bit microcontroller. The product has excellent quality, fast response, strong anti-jamming capability, and high cost. Standard single-bus interface, system integration quick and easy. Small size, low power consumption, signal transmission distance up to 20 meters, making it the best choice of all kinds of applications and even the most demanding applications. DHT22 has higher precision and can replace the expensive imported SHT10 temperature and humidity sensor. It can measure the environment temperature and humidity to meet the high demand. The product has high reliability and good stability

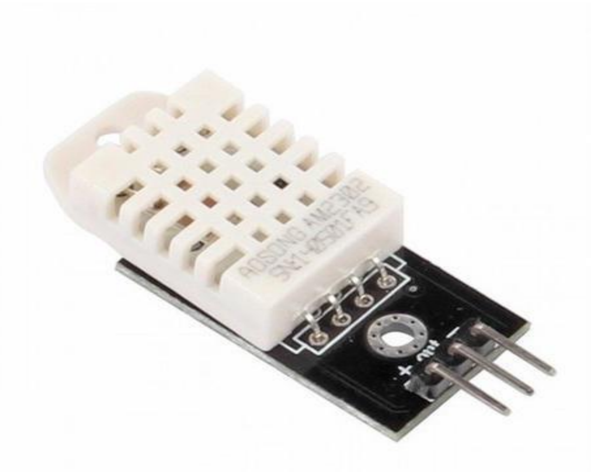


Figure 4.3 dh22 temperature and humidity sensor

Features of DH22:

- High precision
- Capacitive type
- Full range temperature compensated
- Relative humidity and temperature measurement
- Calibrated digital signals
- Outstanding long-term stability
- Extra components not needed
- Long transmission distance, up to 100 meters
- Low power consumption
- 4 pins packaged and fully interchangeable

- **Air quality Sensor (MQ-135)**

MQ-135 gas sensor applies SnO2 which has a lower conductivity in the clear air as a gas-sensing material. In an atmosphere where there may be polluting gas, the conductivity of the gas sensor raises along with the concentration of the polluting gas increases. MQ-135 performs a good detection to smoke and other harmful gas, especially sensitive to ammonia, sulfide and benzene steam. Its ability to detect various harmful gas and lower cost make MQ-135 an ideal choice of different applications of gas detection.

Resistance value of MQ-135 is difference to various kinds and various concentration gases. So, When using this components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for100ppm NH3 or 50ppm Alcohol concentration in air and use value of Load resistance that(RL) about 20 KΩ (10KΩto 47 KΩ). When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence.

Figure 4.4 air quality sensor

Features:

- High Sensitivity
- High sensitivity to Ammonia, Sulfide and Benze
- Stable and Long Life
- Detection Range: 10 - 300 ppm NH3, 10 - 1000 ppm Benzene, 10 - 300 Alcohol
- Heater Voltage: 5.0V
- Dimensions: 18mm Diameter, 17mm High excluding pins, Pins - 6mm High
- Long life and low cost

4.1.2 CONTROLLER

The controller performs tasks, processes data and controls the functionality of other components in the sensor node. While the most common controller is a microcontroller, other alternatives that can be used as a controller are: a general purpose desktop microprocessor, digital signal processors, FPGAs and ASICs. A microcontroller is often used in many embedded systems such as sensor nodes because of its low cost, flexibility to connect to other devices, ease of programming, and low power consumption. A general purpose microprocessor generally has a higher power consumption than a microcontroller, therefore it is often not considered a suitable choice for a sensor node. In this system Arduino nano act as data processor and esp8266 allows the sensor node to communicate with database wirelessly by connecting to WLAN

- **Arduino Nano**

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano). It has more or less the same functionality of the ArduinoDuemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

- Power

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

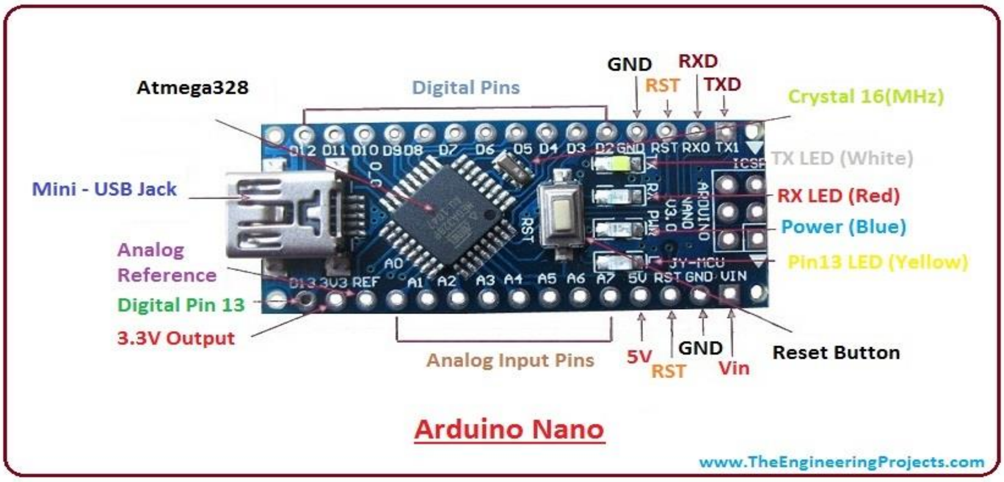


Figure 4.5 pinout of Arduino nano

- Memory

The ATmega328 has 32 KB, (also with 2 KB used for the bootloader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

- Input and Output

Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Nano has 8 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the analogReference() function. Analog pins 6 and 7 cannot be used as digital pins. Additionally, some pins have specialized functionality:

I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board:

AREF.Reference voltage for the analog inputs. Used with analogReference().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

- Communication

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

- **Node MCU ESP 8266 Wifi module**

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.The term "NodeMCU" by default refers to the firmware rather than the development kits.

Features:

- Finally, programmable WiFi module.
- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included, plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc. all in one board.
- Wifi networking (can be used as access point and/or station, host a web server), connect to internet to fetch or upload data.
- Event-driven API for network applications.
- PCB antenna.

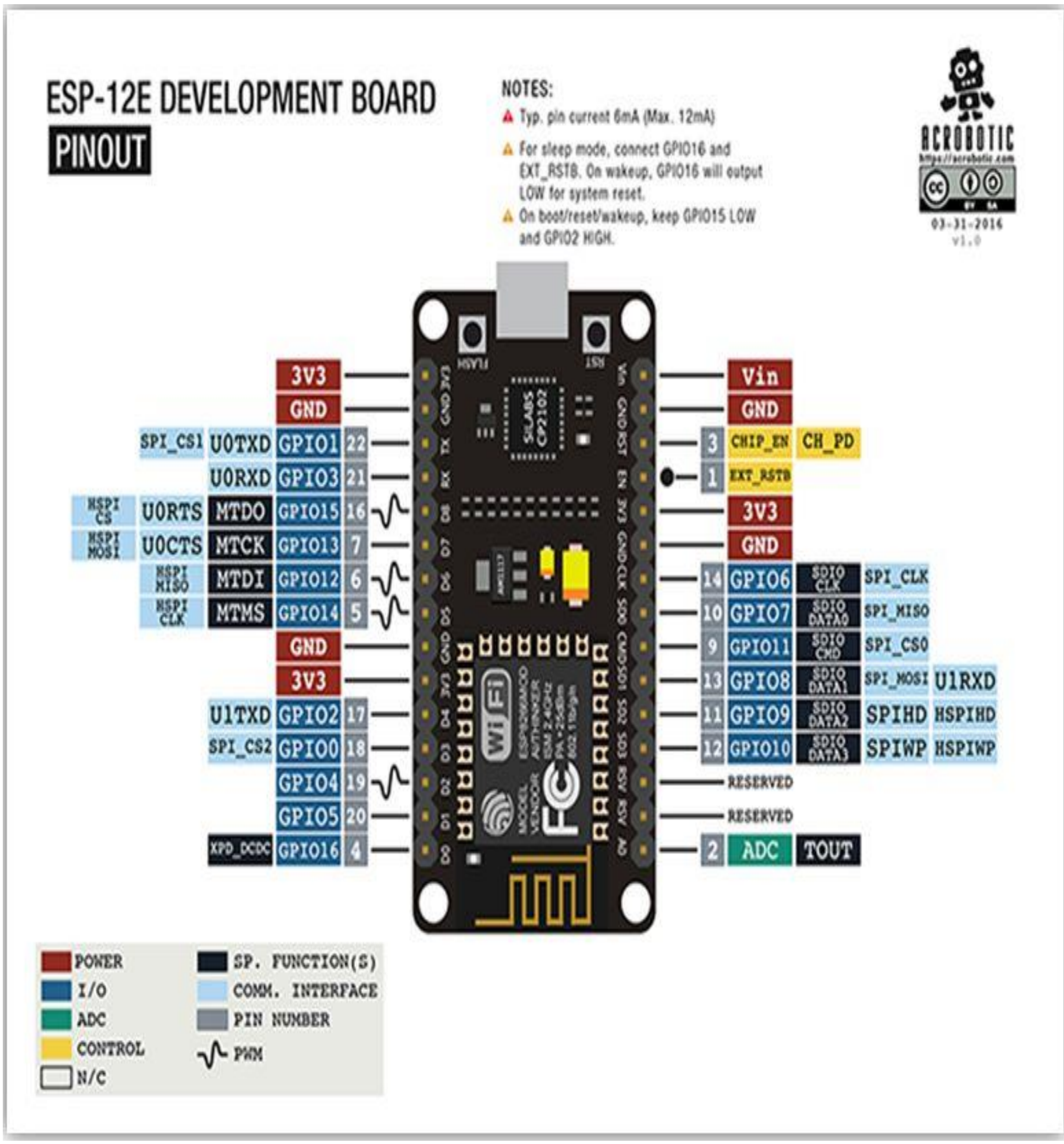


Figure 4.6 Node MCU ESP8266

As Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled for these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an Arduino core for the ESP8266 WiFiSoC, popularly called the "ESP8266 Core for the Arduino IDE.

- **Interfacing Node MCU with Arduino Nano**

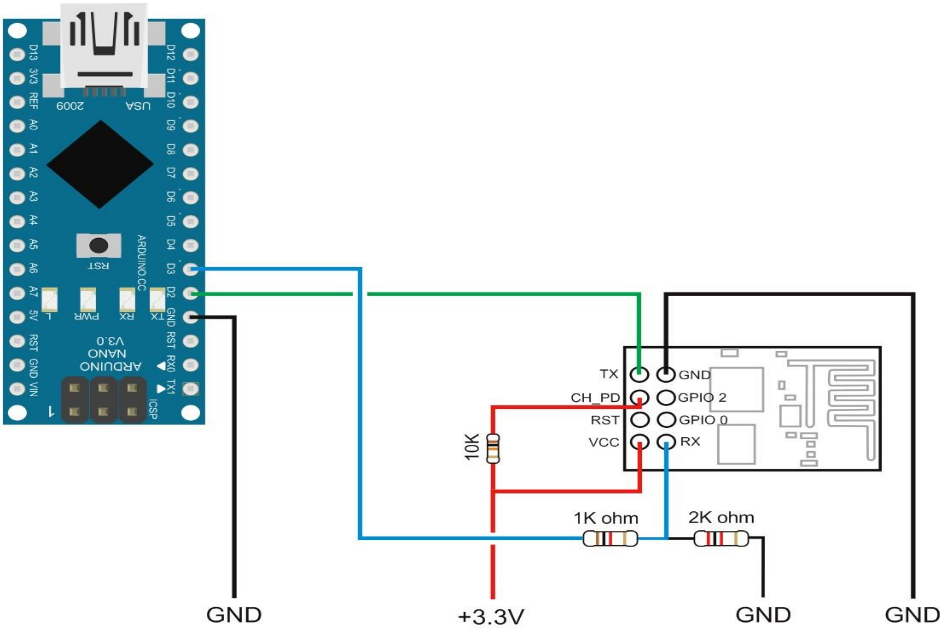


Figure 4.7 node MCU with Arduino nano

4.1.3 WATER LEVEL CONTROLLER

The objective of this part is to notify the user the amount of water that is present in the overhead water tank. This can be further enhanced to control the water level in the tank by turning it ON, when the water level is LOW, and turning it OFF when the water level is HIGH. Thus, the Arduino water level indicator helps in preventing wastage of water in overhead tank. This project is wireless so, it is easy to install and it can work up to 100 meters.

