

AUTOMATED WATERING THE PLANTS USING ARDUINO UNO

A Project Report Phase - II

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Electronics and Communication Engineering

By

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(DEEMED TO BE UNIVERSITY)

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **UTTHARPALLY PAVAN KUMAR (39130489)** and **THUMMA SIVA KOTI REDDY (39130480)** who carried out the project entitled "**AUTOMATED WATERING OF PLANTS USING ARDUINO UNO** " under my supervision from November 2022 to April 2023.

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We, **UTTHARPALLY PAVAN KUMAR (39130489)** and **THUMMA SIVA KOTI REDDY (39130480)** here by declare that the Project Report entitled " **AUTOMATED WATERING OF PLANTS USING ARDUINO UNO** " done by us under the guidance of **Dr. M . SUBRAMONIAM, M.E., Ph. D.**, Associate Professor, Dept. of Electronics and Communication Engineering, Sathyabama institute of science and technology , Chennai, submitted partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

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2. 

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ABSTRACT

Internet of Things (IoT) technology has brought revolution to each and every field of common man's life by making everything smart and intelligent. IoT refers to a network of things which make a self-configuring network. The development of Intelligent Smart Farming IoT based devices is day by day turning the face of agriculture production by not only enhancing it but also making it cost-effective and reducing wastage. The aim objective of this report is to propose IoT based smart farming system assisting farmers in getting live data (Temperature, Soil Moisture, Light Intensity, Acoustic Sound) for efficient environment monitoring which will enable them to increase their overall yield and quality of products. The IoT based SmartFarming System being proposed via this report is integrated with Arduino technology mixed with different sensors and a Wi-Fi module producing live data feed that can be obtained online from thingspeak.com. The product being proposed is tested on live agriculture fields giving high accuracy over 98% in data feeds.

The objectives of this report is to proposed IoT based smart farming system which will enable farmers to have live data of soil moisture environment temperature at very low cost so that live monitoring can be done. The structure of the report is as follows will cover over of overview of IoT technology and agriculture-concepts and definition, IoT enabling technologies, IoT application in agriculture, benefits of IoT in agriculture and IoT and agriculture current scenario and future forecasts will cover definition of IoT based smart farming system, the components and modules used in it and working principal of it will cover algorithm and flowchart of the overall process carried out in the system and its final graphical output consist of conclusion, future scope and references.

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CHAPTER - 1

INTRODUCTION

1.1 GENERAL:

Internet of things IoT consists of two words Internet and Things. The term things in IoT refers to various IoT devices having unique identities and have capabilities to perform remote sensing, actuating and live monitoring of certain sort of data. IOT devices are also enable to have live exchange of data with other connected devices and application either directly or indirectly , or collected data from other devices and process the data and send the data to various servers. The other term internet is define as global communication network connecting trillions of computers across the planets enabling sharing of information. Thus, the IoT can be define as: “a dynamic global network infrastructure with self-configuring capabilities based on standard and inter operable communication to protocol where physical and virtual things have identities, physical attributes and virtual personalities and use intelligent interfaces and are seamlessly integrated into the information network, often communicate data associated with user and their environment.” An ideal IoT device consists of various interfaces for making connectivity to other devices which can either be wired or wireless. Any IoT based device consists of following components: interface for Sensors. Interface for connecting to Internet. Interface for memory and storage.



Figure 1.1 Automated Watering of Plants

1.2 INTERNET OF THINGS:

Internet of Things (IoT) is a concept where each device is assigned to an IP address and through that IP address, anyone makes that device identifiable on the internet. The mechanical and digital machines are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Basically, it started as the "Internet of Computers". Research studies have forecast explosive growth in the number of "things" or devices that will be connected to the internet. The resulting network is called the "Internet of Things". The recent developments in technology that permit the use of wireless controlling environments like Bluetooth and Wi-Fi have enabled different devices to have the capability of connecting with each other. Using a Wi-Fi shield to act as a micro webserver for the Arduino eliminates the need for wired connections between the Arduino board and computer which reduces cost and enables it to work as a standalone device. The Wi-Fi shield needs a connection to the internet from a wireless router or wireless hotspot and this would act as the gateway for the Arduino to communicate with the internet. With this in mind, an internet-based irrigation system for remote control and observing the status of is irrigation system designed.

1.3 BACKGROUND:

The concept of "Irrigation System" has been in existence for several years. "Smart Farming", and "Intelligent Home" are terms that followed and is been used to introduce the concept of networking appliances within the irrigation system. Smart Agricultural Management System (SAMS) includes centralized control and distance status monitoring of lighting, security system, and other appliances and systems within a system. Smart Farming systems enable energy efficiency, improve the security systems, and certainly the comfort and ease of users. In the present emerging market, the irrigation system is gaining popularity and has attracted the interest of many users. Our system comes with its own challenges. Mainly being, in the present day, end-users especially the elderly and disabled.

1.4 PROJECT OBJECTIVES:

- A. Design of an Independent Smart Agricultural Management System (SAMS)
- B. Wireless Control of Home appliances (Switch, Cloud, and, Bluetooth)
- C. Monitoring status of appliances
- D. Secure connection channels between application and Arduino Uno
- E. Controlled by any device capable of Wi-Fi (Android, iOS, PC)
- F. An extensible platform for future enhancement

1.4.1 Design of an independent (SAMS):

To formulate the design of an interconnected network of home appliances to be integrated into the HAS. The objective to account for every appliance and its control to be automated and integrated into the network further formulated into the SAMS.

1.4.2 Wireless control of home appliances (Switch, Cloud, and, Bluetooth):

To develop the application that would include features of the switch and/or voice modes to control the applications.

1.4.3 Monitoring status of appliances:

Being able to view the status of home appliances on the application, in order to have a better HAS.

1.4.4 Secure connection channels between application and Arduino Uno:

Use of secure protocols over Wi-Fi so that other devices are prevented to achieve control over the HAS. Secure connections are obtained by SSL over TCP and SSH.

1.4.5 Controlled by any device capable of Wi-Fi (Android, iOS, PC):

To achieve flexibility in control of the home appliances, a device capable of Wi-Fi connectivity will be able to obtain secure control of the HAS.

1.4.6 An extensible platform for future enhancement:

With a strong existing possibility of adding and integrating more features and appliances to the system, the designed system needs to be highly extensible in nature.

1.5 SCOPE:

The aim is to design a prototype that establishes wireless remote control over a network of home appliances. The application is designed to run on an android device providing features like switch-mode control, voice command control, and a provision to view the status of the devices on the application itself. Considering its wide range of applications, the following are the scope of this prototype. The system can be implemented in homes, small offices, and malls as well, being in charge of control of the electrical appliances. For remote access to appliances on the internet or intranet. The appliances in the above-mentioned environment can be controlled intra-network or can be accessed via the internet. The development of a technology-friendly environment. The system incorporates the use of technology and making SAS. By the use of day-to-day gadgets can utilize them from a different perspective.

1.5 PROJECT MANAGEMENT:

Management of any project can be briefly disintegrated into several phases. This project has been decomposed into the following phases:

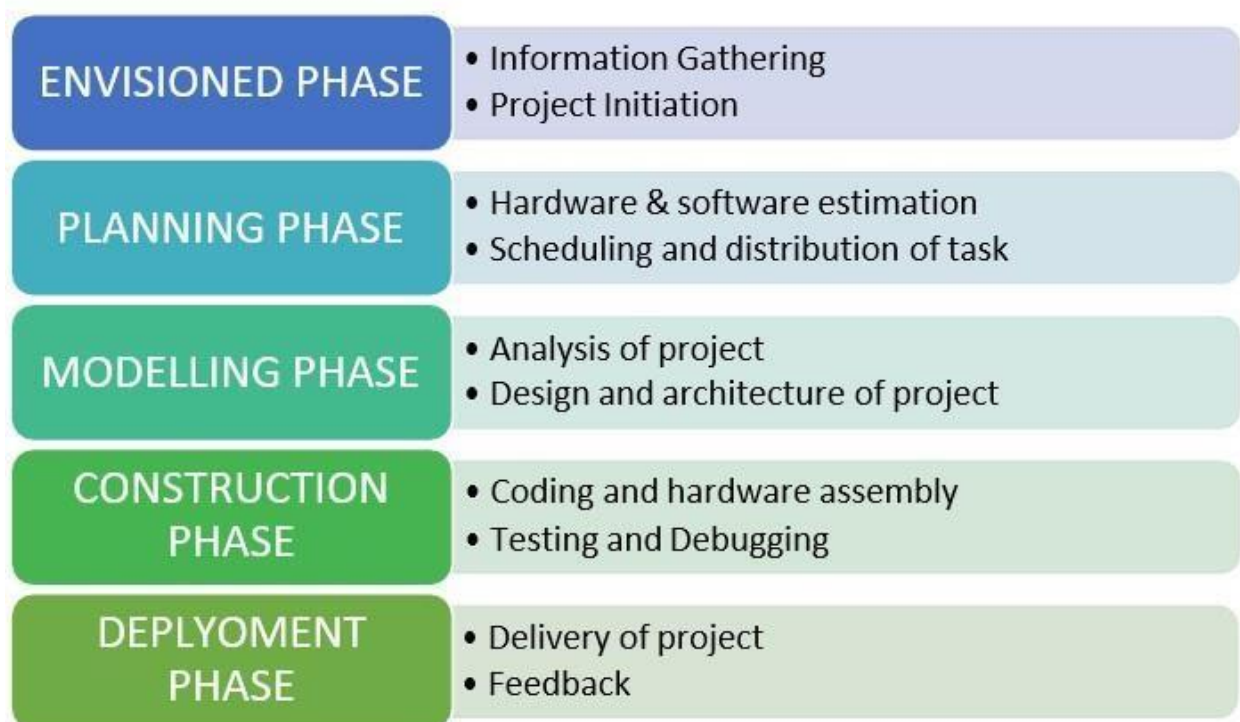


Figure 1.2 Model of Phases in Project Management

Experimentation:

This phase involved discussions regarding necessary equipment for the project. The study of related already existing projects, gathering required theoretical learning. It also included figuring out the coding part, by developing simple algorithms and flowcharts to design the whole process

Design:

This phase was, designing the layout of the application, and the necessary features to be included. This involved the complete hardware assembly and installing the code to Node MCU. The power strip was designed to connect the home appliances that can be controlled via GPIO pins.

