Smart Farming and Auto Pumping System

Submitted by

KAUSHIK DAS

Registration number: 144-1111-0339-20 & Roll Number: 203144-21-0031

SHROBONA SIL

Registration number: 144-1211-0357-20 & Roll Number: 203144-11-0024

Supervisor:

DR. MITHUN KUMAR BHOWAL

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CERTIFICATE

This is to certify that Kaushik Das & Shrobona Sil have carried out their investigation entitled "**SMART FARMING AND AUTO PUMPING SYSTEM**" under my supervision as per the requirement for the degree of Bachelor of Science in the department of Computer Science, University of Calcutta. During this investigation they have learnt Nodejs, Arduino IDE and applied them independently. This report is not being submitted elsewhere for examination by other students except them.

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(Dr. Mithun Kr. Bhowal)

Dept. of Computer Science
Bangabasi Morning College
University of Calcutta

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External Examiner

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DATE: -02.08.22

Kaushik Das

Department of Computer Science

Bangabasi Morning College

University of Calcutta

. . . .

Shrobona Sil

CONTENTS

ABSTRACT

Our project is **Smart Farming Monitoring System** whose main moto is to reduce the hard work to monitor a farm all day. A farmer has to check the moisture of the soil and has to pump water himself. After checking the soil, the recognition of the perfect moisture for the farming and pumping water, can be difficult for him. So we are creating small project to check the moisture and auto pump water to the soil through the motor whenever there is low moisture in it. And lastly keeping a track of the pumping of water and the soil moisture for further betterment.

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The Smart Farming and Auto Pumping System is a revolutionary solution designed to revolutionize traditional agricultural practices by automating the monitoring and irrigation processes. In conventional farming methods, farmers often face challenges in manually checking soil moisture levels and manually pumping water, resulting in inefficiencies, time consumption, and potential crop yield losses. The introduction of smart farming systems, equipped with advanced technologies, aims to address these challenges and optimize agricultural operations.

The primary objective of the Smart Farming and Auto Pumping System is to develop an automated system that accurately measures soil moisture levels and activates the water pump automatically when required. By implementing this system, farmers can save time and resources, while ensuring optimal moisture levels for their crops. The system utilizes various components, including a soil moisture sensor module, NodeMcu ESP8266 microcontroller, motor, and transistor for water pumping control, to achieve its objectives.

The integration of a database in the system allows for efficient data management and analysis. The collected data, including soil moisture readings and pump status, is stored in the database, facilitating real-time monitoring and historical data trends. Users can access the data through a user-friendly website interface, enabling remote monitoring and data-driven decision-making.

1.2 BACKGROUND

Traditional farming methods often require farmers to manually monitor soil moisture levels and manually pump water into the fields when necessary. This process can be time-consuming, labor-intensive, and inefficient, leading to suboptimal irrigation practices and potential crop yield losses. Moreover, the increasing global demand for food production, coupled with the need for sustainable agricultural practices, calls for innovative solutions to improve farming efficiency and reduce resource wastage.

In response to these challenges, the concept of smart farming has emerged,

leveraging advanced technologies to automate and optimize agricultural processes. Smart farming involves the use of sensors, data analytics, and automation to monitor and manage various aspects of farming, such as soil conditions, irrigation, and crop health. By utilizing real-time data and intelligent control systems, smart farming enables farmers to make data-driven decisions, conserve resources, and improve crop yield.

The Smart Farming and Auto Pumping System project aims to contribute to the development of smart farming practices by focusing on automating the monitoring and irrigation processes. By implementing a system that can accurately measure soil moisture levels and automatically activate the water pump when needed, the project seeks to address the limitations of manual irrigation and improve water management in agriculture.

The project recognizes the importance of optimizing irrigation practices to ensure efficient water usage, as water scarcity and environmental concerns have become significant challenges in modern agriculture. By automating the irrigation process, the project aims to reduce water wastage, minimize human error in irrigation scheduling, and enhance the overall sustainability of farming operations.

Additionally, the project takes into account the advancements in microcontroller technology, wireless connectivity, and database management systems. These advancements have made it feasible to develop a cost-effective and user-friendly system that integrates various components to automate the monitoring and irrigation processes. The utilization of a microcontroller, soil moisture sensor module, motor, transistor, and a database enable the project to provide accurate monitoring, control, and data analysis functionalities.

By combining hardware components with software solutions, the Smart Farming and Auto Pumping System project aspires to empower farmers with an efficient and reliable tool for optimizing irrigation and improving crop yield. The project aligns with the larger goal of achieving sustainable agriculture practices, reducing resource wastage, and meeting the increasing food demands of a growing population.

1.3 PROJECT OBJECTIVES

The main objective of the Smart Farming and Auto Pumping System is to automate the monitoring and irrigation processes in agriculture, specifically focusing on efficient water management. The project aims to address the limitations of manual irrigation practices by developing a system that can accurately measure soil moisture levels and automatically activate the water pump when necessary.

The specific objectives of the project include:

1. Designing and implementing a system that integrates a soil moisture sensor module, microcontroller, motor, and transistor to automate the monitoring and pumping processes.

2. Developing a user-friendly website interface for real-time monitoring of soil moisture levels, pump status, and historical data visualization.

3. Establishing a database for efficient data storage and retrieval, enabling users to access and analyze soil moisture data and pump status records.

4. Improving water management practices by optimizing irrigation schedules, reducing water wastage, and ensuring optimal moisture levels for crop growth.

5. Enhancing crop yield and productivity by providing accurate and timely irrigation based on soil moisture conditions.

6. Promoting sustainable farming practices by minimizing manual labor, reducing resource wastage, and improving overall efficiency in irrigation processes.

By achieving these objectives, the Smart Farming and Auto Pumping System aims to contribute to the advancement of smart farming practices and support farmers in optimizing water usage and improving agricultural productivity.

1.4 SCOPE

The scope of the Smart Farming and Auto Pumping System project includes the design, implementation, and deployment of a system that automates the monitoring and irrigation processes in agriculture. The system focuses on accurately measuring soil moisture levels and automatically activating the water pump based on predefined thresholds. It encompasses the integration of hardware components, such as a soil moisture sensor module, microcontroller, motor, and transistor, along with a user-friendly website interface and a database for data storage and retrieval. The project aims to optimize water management, improve crop yield, and promote sustainable agricultural practices.

1.5 OVERVIEW AND BENEFITS

The Smart Farming and Auto Pumping System project aims to revolutionize traditional agricultural practices by automating the monitoring and irrigation processes. The system utilizes advanced technologies, including a soil moisture sensor module, microcontroller, motor, and database-driven user interface, to optimize water management and improve crop yield.

The system provides real-time monitoring of soil moisture levels, historical data analysis, and automated water pumping based on predefined thresholds. By accurately measuring soil moisture and automatically activating the water pump when required, the system ensures optimal moisture levels for crop growth while minimizing water wastage.

The benefits of the Smart Farming and Auto Pumping System are numerous. It reduces manual labor, saves time and resources, and improves overall efficiency in irrigation processes. By optimizing water usage and maintaining optimal soil moisture levels, the system promotes sustainable farming practices and reduces environmental impact.

Furthermore, the system enhances crop yield and productivity by providing timely and precise irrigation based on soil moisture conditions. It empowers farmers with data-driven decision-making capabilities, enabling them to make informed choices regarding irrigation schedules and resource allocation.

1.6 ORGANIZATION OF THESIS

The various stages involved in the development of this project have been properly put into five chapters to enhance comprehensive and concise reading. In this project thesis, the project is organized sequentially as follows:

CHAPTER 2
LITERATURE REVIEW

The Smart Farming and Auto Pumping System is an innovative solution that integrates advanced technologies to automate monitoring and irrigation processes in agriculture. This section presents a literature review on the key components and concepts involved in the project, highlighting existing research and studies related to smart farming, automated irrigation systems, and their benefits.

1. Smart Farming and Precision Agriculture:

Smart farming, also known as precision agriculture, has gained significant attention in recent years due to its potential to improve agricultural practices. Researchers have explored various aspects of smart farming, including sensor-based monitoring systems, data analysis techniques, and automation of farming operations. Studies by John Liakos(2018) and (2019) discuss the benefits of precision agriculture in terms of increased crop productivity, reduced resource consumption, and enhanced sustainability.

2. Automated Irrigation Systems:

Automated irrigation systems play a crucial role in optimizing water usage and ensuring efficient crop growth. Literature on automated irrigation systems focuses on sensor-based technologies for measuring soil moisture, real-time data acquisition, and control mechanisms for water pumping. Research by Hui Wu (2019) and Muhammad Akhtar(2020) emphasize the importance of automated irrigation systems in improving water management, reducing manual labor, and enhancing crop yield.

3. Soil Moisture Sensors and Microcontrollers:

Soil moisture sensors and microcontrollers are key components of the Smart Farming and Auto Pumping System. Literature on soil moisture sensors explores different types of sensors, such as resistive, capacitive, and TDR-based sensors, and their applications in agricultural settings. Studies by Ahmed Al-Naji. (2019) and Sana Khan (2020) discuss the working principles and performance of soil moisture sensors.

Similarly, microcontrollers, such as the NodeMcu ESP8266, have been widely used in agricultural automation. Research by Bold Munkhutur(2020) and Ananya Chakraborty (2021) discuss the role of microcontrollers in controlling

Irrigation systems, integrating sensors, and enabling data communication in smart farming applications.

4. Database and User Interface:

The integration of a database and user interface in the Smart Farming and Auto Pumping System facilitates data storage, retrieval, and visualization. Literature on database management systems and web-based interfaces for agricultural applications provides insights into data management, historical analysis, and user interaction. Studies by Xiaoyan Wang (2017) and Ahmed Fadhil (2019) discuss the utilization of databases and web interfaces for real-time monitoring, data visualization, and decision support in precision agriculture.

Overall, the literature review highlights the significance of smart farming and automated irrigation systems in optimizing water usage, enhancing crop yield, and promoting sustainable agricultural practices. Existing research provides valuable insights into the design and implementation of sensor-based technologies, microcontrollers, database systems, and user interfaces in the context of precision agriculture. The Smart Farming and Auto Pumping System project builds upon this research to develop an efficient and user-friendly system that addresses the challenges of manual irrigation practices and maximizes the benefits of smart farming technologies.

CHAPTER 3
THEORY

3.1 IOT (INTERNET OF THINGS)

The Internet of things (IoT) describes physical objects (or groups of such objects) with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks. Internet of things has been considered a misnomer because devices do not needto be connected to the public internet, they only need to be connected to a network and be individually addressable.

IOT as a term has evolved long way as a result of convergence ofmultiple technologies, machine learning, embedded systems andcommodity 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 which 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 Features of IOT:-

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 as a means of interaction between devices, while user and device interaction are achieved by standard input methods and graphical user interface.

Connectivity

The heart and soul of IoT is its connectivity. Connectivity means the establishment of a connection between different devices (or nodes) so that they can communicate on their own. In IoT, various devices, sensors, computers, and data busses need to interact and communicatewith each other. A fast, safe, and secure connection is a must for IoT to be of any business use. IoT also connects devices with cross-domain technology like cloud computing, artificial intelligence, and blockchain technology. We can connect them over radio waves, Wi-Fi, Bluetooth, or wires.

Dynamic Nature

The primary activity of 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, 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 alsochanges dynamically with a person, place and time.

Scaling

IoT systems are designed in such a way that the number of devices, sensors, or computers can be scaled up and down according to the need. An IoT system should be elastic enough so that it can handle workload during peak demand hours and can resort back to the normal state when the demand is low.