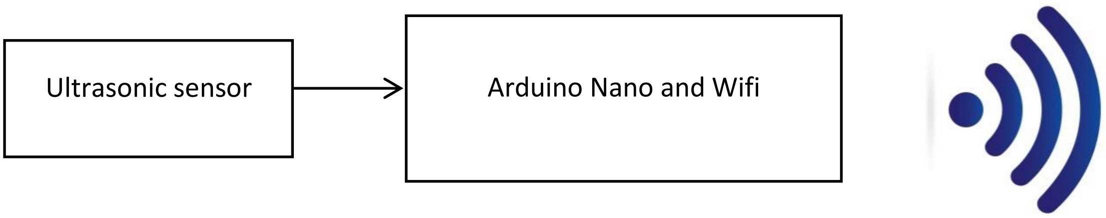


Figure 4.8 block diagram of water level controller

Circuit Diagram:

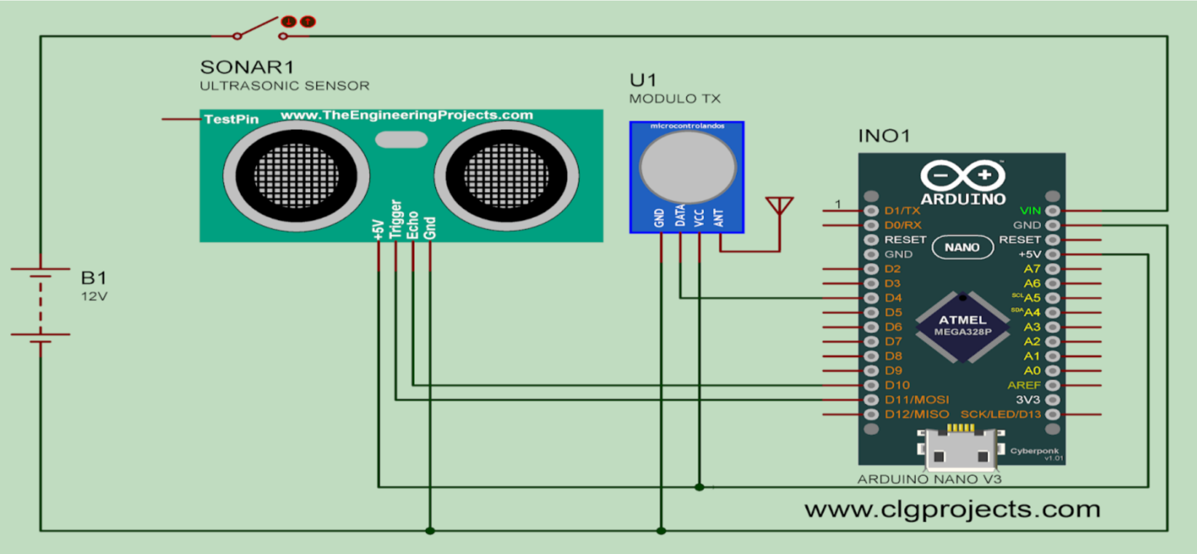


Figure 4.9 circuit diagram of water level controller

- **Ultrasonic sensor**

Ultrasonic transducers or ultrasonic sensors are a type of acoustic sensor divided into three broad categories: transmitters, receivers and transceivers. Transmitters convert electrical signals into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can both transmit and receive ultrasound.

In a similar way to radar and sonar, ultrasonic transducers are used in systems which evaluate targets by interpreting the reflected signals. For example, by measuring the time between sending a signal and receiving an echo the distance of an object can be calculated. Passive ultrasonic sensors are basically microphones that detect ultrasonic noise that is present under certain conditions**.** Ultrasound can be used for measuring wind speed and direction (anemometer), tank or channel fluid level, and speed through air or water. For measuring speed or direction, a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure tank or channel liquid level, and also sea level (tide gauge), the sensor measures the distance (ranging) to the surface of the fluid.

Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18 kHz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

Figure 4.10 ultrasonic sensor

The technology is limited by the shapes of surfaces and the density or consistency of the material. Foam, in particular, can distort surface level readings. This technology, as well, can detect approaching objects and track their positions. Ultrasound can also be used to make point-to-point distance measurements by transmitting and receiving discrete bursts of ultrasound between transducers. This technique is known as Sonomicrometry where the transit-time of the ultrasound signal is measured electronically (ie digitally) and converted mathematically to the distance between transducers assuming the speed of sound of the medium between the transducers is known. This method can be very precise in terms of temporal and spatial resolution because the time-of-flight measurement can be derived from tracking the same incident (received) waveform either by reference level or zero crossing. This enables the measurement resolution to far exceed the wavelength of the sound frequency generated by the transducers.

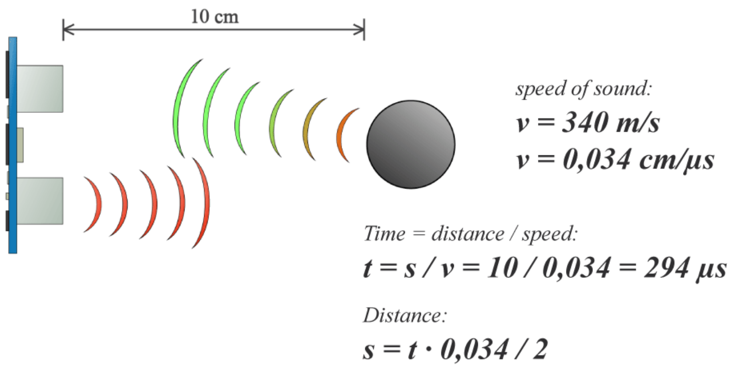


Figure 4.11 ultrasonic working principle

4.2 DATA BASE

A database is an organized collection of data, generally stored and accessed electronically from a computer system. Where databases are more complex they are often developed using formal design and modeling techniques.

The database management system (DBMS) is the software that interacts with end users, applications, and the database itself to capture and analyze the data. The DBMS software additionally encompasses the core facilities provided to administer the database. The sum total of the database, the DBMS and the associated applications can be referred to as a "database system". Often the term "database" is also used to loosely refer to any of the DBMS, the database system or an application associated with the database.

Formally, a "database" refers to a set of related data and the way it is organized. Access to this data is usually provided by a "database management system" (DBMS) consisting of an integrated set of computer software that allows users to interact with one or more databases and provides access to all of the data contained in the database (although restrictions may exist that limit access to particular data). The DBMS provides various functions that allow entry, storage and retrieval of large quantities of information and provides ways to manage how that information is organized.

Because of the close relationship between them, the term "database" is often used casually to refer to both a database and the DBMS used to manipulate it. Outside the world of professional information technology, the term database is often used to refer to any collection of related data (such as a spreadsheet or a card index) as size and usage requirements typically necessitate use of a database management system.

Existing DBMSs provide various functions that allow management of a database and its data which can be classified into four main functional groups:

- Data definition – Creation, modification and removal of definitions that define the organization of the data.
- Update – Insertion, modification, and deletion of the actual data.
- Retrieval – Providing information in a form directly usable or for further processing by other applications. The retrieved data may be made available in a form basically the same as it is stored in the

database or in a new form obtained by altering or combining existing data from the database.

- Administration – Registering and monitoring users, enforcing data security, monitoring performance, maintaining data integrity, dealing with concurrency control, and recovering information that has been corrupted by some event such as an unexpected system failure.

4.2.1. RASPBERRY PI AS DATABASE SERVER

The data from the acquisition sections are transfered in to the database server of the raspberry-pi with the help of WLAN. In this project we use MySQL as an open source relational database management system.

- **Raspberry Pi**

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards and mice) and cases. Several generations of Raspberry P is have been released. All models feature a Broadcom system on a chip (SoC) with an integrated ARM-compatible central processing unit (CPU) and on-chip graphics processing unit (GPU).

Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+; on-board memory ranges from 256 MB to 1 GB RAM. Secure Digital (SD) cards in MicroSDHC form factor (SDHC on early models) are used to store the operating system and program memory. The boards have one to four USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm tip-ring-sleeve jack for audio output. Lower-level output is provided by a number of GPIO pins, which support common protocols like I²C. The B-models have an 8P8C Ethernet port and the Pi 3 and Pi Zero W have on-board Wi-Fi 802.11n and Bluetooth. While operating at 700 MHz by default, the first generation Raspberry Pi provided a real-world performance roughly equivalent to 0.041 GFLOPS.[25][26] On the CPU level the performance is similar to a 300 MHz Pentium II of 1997–99. The GPU provides 1 Gpixel/s or 1.5 Gtexel/s of graphics processing or 24 GFLOPS of general purpose computing performance. The graphical capabilities of the Raspberry Pi are roughly equivalent to the performance of the Xbox of 2001.

Raspberry Pi 2 V1.1 included a quad-core Cortex-A7 CPU running at 900 MHz and 1 GB RAM. It was described as 4–6 times more powerful than its predecessor. The GPU was identical to the original. In parallelised benchmarks, the Raspberry Pi 2 V1.1 could be up to 14 times faster than a Raspberry Pi 1 Model B+. The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as having ten times the performance of a Raspberry Pi 1.This was suggested[by whom?] to be highly dependent upon task threading and instruction set use.[citation needed] Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelised tasks.

Most Raspberry Pi systems-on-chip could be overclocked to 800 MHz, and some to 1000 MHz. There are reports the Raspberry Pi 2 can be similarly overclocked, in extreme cases, even to 1500 MHz (discarding all safety features and over-voltage limitations). In the Raspbian Linux distro the overclocking options on boot can be done by a software command running "sudoraspi-config" without voiding the warranty.

In those cases the Pi automatically shuts the overclocking down if the chip temperature reaches 85 °C (185 °F), but it is possible to override automatic over-voltage and overclocking settings (voiding the warranty); an appropriately sized heat sink is needed to protect the chip from serious overheating. Newer versions of the firmware contain the option to choose between five overclock ("turbo") presets that when used, attempt to maximise the performance of the SoC without impairing the lifetime of the board.

This is done by monitoring the core temperature of the chip and the CPU load, and dynamically adjusting clock speeds and the core voltage. When the demand is low on the CPU or it is running too hot the performance is throttled, but if the CPU has much to do and the chip's temperature is acceptable, performance is temporarily increased with clock speeds of up to 1 GHz, depending on the board version and on which of the turbo settings is used. The seven overclock presets are:

none; 700 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting

modest; 800 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting, medium; 900 MHz ARM, 250 MHz core, 450 MHz SDRAM, 2 overvolting,

high; 950 MHz ARM, 250 MHz core, 450 MHz SDRAM, 6 overvolting,

turbo; 1000 MHz ARM, 500 MHz core, 600 MHz SDRAM, 6 overvolting,

Pi 2; 1000 MHz ARM, 500 MHz core, 500 MHz SDRAM, 2 overvolting,

Pi 3; 1100 MHz ARM, 550 MHz core, 500 MHz SDRAM, 6 overvolting.

In system information the CPU speed will appear as 1200 MHz. When idling, speed lowers to 600 MHz. In the highest (turbo) preset the SDRAM clock was originally 500 MHz, but this was later changed to 600 MHz because 500 MHz sometimes causes SD card corruption. Simultaneously in high mode the core clock speed was lowered from 450 to 250 MHz, and in medium mode from 333 to 250 MHz.

The CPU on the first and second generation Raspberry Pi board did not require cooling, such as a heat sink or fan, even when overclocked, but the Raspberry Pi 3 may generate more heat when overclocked.

On the older beta Model B boards, 128 MB was allocated by default to the GPU, leaving 128 MB for the CPU. On the first 256 MB release Model B (and Model A), three different splits were possible. The default split was 192 MB (RAM for CPU), which should be sufficient for standalone 1080p video decoding, or for simple 3D, but probably not for both together. 224 MB was for Linux only, with only a 1080p framebuffer, and was likely to fail for any video or 3D. 128 MB was for heavy 3D, possibly also with video decoding (e.g. XBMC). Comparatively the Nokia 701 uses 128 MB for the Broadcom VideoCore IV.