Development and testing:

This phase had the development of the application. The android device was connected to the Node MCU via wireless network (Wi-Fi) and the whole prototype was tested for identification and removal of bugs.

Real-world testing:

The prototype was ready to be tested in the real world and integrated with various real-time electrical appliances.

OVERVIEW AND BENEFITS

The benefits of an established wireless remote switching system for home appliances include:

No legal issues:

Obtaining access to or traversing properties with hard lines is extremely difficult.

Reduced wiring issues

Considering the increase in the price of copper, thus increases the possibility of the wire being stolen. The use of a wireless remote system to control home appliances means no wire for thieves to steal.

Extended range:

As the system establishes control over Wi-Fi, it was a generally considered decent range. That is 150 feet indoors. Outdoors it can be extended to 300 feet, but since the application is of a HAS, an indoor range is considered.

Security:

As the connection of the control of the HAS is established over a secure network the system ensures security to the maximum extent.

Integrable and extensive nature:

The prototype design can be integrated to a larger scale. Also, it has an extensive nature being able to add or remove the appliances under control according to application.

1.6 ORGANIZATION OF REPORT

The thesis is organized into seven chapters including the introduction. Each chapter is unique on its own and is described with the necessary theory to comprehend it.

Chapter 2 deals with *Literature Review*, this chapter reflects a comprehended form of the existing projects related to the topic. It credits the projects along with a brief paragraph summary about the project. This reflects the various people who worked in this area, and how different and advanced each project is from one another.

Chapter 3 has the *Theory* that has been acquired to commence the project work. This discussed IoT, the advantages, and disadvantages of the network topologies, and communication protocols. This chapter also briefs about the main microcontroller unit of the prototype, Node MCU. Its pin configuration, various functional units of the development board, and the installation process of the device. The chapter further gives a brief overview of the project, a block diagram of the system, and the circuit diagram.

Chapter 4 describes the *Hardware Modelling and setup* of the project. The chapter points out the main features of the prototype, gives a layout of the project and lists the components requires. It briefly describes the various setup processes involved with the project, including hardware interfacing and software installation and setup according to our requirements. It finally gives the hardware assembly involved.

Chapter 5 is the *Logic and operation* of the project. A flow chart presents the actions and describes the working process of the prototype. It discussed the principle of operation of the system with the advantages and disadvantages of the microcontroller unit. It describes Blynk and IFTTT application and the wireless network established to attain remote control over the system. It describes the process of voice control mode and gives an overall cost estimation of the project.

Chapter 6 is the *conclusion and future scope*. This chapter includes the result of the project work carried out, the limitations it possesses, the further enhancements and modifications that can be integrated into the prototype, and finally concludes the project work carried out so far.

Chapter 7 lists the *References* that have been used for the commencement of the project work.

Appendix A & B individual *hardware descriptions* of the prototype and associated *datasheets*.

CHAPTER - 2

LITERATURE REVIEW

2.1 INTRODUCTION:

The following shows a survey done for Smart Farming for with and without internet on real time which includes an instant feedback mechanism that drives the appliances. This system is reliable to integrate on multiple platforms with the help of Arduino Uno board which serves as standard firmware. Further, the study was extended to multiple operation platforms like Linux, Windows, and IOS are discussed as follows. In this detailed survey, we have learned a lot in stabilizing our concepts from the existing feedback mechanisms that were designed in the previous study

2.2 LITERATURE SURVEY:

M. Nesa Sudha et al., 2011 proposed a TDMA based MAC protocol used for collect data such as soil moisture and temperature for optimum irrigation to save energy. MAC protocol plays an important role to reduce energy consumption. Two methods used for energy efficiency as Direct Communication method and aggregation method. Direct Communication method provides collision free transmission of data, because all the sensor nodes send data directly to the base station without the need of header node. This method is better where the base station is near but it is not optimum where the base station is far because sensor nodes consume more energy during transmission of data and if there is much data to the sensor node, sensor nodes quickly damaged. The data aggregation method is better to use rather than direct communication method. The sensor node senses the data and send to the head node. The head node collects data from the entire sensor node, performs aggregation using various aggregation techniques, and then sends data to the base station. Thus by using aggregation method overall energy consumption reduce of the network. The simulation result show that aggregation method provide better performance rather than direct communication method. It provides 10% increase in residual energy and 13% increase in throughput. Sensor nodes consume more energy while transmitting data.

Anuj Nayak et al., 2014 describe that sensor nodes batteries are charged by using

harnessing wind energy. A routing algorithm named DEHAR is proposed to extend overall batteries power. The proposed method is efficient where the amount of sensor nodes very low because of latency experienced due to synchronous sleep scheduling. A small band belt used to harness wind energy to sensor nodes. Wind belt is aero elastic flutter, which is capable for harnessing wind energy. Harnessing wind energy is a renewable energy source. However, the main problem using harnessing wind energy is the unreliability as the power of the wind is not permanent.

Man Zhang et al., 2012 analysis the temporal and spatial variability of soil moisture for the realization of variable irrigation and for improve yield in the farm. Temporal variability adopts the changes of soil moisture at the place where the sensor nodes installed and analyze soil moisture variation at different times according to season. Spatial variability analyses calculate all parameter of soil moisture as average, maximum, minimum in whole area. The temporal variability curve has drawn according to measure data. It showed that the corn was in severe water stress state during the completely monitoring period.

Joaquin Gutierrez et al., 2013 proposed an irrigation system that uses photovoltaic solar panel to power system because electric power supply would be expensive. For water saving purpose, an algorithm developed with threshold value of temperature and soil moisture programmed into a micro controller gateway. The system has a full duplex communication links based on internet cellular interface using GPRS based on mobile data for graphically display and stored in a database server. The automation irrigation system consists of two components were WSU and WIU. Wireless Sensor Units (WSU) components were used for minimize power consumption because microcontroller is well suited by its lower power current in sleep mode. Wireless Information Unit (WIU) transmits soil moisture and temperature data to a web server using GPRS module. The WIU identify recorded and analyzed received temperature and soil moisture data collected by WSU. WIU functionality is bases on microcontroller that programmed to perform different task as to download the date and time information from web server and compare the temperature and soil moisture value with maximum soil moisture and minimum temperature value so that irrigated pumps activated. The router node is used to forward collected values to the gateway that provide automatically pump the water

to the crop in a field. An Android app used for connectivity such as Wi-Fi. Android app wakes up the Smartphone by using given parameters. In-built camera takes an RGB picture of the soil through an anti-reflective glass window to take estimation of wet and dry area. The mobile app enables the Wi-Fi connection of Smartphone to transmit the estimation value to the gateway via a router node for control an irrigation water pumping.

Sherine M. Abd El-kader et al., 2013 proposed APTEEN (Periodic Threshold old-sensitive Energy-Efficient sensor Network) protocol. APTEEN is a Hierarchical based routing protocol in which nodes have grouped into clusters. Each cluster has a head node and head node is responsible for broadcast data to the base station. APTEEN broadcast parameters attribute, which is a set of physical parameters, in which the user is interested to obtain info, Thresholds value as Hard Threshold and Soft Threshold, Schedule as TDMA schedule uses to assign slots to save energy, which provide collision free transmission. It controls the energy consumption by changing threshold values and count time. The performance of proposed protocol is better than LEACH on average 79% and by LEACH-C on average 112%.

B. Balaji Bhan et al., 2014 proposed a system to develop WSN based soil moisture controllers that determine the water requirement by comparing soil moisture with predefined threshold value. An intelligent remote system consists of wireless sensor nodes and computer system in which data is transmitted to a server system from where the data accessed by individuals for decision making for automated control of irrigation for the yield productivity. Field validation tests routinely performed on different soils to measure the soil moisture, water amount in soil for efficient irrigation system. If the stored data does not match with the soil measured data, an interrupt sent to the pressure unit and stop irrigation automatically.

Sbrine Khriji et al., 2014 describe different type of sensor nodes for real monitoring and control of irrigation system. Each node consists of TelosB mote and actuator. TelosB mote is an ultra low power wireless module for monitoring applications. Soil nodes used to measure the soil moisture weather nodes used to measure environmental parameter and actuator used for controlling the opening of valves for

irrigation. The system has cost efficient and reduce the power consumption. The experimental result shows that the plants are well irrigated and if there is any change in threshold value the system alerts the farmer about the problem to take the appropriate decision.