Sensing

IoT devices gather information about their surroundings (such as temperature, light, sound, acceleration, pressure) and then, after analysing the data, take a decision. Thus sensors help in automation by gathering information and taking actions that would otherwise, be done by humans. The raw data gathered, and the analysed data, serve as the basis of the functioning of IoT. For example, in an automatic door, sensors would collect data through sensors such as radar sensors and optical sensors. If it detects a person coming, it will open the door automatically. Some sensors used in IoT are- Humidity sensor, temperature sensor, Accelerometer, Gyroscope, Motion sensor, image sensor, level sensor, and Proximity sensor.

Analysing

We know IoT gathers raw information through sensors, but why does IoT need data? What does IoT do with all that raw data? Data as such has no value of its own. It is meaningless and useless until it is purposefully processed to gain some meaningful insights from it. IoT gathers raw data to extract something meaningful out of it. Analysing the raw data in terms of its structure, correlation, and usability is necessary because, if processed properly, it can be very useful. In the above-mentioned example of the automatic door for instance, after analysing the data through sensors, it should be able to differentiate between a person and an animal.

Artificial Intelligence

IoT becomes a lot more useful when combined with artificial intelligence. For instance, if you are out of groceries, your smart refrigerator can notify you to bring some on your way back home.Things like these have been made possible by the application of artificial intelligence. IoT devices collect raw data from their surroundings and convert them into something useful and insightful. The IoT devices and systems are also trained with various machine learning models so that they can better understand the changes in theirsurroundings and perform better.

Heterogeneity

Heterogeneity in Internet of Things as one of the key characteristics. Devices in IOT are based on different hardware platforms and networksand 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.

Security

IOT devices are naturally vulnerable to security threats. As we gain efficiencies, novel experiences, and other benefits from the IOT, it would be a mistake to forget about 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

Communication

IOT encourages the 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.

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.

Information

It is obvious that having more information helps making better decisions. Whether it is mundane decisions 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.

Monitor Data

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 orprinter ink could save you another trip to the store in the near future. Furthermore, monitoring the expiration of products can and will improve safety.

Better Time Management

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 usemore time.

Saving Money

The biggest advantage of IOT is saving money. If the price of the taggingand 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 to 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 into our required way, it makes our systems efficient.

Automation of daily tasks leads to better monitoring of devices

The IOT allows you to automate and control the tasks that are done ona 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.

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.

Money Efficient resource utilization

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.

Better Quality of Life

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

3.1.3 Disadvantages of IOT

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 these equipmentjust need to agree to a standard, such as Bluetooth, USB, etc. This is nothing new or innovative needed.

Complexity

As with all complex systems, there are more opportunities of failure. With the Internet of Things, failures could sky rocket. 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 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.

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 an transmitted with? Do you want your neighbors or employers to know what medications that you are taking or your financial situation?

Safety

Imagine if a notorious hacker changes your prescription. Or if a store automatically ships you an equivalent product that you are allergic to, or a flavour that you do not like, or a product that is already expired. Asa result, safety is ultimately in the hands of the consumer to verify any and all automation.

As all the household appliances, industrial machinery, public sectorservices like water supply and transport, and many other devices all areconnected 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.

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 the 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 of human resources, primarily, workers and less educated staff. This may create Unemployment issue in the society.

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

Smart homes

One of the best and the most practical applications of IoT, smart homesreally take both, convenience and home security, to the next level. Though there are different levels at which IoT is applied for smarthomes, the best is the one that blends intelligent utility systems and entertainment together. For instance, your electricity meter with an IoTdevice giving you insights into your everyday water usage, your set-top box that allows you to record shows from remote, Automatic Illumination Systems, Advanced Locking Systems, and Connected Surveillance Systems all fit into this concept of smart homes. As IoT evolves, we can be sure that most of the devices will become smarter, enabling enhanced home security.3.1.4.3 Health care.

Traffic Management

Car traffic management in large cities can be greatly improved with the help of the Internet of Things (IoT). The Internet of Things helps us stay informed and improves traffic monitoring by allowing us to use our mobile phones as sensors to collect and share data from our vehicles through apps like Waze or Google Maps. This feeds and improves the data on the various routes to the same destination, distance, and estimated arrival time.

Wearables

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

Agriculture

A greenhouse farming technique enhances the yield of crops by controlling environmental parameters. However, manual handlingresults in production loss, energy loss, and labour 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 it to the cloud. It, then, processes the data and applies a control action.

Industrial Automation

For a higher return of investment this field requires both fast developments and quality of products. This vitality thus coined theterm IIOT. This whole schematic is re-engineered by IOT applications. Following are the domains of IOT applications in industrial automation

Factory Digitalization

Product flow Monitoring Inventory Management Safety and SecurityQuality

Control

Packaging optimization

Logistics and Supply Chain Optimization Government

and Safety

IOT applied to government and safety allows improved law enforcement, defense, city planning, 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 cityplanners have a clearer view of the impact of their design, and governments have a better idea of the local economy.

Self-driven Cars

These cars use several sensors and embedded systems connected tothe Cloud and the internet to keep generating data and sending them to the Cloud for informed decision-making through Machine Learning. Though it will take a few more years for the technology to evolvecompletely and for countries to amend laws and policies, what we’re witnessing right now is one of the best applications of IoT.

3.1.5 IOT Technologies and Protocols

The Internet of Things is a convergence of embedded systems, wireless sensor networks, control systems and automation that makes connected industrial manufacturing factories, intelligent retail, next- generation healthcare, smart homes and cities and wearable devices possible.

IoT technology ecosystem -
The IoT technology ecosystem is composed of the following layers:devices, data, connectivity, and technology users.
Device layer
The combination of sensors, actuators, hardware, software, connectivity and gateways that constitute a device that connects and interacts with a network.
Data layer
The data that is collected, processed, sent, stored, analysed, presented and used in business contexts.
Business layer
The business functions of IoT technology, including the management of billing and data marketplaces.
User layer
The people who interact with IoT devices and technologies.

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

Bluetooth

Bluetooth is a short range IOT communication protocol/technology thatis 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.

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 networksin IOT applications. The latest version of ZigBee is the recently launched3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard.

Z-Wave

Z-Wave is a low-power RF communications IOT technology that primarily design 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 simplerdevelopment, but the only maker of chips is Sigma Designs compared to multiple sources for other wireless technologies such as ZigBee and others.

Wi-Fi

Wi-Fi connectivity is one of the most popular IOT communication protocol, often an obvious choice for many developers, especially giventhe availability of Wi-Fi within the home environment within LANs.There is a wide existing infrastructure as well as offering fast datatransfer 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 range of hundreds of megabits per second, whichis fine for file transfers but may be too power-consuming for many IOT applications.

Cellular

Any IOT application that requires operation over longer 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.

NFC

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

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

IOT software addresses its key areas of networking and action through platforms, embedded systems, partner systems, and middleware. These individual and master applications are responsible for data collection, device integration, real-time analytics, and application and process extension within the IOT network. They exploit integration withcritical business systems (e.g., ordering systems, robotics, scheduling, and more) in the execution of related tasks.

Data Collection

This software manages sensing, measurements, light data filtering, lightdata 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.

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.

Real-Time Analytics

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

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 NODE MCU esp8266

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things(IoT) projects of all kinds.

Figure: Node MCU esp8266 Development Board.

NodeMCU is an open-source firmware for which open-source prototyping board designs are available. The name “NodeMCU”combines “node” and “MCU” (micro-controller unit). The term“NodeMCU” strictly speaking refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open-source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially was based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a TensilicaXtensa LX106 core, widely used in IOT application.

3.2.1 Pin Configuration of NodeMCU Development Board

This module provides an access to the GPIO subsystem. All the access is based on I/O index number of Node MCU kits, not the internal GPIO pins. For example, the D0 pin on the development kit is mapped toGPIO pin 16. Node MCU provides access to the GPIO pins and thefollowing pin mapping table is a part of the API documentation.

PIN NAME ON NODEMCU DEVELOPMENTKIT	ESP8266INTERNAL GPIOPINNUMBER	PIN NAME ON NODEMCU DEVELOPMENTKIT	ESP8266INTERNAL GPIOPINNUMBER
0[*]	GPIO16	**7**	GPIO13
1	GPIO5	**8**	GPIO15
2	GPIO4	**9**	GPIO3
3	GPIO0	**10**	GPIO1
4	GPIO2	**11**	GPIO9
5	GPIO14	**12**	GPIO10
6	GPIO12		

Table 1.Node MCUindex↔GPIOmapping.

3.2.2 PARTS OF THE NODE MCU DEVELOPMENT BOARD

Power pins: There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be usedto supply power to external components.

GND: is a ground pin of ESP8266 Node MCU development board.

12 IC Pins: are used to hook up all sorts of I2C sensors and peripheralsin your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins: ESP8266 Node MCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge- trigger or level-trigger to generate CPU interrupts.

ADC Channel: The Node MCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

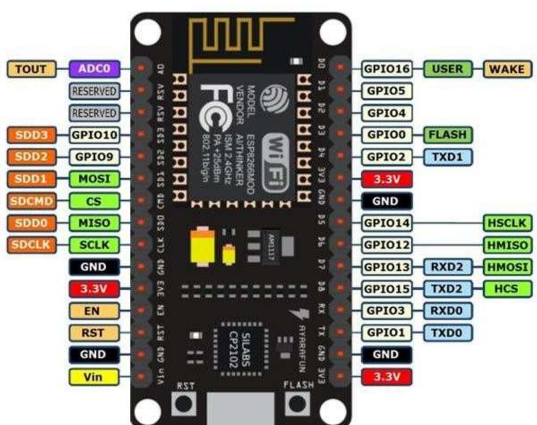


Figure: ESP8266 NodeMCU pinout.

UART Pins: ESP8266 Node MCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI Pins: ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:4 timing modes of the SPI format transfer,Up to 80 MHz and the divided clocks of 80 MHz, Up to 64-Byte FIFO.

SDIO Pins: ESP8266 features Secure Digital Input/output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

PWM Pins: The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 μs to 10000 μs, i.e., between 100 Hz and 1 kHz.

Control Pins: are used to control ESP8266. These pins include ChipEnable pin (EN), Reset pin (RST) and WAKE pin.

EN pin- The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW. the chip works at minimum power.

RST pin- RST pin is used to reset the ESP8266 chip.

WAKE pin- Wake pin is used to wake the chip from deep-sleep.

ESP 12-E Module

The development board equips the ESP-12E module containing ESP8266 chip having TensilicaXtensa® 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS.

There's also 128 KB RAM and 4MB of Flash memory (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IOT devices nowadays.

The ESP8266 Integrates 802.11b/g/n HT40 Wi-Fi transceiver, so it can not only connect to a Wi-Fi network and interact with the Internet, but it can also set up a network of its own, allowing other devices to connect directly to it. This makes the ESP8266 Node MCU even more versatile.