The Model B with 512 MB RAM, new standard memory split files (arm256_start.elf, arm384_start.elf, arm496_start.elf) were initially released for 256 MB, 384 MB and 496 MB CPU RAM (and 256 MB, 128 MB and 16 MB video RAM) respectively. But a week or so later the RPF released a new version of start. lf that could read a new entry in config.txt (gpu_mem=xx) and could dynamically assign an amount of RAM (from 16 to 256 MB in 8 MB steps) to the GPU, so the older method of memory splits became obsolete, and a single start. lf worked the same for 256 MB and 512 MB Raspberry P. The Raspberry Pi 2 and the Raspberry Pi 3 have 1 GB of RAM. The Raspberry Pi Zero and Zero W have 512 MB of RAM.

The Model A, A+ and Pi Zero have no Ethernet circuitry and are commonly connected to a network using an external user-supplied USB Ethernet or Wi-Fi adapter. On the Model Band B+ the Ethernet port is provided by a built-in USB Ethernet adapter using the SMSC LAN9514 chip.[39] The Raspberry Pi 3 and Pi Zero W (wireless) are equipped with 2.4 GHz WiFi 802.11n (150 Mbit/s) and Bluetooth 4.1 (24 Mbit/s) based on the Broadcom BCM43438 Full MAC chip with no official support for monitor mode but implemented through unofficial firmware patching[40] and the Pi 3 also has a 10/100 Mbit/s Ethernet port. The Raspberry Pi 3B+ features dual-band IEEE 802.11b/g/n/ac WiFi, Bluetooth 4.2, and Gigabit Ethernet (limited to approximately 300 Mbit/s by the USB 2.0 bus between it and the SoC).

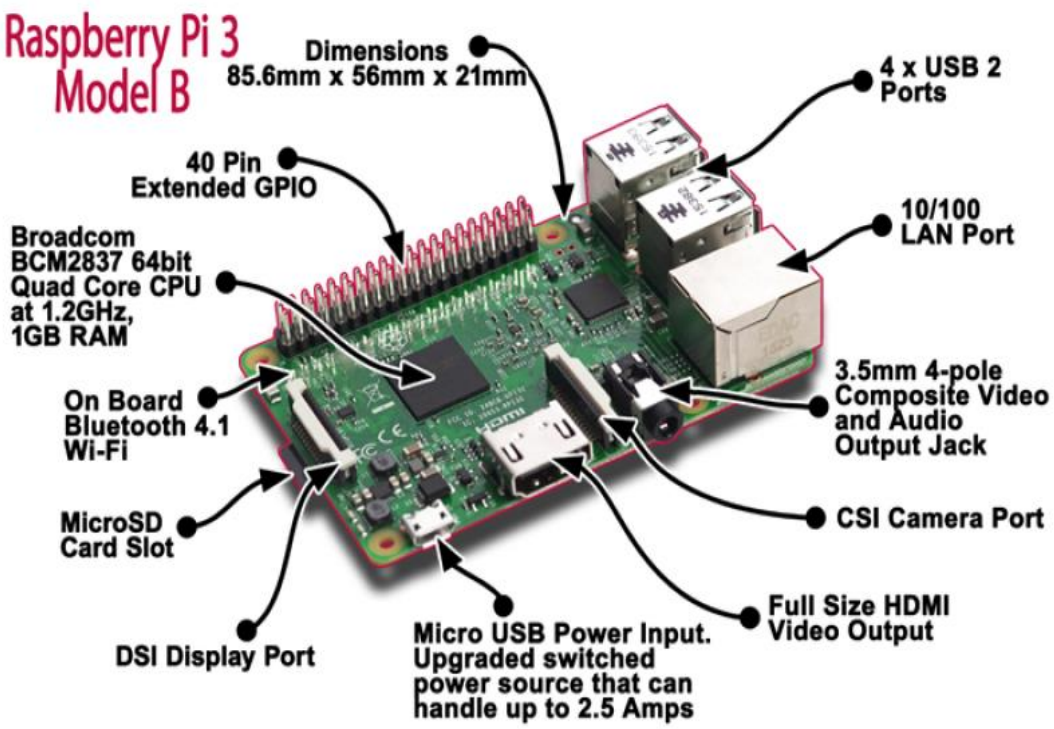


Figure 4.12 raspberry pi model B

The Pi Zero can be used as a USB device or "USB gadget", plugged into another computer via a USB port on another machine. It can be configured in multiple ways, for example to show up as a serial device or an ethernet device. Although originally requiring software patches, this was added into the mainline Raspbian distribution in May 2016.The Pi 3 can boot from USB, such as from a flash drive. Because of firmware limitations in other models, the Pi 3 is the only board that can do this.

The Model 2B boards incorporate four USB ports for connecting peripherals. The Raspberry Pi may be operated with any generic USB computer keyboard and mouse. It may also be used with USB storage, USB to MIDI converters, and virtually any other device/component with USB capabilities. Other peripherals can be attached through the various pins and connectors on the surface of the Raspberry Pi. The early Raspberry Pi 1 Model A, with an HDMI port and a standard RCA composite video port for older displays

The video controller can generate standard modern TV resolutions, such as HD and Full HD, and higher or lower monitor resolutions as well as older NTSC or PAL standard CRT TV resolutions. As shipped (i.e., without custom overclocking) it can support the following resolutions: 640×350 EGA; 640×480 VGA; 800×600 SVGA; 1024×768 XGA; 1280×720 720p HDTV; 1280×768 WXGA variant; 1280×800 WXGA variant; 1280×1024 SXGA; 1366×768 WXGA variant; 1400×1050 SXGA+; 1600×1200 UXGA; 1680×1050 WXGA+; 1920×1080 1080p HDTV; 1920×1200 WUXGA.

Higher resolutions, up to 2048×1152, may work or even 3840×2160 at 15 Hz (too low a frame rate for convincing video). Note also that allowing the highest resolutions does not imply that the GPU can decode video formats at these resolutions; in fact, the P is are known to not work reliably for H.265 (at those high resolutions), commonly used for very high resolutions (however, most common formats up to Full HD do work).

Although the Raspberry Pi 3 does not have H.265 decoding hardware, the CPU is more powerful than its predecessors, potentially fast enough to allow the decoding of H.265-encoded videos in software. The GPU in the Raspberry Pi 3 runs at higher clock frequencies of 300 MHz or 400 MHz, compared to previous versions which ran at 250 MHz.

The Raspberry Pi can also generate 576i and 480i composite video signals, as used on old-style (CRT) TV screens and less-expensive monitors through standard connectors – either RCA or 3.5 mm phono connector depending on model. The television signal standards supported are PAL-BGHID, PAL-M, PAL-N, NTSC and NTSC-J.

None of the current Raspberry Pi models have a built-in real-time clock, so they are unable to keep track of the time of day independently. Instead, a program running on the Pi can retrieve the time from a network time server or from user input at boot time, thus knowing the time while powered on. To provide consistency of time for the file system, the Pi automatically saves the current system time on shutdown, and re-loads that time at boot.

A real-time hardware clock with battery backup, such as the DS1307, may be added (often via the I^2C interface). Note however that this conflicts with the camera's CSI interface, effectively disabling the camera.

The Broadcom BCM2835 SoC processor used in the first generation Raspberry Pi includes a 700 MHz ARM11 76JZF-S processor, VideoCore IV graphics processing unit (GPU), and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible. The 1176JZ(F)-S is the same CPU used in the original iPhone, although at a higher clock rate, and mated with a much faster GPU.

The earlier V1.1 model of the Raspberry Pi 2 used a Broadcom BCM2836 SoC with a 900 MHz 32-bit, quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache. The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor the same SoC which is used on the Raspberry Pi 3, but underclocked (by default) to the same 900 MHz CPU clock speed as the V1.1. The BCM2836 SoC is no longer in production as of late 2016.The Raspberry Pi 3+ uses a Broadcom BCM2837B0 SoC with a 1.4 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.

Features:

- CPU: Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz
- GPU: 400MHz VideoCore IV multimedia
- Memory: 1GB LPDDR2-900 SDRAM (i.e. 900MHz)
- USB ports: 4
- Video outputs: HDMI, composite video (PAL and NTSC) via 3.5 mm jack
- Network: 10/100Mbps Ethernet and 802.11n Wireless LAN
- Peripherals: 17 GPIO plus specific functions, and HAT ID bus
- Bluetooth: 4.1

- Power source: 5 V via MicroUSB or GPIO header
- Size: 85.60mm × 56.5mm
- Weight: 45g (1.6 oz)

4.3 CONTROL SECTION

In this section according to the database values and status of different sensors the control side is actuated using relays and triac Each load connected to the control side is connected with a current sensors to provide data on power consumed by each load which is updated on database.

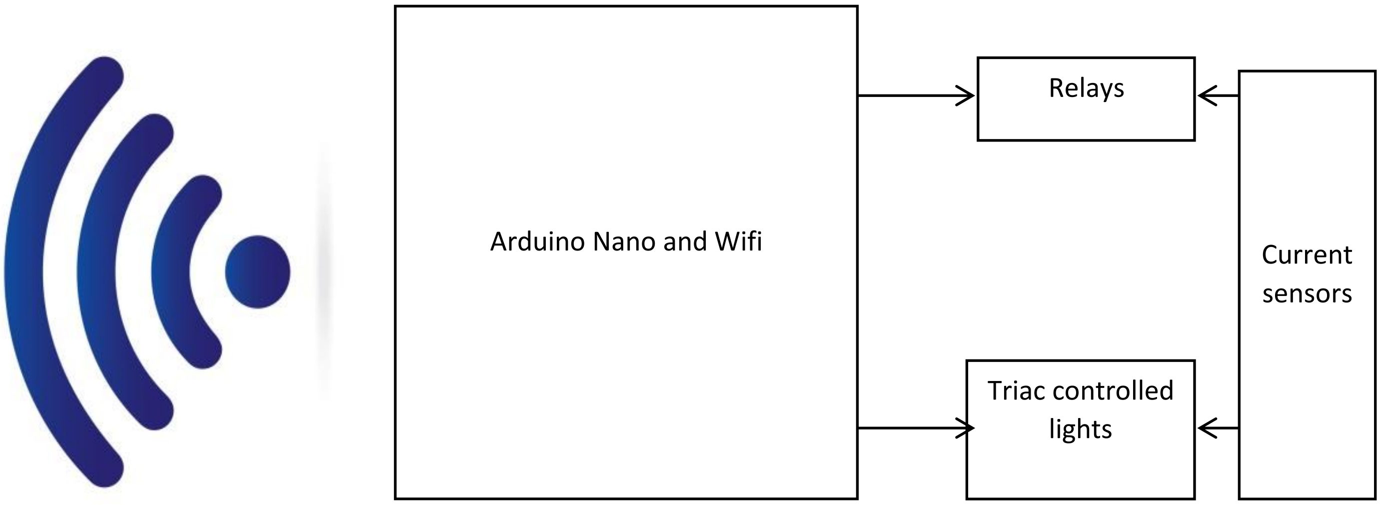


Figure 4.13 block diagram of control section

4.3.1 RELAY MODULES

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays". A relay is used to switch on a high powered circuit with a small current.