Yunseop Kim et al., 2008 represents real time monitoring and control of variable rate irrigation controller. The sensor nodes measure environmental parameters and transmit data to the base station where the base station processes data through a user-friendly decision making program and all data commands send to irrigation control station. The Irrigation control station sends machine location using GPS to the base station, send control signal back to irrigation control

Fiona Regan et al., 2009 develop heterogeneous real time water monitoring network system to monitor water quality parameters such as pH, temperature, turbidity and conductivity. The implementation of intelligent sensors incorporating TEDS (Transducer Electronic Data Sheet) which is a machine-readable specification of the sensor characteristics, enable sensors to interface with the system in a plug and play fashion. PSOC system used to create generic sensor interface. The plug and play capabilities enabled by the developed WSN platform allow for integration of any commercially available water quality sensors. PSOC plug and play system capable of transmitting data to the sensor that processed data for transmission to the web.

Joaquin Gutierrez et al., 2015 represents that the sensors use Smartphone to capture and process images of soils. Images can be captured to estimate the water content of the soil. The router node is used to forward collected values to the gateway that provides automatic pump the water to the crop in a field. An Android app used for connectivity such as Wi-Fi. Android app wakes up the Smartphone by using given parameters. In-built camera takes an RGB picture of the soil through an anti-reflective glass window to take estimation of wet and dry area. The mobile app enables the Wi-Fi connection of Smartphone to transmit the estimation value to the gateway via a router node for control an irrigation water pumping.

2.3 MAJOR DISADVANTAGES TO OVERCOME:

Gestures have the power to act as effective tools of communication and also in Realtime Automation. Augmented Reality is that it creates unique digital experiences that blend the best of the digital and physical worlds. Augmented Reality present information in neatly summarized digital snippets. AR can help users take quick decisions without cognitive overload. Augmented Reality is the integration of digital information with the user's environment in real-time. This proposed system can show the live status of a machine to the operator through his AR glasses or tablet. In our augmented reality application, the position of the label is determined by images, text labels, or by QR codes. This methodology will make the user benefit by showing the live data from the unit when the camera of the label scans the corresponding card. This in turn makes it possible to control your environment with augmented reality Augmented Reality would be the one and only choice to handle impossible situations that occurs due to fire, flood, and other Natural Calamities.



Figure 2.1 Visual Examination of the System

CHAPTER - 3

SYSTEM ANALYSIS

3.1 IoT (Internet of Things)

IoT as a term has evolved a long way as a result of the convergence of multiple technologies, machine learning, embedded systems, and commodity sensors. IoT is a system of interconnected devices assigned a UIDS, enabling data transfer and control of devices over a network. It reduced the necessity of actual interaction in order to control a device. IoT is an advanced automation and analytics system that exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system.

3.1.1 Feature of IoT:

- A. Intelligence
- B. Connectivity
- C. Dynamic Nature
- D. Enormous Scale
- E. Sensing
- F. Heterogeneity
- G. Security

3.1.1.1 Intelligence:

IoT comes with the combination of algorithms and computation, software & hardware that makes it smart. Ambient intelligence in IoT enhances its capabilities which facilitate the things to respond in an intelligent way to a particular situation and supports them in carrying out specific tasks. In spite of all the popularity of smart technologies, intelligence in IoT is only concerned with a means of interaction between

devices, while user and device interaction are achieved by standard input methods and graphical user interface.

3.1.1.2 Connectivity:

Connectivity empowers the Internet of Things by bringing together everyday objects. The connectivity of these objects is pivotal because simple object-level interactions contribute to collective intelligence in the IoT network. It enables network accessibility and compatibility in the things. With this connectivity, new market opportunities for the Internet of things can be created by the networking of smart things and applications

3.1.1.3 Dynamic Nature:

The primary activity of the Internet of Things is to collect data from its environment, this is achieved with the dynamic changes that take place around the devices. The state of these devices changes dynamically, for example sleeping and waking up, connected and/or disconnected as well as the context of devices including temperature, location, and speed. In addition to the state of the device, the number of devices also changes dynamically with a person, place, and time

3.1.1.4 Enormous Scale:

The number of devices that need to be managed and that communicate with each other will be much larger than the devices connected to the current Internet. The management of data generated from these devices and their interpretation for application purposes becomes more critical. Gartner (2015) confirms the enormous scale of IoT in the estimated report where it stated that 5.5 million new things will get connected every day and 6.4 billion connected things will be in use worldwide in 2016, which is up by 30 percent from 2015. The report also forecasts that the number of connected devices will reach 20.8 billion by 2020

3.1.1.5 Sensing:

It wouldn't be possible without sensors that will detect or measure any changes in the environment to generate data that can report on their status or even interact with the environment. Sensing technologies provide the means to create capabilities that reflect a true awareness of the physical world and the people in it. The sensing information is simply the analog input from the physical world, but it can provide a rich understanding of our complex world

3.1.1.6 Heterogeneity:

Heterogeneity in the Internet of Things is one of the key characteristics. Devices in IoT are based on different hardware platforms and networks and can interact with other devices or service platforms through different networks. IoT architecture should support direct network connectivity between heterogeneous networks. The key design requirements for heterogeneous things and their environments in IoT are scalabilities, modularity, extensibility, and interoperability.

3.1.1.7 Security:

IoT devices are naturally vulnerable to security threats. As we gain efficiencies, new experiences, and other benefits from the IoT, it would be a mistake to forget about the security concerns associated with it. There is a high level of transparency and privacy issues with IoT. It is important to secure the endpoints, the networks, and the data that is transferred across all of it means creating a security paradigm.

3.1.2 Advantages of IoT

- A. Communication
- B. Automation and Control
- C. Information
- D. Monitor
- E. Time

F. Money

G. Automation of daily tasks leads to better monitoring of devices

H. Efficient and saves time

I. Saves money

J. Better Quality of Life

3.1.2.1 Communication

IoT encourages communication between devices, also famously known as Machine- to-Machine (M2M) communication. Because of this, the physical devices are able to stay connected, and hence the total transparency is available with lesser inefficiencies and greater quality.

3.1.2.2 Automation and Control

Due to physical objects getting connected and controlled digitally and centrally with wireless infrastructure, there is a large amount of automation and control in the workings. Without human intervention, the machines are able to communicate with each other leading to faster and timely output.

3.1.2.3 Information

It is obvious that having more information helps make better decisions. Whether it is mundane decisions such as needing to know what to buy at the grocery store or if your company has enough widgets and supplies, knowledge is power and more knowledge is better.

3.1.2.4 Monitor

The second most obvious advantage of IoT is monitoring. Knowing the exact quantity of supplies or the air quality in your home can further provide more information that could not have previously been collected easily. For instance, knowing that you are low on milk or printer ink could save you another trip to the store in the near future.

3.1.2.5 Time

As hinted in the previous examples, the amount of time saved because of IOT could be quite large. And in today's modern life, we all could use more time.

3.1.2.6 Money

The biggest advantage of IoT is saving money. If the price of the tagging and monitoring equipment is less than the amount of money saved, then the Internet of Things will be very widely adopted. IoT fundamentally proves to be very helpful to people in their daily routines by making the appliances communicate with each other in an effective manner thereby saving and conserving energy and cost. Allowing the data to be communicated and shared between devices and then translating it in our required way, makes our systems efficient.

3.1.2.7 Automation of daily tasks leads to better monitoring of devices

The IoT allows you to automate and control the tasks that are done on a daily basis, avoiding human intervention. Machine-to-machine communication helps to maintain transparency in the processes. It also leads to uniformity in the tasks. It can also maintain the quality of service. We can also take necessary action in case of emergencies.

3.1.2.8 Efficient and saves time

The machine-to-machine interaction provides better efficiency, hence; accurate results can be obtained fast. This results in saving valuable time. Instead of repeating the same tasks every day, it enables people to do other creative jobs.

3.1.2.9 Saves Money

Optimum utilization of energy and resources can be achieved by adopting this technology and keeping the devices under surveillance. We can be alerted in case of possible bottlenecks, breakdowns, and damages to the system. Hence, we can save money by using this technology.

3.1.2.10 Better Quality of Life

All the applications can be achieved by adopting this technology of this culminate in increased comfort, convenience, and better management, thereby improving the quality of life.

3.1.3 Disadvantages of IoT:

- A. Compatibility
- B. Complexity
- C. Privacy / Security
- D. Safety
- E. Lesser Employment of Menial Staff
- F. Technology Takes Control of Life

3.1.3.1 Compatibility

Currently, there is no international standard of compatibility for the tagging and monitoring equipment. I believe this disadvantage is the easiest to overcome. The manufacturing companies of this equipment just need to agree to a standard, such as Bluetooth, USB, etc. This is nothing new or innovative needed.

3.1.3.2 Complexity

Internet of Things, failures could skyrocket. For instance, let's say that both you and your spouse each get a message saying that your milk has expired, and both of you stop at a store on your way home, and you both purchase milk. As with all complex systems, there are more opportunities for failure. As a result, you and your spouse have purchased twice the amount that you both need. Or maybe a bug in the software ends up automatically ordering a new ink cartridge for your printer each and every hour for a few days, or at least after each power failure when you only need a single replacement.