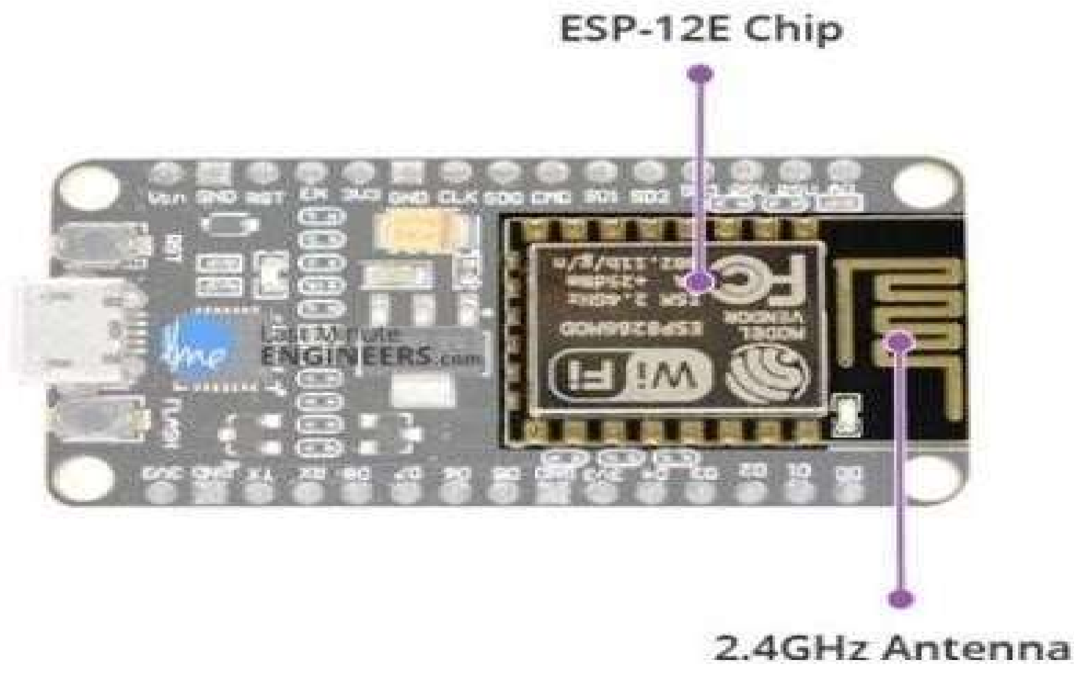


Figure: ESP12Emodule in NodeMCU Development board

Power Requirements

As the operating voltage range of ESP8266 is 3V to 3.6V, the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA, which should be more than enough when ESP8266 pulls as much as 80mA during RF transmissions. The output of the regulator is also broken out to one of the sides of the board and labelled as 3V3. This pin can be used to supply power to external components.

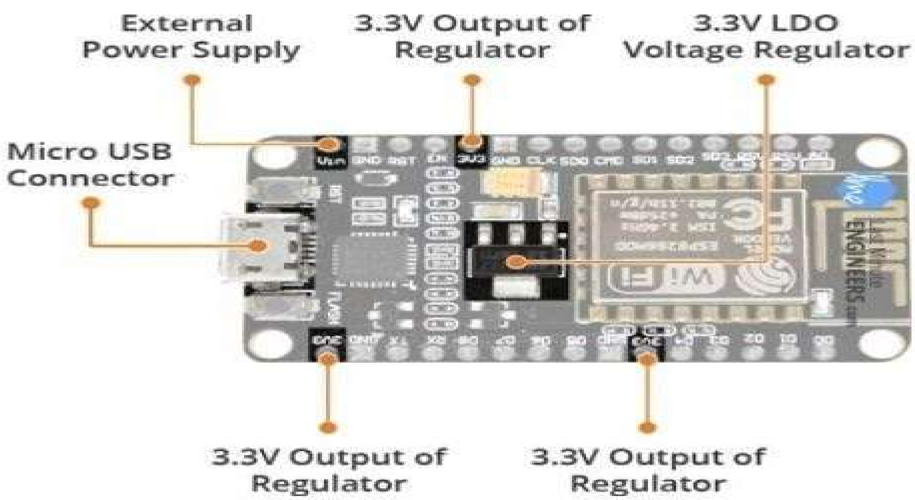


Figure: Power module on a NodeMCU development board.

Power to the ESP8266 Node MCU is supplied via the on-board Micro B USB connector. Alternatively, if you have a regulated 5V voltage source,the VIN pin can be used to directly supply the ESP8266 and its peripherals.

Peripheral I/O

The ESP8266 Node MCU has total 17 GPIO pins broken out to the pin headers on both sides of the development board. These pins can be assigned to all sorts of peripheral duties, including:

ADC channel – A 10-bit ADC channel.
UART interface – UART interface is used to load code serially. PWM

outputs – PWM pins for dimming LEDs or controlling motors.

SPI, I2C & I2S interface – SPI and I2C interface to hook up all sorts ofsensors and peripherals.

I2S interface – I2S interface if you want to add sound to your project.

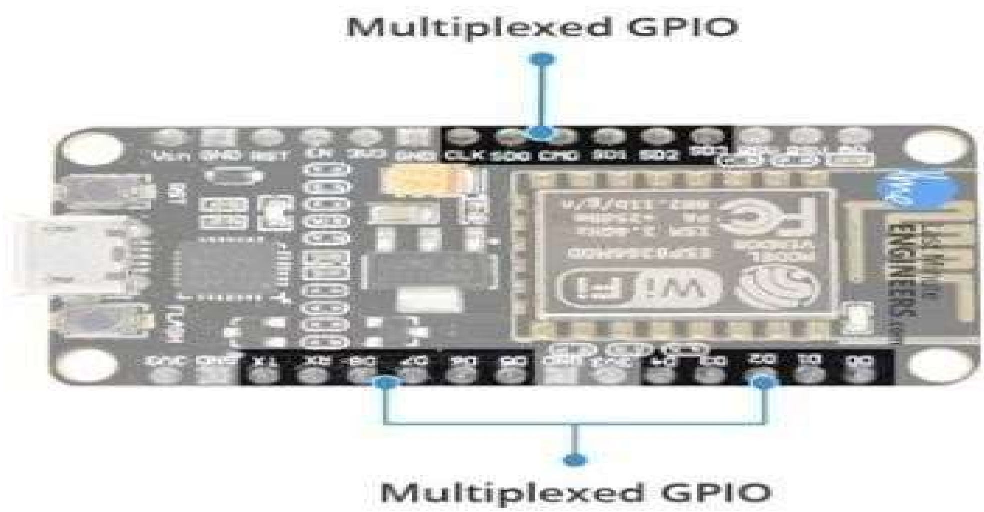


Figure: GPIO pins on NodeMCU development board.

As a result of the pin multiplexing feature (Multiple peripherals multiplexed on a single GPIO pin), a single GPIO pin can act as PWM/UART/SPI.

On Board Switches and LED Indicators

The ESP8266 Node MCU features two buttons. One marked as RST located on the top left corner is the Reset button, used of course to reset the ESP8266 chip. The other FLASH button on the bottom left corner is the download button used while upgrading firmware. The board also has a LED indicator which is user programmable and is connected to the D0 pin of the board.

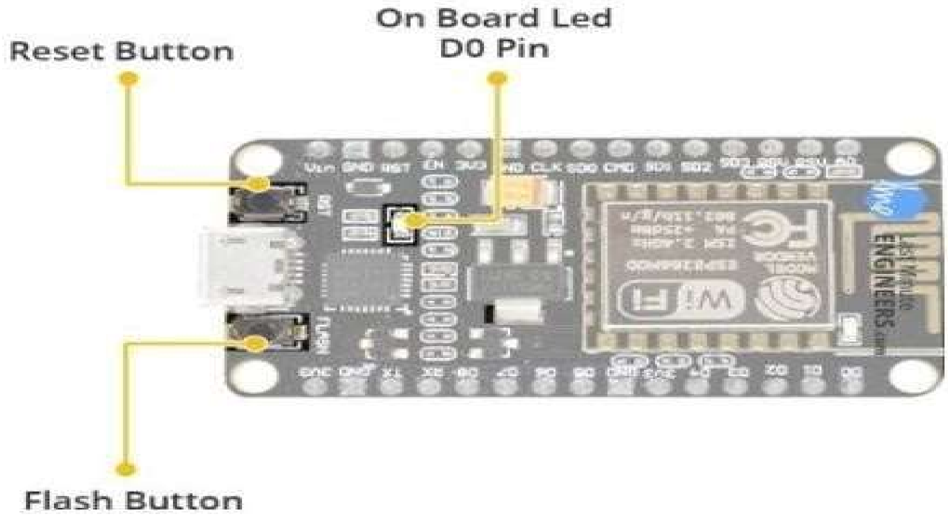


Figure: On board switches and LED indicators on NodeMCU development board.

Serial Communication

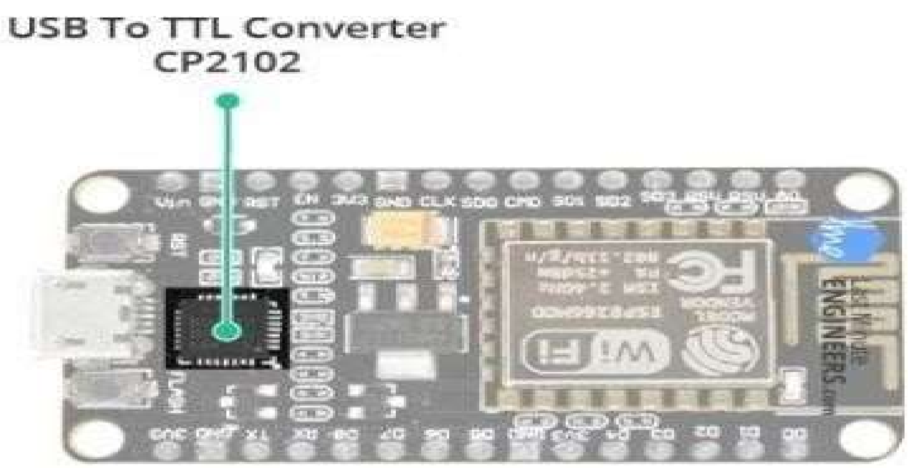


Figure: CP2120 on NodeMCU development board.

The board includes CP2102 USB-to-UART Bridge Controller from Silicon Labs, which converts USB signal to serial and allows your computer to program and communicate with the ESP8266 chip.

3.2.3 Installation of Node MCU

Mostly these days devices download and install drivers on their own, automatically. Windows doesn't know how to talk to the USB driver on the Node MCU so it can't figure out that the board is a Node MCU and proceed normally. Node MCU Amica is an ESP8266 Wi-Fi module-based development board. It has got Micro USB slot that can directly be connected to the computer or other USB host devices. Ti has got 15X2 header pins and a Micro USB slot, the headers can be mounted on a breadboard and Micro USB slot is to establish connection to USB host device. It has CP2120 USB to serial converter. In order to install CP2120 (USB to serial converter), user is needed to download the driver for the same. Once user downloads drivers as per its respective operating system, the system establishes connection to Node MCU. The user needs to node down the COM post allotted to newly connected USB device (Node MCU) from device manager of the system. This com port number will be required while using Node MCU Amica. As the CP2120 driver is been installed, the Node MCU can be programmed using Arduino IDE software by coding in embedded C. this requires ESP8266 board installation in Arduino IDE from board manager, and assigning communication program.

3.3 BLOCK DIAGRAM

The block diagram of the Smart Farming and Auto Pumping System provides a visual representation of the system's components and their interconnections. It illustrates the flow of data and signals within the system, showcasing the main functional blocks and their interactions. The block diagram helps in understanding the system architecture and the relationship between different components.

At the core of the block diagram is the NodeMcu ESP8266 microcontroller, which serves as the central processing unit. It receives inputs from the soil moisture sensor module and processes the data to determine the moisture level in the soil. The microcontroller also controls the water pumping mechanism based on the moisture readings.