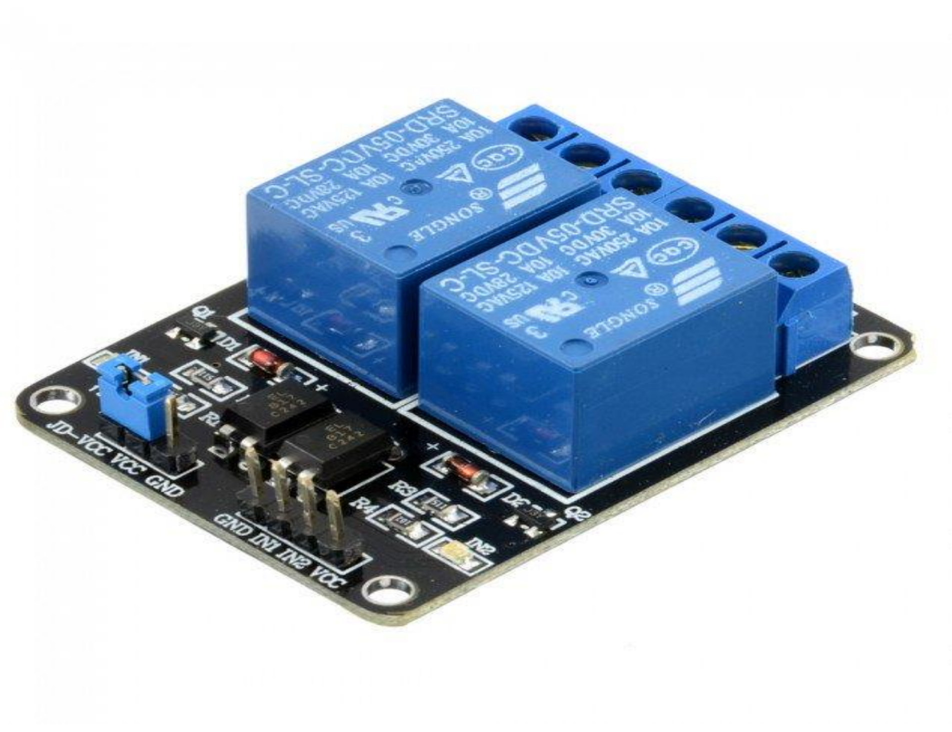


Figure 4.14 relay module

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.

Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands. It was used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another.

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core (a solenoid), an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two contacts in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. The armature is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

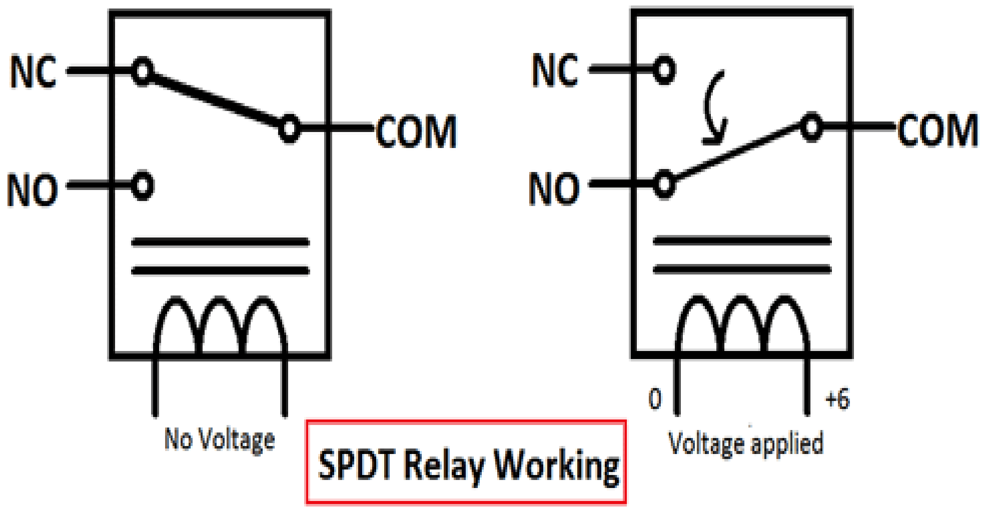


Figure 4.15 Realy working

When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Such diodes were not widely used before the application of transistors as relay drivers, but soon became ubiquitous as early germanium transistors were easily destroyed by this surge. Some automotive relays include a diode inside the relay case.

If the relay is driving a large, or especially a reactive load, there may be a similar problem of surge currents around the relay output contacts. In this case a snubber circuit (a capacitor and resistor in series) across the contacts may absorb the surge. Suitably rated capacitors and the associated resistor are sold as a single packaged component for this commonplace use.

If the coil is designed to be energized with alternating current (AC), some method is used to split the flux into two out-of-phase components which add together, increasing the minimum pull on the armature during the AC cycle. Typically this is done with a small copper "shading ring" crimped around a portion of the core that creates the delayed, out-of-phase component, which holds the contacts during the zero crossings of the control voltage.

Contact materials for relays vary by application. Materials with low contact resistance may be oxidized by the air, or may tend to "stick" instead of cleanly parting when opening. Contact material may be optimized for low electrical resistance, high strength to withstand repeated operations, or high capacity to withstand the heat of an arc. Where very low resistance is required, or low thermally-induced voltages are desired, gold-plated contacts may be used, along with palladium and other non-oxidizing, semi-precious metals. Silver or silver-plated contacts are used for signal switching. Mercury-wetted relays make and break circuits using a thin, self-renewing film of liquid mercury. For higher-power relays switching many amperes, such as motor circuit contatctors, contacts are made with a mixtures of silver and cadmium oxide, providing low contact resistance and high resistance to the heat of arcing. Contacts used in circuits carrying scores or hundreds of amperes may include additional structures for heat dissipation and management of the arc produced when interrupting the circuit. Some relays have field-replaceable contacts, such as certain machine tool relays; these may be replaced when worn out, or changed between normally open and normally closed state, to allow for changes in the controlled circuit.

4.3.2 TRIAC CONTROLLING

Arduino involves controlling devices running on DC voltage. The devices running on DC voltage are usually controlled by changing logic at GPIO pins for switching control or by PWM for operational control. There are times when devices running on AC current also needs to be controlled by the microcontroller. For switching control, the AC appliances are usually interfaced to microcontroller boards via relays or relay circuits. For operational control over AC appliances like controlling the speed of a fan or dimming a light bulb, power electronics comes into the picture. This project is a demonstration of operational control of AC appliances using zero voltage crossing detection.

An alternating voltage changes its sign periodically. The alternating voltage supplied to households is usually the sine wave. An alternating voltage can be other forms of the wave also. Irrespective of the waveform, an alternating voltage in the first half of every cycle flows in one direction reaching to a peak voltage and then drops down to zero level. Then in the next half of each cycle, it flows in alternate direction reaching to a peak voltage and then drops down to zero level. The rise and drop of voltage in alternate direction are graphically shown with a negative sign of voltage and voltage curve. The cycles are repeated throughout the voltage supply. For controlling AC appliances operationally, the peak voltage of both the halves of a cycle needs to be chopped off. For this, it is important to detect when voltage alternates its direction. The point on voltage curve where it alternates direction is called zero voltage crossing.

The zero voltage crossing of AC voltage can be detected by first rectifying it using full wave rectifier and then using an optoisolator which will switch OFF and ON upon zero voltage crossings and past zero voltage crossings respectively. The output of optoisolator can then be passed to the microcontroller to indicate zero voltage crossings to it.

For controlling AC voltage to a load, TRIAC needs to be used. TRIAC (Triode for AC) is commonly used for power control and switching applications. The TRIAC can be feed control using an optocoupler which itself would be driven by a microcontroller pin.

The project is built upon Arduino UNO and 4N25 optoisolator with a full bridge rectifier is used for zero voltage crossing detection. The 3021 optocoupler and BT136 TRIAC are used for chopping off AC voltage to the load. The tasks of zero voltage crossing detection and switching of 3021 IC are programmatically controlled by the Arduino board.

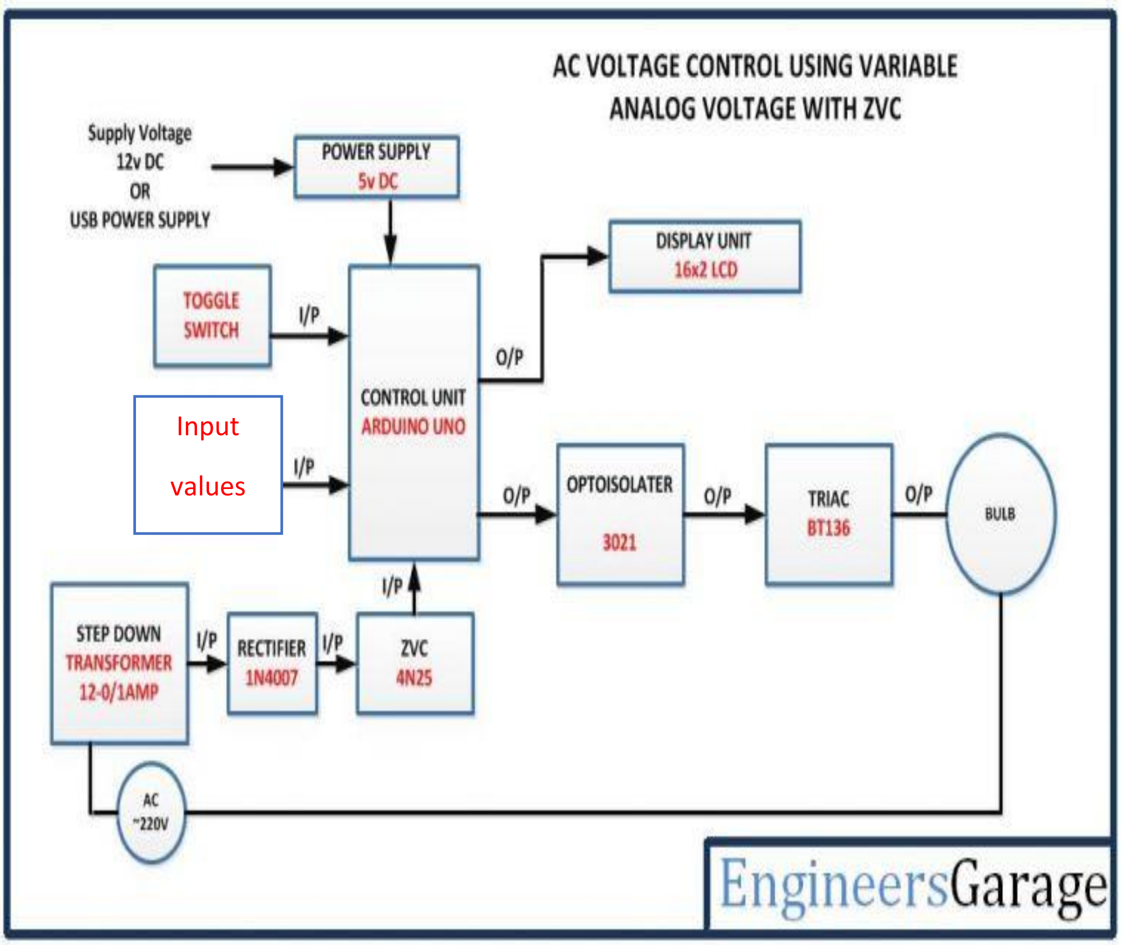


Figure 4.16 Block diagram of triac light controlling

➢ Circuit Connections

The circuit is built around Arduino UNO. There are distinct circuit sections that are interfaced to the Arduino to realize the project functioning. In the project, following circuit sections are assembled together -

Power Supply - The Arduino and LCD module need 5V DC supply. The required DC voltage is supplied by a battery. The supply from the battery is regulated to 5V DC using 7805 IC. The IC has three pins - pin 1 should be connected to the anode of the battery, pin 2 and 3 with the cathode (common ground). The 5V DC should be drawn from the pin 3 of the IC. An LED along with a 10K Ω pull-up resistor can also be connected between common ground and output pin to get a visual hint of supply continuity.

ON-OFF Switch: An ON-OFF switch is provided to turn ON/OFF the supply to the load. The switch is interfaced to Arduino by connecting between ground and pin 7 of the board. The pin 7 by default receives HIGH logic by direct connection to VCC but on toggling the switch it receives a LOW logic. The switching of the supply voltage to the load is controlled by detecting logic at pin 7 of the Arduino board.

Zero Voltage Crossing Detection Circuit - First the AC voltage from the main supply is stepped down using a transformer to 12V. The stepped down AC voltage is feed to full bridge rectifier circuit built using 1N4007 diodes. The rectified voltage is supplied to pins 1 and 2 of 4N25 optocoupler. The 4N25 is a phototransistor type optocoupler. At pin 1, there is an anode of in-built LED and at pin 2 is the cathode of it.

Opto-Isolator EL3021 - EL3021 is a photo-TRIAC type optocoupler. It should be noted that photo-transistor and photodarlington type optocouplers are used for controlling DC devices while photo-SCR and photo-triac type optocouplers are used for controlling AC devices.