3.1.3.3 Privacy / Security

With all of this IoT data being transmitted, the risk of losing privacy increases. For instance, how well encrypted will the data be kept and transmitted? Do you want your neighbors or employers to know what medications you are taking or your financial situation?

3.1.3.4 Safety

Imagine if a notorious hacker changes your prescription. Or if a store automatically ships you an equivalent product that you are allergic to, a flavor that you do not like, or a product that is already expired. As a result, safety is ultimately in the hands of the consumer to verify any and all automation. As all the household appliances, industrial machinery, public sector services like water supply and transport, and many other devices are connected to the Internet, a lot of information is available on it. This information is prone to attack by hackers. It would be very disastrous if private and confidential information is accessed by unauthorized intruders.

3.1.3.5 Lesser Employment of Menial Staff

The unskilled workers and helpers may end up losing their jobs in the effect of automation of daily activities. This can lead to unemployment issues in society. This is a problem with the advent of any technology and can be overcome with education. With daily activities getting automated, naturally, there will be fewer requirements for human resources, primarily, workers and less educated staff. This may create an Unemployment issue in society.

3.1.3.6 Technology Takes Control of Life

Our lives will be increasingly controlled by technology and will be dependent on it. The younger generation is already addicted to technology for every little thing. We have to decide how much of our daily lives are we willing to mechanize and be controlled by technology.

3.1.4 Application Grounds of IoT:

- A. Wearables
- B. Smart Homes
- C. Health Care
- D. Agriculture
- E. Industrial Automation
- F. Government and Safety

3.1.4.1 Wearables

Wearable technologies are a hallmark of IoT applications and are one of the earliest industries to have deployed IoT at its services. Fit Bits, heart rate monitors, smartwatches, and glucose monitoring devices reflect the successful applications of IoT.

3.1.4.2 Smart homes

This area of application is concerned to this particular project, so a detailed application is discussed further. *Jarvis*, an AI home automation employed by Mark Zuckerberg, is a remarkable example in this field of application.

3.1.4.3 Health Care

IoT applications have turned the reactive medical-based system into the proactive wellness-based system. IoT focuses on creating systems rather than equipment. IoT creates a future of medicine and healthcare which exploits a highly integrated network of sophisticated medical devices. The integration of all elements provides more. accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations.



Figure 3.1 Working of IoT enables care device

3.1.4.4 Agriculture

A green house farming technique enhances the yield of crops by controlling environmental parameters. However, manual handling results in production loss, energy loss, and labor cost, making the process less effective. A greenhouse with embedded devices not only makes it easier to be monitored but also, enables us to control the climate inside it. Sensors measure different parameters according to the plant requirement and send them to the cloud.

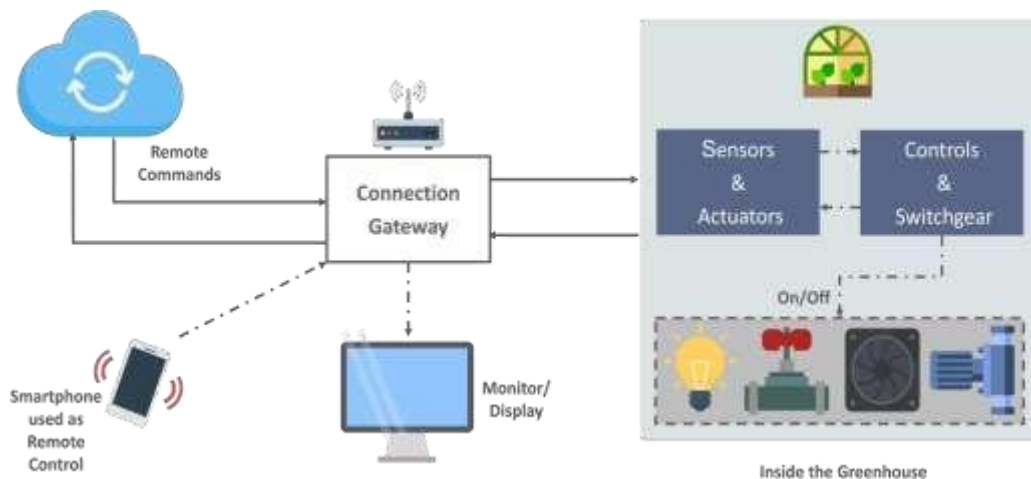


Figure 3.2 IoT Controlled Green House Environment

3.1.4.5 Industrial Automation

For a higher return on investment, this field requires both fast developments and quality products. This vitality thus coined the term IIOT. This whole schematic is reengineered by IoT applications. Following are the domains of IoT applications in industrial automation

- 1) Factory Digitalization
- 2) Product flow Monitoring
- 3) Inventory Management
- 4) Safety and Security
- 5) Quality Control
- 6) Packaging optimization
- 7) Logistics and Supply Chain Optimization

3.1.4.6 Government and Safety

IoT applied to government and safety allows improved law enforcement, defense, cityplanning, and economic management. The technology fills in the current gaps, corrects many current flaws, and expands the reach of these efforts. For example, IoT can help city planners have a clearer view of the impact of their design, and governments have a better idea of the local economy.

3.1.5 IoT Technologies and Safety:

Several communication protocols and technologies cater to and meet the specific functional requirements of the IoT system.

- A. Bluetooth
- B. Zigbee
- C. Z-Wave
- D. Wi-Fi

E. Cellular

F. NFC

G. LoRaWAN

3.1.5.1 Bluetooth

Bluetooth is a short-range IoT communication protocol/technology that is profound in many consumers product markets and computing. It is expected to be key for wearable products, in particular, again connecting to the IoT albeit probably via a smartphone in many cases. The new Bluetooth Low-Energy (BLE) – or Bluetooth Smart, as it is now branded – is a significant protocol for IoT applications. Importantly, while it offers a similar range to Bluetooth it has been designed to offer significantly reduced power consumption.

3.1.5.2 Zigbee

ZigBee is similar to Bluetooth and is majorly used in industrial settings. It has some significant advantages in complex systems offering low-power operation, high security, robustness, and high and is well-positioned to take advantage of wireless control and sensor networks in IoT applications. The latest version of ZigBee is the recently launched 3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard.

3.1.5.3 Z-Wave

Z-Wave is a low-power RF communications IoT technology that is primarily designed for home automation for products such as lamp controllers and sensors among many other devices. A Z-Wave uses a simpler protocol than some others, which can enable faster and simpler development, but the only maker of chips is Sigma Designs compared to multiple sources for other wireless technologies such as ZigBee and others.

3.1.5.4 Wi-Fi

Wi-Fi connectivity is one of the most popular IoT communication protocols, often an obvious choice for many developers, especially given the availability of Wi-Fi of

the home environment within LANs. There is a wide existing infrastructure as well as offering fast of data transfer and the ability to handle high quantities of data. Currently, the most common Wi-Fi standard used in homes and many businesses is 802.11n, which offers a range of hundreds of megabits per second, which is fine for file transfers but maybe too power-consuming for many IoT applications.

3.1.5.5 Cellular

Any IoT application that requires operation over long distances can take advantage of GSM/3G/4G cellular communication capabilities. While cellular is clearly capable of sending high quantities of data, especially for 4G, the cost and also power consumption will be too high for many applications. But it can be ideal for sensor-based low-bandwidth-data projects that will send very low amounts of data over the Internet.

3.1.5.6 NFC

NFC (Near Field Communication) is an IoT technology. It enables simple and safe communications between electronic devices, specifically smartphones, allowing consumers to perform transactions in which one does not have to be physically present. It helps the user to access digital content and connect electronic devices. Essentially it extends the capability of contactless card technology and enables devices to share information at a distance that is less than 4cm.

3.1.5.7 LoRa WAN

LoRa WAN is one of popular IOT Technology, targets wide-area network (WAN) applications. The LoRa WAN design to provide low-power WANs with features specifically needed to support low-cost mobile secure communication in IOT, smart city, and industrial applications. Specifically meets requirements for low-power consumption and supports large networks with millions and millions of devices, data rates range from 0.3 kbps to 50 kbps.

3.1.6 IoT Software:

- A. Data Collection
- B. Device Integration
- C. Real-Time Analytics
- D. Application and Process Extension

3.1.6.1 Data Collection

This software manages sensing, measurements, light data filtering, light data security, and aggregation of data. It uses certain protocols to aid sensors in connecting with real-time, machine-to-machine networks. Then it collects data from multiple devices and distributes it in accordance with settings. It also works in reverse by distributing data over devices. The system eventually transmits all collected data to a central server.

3.1.6.2 Device Integration

Software supporting integration binds (dependent relationships) all system devices to create the body of the IoT system. It ensures the necessary cooperation and stable networking between devices. These applications are the defining software technology of the IoT network because, without them, it is not an IoT system. They manage the various applications, protocols, and limitations of each device to allow communication.

3.1.6.3 Real-Time Analysis

These applications take data or input from various devices and convert it into feasible actions or clear patterns for human analysis. They analyze information based on various settings and designs in order to perform automation-related tasks or provide the data required by the industry.

3.1.6.4 Application and Process Extension

These applications extend the reach of existing systems and software to allow a wider, more effective system. They integrate predefined devices for specific purposes such as allowing certain mobile devices or engineering instruments access. It supports improved productivity and more accurate data collection.