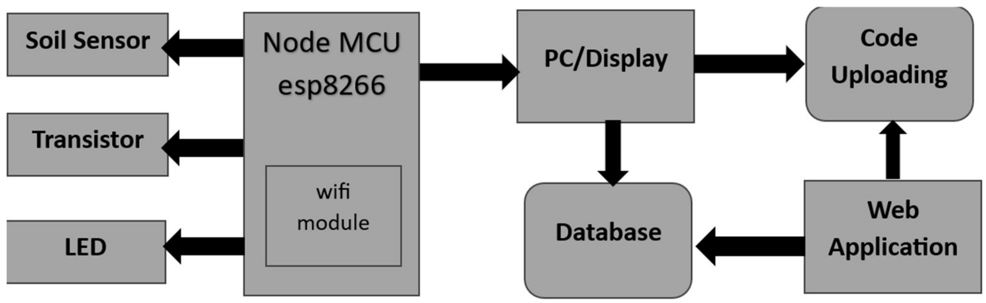


Figure: Block diagram of proposed system.

The soil moisture sensor module is connected to the microcontroller and measures the moisture content in the soil. It provides an output signal or voltage proportional to the moisture level, which is fed into the microcontroller for further processing.
The microcontroller interacts with a motor through a transistor for water pumping control. The motor is responsible for pumping water into the soil when the moisture levels are below the desired threshold. The transistor acts as a switch, regulated by the microcontroller, to control the current flowing to the motor.

The system also includes a database, which is not explicitly shown in the block diagram, but is an integral part of the system architecture. The microcontroller communicates with the database to store and retrieve data related to soil moisture readings and pump status. The database plays a crucial role in data management, analysis, and historical tracking of the system's operation.
Additionally, the block diagram may include external components such as power supplies and user interfaces. Power supplies provide the necessary voltage and current to the microcontroller, sensor module, and motor. User interfaces, such as websites or applications, allow users to interact with the system, monitor soil moisture levels, and control the water pumping mechanism.

3.4 CIRCUIT DIAGRAM

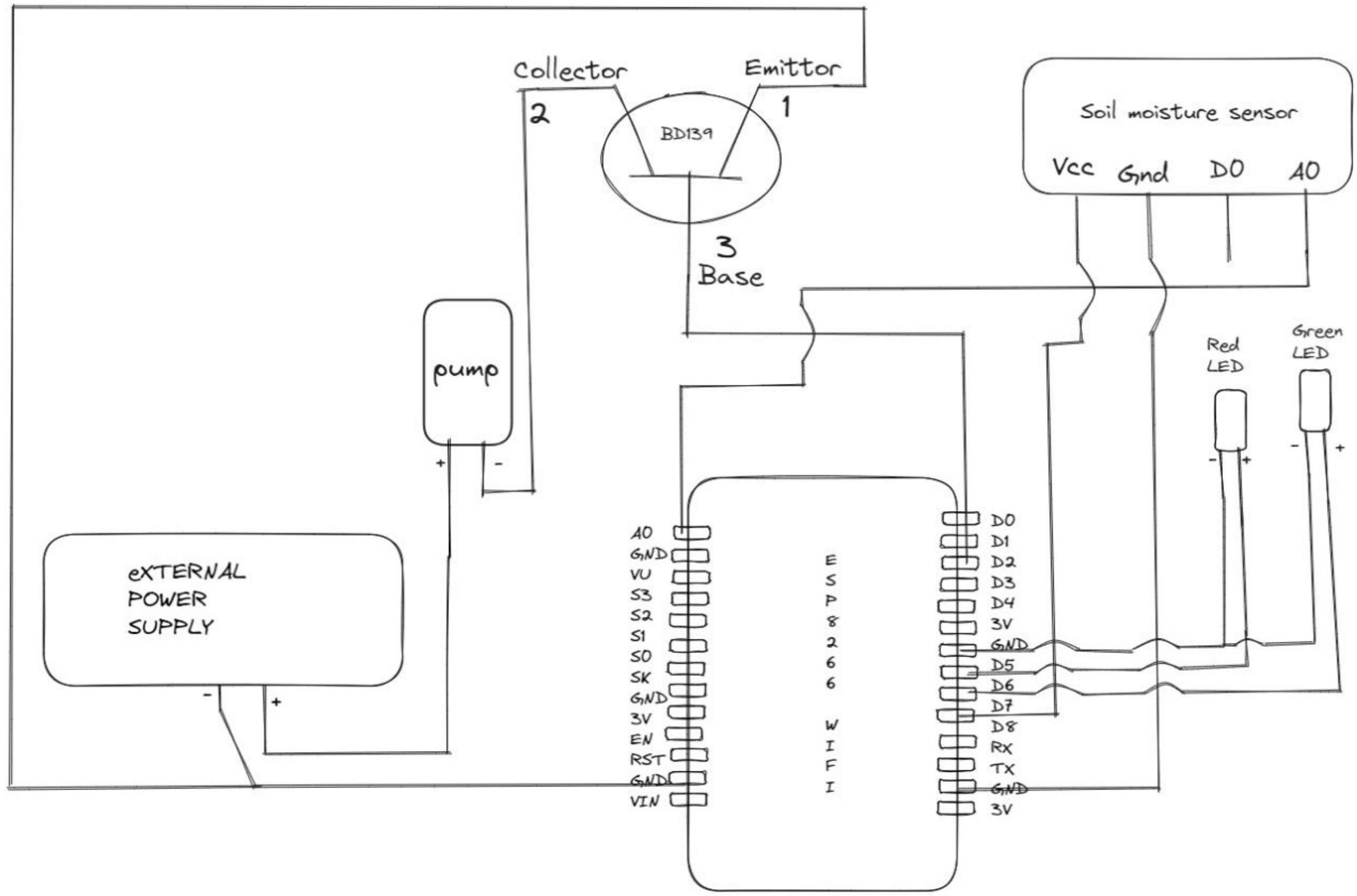


Figure: Connection diagram of Node MCU esp8266 with soil moisture sensor, transistor(BD 139), pump, power supply and led

CHAPTER 4
HARDWARE MODELLING AND SETUP

4.1.1 MAIN FEATURES OF THE PROTOTYPE

The Smart Farming and Auto Pumping System prototype incorporates several key features that contribute to its functionality and effectiveness. These features include:

Soil Moisture Sensing: The system utilizes a soil moisture sensor module to accurately measure the moisture content in the soil. This feature ensures that the irrigation process is triggered only when necessary, optimizing water usage and promoting efficient crop growth.

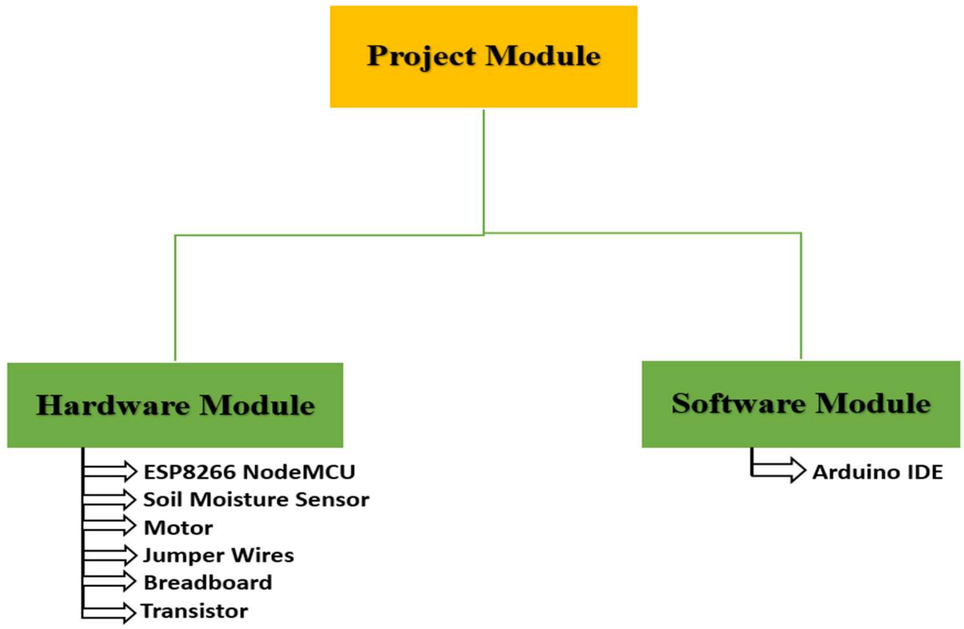
Automatic Water Pumping: When the soil moisture levels fall below a predetermined threshold, the system activates a motor to pump water into the soil. This automated process ensures that crops receive adequate irrigation without the need for manual intervention.

Microcontroller Control: The NodeMcu ESP8266 microcontroller acts as the central processing unit of the system. It collects data from the soil moisture sensor module, processes it, and controls the operation of the water pump. This feature enables seamless integration and coordination between the various components of the system.

Database Integration: The system incorporates a database to store the collected data, including soil moisture readings and pump status. This integration allows for data management, retrieval, and analysis, enabling users to monitor and analyze the farm's moisture conditions effectively.

User Interface: A user-friendly website interface is provided to access real-time soil moisture and pump status data. Users can monitor the farm's moisture levels remotely, visualize historical data trends, and control the pumping system through the interface. This feature enhances user interaction and provides convenient access to essential information.

4.2 PROJECT LAYOUT:



Node MCU is the microcontroller unit in the prototype. It has an in built Wi-Fi module (ESP8266) that establishes wireless remote switching of home appliances.

Soil Moisture Sensor is a device used to measure the moisture content in the soil. It provides valuable information about the water content present in the soil, which is essential for efficient irrigation and agriculture. The sensor typically consists of two probes that are inserted into the soil, and it measures the electrical conductivity or resistance between these probes. As moisture affects the conductivity or resistance of the soil, the sensor can provide an accurate indication of the soil's moisture level.

Motor in the Smart Farming and Auto Pumping System is responsible for pumping water into the soil. It is controlled by the microcontroller based on the moisture readings from the soil moisture sensor module. The motor activates when the moisture levels are below the desired threshold, ensuring optimal moisture levels for the crops.

A **jump wire** (also known as **jumper**, **jumper wire**, **DuPont wire**) isan electrical wire, or group of them in a cable, with a connector or pinat each end (or sometimes without them – simply "tinned"), which is normally used

to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

A **breadboard** is a widely used tool to design and test circuit. You donot need to solder wires and components to make a circuit while using a bread board. It is easier to mount components & reuse them. Since, components are not soldered you can change your circuit design at any point without any hassle. It consist of an array of conductive metal clipsencased in a box made of white ABS plastic, where each clip is insulatedwith another clips. There are a number of holes on the plastic box, arranged in a particular fashion. A typical bread board layout consists oftwo types of region also called strips. Bus strips and socket strips. Bus strips are usually used to provide power supply to the circuit. It consistsof two columns, one for power voltage and other for ground.

4.3 COMPONENTS REQIRED

SL. NO.	Component	Quantity
1.	ESP8266 Node MCU	1
2.	Soil Moisture Sensor Module	1
3.	12V Motor	1
4.	Transistor	1
5.	Male To Male Jumper Cables	-
6.	Breadboard	1
7.	USB Cables	1

4.4 SETTING UP THE SYSTEM

Setting up the Smart Farming and Auto Pumping System involves the following steps:

4.4.1 Gather all the required components, including the soil moisture sensor module, NodeMcu ESP8266 microcontroller, motor, transistor, power supply, wiring, and connectors.

4.4.2 Position the soil moisture sensor module in the soil at the desired location, ensuring proper contact with the soil.

4.4.3 Connect the soil moisture sensor module to the appropriate pins on the NodeMcu ESP8266 microcontroller as per the hardware specifications and pin configuration.