The pin 2 of EL3021 is connected to ground and pin 1 is connected to pin 10 of the Arduino. The Main Terminal pins of photo-TRIAC, pins 4 and 6 of EL3021 are connected to pins 3 (Base) and 2 (Main Terminal 2) of BT136. The pin 2 of BT136 and pin 6 of EL3021 are connected to a junction with phase wire of main supplies. The pin 5 of the EL3021 is not connected so the photo-TRIAC actually operates like a photo-DIAC. The load is connected between pin 1 of BT136 and neutral wire. The phase voltage is controlled by the BT136 which itself is controlled by the photo-TRIAC operating as photo-DIAC of EL3021.

TRIAC BT136 - A TRIAC has three terminals - Main Terminal 1, Main Terminal 2 and Gate. TRIAC is equivalent to two SCRs connected in inverse parallel with the gates connected together. Therefore TRIAC works as a bi-directional switch which is triggered by the pulse on the base. The Main Terminal 1 and Main Terminal 2 of the TRIAC are used for connecting phase and neutral wire and the triggering pulse is supplied to Gate terminal from the photo-TRIAC of EL3021. The Gate terminal can be triggered either by a positive or negative voltage. There are four possible modes of the operation of a TRIAC -

a) Main Terminal 2 has a positive voltage compared to Main Terminal 1 and there is positive pulse at Gate

b) Main Terminal 2 has a positive voltage compared to Main Terminal 1 and there is negative pulse at Gate

c) Main Terminal 1 has a positive voltage compared to Main Terminal 2 and there is positive pulse at Gate

d) Main Terminal 1 has a positive voltage compared to Main Terminal 2 and there is negative pulse at Gate

The TRIAC conducts current when either Main Terminal 2 gets a positive voltage with respect to the Main Terminal 1 and the Gate gets a positive trigger or Main Terminal 1 has a positive voltage compared to Main Terminal 2 and there is a negative pulse at Gate.

4.3.3 CURRENT SENSORS

A current sensor is a device that detects electric current in a wire, and generates a signal proportional to that current. The generated signal could be analog voltage or current or even a digital output. The generated signal can be then used to display the measured current in an ammeter, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control.

The sensed current and the output signal can be:

Alternating current input

- analog output, which duplicates the wave shape of the sensed current
- bipolar output, which duplicates the wave shape of the sensed current.
- unipolar output, which is proportional to the average or RMS value of the sensed current.

Direct current input,

- unipolar, with a unipolar output, which duplicates the wave shape of the sensed current
- digital output, which switches when the sensed current exceeds a certain threshold.

  A current sensor is a device that detects and converts current to an easily measured output voltage, which is proportional to the current through the measured path.

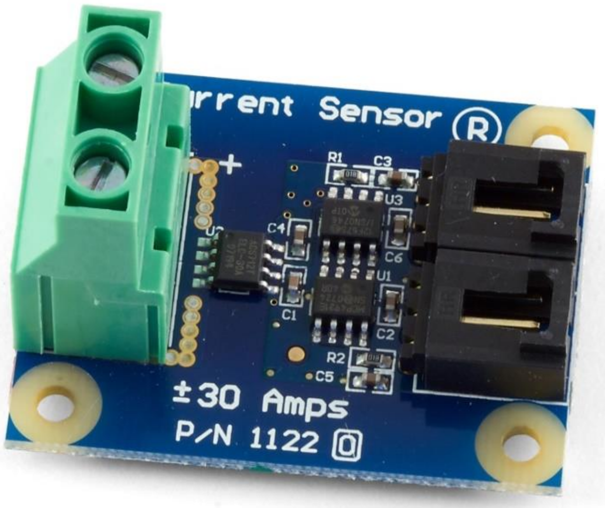


Figure 4.17 current sensor

When a current flows through a wire or in a circuit, voltage drop occurs. Also, a magnetic field is generated surrounding the current carrying conductor. Both of these phenomena are made use of in the design of current sensors. Thus, there are two types of current sensing: direct and indirect. Direct sensing is based on Ohm’s law, while indirect sensing is based on Faraday’s and Ampere’s law Direct Sensing involves measuring the voltage drop associated with the current passing through passive electrical components.

4.3.4 DISPLAY SECTION

The full status and working conditions of all the loads and sensors can be viewed in HDMI display of raspberry-pi and mobile app interface. The visual display interfaces helps in monitoring of atmospheric parameters and to control loads connected to the AC mains supply in the buildings or office. Time by time data updation are provided from remote areas to the main server wirelessly. The updation of data is transfered to the authorities by the means of different display output mechanisms.

The Raspberry Pi has an HDMI port which you can connect directly to a monitor or TV with an HDMI cable. This is the easiest solution; some modern monitors and TVs have HDMI ports'

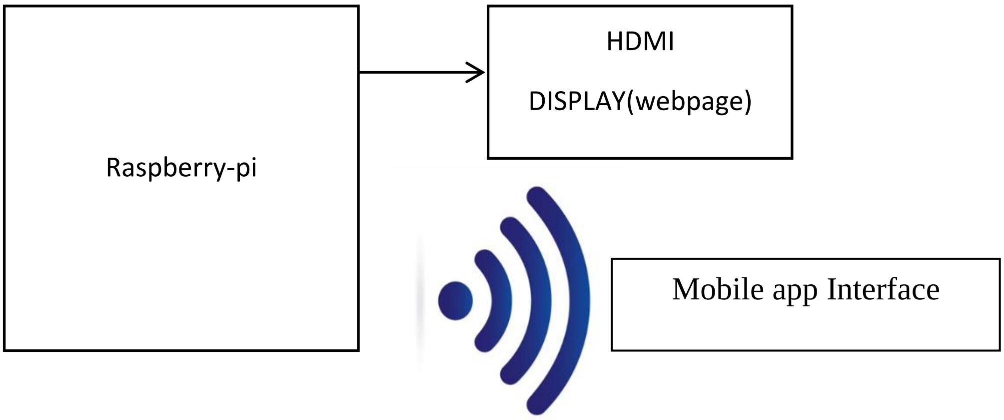


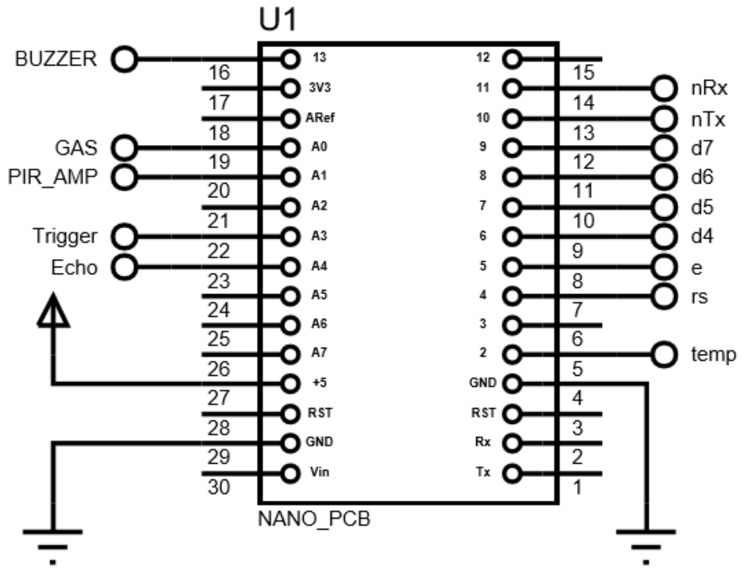
Figure 4.18 Display Components

CHAPTER 5

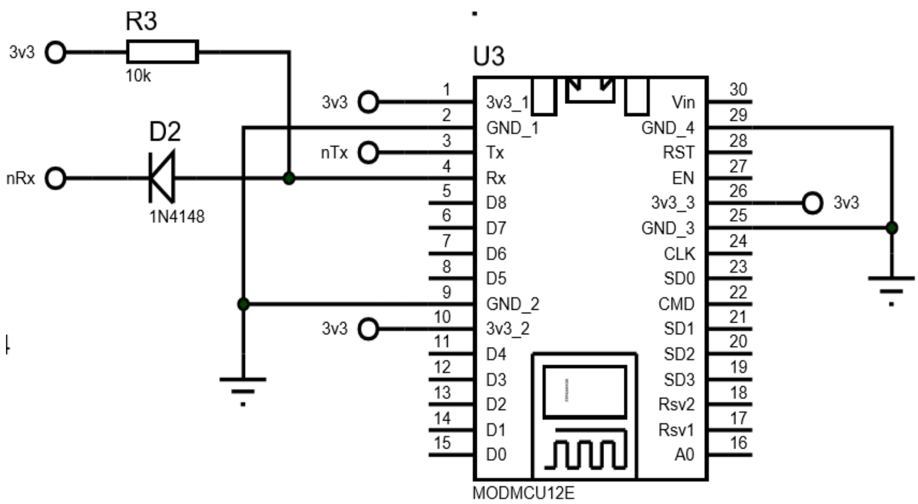
CIRCUIT DESIGN

The entire design of the system consists of 4 circuit boards. Two of them for data acquisition and the rest for load controlling. Each of the four boards include an Arduino controller and a NodeMCU for communicating wirelessly with Raspberry-pi. Both the boards for data acquisition are made of same PCB layout, similarly the two control boards are also of same PCB layout. Circuits are designed using Proteus PCB designing software. Following figures shows the connection diagram of each component in the circuit.

➢ Arduino Controller at Data Acquisition Section

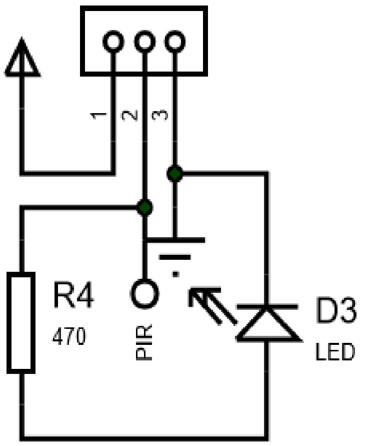


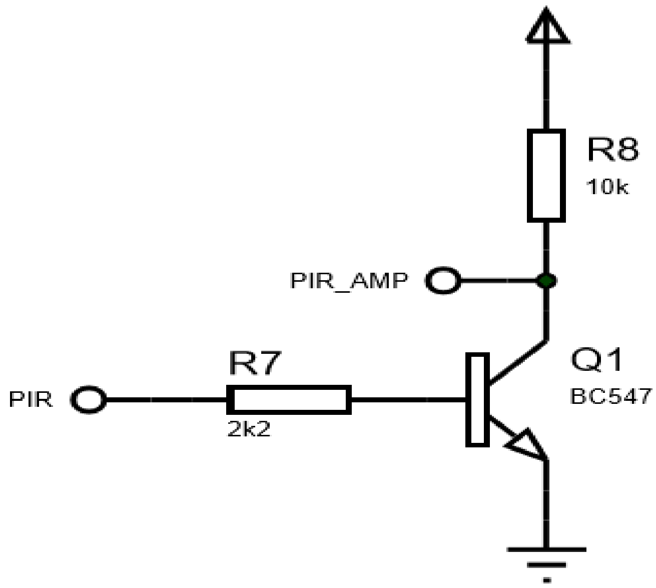
➢ NodeMCU Wireless Module at Data Acquisition Section