3.2 Arduino Uno

Arduino UNO is a microcontroller board it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (Flash, Processing, Max MSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handy board, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:



Figure 3.4 Arduino Uno Board

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50
- **Cross-platform** - The Arduino software runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with the look and feel of Arduino
- **Open source and extensible software**- The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.
- **Open source and extensible hardware** - The Arduino is based on Atmel's ATMEGA8 and ATMEGA168/ATMEGA2560 microcontrollers. The plans for the modules are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money. The Uno is a microcontroller board based on the ATmega328P. It has 14 digitalinput/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz

quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

You can find here your board warranty information.

Getting Started

You can find in the Getting Started section all the information you need to configure your board, use the Arduino Software (IDE), and start tinker with coding and electronics.

Need Help?

- On the Software on the Arduino Forum
- On Projects on the Arduino Forum
- On the Product itself through our Customer Support

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6

DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Table 1 Arduino Uno Pinouts and Specs

3.2.1 ARDUINO UNO PIN TYPE DEFINITIONS: (TAKE A LOOK AT YOUR ARDUINO BOARD)

Reset	3v3	5v	Gnd	Vin	Analog In	RX/TX	Digital	PWM(~)	AREF
Resets Arduino sketch on board	3.3 volts in and out	5 volts in and out	Ground	Voltage in for sources over 7V (9V - 12V)	Analog inputs, can also be used as Digital	Serial comm. Receive and Transmit	Input or output, HIGH or LOW	Digital pins with output option of PWM	External reference voltage used for analog

3.3 Soil Moisture Sensors



Figure no 3.5 Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil.^[1] Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks.

A resistive soil moisture sensor works by using the relationship between electrical resistance and water content to gauge the moisture levels of the soil. You'll observe these sensors to possess two exposed probes that are inserted directly into the soil sample. A soil moisture sensor is a device that measures current soil moisture. Sensors integrated into the irrigation system aid in scheduling water supply and distribution.

Tensiometers are soil moisture sensors that measure this tension between soil particles and water molecules. In order for plants to access this water they must overcome the tension to draw water molecules away from the soil particles and into their roots.

3.3.1 Agriculture

Measuring soil moisture is important for agricultural applications to help farmers manage their irrigation systems more efficiently. Knowing the exact soil moisture conditions on their fields, not only are farmers able to generally use less water to grow a crop, they are also able to increase yields and the quality of the crop by improved management of soil moisture during critical plant growth stages.

Landscape irrigation

In urban and suburban areas, landscapes and residential lawns are using soil moisture sensors to interface with an irrigation controller. Connecting a soil moisture sensor to a simple irrigation clock will convert it into a "smart" irrigation controller that prevents irrigation cycles when the soil is already wet, e.g. following a recent rainfall event. Golf courses are using soil moisture sensors to increase the efficiency of their irrigation systems to prevent over-watering and leaching of fertilizers and other chemicals into the ground.

3.3.2 Research

Soil moisture sensors are used in numerous research applications, e.g. in agricultural science and horticulture including irrigation planning, climate research, or environmental science including solute transport studies and as auxiliary sensors for soil respiration measurements

Simple sensors for gardeners

Relatively cheap and simple devices that do not require a power source are available for checking whether plants have sufficient moisture to thrive. After inserting a probe into the soil for approximately 60 seconds, a meter indicates if the soil is too dry, moist or wet for plants.

3.3.2 Technologies

Frequency Domain Reflectometry (FDR): The dielectric constant of a certain volume element around the sensor is obtained by measuring the operating frequency of an oscillating circuit.

Time Domain Transmission (TDT) and Time Domain Reflectometry (TDR): The dielectric constant of a certain volume element around the sensor is obtained by measuring the speed of propagation along a buried transmission line.

Neutron moisture gauges: The moderator properties of water for neutrons are utilized to estimate soil moisture content between a source and detector probe.

Soil resistivity: Measuring how strongly the soil resists the flow of electricity between two electrodes can be used to determine the soil moisture content.

Galvanic cell: The amount of water present can be determined based on the voltage the soil produces because water acts as an electrolyte and produces electricity. The technology behind this concept is the galvanic cell

Soil Moisture Sensor Work

A small charge is placed on the electrodes and electrical resistance through the sensor is measured. As water is used by plants or as the soil moisture decreases, water is drawn from the sensor and resistance increases. Conversely, as soil moisture increases, resistance decreases.

Used in Soil Moisture

Meter soil moisture sensors use high-frequency capacitance technology to measure the volumetric water content of the soil, meaning they measure the quantity of water on a volume basis compared to the total volume of the soil.

Testing Soil for Moisture

Insert a trowel into the soil, then tilt the trowel to check the moisture of garden plants. You can also insert a wooden dowel into the soil to determine the depth of soil moisture. If the dowel comes out clean, the soil is dry. Damp soil will cling to the dowel.

3.4 DC motor

DC motors are configured in many types and sizes, including brush less, servo, and gear motor types. A motor consists of a rotor and a permanent magnetic field stator. The magnetic field is maintained using either permanent magnets or electromagnetic windings. DC motors are most commonly used in variable speed and torque. Motion and controls cover a wide range of components that in some way are used to generate and/or control motion. Areas within this category include bearings and bushings, clutches and brakes, controls and drives, drive components, encoders and resolvers, Integrated motion control, limit switches, linear actuators, linear and rotary motion components, linear position sensing, motors (both AC and DC motors), orientation position sensing, pneumatics and pneumatic components, positioning stages, slides and guides, power transmission (mechanical), seals, slip rings, solenoids, springs.

Motors are the devices that provide the actual speed and torque in a drive system. This family includes AC motor types (single and multiphase motors, universal, servo motors, induction, synchronous, and gear motor) and DC motors (brush less, servo motor, and gear motor) as well as linear, stepper and air motors, and motor contactors and starters.

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion. Let's start by looking at a simple 2-pole DC electric motor (here red represents a magnet or winding with a "North" polarization, while green represents a magnet or winding with a "South" polarization).



Figure 3.6 DC Motor

Every DC motor has six basic parts -- axle, rotor (a.k.a., armature), stator, commutator, field magnet(s), and brushes. In most common DC motors (and all that Beamers will see), the external magnetic field is produced by high-strength permanent magnets¹. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout - with the rotor inside the stator (field) magnet

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the motors are currently used in propulsion of electric vehicles, elevator and

hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

3.4.1 DC motors usages

At home, small DC motors are used in tools, toys and various household appliances. In retail, the applications of DC motors include conveyors and turntables, while in an industrial setting, large DC motor uses also include braking and reversing applications.

Principle of DC motor

DC motors operate on Faraday's principle of electromagnetism which states that a current-carrying conductor experiences a force when placed in a magnetic field.

Types of DC motor:

There are 4 main types of DC motors:

- Permanent Magnet DC Motors. The permanent magnet motor uses a permanent magnet to create field flux
- Series DC Motors. In a series DC motor, the field is wound with a few turns of a large wire carrying the full armature current
- Shunt DC Motors
- Compound DC Motors

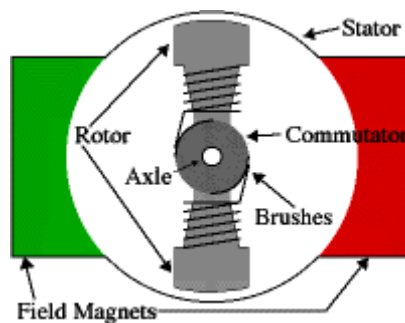


Figure no -3.7 DC Motor performance

3.5 RELAY



Figure no 3.8 Relay Module

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. The traditional form of a relay uses an electromagnet to close or open the contacts, but other operating principles have been invented, such as in solid-state relays which use semiconductor properties for control without relying on moving parts. Relays with

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*.

Latching relays require only a single pulse of control power to operate the switch persistently. Another pulse applied to a second set of control terminals, or a pulse with opposite polarity, resets the switch, while repeated pulses of the same kind have no effects. Magnetic latching relays are useful in applications when interrupted power should not affect the circuits that the relay is controlling. 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.

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 or resistor 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 for the

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. Resistors, while more durable than diodes, are less efficient at eliminating voltage spikes generated by relays and therefore not as commonly used. 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 contactors, contacts are made with a mixture 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.

Relay module

The relay module is an electrically operated switch that can be turned on or off deciding to let current flow through or not. They are designed to be controlled with low voltages like 3.3V like the ESP32, ESP8266, etc, or 5V like your Arduino.

Relay function

Converting a small electrical input into a high-current output is no easy feat, but this task is necessary to efficiently operate a wide range of standard appliances and vehicles. Many circuits achieve these conversions through the use of relays, which are indispensable in all kinds of electronic equipment.

Relay used

Relays are normally used in the control panels, manufacturing and building automation to control the power along with switching the smaller current values in a control circuit.

3.5.1 Advantages of relays

- Simple and effective operation. The operating principle of a relay is really simple
- Circuit multiplication. Relays can switch many contacts at once
- Galvanic isolation
- Voltage conversion
- Accessory options
- AC or DC contact switching
- Compact size and low cost
- Terminal connection

3.6 BLOCK DIAGRAM:

The block diagram gives the functionality of the overall project. The Arduino Uno board is the microcontroller or the main controlling unit of the system. The user uses the mobile application in setting commands for the functioning of the appliances. The mobile application interprets the command from the user in voice or switch mode and sends a signal to the Arduino Uno, over a wireless network established by Wi-Fi communication. Hence the Wi-Fi module (actually inbuilt into Arduino board), helps the microcontroller establish Wi-Fi communication with a device and take commands

from an application over the wireless network. The Arduino further receives the signal and then turns on/off the appliance with the help of the relay. The Arduino Uno, relay, and the final appliances are physically connected. There is a power supply unit that powers the microcontroller, the relay as well as the final appliances. There is also a display unit that displays the status of the application.