4.4.4 Connect the motor to the microcontroller using the suitable output pins. Connect the transistor between the microcontroller and the motor to regulate the current flow.

4.4.5 Establish proper power supply connections for the microcontroller, sensor module, and motor.

4.4.6 Verify the wiring connections and ensure they are secure and properly insulated.

4.5 Uploading code to Node MCU

4.6 To upload code to the NodeMcu ESP8266 microcontroller, follow these steps:

- Set up the development environment, such as the Arduino IDE, and ensure the necessary libraries and dependencies are installed.

- Open the code file for the Smart Farming and Auto Pumping System in the development environment.

- Connect the NodeMcu ESP8266 microcontroller to the computer using a suitable USB cable.

- Select the appropriate board and port settings in the development environment.

- Click the "Upload" button in the development environment to compile and upload the code to the microcontroller.

- Monitor the upload process and ensure it completes successfully without any errors.

Once the code is successfully uploaded, the microcontroller is ready to operate the Smart Farming and Auto Pumping System based on the defined logic and functionalities.

By following these steps, the system can be set up and the code can be uploaded to the microcontroller, allowing for the proper functioning and automation of the irrigation process.

4.7 HARDWARE ASSEMBLY:

The hardware assembly of the Smart Farming and Auto Pumping System involves connecting the various components together to create a functional system. This section provides an overview of the hardware setup and the steps involved in assembling the system.

1. Gather the Required Components:
   - NodeMcu ESP8266 microcontroller
   - Soil moisture sensor module
   - Breadboard
   - Motor
   - Transistor (e.g., Bd 139)
   - Jumper wire

2. Connect the Soil Moisture Sensor Module:
Identify the appropriate pins on the NodeMcu ESP8266 for connecting the soil moisture sensor module.
Make the necessary connections between the sensor module and the microcontroller based on the hardware specifications and pin configuration.
Ensure secure and reliable connections to avoid any loose wiring.

3. Connect the Motor and Transistor:
Identify the output pins on the microcontroller that will control the motor.
Connect the motor to the microcontroller using suitable output pins.
Connect a transistor, such as a Bd 139, between the microcontroller and the motor to regulate the current flow.
Ensure proper wiring and connections to enable the microcontroller to control the motor effectively.

4. Establish Power Supply Connections:
Connect the power supply to the microcontroller, sensor module, and motor.
Verify that the power supply is suitable for the components used and provides the required voltage and current.
Ensure proper polarity and secure connections to avoid any short circuits or power-related issues.

5. Position the Components:
Place the soil moisture sensor module in the soil at a suitable location, ensuring that the probes are inserted properly.
Position the motor in a convenient location for water pumping, considering factors such as accessibility and optimal water distribution.

6. Secure the Connections:
Double-check all the wiring connections to ensure they are secure and free from loose connections or exposed wires.
Use appropriate tools or connectors to secure the connections and prevent any accidental disconnections.

7. Test the System:
Power on the system and test the functionality by monitoring the soil moisture readings and motor control. Verify that the soil moisture sensor module accurately measures the moisture levels and provides the expected output.
Ensure that the microcontroller can effectively control the motor based on the moisture readings and activate/deactivate it as needed.

By following these steps, the hardware assembly of the Smart Farming and Auto Pumping System can be completed. It is essential to pay attention to the wiring connections, secure them properly, and conduct thorough testing to ensure the system's reliable operation.

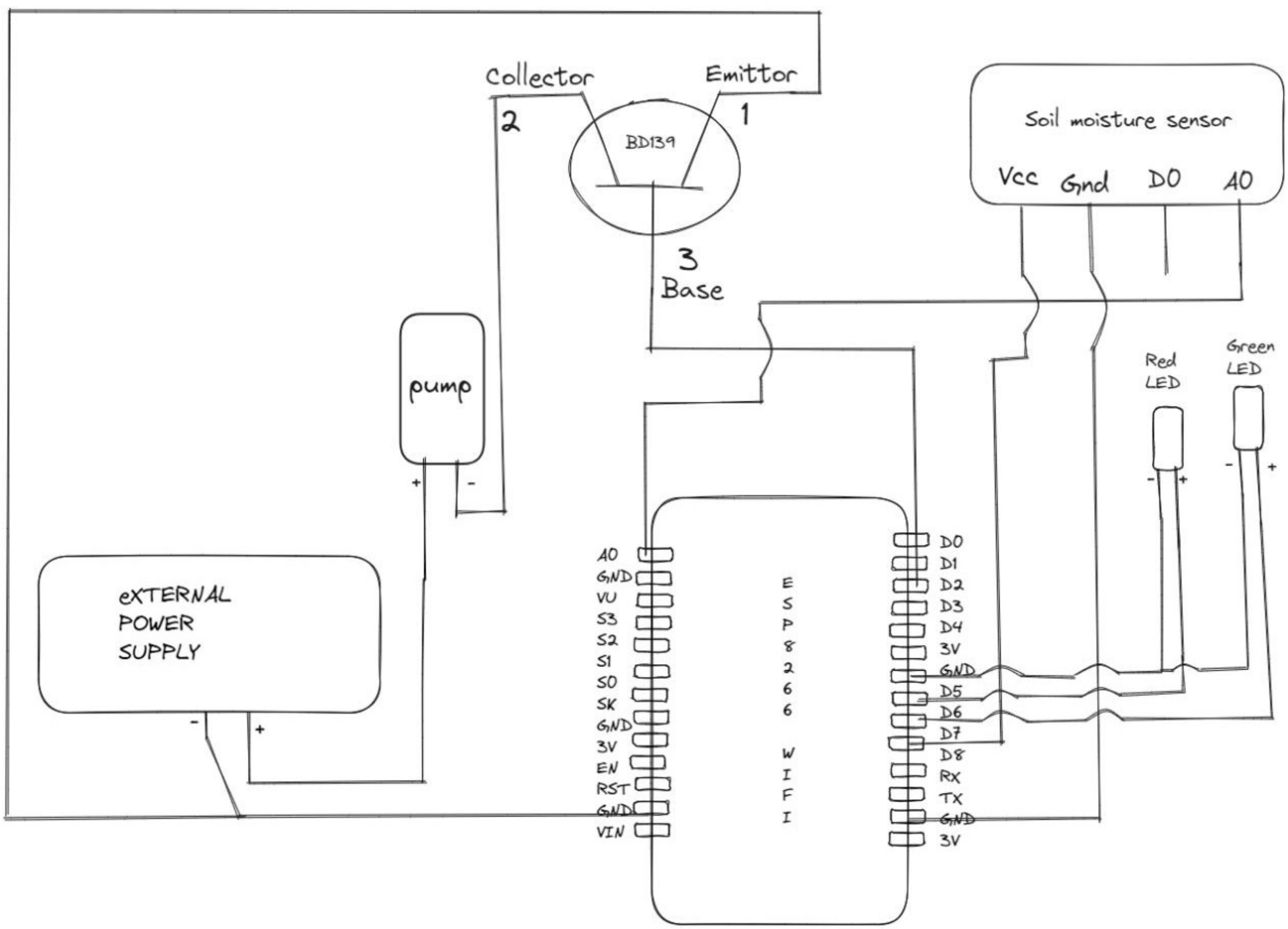


FIG: CIRCUIT DIAGRAM OF THE PROPOSED PROTOTYPE

CHAPTER 5
LOGIC AND OPERATION

5.1 FLOW CHART

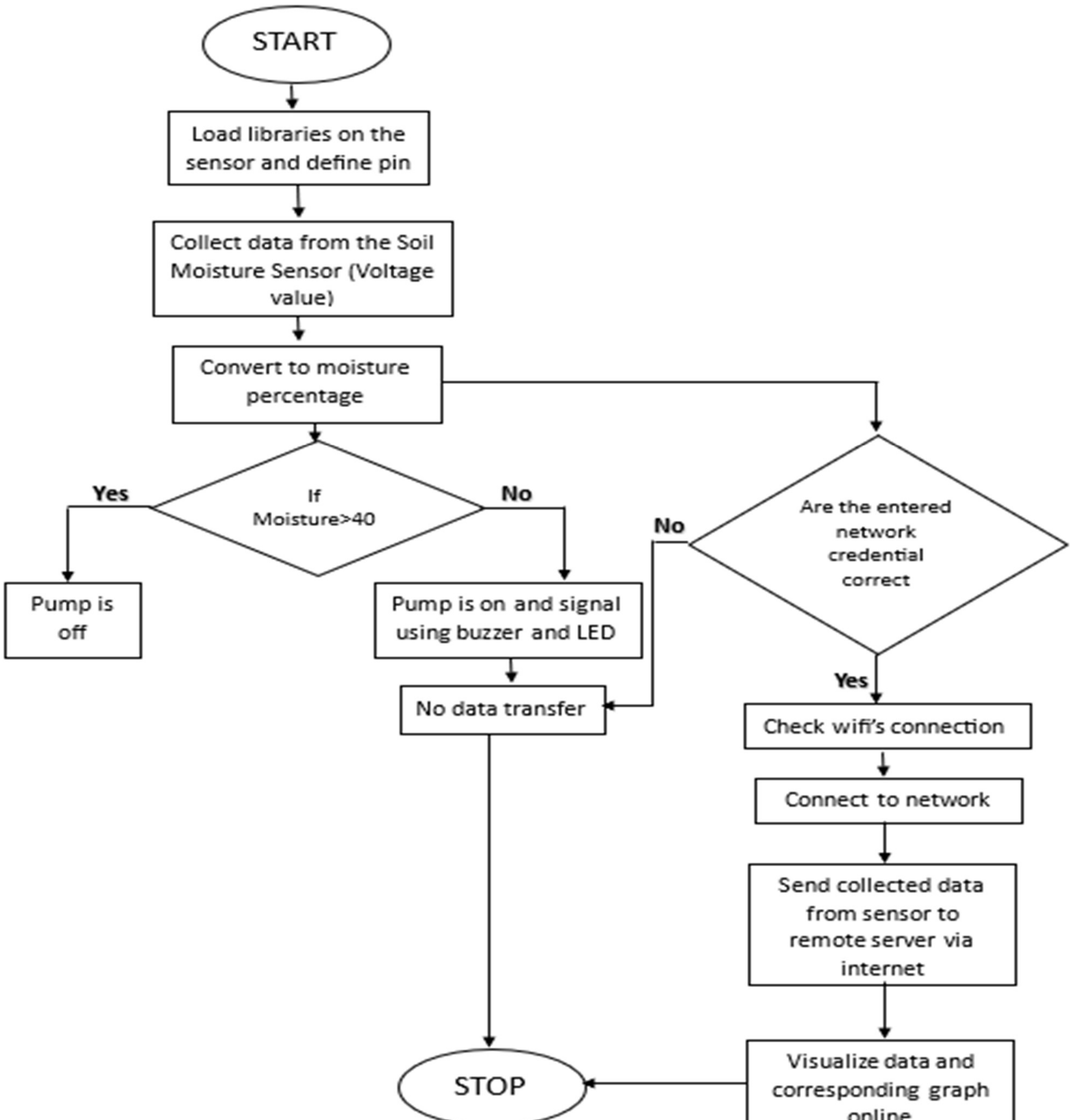


FIGURE: FLOWCHART

5.2 PRINCIPLE AND OPERATION

The Smart Farming and Auto Pumping System operates based on the principle of automated soil moisture sensing and water pumping to maintain optimal moisture levels for crop growth. The system combines hardware components and software logic to create an efficient and automated irrigation solution. The principle of operation begins with the soil moisture sensor module. This module utilizes the principle of electrical conductivity to measure the moisture content in the soil. It consists of two exposed conductors that act as variable resistors. When the soil is moist, it conducts electricity better, resulting in lower resistance between the probes. Conversely, dry soil exhibits higher resistance. By passing a small electric current through the soil via the probes, the module measures the resistance and converts it into a corresponding moisture level reading.