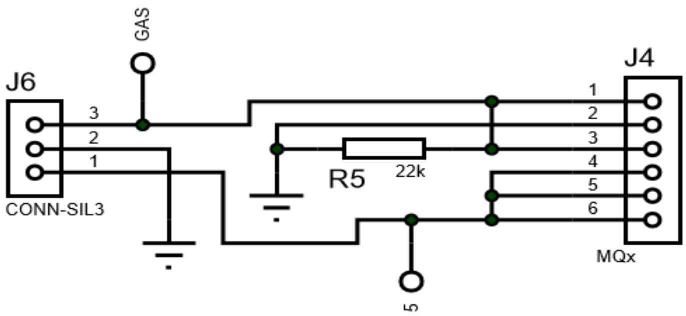
➢ SENSOR CONNECTIONS

- PIR sensor

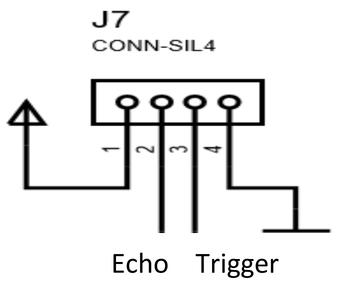




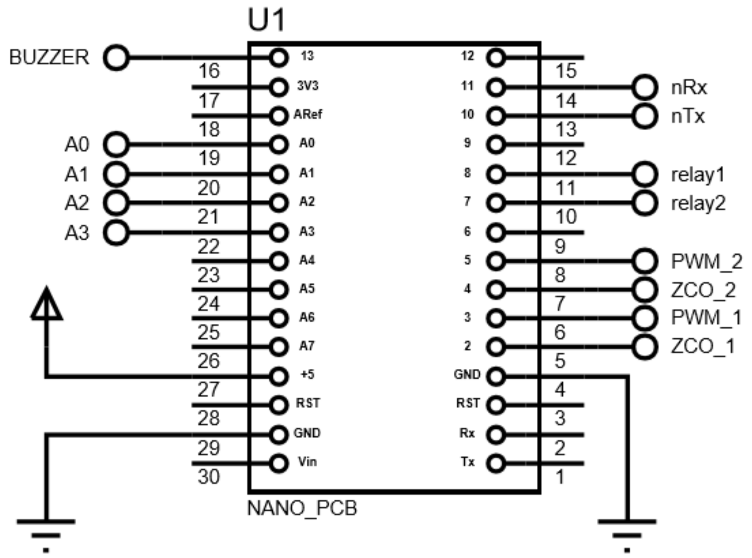
- Air quality sensor



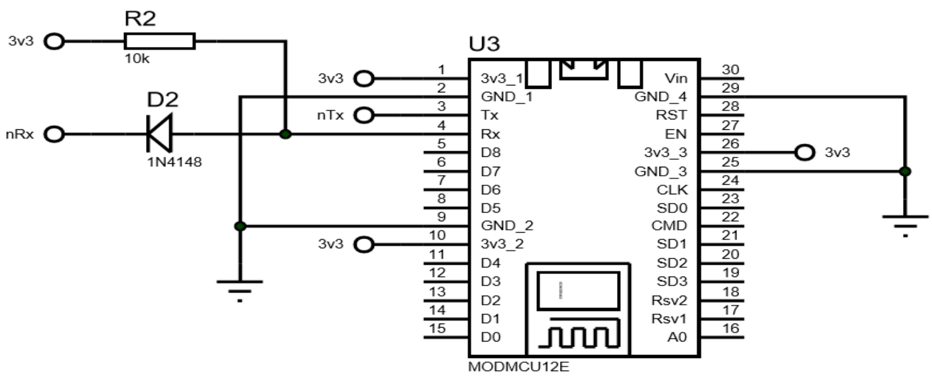
- Ultrasonic sensor



➢ Arduino Controller at Control Section

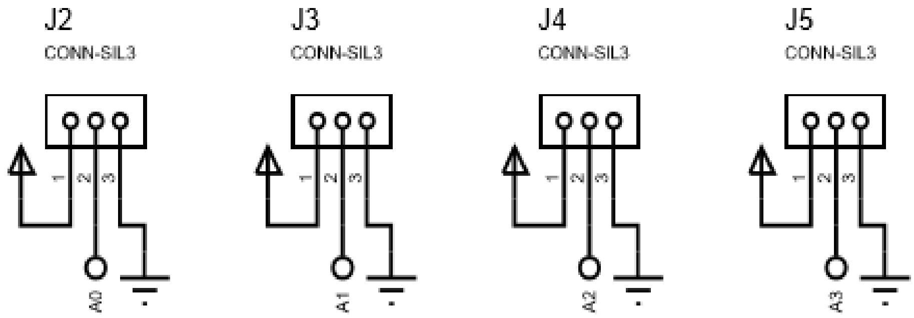


➢ NodeMCU Wireless Module at Control Section

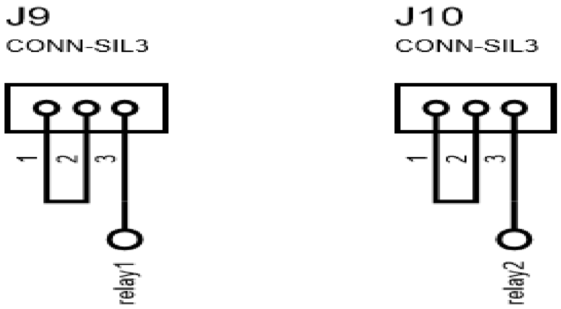


➢ CONTROL CONNECTIONS

- Current sensors

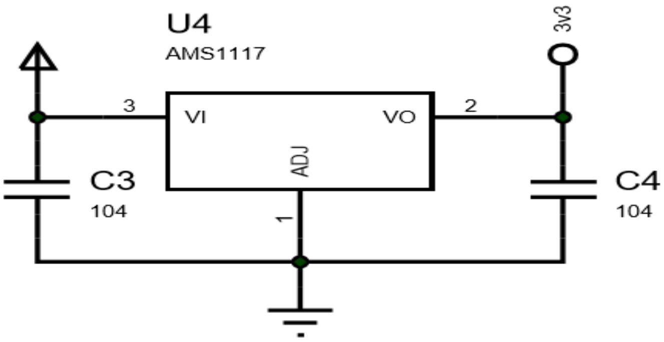


- Relay

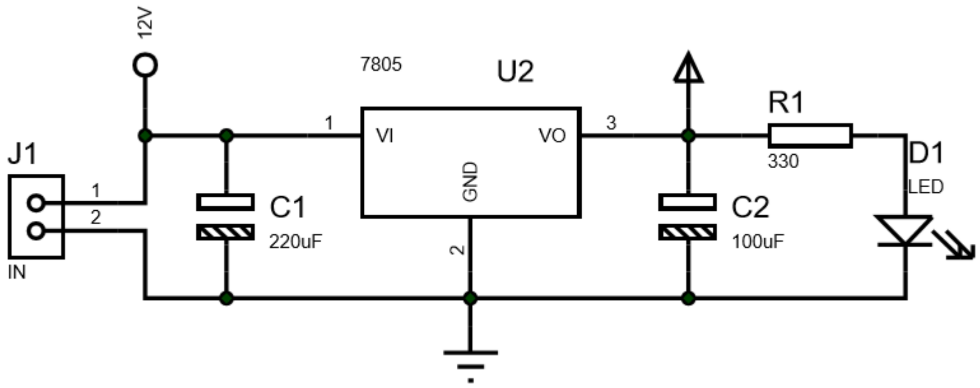


POWER SUPPLY CONNECTIONS

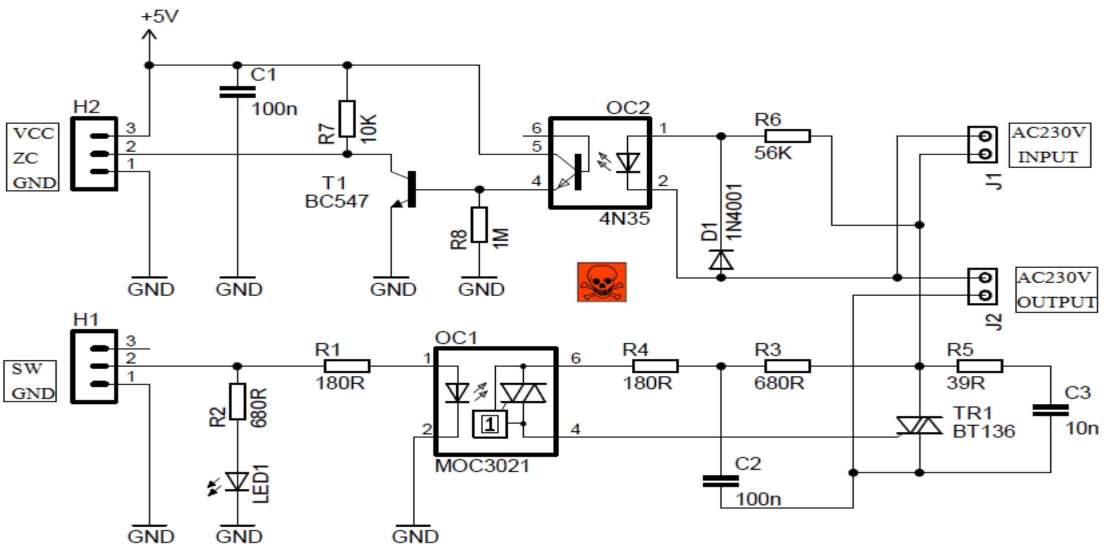
- Power supply for NODE MCU



- Power supply connections for each PCB boards



➢ LIGHT INTENSITY CONTROL CONNECTIONS



CHAPTER 6

SOFTWARE SECTIONS

The collection of data or computer instructions that tell the computer how to work. This is in contrast to physical hardware, from which the system is built and actually performs the work. In computer science and software engineering, computer software is all information processed by computer systems, programs and data. Computer software includes computer programs, libraries and related non-executable data, such as online documentation or digital media.

Softwares used are:

- Arduino IDE
- MySQL
- PHP

6.1 ARDUINO IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2.The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

6.2 MySQL

MySQL is an open source relational database management system (RDBMS).Its name is a combination of "My", the name of co-founder Michael Widenius's daughter,and "SQL", the abbreviation for Structured Query Language.

MySQL is free and open-source software under the terms of the GNU General Public License, and is also available under a variety of proprietary licenses. MySQL was owned and sponsored by the Swedish company MySQL AB, which was bought by Sun Microsystems (now Oracle Corporation).MySQL is written in C and C++. Its SQL parser is written in yacc, but it uses a home-brewed lexical analyzer. MySQL works on many system platforms, including AIX, BSDi, FreeBSD, HP-UX, eComStation, i5/OS, IRIX, Linux, macOS, Microsoft Windows, NetBSD, Novell NetWare, OpenBSD, OpenSolaris, OS/2 Warp, QNX, Oracle Solaris, Symbian, SunOS, SCO OpenServer, SCO UnixWare, Sanos and Tru64. A port of MySQL to OpenVMS also exists.

6.3 PHP

PHP: Hypertext Preprocessor (or simply PHP) is a general-purpose programming language originally designed for web development. It was originally created by Rasmus Lerdorf in 1994; the PHP reference implementation is now produced by The PHP Group.PHP originally stood for Personal Home page but it now stands for the recursive initialism PHP: Hypertext Preprocessor.

PHP code may be executed with a command line interface (CLI), embedded into HTML code, or it can be used in combination with various web template systems, web content management systems, and web frameworks. PHP code is usually processed by a PHP interpreter implemented as a module in a web server or as a Common Gateway Interface (CGI) executable. The web server combines the results of the interpreted and executed PHP code, which may be any type of data, including images, with the generated web page. PHP can be used for many programming tasks outside of the web context, such as standalone graphical applications and robotic drone control.

6.4 PROTEUS

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards It was developed in Yorkshire, England by Labcenter Electronics Ltd.

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an autorouter and basic mixed mode SPICE simulation capabilities.

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control,temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- MicrochipTechnologiesPIC10,PIC12,PIC16,PIC18,PIC24,dsPIC33 Microcontrollers.
- Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Microcontrollers
- NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.
- Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.
- Parallax Basic Stamp, Freescale HC11, 8086 Microcontrollers.