Figure no 3.9 Block Diagram of the Proposed System

3.6.1 Proposed System:

Automatic watering of plants is based on Internet Of Things(IoT).In this proposed system we use Arduino uno software and hardware, Soil moisture sensor, Rechargable Battery, Relay Module, Dc motor. The sensors automatically check the soil moisture and based on some threshold value if soil is dry then it waters the plant and if soil is wet which is more than threshold value then is stops watering the plants.

The Soil Moisture Sensor, Humidity, Temperature and Acoustic Sensor are connected to Arduino Uno controller. Then sensors send the data from their respective positions to Arduino Uno controller. The received analog data can be processed by the controller and then send to end users like web server, via MQTT server. The Soil Moisture Sensor, Humidity, and Temperature Sensor are connected as inputs to controller. The water pump is connected via Relay. The measured temperature and humidity values send to the end user. The moisture sensor senses the water quantity in the soil and the water pump will supply it whenever the quantity of water in the soil is reduced. For a better understanding of end users notifications can be sent like

“Water deficiency in the soil ON water pump ”.The water level in a reservoir continuously survey by the sensor and alerts the customer with notifications like the height of the water level from the top view, and the current percentage of water present in the reservoir at that moment.

3.7 OVERVIEW OF PROJECT :

The process of creating an account in the Blynk application and generating a unique ID against a particular device. This ID acts as an identifier for the particular device on the Blynk server. Once the unique Id is generated the next step would be to include this key into the coding written in embedded C to establish communication between Arduino Uno and Blynk Server. Once the unique Id is generated the next step would be to include this key into the coding written in embedded C to establish communication between Arduino Uno and Blynk Server.

CHAPTER: 4

HARDWARE MODELLING AND SETUP

4.1 MAIN FEATURES OF THE PROTOTYPE:

The features of the developed prototype are:

- 1) The prototype establishes a wireless remote switching system for home appliances.
- 2) The prototype uses Wi-Fi to establish wireless control, which gives an indoor range of about 150 feet.
- 3) The command to switch on and off an appliance can be given from radio buttons on the application from one's smartphone.
- 4) There is also a provision developed to use voice commands on a smartphone to remotely switch home appliances
- 5) Any device capable of Wi-Fi connectivity can be used to control the prototype.
- 6) The control over home appliances is obtained over secure connections, by SSL over TCP, SSH.
- 7) Simple design easy to integrate into a variety of appliances and extend on the further range.
- 8) Displays the status of each appliance on the application in the smartphone
- 9) Cost-effective.

4.2 SOFTWARE AND ALGORITHM

Arduino Uno is the microcontroller unit in the prototype. It inbuilt Wi-Fi module that establishes wireless remote switching of home appliances.

Four-channel relay module consists of 4 individual relays physically connected between Arduino and the home appliances. It takes the signal from GPIO pins of Arduino and accordingly connects or disconnects home appliances from the supply. They act as the switching device.

LED and resistors are used in this prototype to replace real appliances. They indicate power being turned on and off to the appliances. In real-time operation, they would be replaced by actual home appliances.

Blynk application was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, can store data, visualize it, etc. prototype primarily uses the Blynk application to sense commands from the user to the hardware wireless network.

Google assistant is a system software present on the android phone. It interprets the voice commands by the user to turn on or off appliances.

IFTTT application the voice commands interpreted by the google assistant aren't understandable by the Blynk application thus unable to send to the hardware. IFTTT is an intermediate application that interprets commands from Google assistant and sends on and off signals to the Blynk application on the Via Blynk server.

4.3 COMPONENTS REQUIRED:

SL. NO	Components	Quantity
1.	Arduino Uno	1
2.	4 channel relay board	1
3.	9V battery	1
4.	LED	4
5.	2.2K Ω Resistor	4
6.	Blank PCB (KS100)	1
7.	Male pin header	1
8.	Female pin header	1
9.	Jumper wires	8
10.	USB Cable	1

Table 2 Component Listing

4.4 SETTING UP THE SYSTEM:

4.4.1 Downloading and installing and Blynk application:

Blynk application is downloaded and installed from the Play Store. Once the application is installed, a new account is created and logged in to it. After logging in, a new project is created. The project is named, hardware is selected as Arduino Uno and the connection type is selected as Wi-Fi, and created. At this point, Blynk will send an authentication token to the email id. This authentication token will be used to identify the hardware in the Blynk server as the prototype uses 4 channel relay module, 4 buttons are added to the screen from the sidebar. All 4 buttons are then customized by adding a name and selecting the digital pin it will correspond to. This section will actually affect the hardware connection as the relays will be physically connected to the digital pins corresponding here. The setup of the Blynk application is now complete.

4.4.2 Driver installation for hardware interfacing:

Mostly these days devices download and install drivers on their own, automatically. Windows don't know how to talk to the USB driver on the Arduino Uno so it can't figure out that the board is a Arduino Uno and proceed normally.

1. Arduino Uno Board module-based development board. It has got a Micro USB slot that can directly be connected to the computer or other USB host devices. It has got 15X2 header pins and a Micro USB slot, the headers can be mounted on a breadboard and the Micro USB slot is to establish a connection to the USB host device. It has CP2120 USB to serial converter.
2. In order to install CP2120 (USB to serial converter), the user is needed to download the driver for the same.
3. Once a user downloads drivers as per its respective operating system, the system establishes a connection to Arduino Uno.
4. The user needs to note down the COM port allotted to the newly connected USB device from the device manager of the system. This com port number will be required while using Arduino Uno
- 5.

4.4.3 Interfacing Arduino with Arduino IDE:

To begin with the latest Arduino IDE version, we'll need to update the board manager with a custom URL. Open up Arduino IDE and go to File > Preferences. Then, copy the below URL into the Additional Board Manager URLs text box situated at the bottom of the window:

http://arduino.esp8266.com/stable/package_esp8266com_index.json

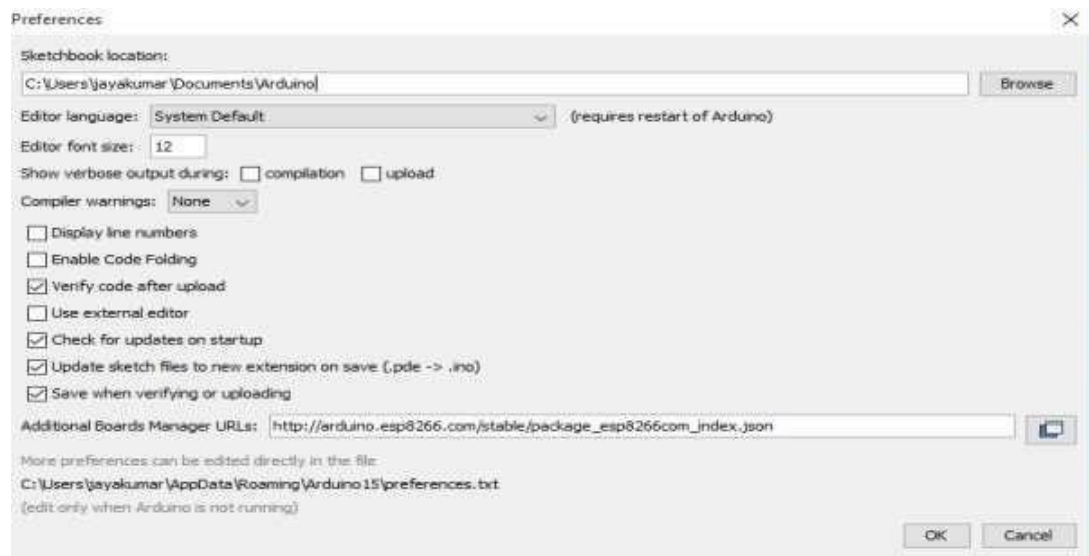


Figure 4.1 Arduino IDE Preferences

OK. Then navigate to the Board Manager by going to Tools > Boards > Boards Manager. There should be a couple of new entries in addition to the standard Arduino boards. Filter your search by typing arduino. Click on that entry and select Install. Before we get to uploading sketches & playing with LED, we need to make sure that the board is selected properly in Arduino IDE. Open Arduino IDE and select Arduino option under your Arduino IDE > Tools > Board menu.