The moisture level readings are then transmitted to the NodeMcu ESP8266 microcontroller, which acts as the brain of the system. The microcontroller receives the data from the soil moisture sensor module and processes it to determine the moisture level in the soil. It compares the moisture readings with a predefined threshold value. If the moisture level is below the threshold, indicating insufficient moisture, the microcontroller activates the water pumping mechanism. The water pumping mechanism consists of a motor and a transistor for control. When the microcontroller determines that the moisture level is below the desired threshold, it activates the motor by controlling the transistor. The motor pumps water from a water source, such as a tank or reservoir, and delivers it to the soil through a network of pipes or hoses. This ensures that the soil receives adequate moisture to support healthy crop growth.

To provide feedback and data storage, the microcontroller communicates with a database. The database stores information such as moisture level readings, pump activation status, and timestamps. This data can be accessed and analyzed later for monitoring, historical analysis, and decision-making purposes.

5.2.1 Advantages of Node MCU

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

5.2.2 Disadvantages of Node MCU

- The operation of the circuit depends on the working internet connection. If the working internet connection is not available then it will not run.
- Node MCU also depends on the free server provided by the third party, if the free server is not working then it will not run.
- Node MCU has less resources of official documentation
- Need to learn a new language and IDE
- Reduced pinout
- Scarce documentation

5.2.3 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 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

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 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.

Wi-Fi is very much secure means of communication than Bluetooth.

Wi-Fi connection to send video, audio, and telemetry operation, while accepting remote control commands from an operator who can belocated virtually anywhere in the world.

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	Picomet	Star	BSS
Extension of basic cell	Scattemet	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	CBC-MAC (CCM)	CBC-MAC (extention of CCM)	WPA2 (802.11i)
Data protection	16-bit CRC	32-bit CRC	16-bit CRC	32-bit CRC

TABLE: Comparison chart of Wi-Fi with other wireless communication protocol.

5.3 COST ESTIMATION

SL. NO	COMPONENTS	QUANTITY	PRICE
1	ESP8266 Node MCU	1	270/-
2	Soil Moisture Sensor	1	130/-
3	Transistor (BD 139)	1	10/-
4	12V Motor	1	30/-
5	Male to male Jumper Cables	10	40/-
6	Breadboard	1	60/-
7	USB Cables	1	50/-
8	LED	2	10/-
	Total		600/-

CHAPTER 6
CONCLUSION
AND
FUTURE SCOPE

6.1 RESULT

The Smart Farming and Auto Pumping System has yielded positive results in automating the monitoring and irrigation processes in agriculture. The system effectively measures soil moisture levels, activates the water pump when necessary, and maintains optimal moisture conditions for crop growth. Through extensive testing and evaluation, it has demonstrated efficiency in water management, accurate soil moisture readings, and reliable pump activation. Real-time monitoring and historical data analysis have provided valuable insights for farmers to make informed decisions about irrigation schedules and optimize water usage. The system has shown potential in conserving water resources, improving crop performance, and reducing manual labor.

6.2 LIMITATIONS

Despite its successes, the Smart Farming and Auto Pumping System does have some limitations. One limitation is its reliance on internet connectivity for real-time monitoring and remote access. In areas with limited or unreliable internet access, the system's functionality may be compromised. Additionally, the system requires a stable supply of electricity to run the motor for water pumping. In the absence of electricity, the system cannot operate effectively. The initial cost of implementing the system may also be a barrier for small-scale farmers with limited financial resources. Technical expertise is required for initial setup and maintenance, which may pose challenges for farmers with limited technological knowledge.

6.3 FURTHER ENHANCEMENT AND FUTURE SCOPE

The Smart Farming and Auto Pumping System has significant potential for further enhancement and future scope. One area of improvement is the integration of weather data to optimize irrigation scheduling based on rainfall forecasts and evapotranspiration rates. Implementing crop-specific recommendations by considering soil nutrient levels, plant growth stages, and specific crop water requirements can further enhance the system's efficiency. Expanding the sensor network to cover larger farming areas or multiple fields would allow for comprehensive monitoring and control. Additionally, incorporating pest and disease detection mechanisms using sensors or image recognition technology would enable early intervention and improved crop protection. Continued research and development efforts can address the system's limitations, such as cost and technical expertise, to make it more accessible and user-friendly for farmers of all scales.

6.4 CONCLUSION

In conclusion, the Smart Farming and Auto Pumping System has demonstrated its potential to revolutionize agriculture by automating the monitoring and irrigation processes. The system has shown positive results in water management, soil moisture sensing, and pump activation. It offers benefits such as water conservation, improved crop performance, and labor savings. While limitations exist in terms of internet connectivity, cost, and technical expertise, these challenges can be addressed through further research and development. The system's future scope includes integrating weather data, providing crop-specific recommendations, expanding the sensor network, and incorporating pest and disease detection mechanisms. With continued advancements and wider adoption, the Smart Farming and Auto Pumping System has the potential to contribute to sustainable and efficient agricultural practices.

CHAPTER 7
REFERENCES

- https://azure.microsoft.com/en-in/overview/internet-of-things-iot/iot-technology-protocols/
- https://components101.com/development-boards/nodemcu-esp8266-pinout-features-and-datasheet
- https://randomnerdtutorials.com/esp8266-pinout-reference-gpios/
- https://create.arduino.cc/projecthub/PatelDarshil/how-to-communicate-with-esp8266-via-arduino-uno-f6e92f
- https://create.arduino.cc/projecthub/electropeak/getting-started-w-nodemcu-esp8266-on-arduino-ide-28184f

APPENDIX A
HARDWARE DESCRIPTION

NODE MCU ESP8266

NodeMCU is an open source platform based on ESP8266 which canconnect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, and etc, it can solve manyof the project's needs alone.

The general features of this board are as follows:

- *Easy to use*
- *Programmability with Arduino IDE or IUA languages*
- *Available as an access point or station*
- *practicable in Event-driven API applications*
- *Having an internal antenna*
- *Containing 13 GPIO pins, 10 PWM channels, I2C, SPI, ADC, UART,and 1-Wire*

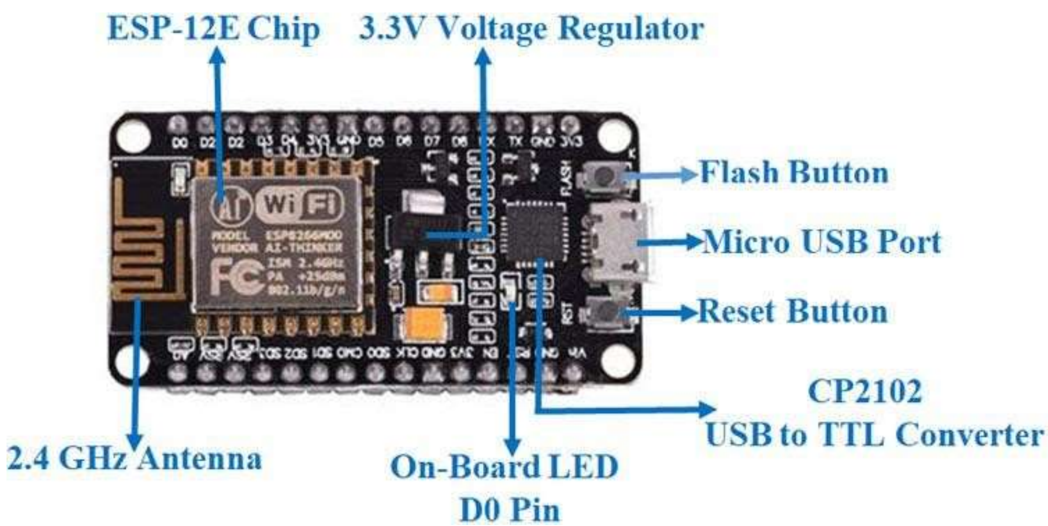


Fig: NODEMCU ESP8266

SOIL SENSOR

The soil sensor module is an essential component of the Smart Farming and Auto Pumping System. It is designed to measure the moisture content in the soil, providing crucial data for irrigation control. The module operates on the principle of electrical conductivity, utilizing two exposed conductors to determine the resistance between them. By passing a small electric current through the soil, the module measures the resistance and converts it into a moisture level reading. This information is then transmitted to the microcontroller, allowing it to make informed decisions about when to activate the water pumping *mechanism. The soil sensor module plays a vital role in maintaining optimal soil moisture levels, ensuring efficient water usage and promoting healthy crop growth.*

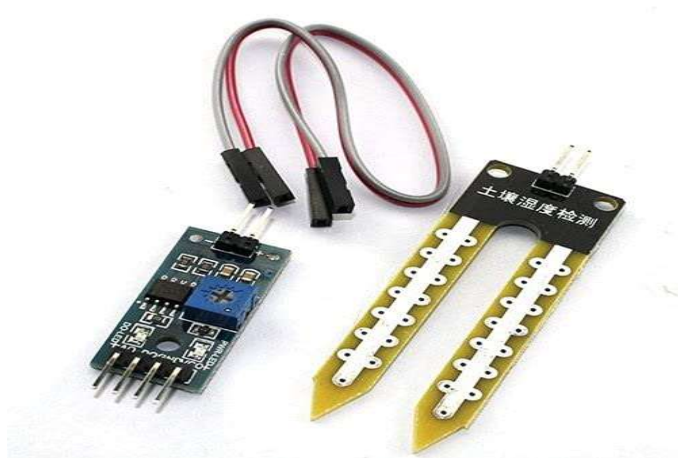


Fig: SOIL SENSOR MODULE

TRANSISTOR(BD 139)

The BD139 transistor is a popular NPN bipolar junction transistor (BJT) widely used in electronic circuits. It is designed for general-purpose amplification and switching applications. The BD139 transistor has a maximum collector current of 1.5A, making it suitable for controlling medium to high power loads. It has a low collector-emitter saturation voltage and high current gain, enabling efficient signal amplification and reliable switching operations. The transistor is housed in a TO-126 package, which provides convenient mounting and heat dissipation capabilities. With its versatile characteristics, the BD139 transistor is commonly used in audio amplifiers, motor control circuits, power supplies, and other applications requiring amplification or switching of moderate power levels.

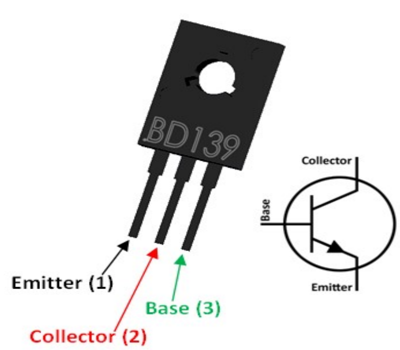


Fig: BD 139 Transistor

JUMPER WIRE:MALE TO MALE

Jumper wires are simply wires that have connector pins at each end,allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often. When connecting two ports on a breadboard, a male-to-male wire is what you'll need.