The PCB Layout module is automatically given connectivity information in the form of a netlist from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

CHAPTER 7

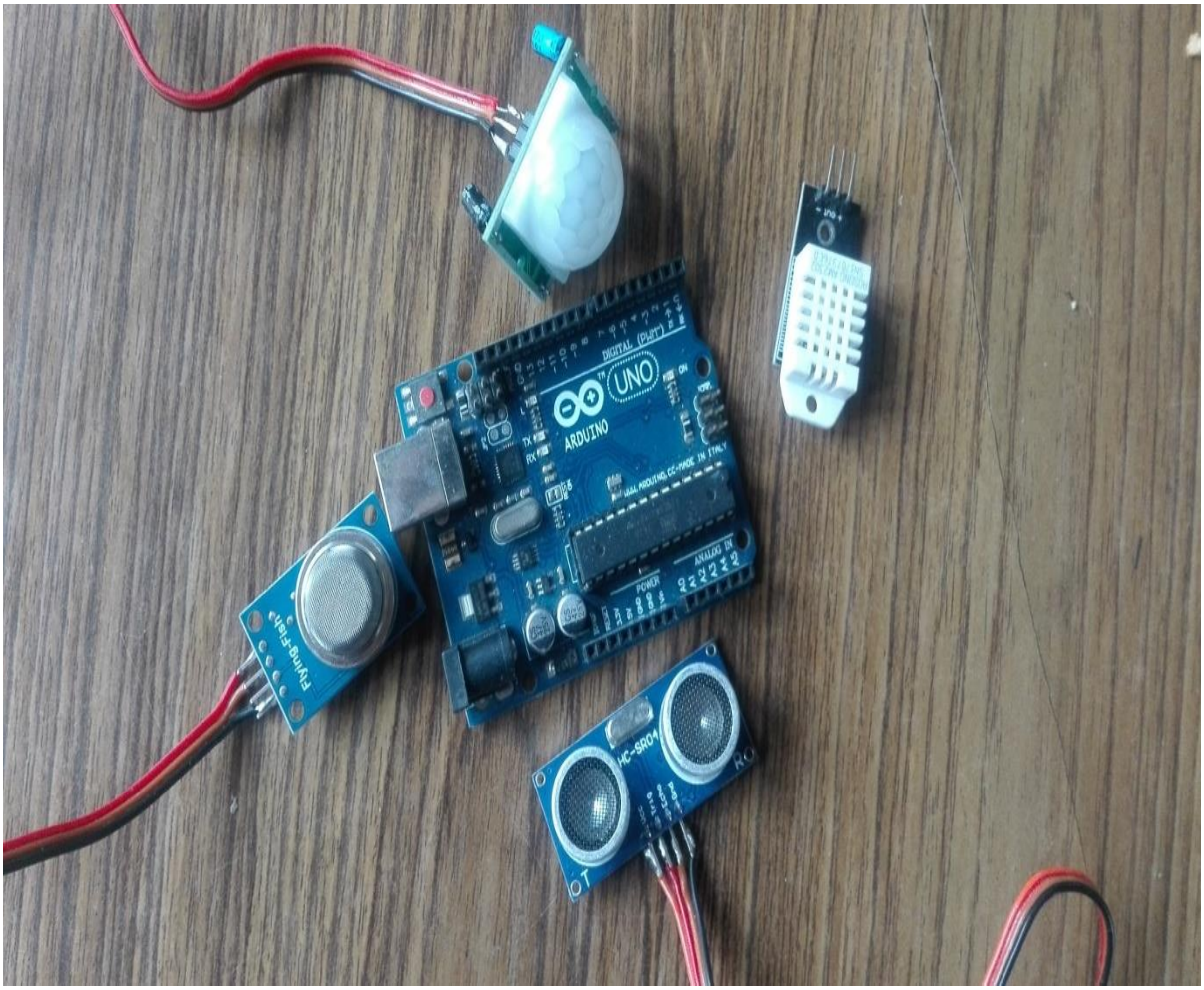
RESULT

The prototype of the proposed system is successfully created and tested. The prototype is working according to the given conditions.

The data from the acquisition PCB board (Sensor Node) is wirelessly send to database. According to the values updated in the database the control PCB enables and disables the connected loads. Power consumption of each load is analysed by employing current sensors. The whole status of the system is displayed in a Webpage and Android platform.

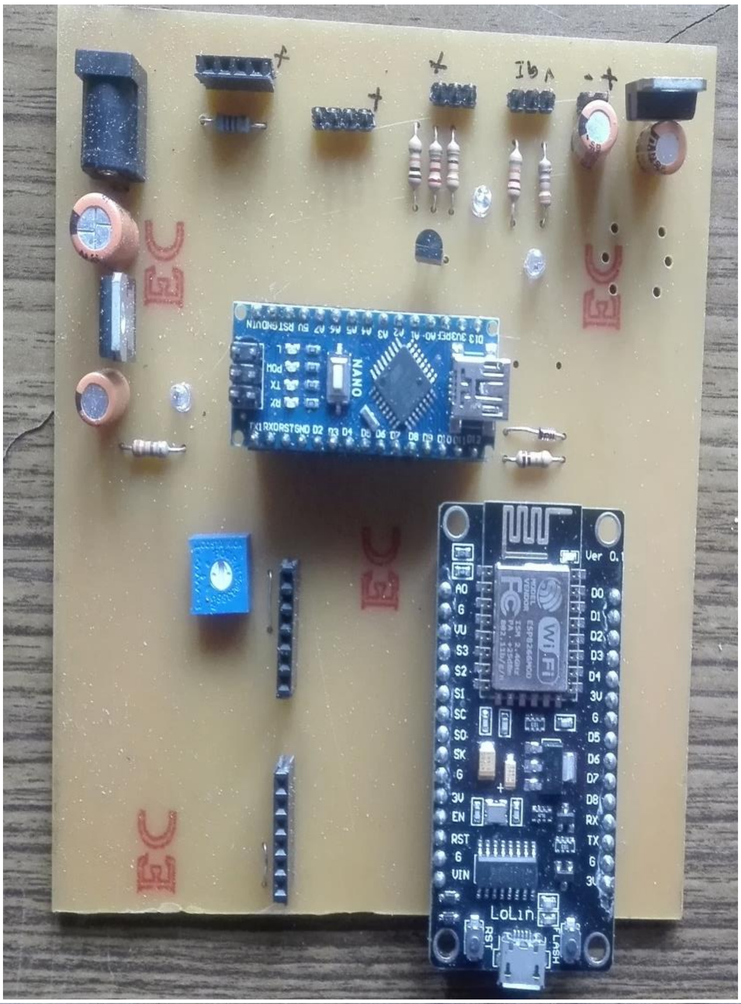
- **HARDWARE**

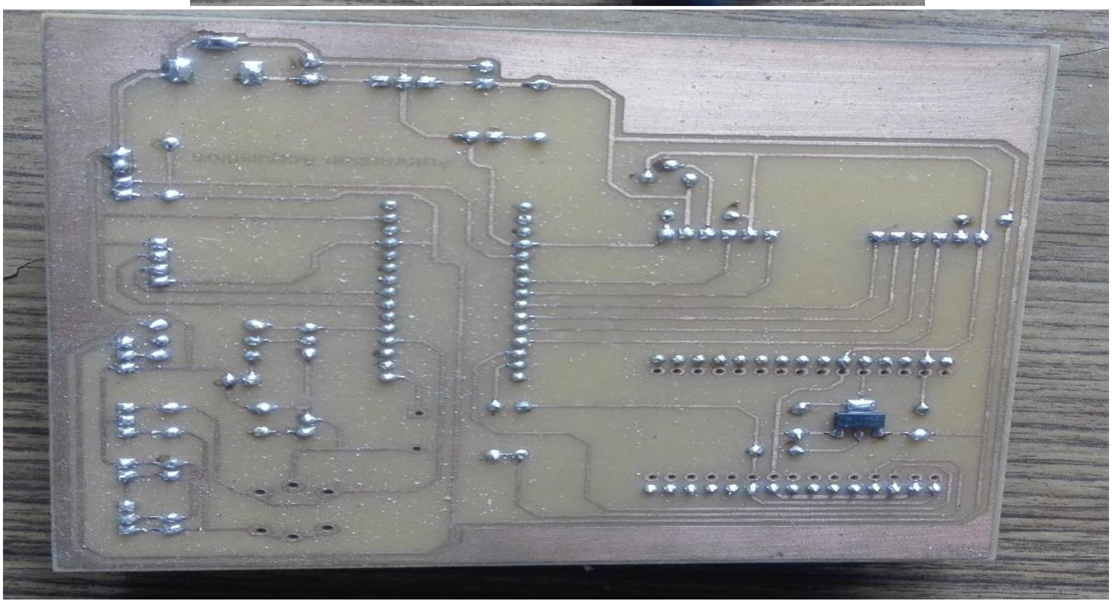
- **Sensor's used**



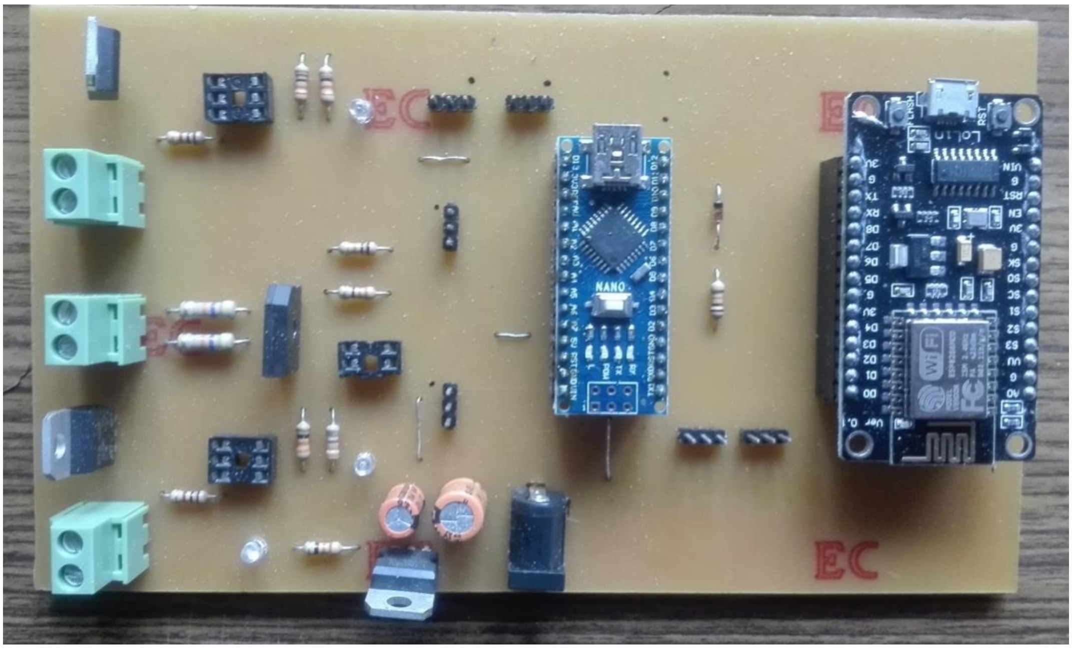
The above figure shows sensor node consists of different sensors.