Now, plug your Arduino IDE into your computer via a micro-B USB cable and. Once the board is plugged in, it should be assigned a unique COM port. On Windows machines, this will be something like COM#, and on Mac/Linux computers it will come in the form of /dev/tty. USB serial-XXXXXX. Select this serial port under the Arduino IDE > Tools > Port menu. Also select the Upload Speed: 115200

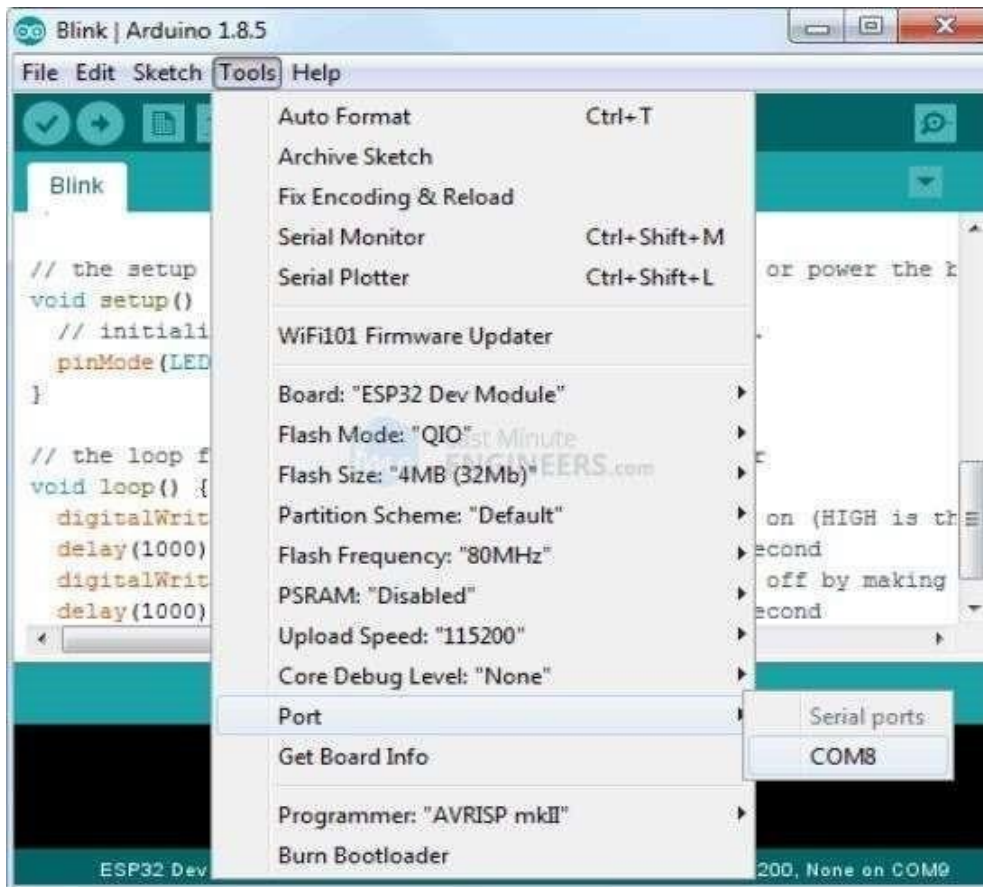


Figure 4.2 Assigning Communication Port on Arduino IDE

4.4.4 Uploading code to Arduino Uno Board

- Arduino Uno is connected to a PC using a USB cable.
- Now, we'll set up the Arduino IDE by changing some settings. So, open up the Arduino IDE. Select Tools > Board and select 'Arduino Uno 1.0' as the board. And that's all the settings we need to change. So now we begin writing the code.
- Select Files > Examples > Blynk > Boards > WIFI > Arduino Uno_Standalone. A new file with some prewritten code opens. The following changes to the code are made.

1. The line which says `char auth [] = "YourAuthToken"`, replace the *YourAuthToken* part with your Blynk's authentication token that was generated by the Blynk server
2. The line which says `char ssid [] = "YourNetworkName"`, replaces the *YourNetworkName* part with the name of the Wi-Fi network that the Arduino Uno must connect to.
3. The line where it says `char pass [] = "your password"` and replace the *Your Password* part with the password of the Wi-Fi network.

The code is ready to be uploaded to the hardware. On clicking the upload button, the code is uploaded to Arduino Uno and the next time it's powered on, it automatically connects to the assigned Wi-Fi network.

4.5 HARDWARE ASSEMBLY:

Hardware assembly mainly includes connecting specific digital pins of Arduino Uno to the 4 relays on the relay module, including the connection of supply and ground pins. The main functional assembly in this prototype is simple. The further 4 relays are fit to be connected to any appliance desired to be controlled the vital part in hardware assembly is taking into account the digital pin that corresponds to which relay. This connection is done as per the setup of the Blynk application. The radio buttons on the Blynk application are set up to switch a particular digital pin in Arduino Uno . It is made sure that the relay connection is physically made according to this setup. For example, we have assigned the radio button on the Blynk application corresponding to relay 1 to work with D3. Then physical connection of relay 1 is made with D3 of Arduino Uno . In this prototype instead of real home appliances, we connect the relays to LEDs, (according to the circuit diagram) to just ensure the functionality of the prototype. The prototype is given a supply from a 9V battery.

CHAPTER- 5

LOGIC AND OPERATION

5.1 FLOW CHART:

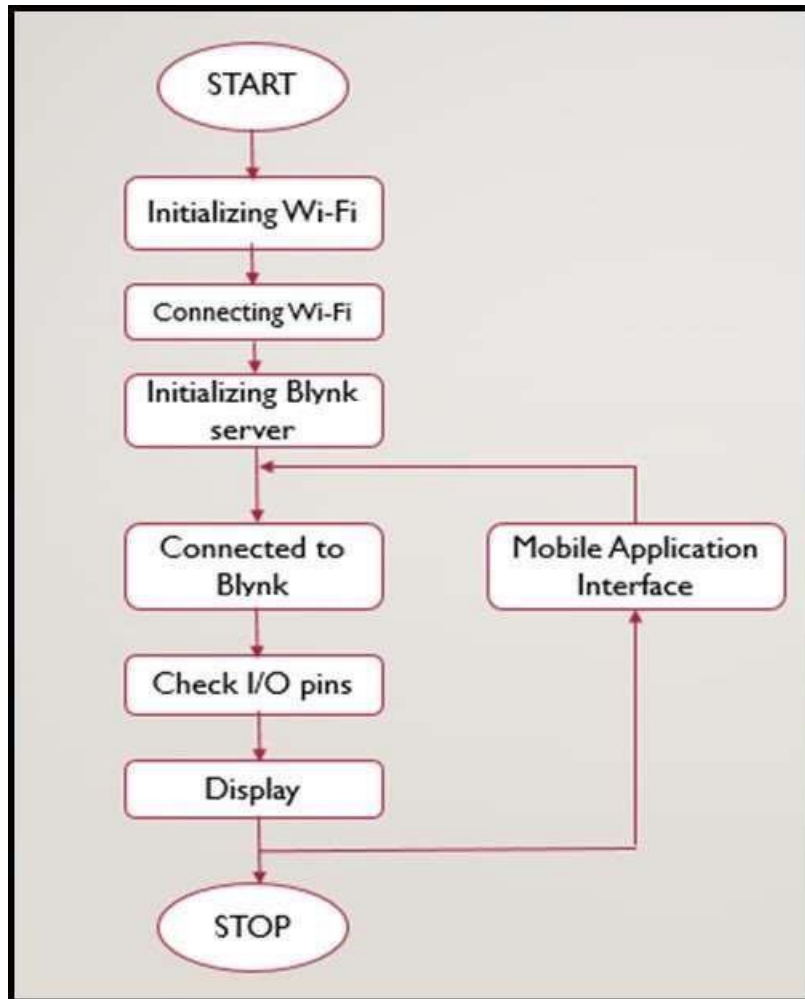


Figure 5.1 Flow chart of Prototype function

This flow chart shows the working of the project. The process starts by initializing the Wi-Fi, the network name and password are written in the code and uploaded to Arduino Uno. The android device is connected to Arduino Uno board over Wi-Fi. The Blynk server is set up and the connection is made, the devices are identified in the Blynk server using the generated authentication token. The command for controlling

the load is given to the application, and this command, over the Wi-Fi network, is sent to the Arduino Uno board.

5.2 PRINCIPLE AND OPERATION:

Arduino Uno is an open-source IoT platform. It includes firmware that runs on the Arduino Wi-Fi SoC from Espressif Systems, and hardware that is based on the Arduino Uno module. The term Arduino by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the project and built on the Espressif Non-OS SDK for Arduino. It uses many open-source projects, such as JSON, and spiffs.

5.2.1 Advantages of Arduino Uno

1. Low cost, the Arduino is less costly compared to any other IoT-based device.
2. Arduino Like hardware I/O. It is becoming very popular these days that Arduino IDE has extended its software to work in the field of arduino Field module version.
3. Arduino has an easily configurable network API.
4. Integrated support for the Wi-Fi network: ESP 8266 is incorporated in arduino, which is an easily accessible Wi-Fi module.
5. Reduced size of the board.
6. Low power consumption.

5.2.2 Disadvantages of Arduino Uno:

- 1) The operation of the circuit depends on the working internet connection. If the working internet connection is not available then it will not run.
- 2) Arduino also depends on the free server provided by the third party, if the free server is not working then it will not run.
- 3) It has fewer resources for official documentation
- 4) Need to learn a new language and IDE
- 5) Reduced pinout
- 6) Scarce documentation

5.3 BLYNK APPLICATION:

The Blynk application was designed for the primary purpose of the Internet of Things. blynk is a platform with IOS and Android apps to control Arduino, Raspberry Pi, and the likes over the Internet. It's a digital dashboard where a graphic interface for a prototype can be built by simply dragging and dropping widgets. It can control hardware remotely, it can display sensor data, can store and visualize data, and possessed a lot more functionality. There are three major components in the platform:

- **Blynk Application:** allows to you create amazing interfaces for your projects using various widgets we provide.
- **Blynk Server:** responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices, and can even be launched on a Raspberry Pi.
- **Blynk Libraries:** for all the popular hardware platforms – enable communication with the server and process all the incoming and outgoing commands.