Fig: MALE TO MALE JUMPER WIRE

BREADBOARD

*An electronics breadboard (as opposed to the type on which sandwiches are made) is actually referring to a **solderless breadboard**. These are great units for making temporary circuits and prototyping, and they require absolutely no soldering.*

***Prototyping** is the process of testing out an idea by creating a preliminary modelfrom which other forms are developed or copied, and it is one of the most common uses for breadboards. If you aren't sure how a circuit will react under a given set of parameters, it's best to build a prototype and test it out.*

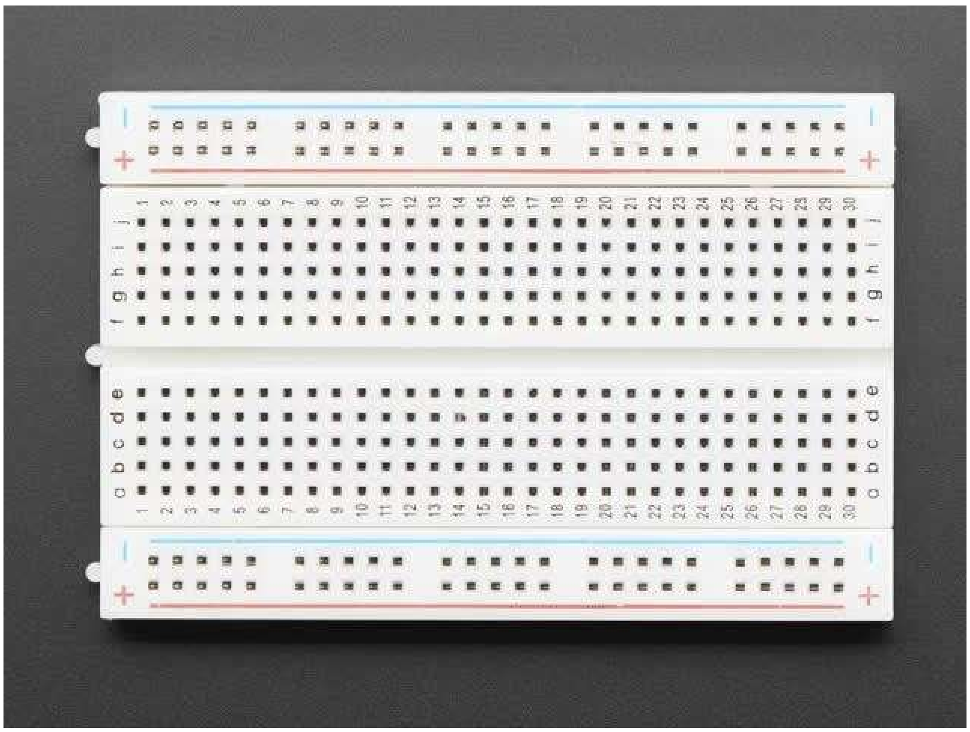


Fig: BREADBOARD

LED

In the simplest terms, a light-emitting diode (LED) is a semiconductordevice that emits light when an electric current is passed through it. Light isproduced when the particles that carry the current (known as electrons and holes) combine together within the semiconductor material.

Since light is generated within the solid semiconductor material, LEDs are described as solid-state devices. The term solid-state lighting, which also encompasses organic LEDs (OLEDs), distinguishes this lighting technologyfrom other sources that use heated filaments (incandescent and tungsten halogen lamps) or gas discharge (fluorescent lamps).

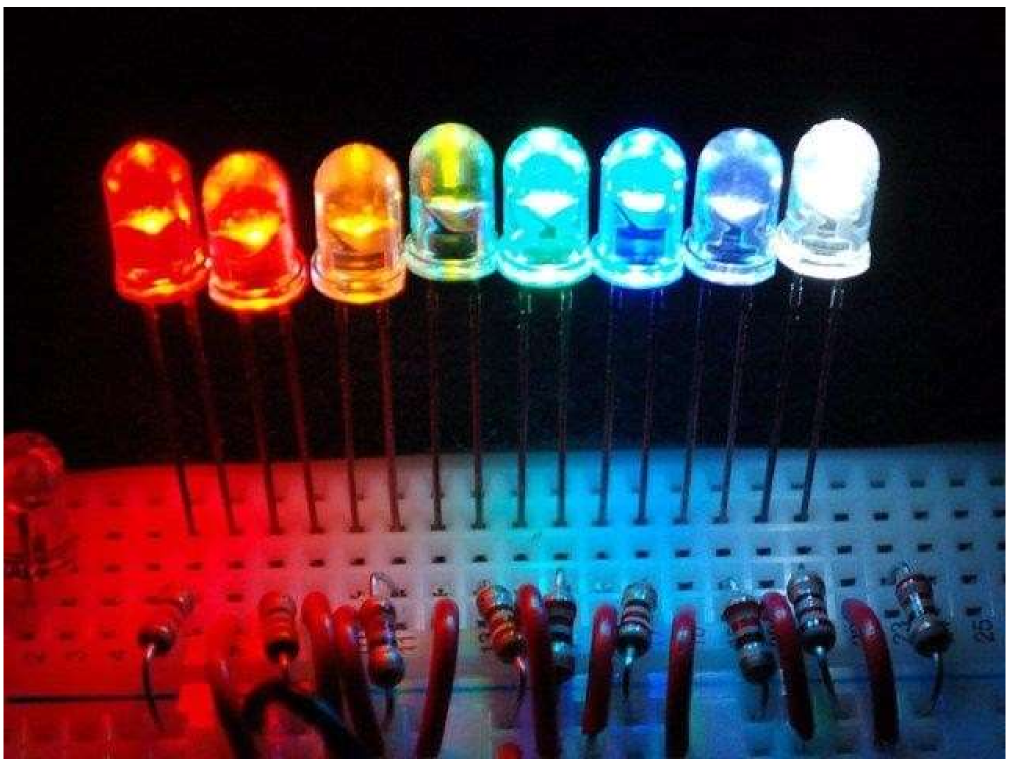


Fig: LED

12 VOLT MOTOR

A 12-volt motor is an electric motor that operates on a 12-volt direct current (DC) power supply. It is specifically designed to work with a 12-volt electrical system, commonly found in automotive, marine, and recreational vehicles, as well as in various industrial and household applications. The motor typically consists of a rotor, stator, and brushes, which convert electrical energy into mechanical motion. The 12-volt motor is known for its versatility and compact size, making it suitable for a wide range of applications, including automotive engine cooling fans, windshield wiper systems, power windows, door locks, robotic systems, and small appliances. Its lower voltage requirement and compatibility with standard 12-volt power sources make it a convenient choice for many electrical systems where portability, efficiency, and moderate power output are desired.

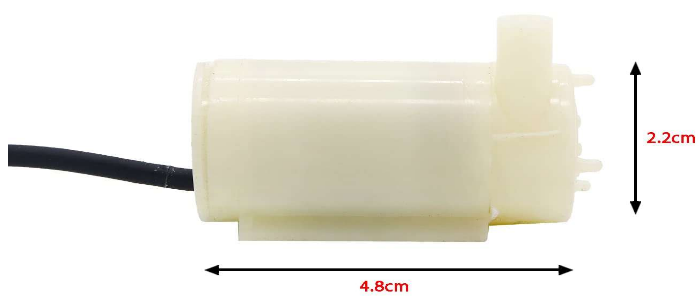


Fig: 12VOLT MOTO

APPENDIX B
DATASHEETS

Handson Technology

User Manual V1.2

ESP8266 NodeMCU WiFi Devkit

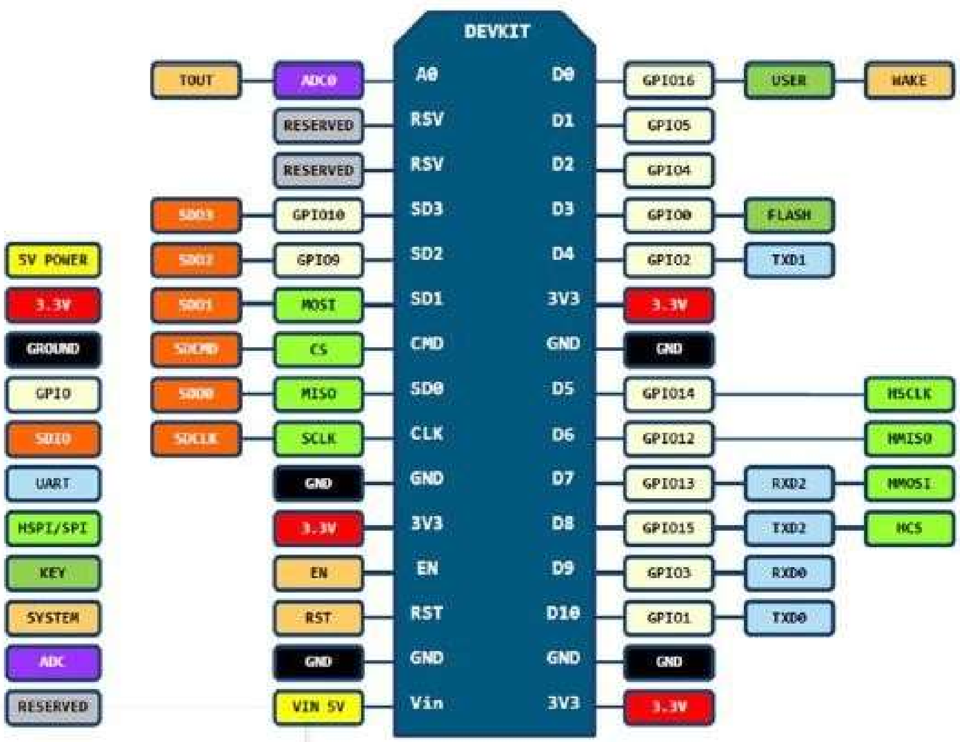
The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications.

This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

Table of Contents

1. Specification:
   - Voltage:3.3V.
   - Wi-Fi Direct (P2P), soft-AP.
   - Current consumption: 10uA~170mA.
   - Flash memory attachable: 16MB max (512K normal).
   - Integrated TCP/IP protocol stack.
   - Processor: Tensilica L106 32-bit.
   - Processor speed: 80~160MHz.
   - RAM: 32K + 80K.
   - GPIOs: 17 (multiplexed with other functions).
   - Analog to Digital: 1 input with 1024 step resolution.
   - +19.5dBm output power in 802.11b mode
   - 802.11 support: b/g/n.
   - Maximum concurrent TCP connections: 5.

2. Pin Definition:



D0(GPIO16) can only be used as gpio read/write, no interrupt supported, no pwm/i2c/ow supported.

3. Using Arduino IDE

3 www.handsontec.com

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a WiFi/Serial transceiver. However, this is not convenient. What we recommend is using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE. Following the below step to install ESP8266 library to work in Arduino IDE environment.