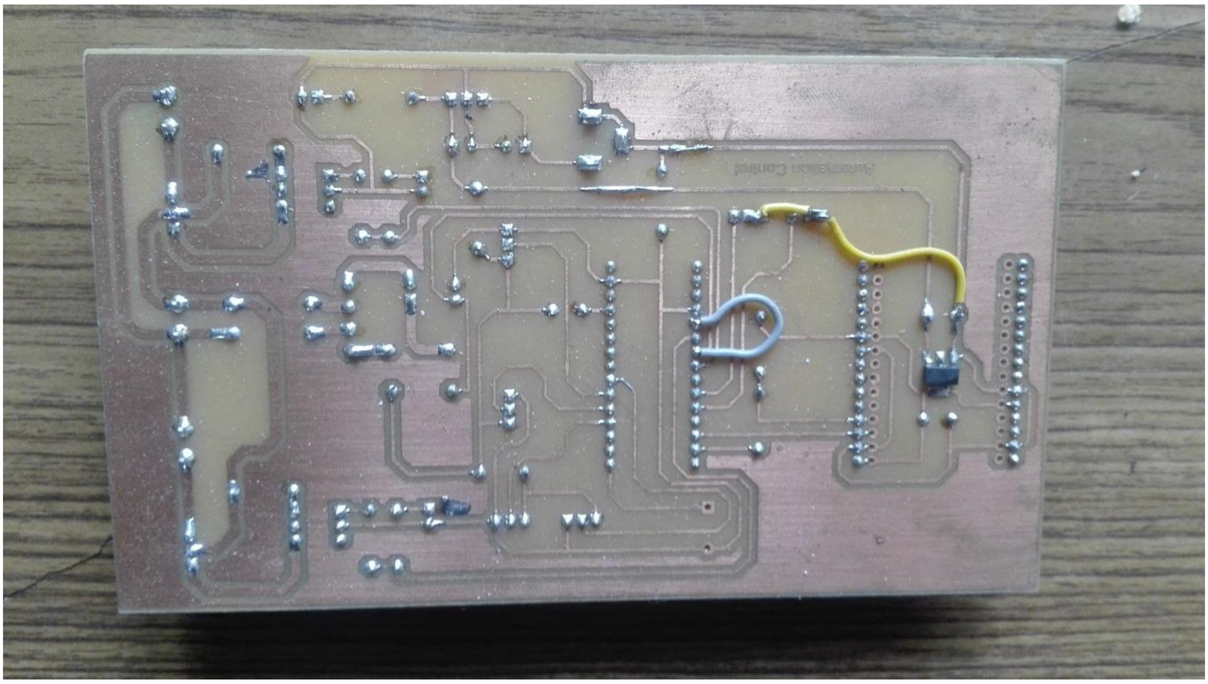
- **Data acquisition Section PCB**



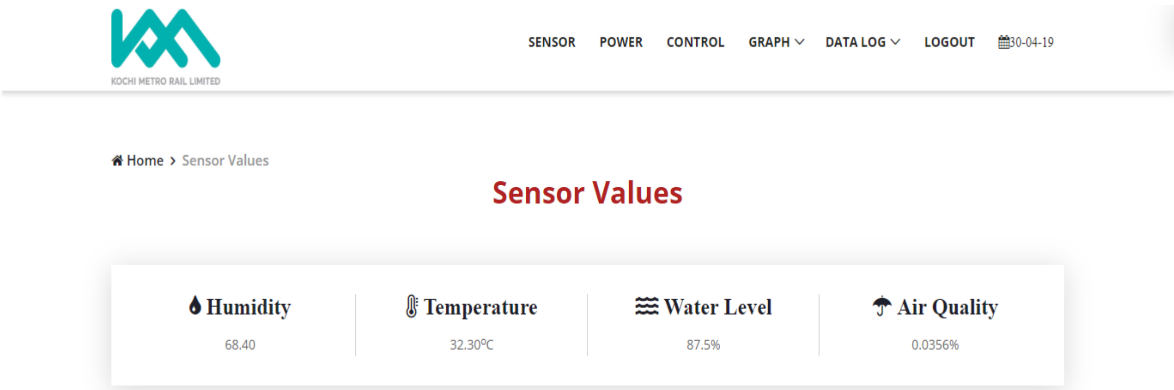


- **Control section PCB**

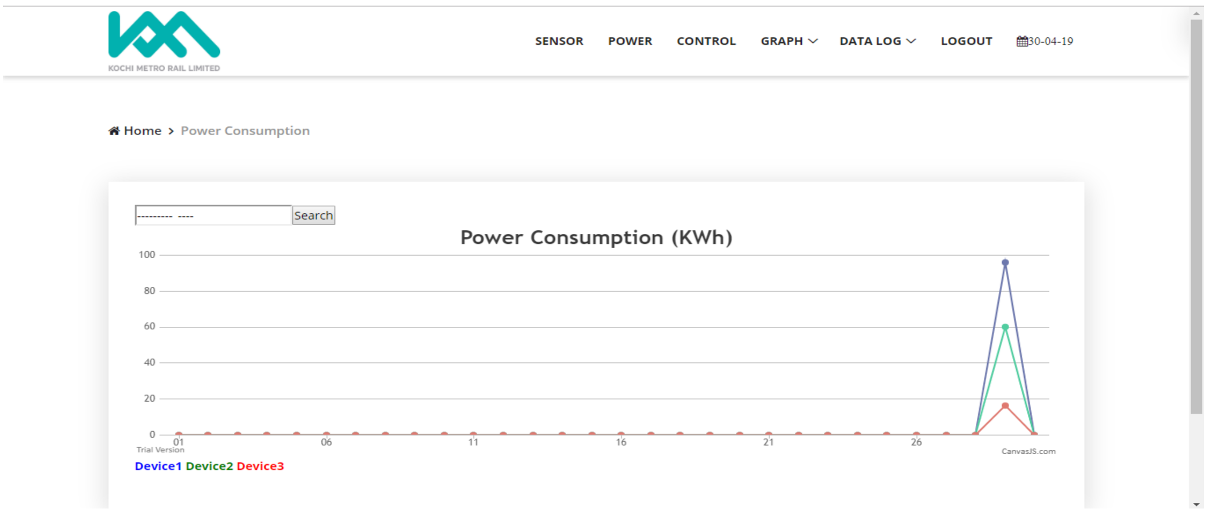




➢ **WEB PAGE**



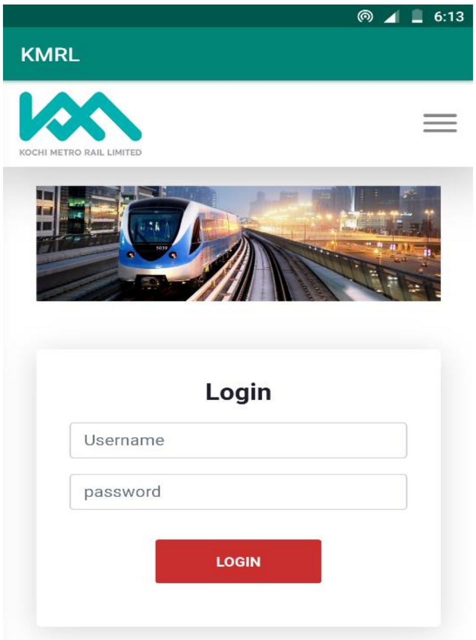
The webpage screenshot which provides the status of the sensors connected.

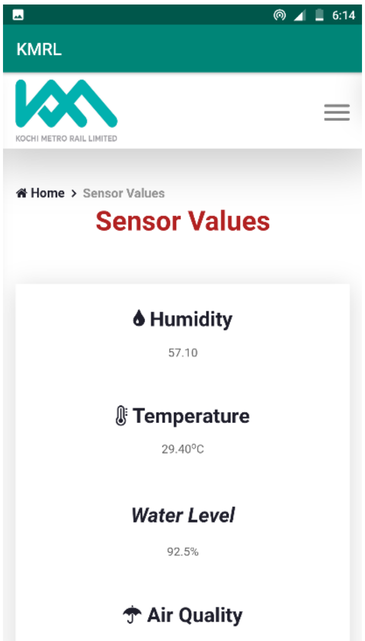


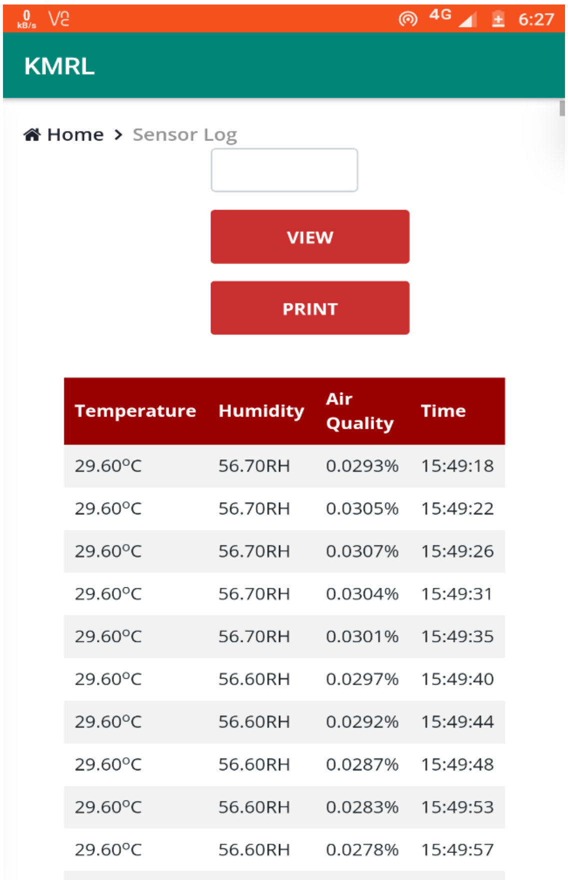
The webpage screenshot which indicates the line graph of power consumption among three electrical loads connected.

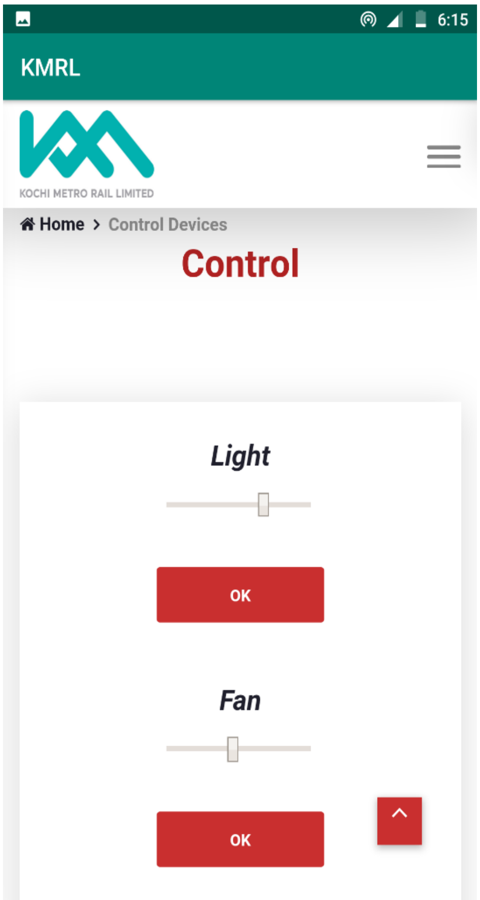
➢ ANDROID APP

Screenshots of android application which helps the user for the remote and easier acess to the whole system.









CHAPTER 8

CONCLUSION

In this digital world, where directly or indirectly everything is dependent information technology. Raspberry Pi proves to be a smart, economical and efficient platform. The main advantage of station automation system, user don't need to control the system manually by using sensors we found the present conditions like temperature, CO2, Humidity, light intensity, water level in station environment. Here corresponding preloaded action is made by the Raspberry Pi. The Android-based office automation system communicates with Raspberry Pi via WiFi. By using android application user can easily control and monitor the office temperature in web link also. The main advantage of office automation system user can control the system anywhere within the network. By using sensors, we found the present conditions like temperature, CO2, Humidity, light intensity in office environment by this to adjust these values as per our required levels. This proposed system is flexible, cost-effective, scalable and efficient. It has many other features like security; energy monitoring and health monitoring can also be integrated.

CHAPTER 9

REFERENCE

- WEBSITES

- www.wikipedia.com
- www.electroschematics.com
- www.arduino.cc
- www.circuitstoday.com
- www.electronicsgarage.com
- www.google.com

- IEEE PAPERS

- ESP8266 based Implementation of Wireless Sensor Network with Linux Based Web-Server.

  [1] “ZigBee vs. Wi-Fi: Understanding Issues and Measuring Performances of their Coexistence”, ZenghuaZhao,Xuanxuan Wu, Xin Zhang, Jing Zhao, Xiang-Yang Li, School of Computer Science and Technology, Tianjin University, China, IEEE – 2014.

  [2] “Wireless Sensor Network System using Raspberry Pi and ZigBee for Environmental Monitoring Applications”,Sudhir G. Nikhade, Assistant Professor, Walchand Collegeof Engineering, Electronics Department, Sangli,Maharashtra, India, International Conference on SmartTechnologies and Management for Computing,Communication 2015

  [3] “Wi-Fi-based Hierarchical Wireless Networked Control Systems”, Esraa A. Makled, Hassan H. Halawa, Ramez M.Daoud, Hassanein H. Amer Electronics and Communications Engineering Department American University in Cairo (AUC) Cairo, Egypt, IEEE 2015

[4] “Wi-Fi-Pi Tracking at Mass Events”, P.H.Patil, A.A.Kokil, Professor & HOE&TC department, Indira College of Engineering & Management, Parandwadi, Pune, International Conference on Pervasive Computing 2015

- Analysis and Pattern Identification on Smart Sensors Data.

[1] R. Pitarma, G. Marques, and B. R. Ferreira, “Monitoring indoor air quality for enhanced occupational health,” Journal of Medical Systems,vol. 41, no. 2, pp. 1–8, 2017.

[2] ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers, “Indoor air quality guide,” 2009.

[3] “ISO, ISO 16000-1:2004 Indoor air - Part 1: General aspects of sampling strategy.”

[4] “ISO, ISO 16814: 2008, Building environment design - Indoor air quality-Methods of expressing the quality of indoor air for human occupancy.”

[5] OSHA Occupational Safety and Health Administration U.S. Department of Labor, “Indoor Air Quality in Commercial and Institutional Buildings,” OSHA 3430-04, 2011.