Every time a radio button is accessed in the Blynk application, the message travels to the Blynk Cloud, where it finds the specific hardware by the unique generated authentication token. It works in the same way in the opposite direction.

5.4 WIRELESS COMMUNICATION NETWORK:

The prototype aims to wireless control over home appliances with the technology of IoT. As discussed earlier, IoT supports various wireless communication protocols, like Bluetooth, Z-Wave, Zigbee, etc. this prototype uses Wi-Fi as a wireless communication network to establish remote access over home appliances. This is because Wi-Fi has its own advantages over other wireless communication protocols.

Advantages of Wi-Fi over other wireless technologies like Bluetooth and ZigBee

1. Bluetooth is generally used for point-to-point networks and Bluetooth operates at a much slower rate of around 720 Kbps which is very small for video transfer or moving a large amount of data like the image captured from a camera, whereas the bandwidth of Wi-Fi can be up to 150Mbps and very ideal for video transmission.
2. Wi-Fi is a very much more secure means of communication than Bluetooth.
3. Wi-Fi connection to send video, audio, and telemetry operation, while accepting remote control commands from an operator who can be located virtually anywhere in the world.
4. Robots are already being eyed for obvious tasks like conducting search-and-rescue missions during emergencies or hauling gear for soldiers in the jungle or woods. The mechanics of the robot uses the concept that has been developed to ensure robust navigation, search, and transportation in rough terrain.

STANDARD	BLUETOOTH	UBW	ZIGBEE	WI-FI
IEEE specification	802.15.1	802.15.3a	802.15.4	802.11a/g/b
Frequency band	2.4 GHz	3.1-10.6 GHz	868/915 MHz; 2.4 GHz	2.4 GHz; 5 GHz
Maximum signal rate	1 Mb/s	110 Mb/s	250 Kb/s	54 Mb/s
Nominal range	10 m	10 m	10-100 m	100 m

Nominal TX power	0-10 dBm	-41.3 dBm/MHz	(-25) -0 dBm	10-20 dBm
RF channels	79	1-15	1/10; 16	14 (2.4 GHz)

Channel bandwidth	1 MHz	500 MHz- 7.5 GHz	0.3/0.6 GHz; 2 MHz	22 MHz
Modulation type	GFSK	BPSK, QPSK	BPSK (+ASK), O- QPSK	BPSK, QPSK, COFDM, CCK, M-QAM
Spreading	FHSS	DS-UBW, MB-OFDM	DSSS	DSSS, CCK, OFDM
Co-existence mechanism	Adaptive frequency hopping	Adaptive frequency hopping	Dynamic frequency selection	Dynamic frequency selection, transmit power control
Basic cell	Piconet	Piconet	Star	BSS
Extension of basic cell	Statement	Peer-to-peer	Cluster tree, Mesh	ESS

Maximum cell nodes	8	8	>65000	2007
Encryption	E0 Stream chipper	AES block cipher (CTR, counter mode)	AES block cipher (CTR, counter mode)	RC4 stream cipher (WEP), AES block cipher
Authentication	Shared secret	CBCMAC (CCM)	CBC-MAC (Extension of CCM)	WPA2 (802.11i)

Table 3 Comparison chart of Wi-Fi with other Wireless Communication Protocols

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 RESULT:

The experimental model was made according to the circuit diagram and the results were as expected. The home appliances could be remotely switched over a Wi-Fi network. Both the switch mode and the voice mode control methodologies were successfully achieved. The Blynk application was also successful in displaying the status of every application.

6.2 LIMITATIONS:

Android devices having a lower API version than 16 require internet access to convert the speech data to string data. Currently, the application is made for Android Smart Phones; other OS platform doesn't support our application. During voice mode, external noises (voice) may affect our result. The speech instruction that we command in our voice mode may not give the exact result as expected. There hence lies an ambiguity in the result.

6.3 FURTHER ENHANCEMENT AND FUTURE SCOPE

Looking at the current situation we can build a cross-platform system that can be deployed on various platforms like iOS, and Windows. The limitation to control only several devices can be removed by extending the automation of all other home appliances. The prototype can include sensors to implement automatic control of the home appliances like; an LDR that can sense daylight and switch lamps accordingly, a PIR to detect motion and be used for security purposes making an alarm buzz, or a DHT11 sensor that senses ambient temperature and humidity of the atmosphere and switch fan/air conditioner accordingly. The scope of this project can be expanded to many areas by not restricting to only homes, but too small offices

6.4 CONCLUSION

It is evident from this project work that an individual control home automation system can be cheaply made from low-cost locally available components and can be used to control multifarious home appliances ranging from the security lamps, and the television to the air conditioning system and even the entire house lighting system. And better still, the components required are so small and few that they can be packaged into a small inconspicuous container. The designed home automation system was tested a number of times and certified to control different home appliances used in the lighting system, air conditioning system, home entertainment system, and many more. Hence, this system is scalable and flexible. All the relevant data are updated to the cloud where we monitor the environmental parameters on the cloud web server for the enhancement of the smart agricultural plant monitoring system. The system is highly secured and stabilized by the webserver protocols.

CHAPTER – 7

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APPENDIX

A. IEEE Standards Activities in the Internet of Things (IoT)

IEEE serves as the gathering place for the global technical community working on the Internet of Things (IoT), as demonstrated by the many ongoing activities of the IEEE Internet of Things Initiative. The IEEE IoT Initiative provides the platform where professionals learn, share knowledge, and collaborate on the sweeping convergence of technologies, markets, applications, and the Internet. The success of IoT depends strongly on standardization, which provides interoperability, compatibility, reliability, and effective operations on a global scale. IEEE has a number of existing standards (current and under development), activities, and events that are directly related to creating the environment needed for a vibrant IoT, recognizing the value of the IoT to industry and the benefits this technology innovation brings to the public. Some key standards activities are:

- **Architectural framework:** The focus of IEEE P2413-2019 is to develop a standard for the architectural framework for the Internet of Things, which includes descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. The architectural framework defined in this standard will promote cross domain interaction, aid system interoperability and functional compatibility.
- **Harmonization and security of IoT:** The IEEE 1451-99 is focused on developing a standard for harmonization of Internet of Things (IoT) devices and systems. This standard defines a method for data sharing, interoperability, and security of messages over a network, where sensors, actuators and other devices can interoperate, regardless of underlying communication technology.
- **Sensor Performance and Quality:** Sensors are fundamental to IoT ecosystem with large volume of different sensors integrated into a complex framework. IEEE 2700 proposes a common framework for sensor performance specification terminology, units, conditions and limits is provided. IEEE P2510 defines quality measures, controls, parameters and definitions for sensor data related to Internet of Things (IoT) implementations.

B. SOURCE CODE

```
#define BLYNK_PRINT Serial

#include <WiFi.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>

#include "DHT.h" char auth[] =
"MkVWEePCZ0DU5chbLM_IYvFCqgJTlvvu"; char ssid[] =
"MSJ Researchers World"; char pass[] = "LIGNH1603209";
#define DHTTYPE DHT11

#define DHTPIN 4

#define Soil 2

#define Sound 34

#define LDR 35

#define Relay 23 #define
Motor 15 int
SoilSensorValue = 0; int
SoundSensorValue = 0;
int LDRSensorValue = 0;
DHT dht(DHTPIN, DHTTYPE);
BlynkTimer timer; void
sendSensor()

{ float h = dht.readHumidity(); float t = dht.readTemperature(); // or
dht.readTemperature(true) for Fahrenheit if (isnan(h) || isnan(t))
{
  Serial.println("Failed to read from DHT sensor!");
return;
```

```

    }
    Blynk.virtualWrite(V5, t);

    Blynk.virtualWrite(V6, h);

    Blynk.virtualWrite(V7, SoundSensorValue);

    Blynk.virtualWrite(V8, LDRSensorValue);

}      void
setup()
{
    Serial.begin(9600); dht.begin();
    timer.setInterval(1000L, sendSensor);
    Blynk.begin(auth, ssid, pass);
    pinMode(Soil,INPUT);
    pinMode(LDR,INPUT);
    pinMode(Relay,OUTPUT);
    pinMode(Motor,OUTPUT);
} void loop() {

    Blynk.run();

    timer.run();

    SoilSensorValue = digitalRead(Soil);
    SoundSensorValue = analogRead(Sound);

    LDRSensorValue = analogRead(LDR);

    Serial.println(SoundSensorValue);
    if(SoilSensorValue == 1)

```

```

{
  Blynk.notify("Kindly Water Me...!, I Need Water...");  digitalWrite(Motor,HIGH);
}
else if(SoundSensorValue >= 3000)
{

  Blynk.notify("Activity of Bug found...!");
}
else if(LDRSensorValue >= 3000)
{
  Blynk.notify("Light Intensity is Very Low...!");  digitalWrite(Relay,HIGH);
}
else
{
  digitalWrite(Relay,LOW ; digitalWrite(Motor,LOW)  }

```