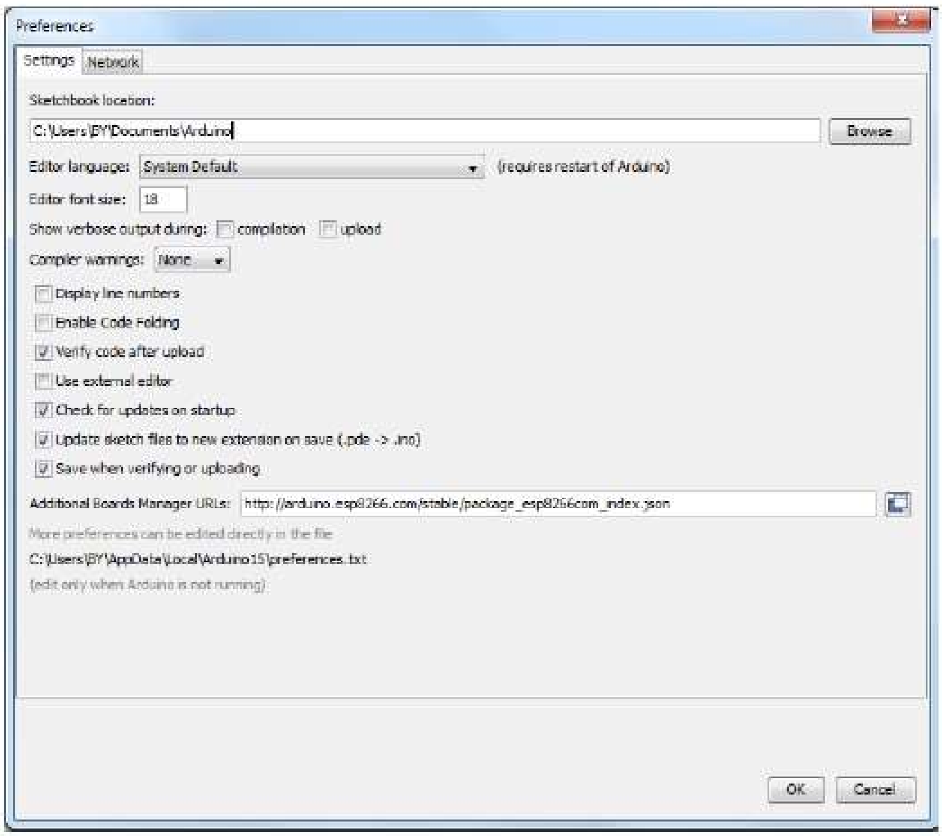
3.1 Install the Arduino IDE 1.6.4 or greater

Download Arduino IDE from Arduino.cc (1.6.4 or greater) - don't use 1.6.2 or lower version! You can use your existing IDE if you have already installed it.

You can also try downloading the ready-to-go package from the ESP8266-Arduino project, if the proxy is giving you problems.

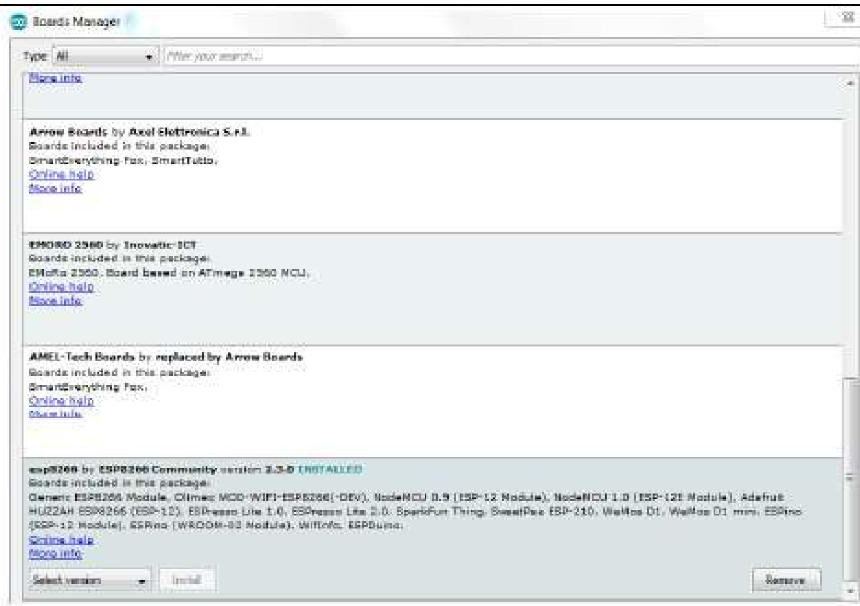
3.2 Install the ESP8266 Board Package

Enter ***http://arduino.esp8266.com/stable/package_esp8266com_index.json*** into *Additional Board Manager URLs* field in the Arduino v1.6.4+ preferences.



Click 'File' -> 'Preferences' to access this panel.

Next, use the Board manager to install the ESP8266 package.

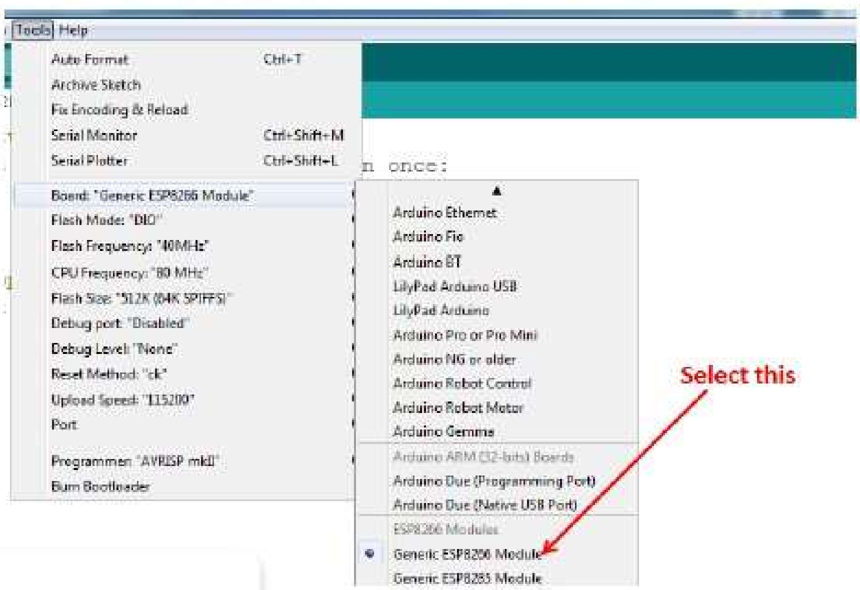


Click 'Tools' -> 'Board:' -> 'Board Manager…' to access this panel.

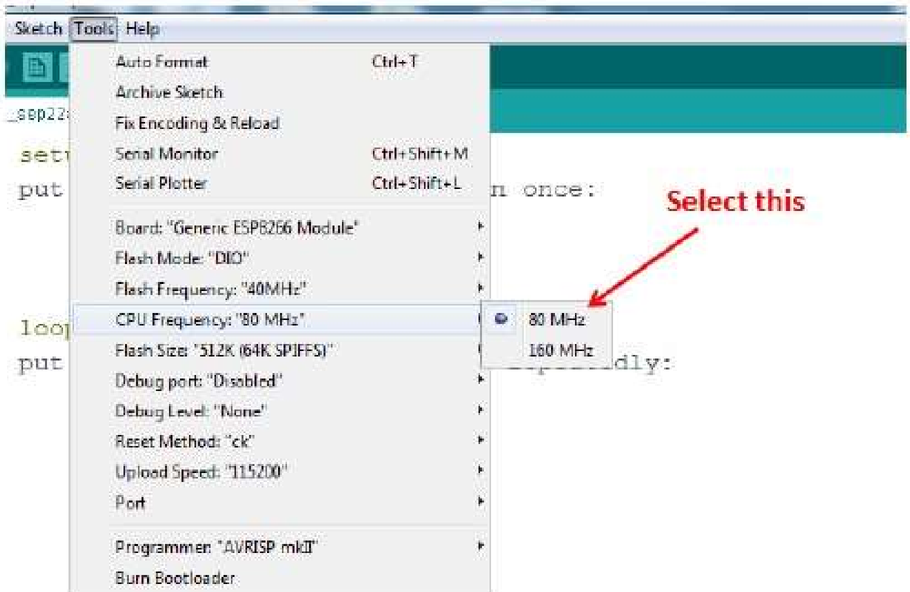
Scroll down to ' esp8266 by ESP8266 Community ' and click "Install" button to install the ESP8266 library package. Once installation completed, close and re-open Arduino IDE for ESP8266 library to take effect.

3.3 Setup ESP8266 Support

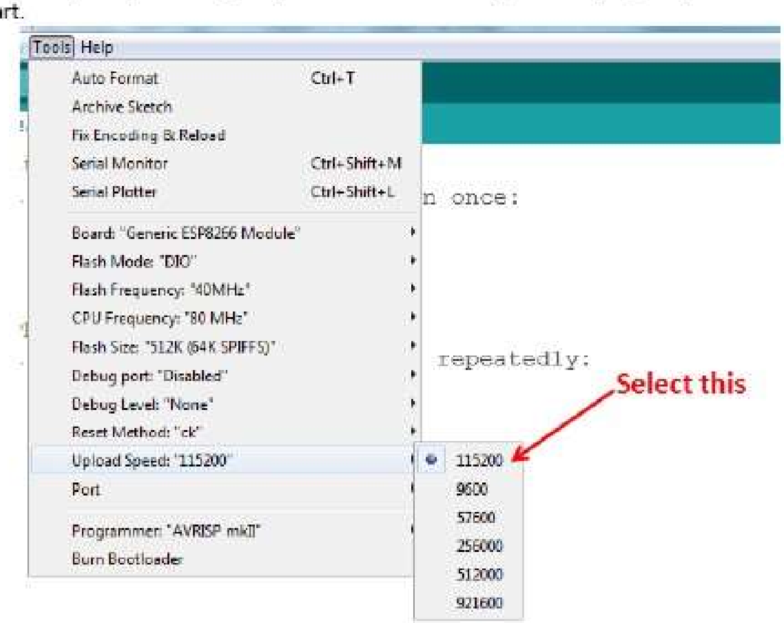
When you've restarted Arduino IDE, select 'Generic ESP8266 Module' from the 'Tools' -> 'Board:' dropdown menu.



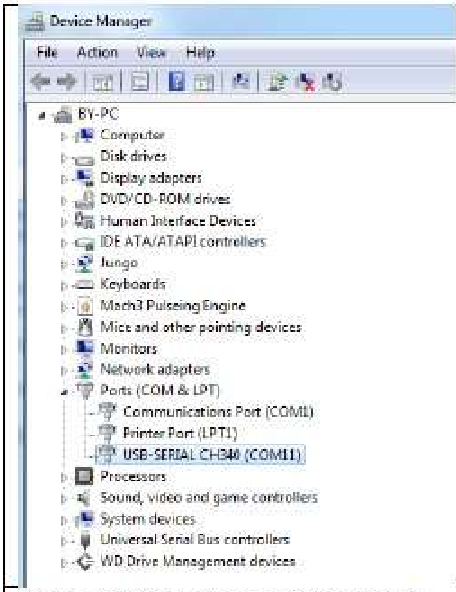
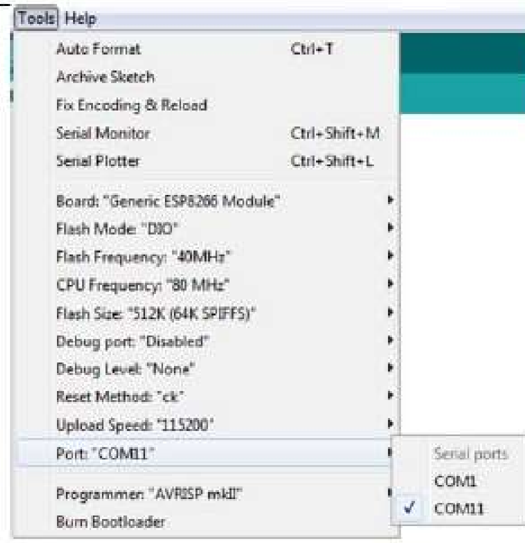
Select 80 MHz as the CPU frequency (you can try 160 MHz overclock later)



Select '115200' baud upload speed is a good place to start - later on you can try higher speeds but 115200 is a good safe place to start.



Go to your Windows 'Device Manager' to find out which Com Port 'USB-Serial CH340' is assigned to. Select the matching COM/serial port for your CH340 USB-Serial interface.

	
Find out which Com Port is assign for CH340	Select the correct Com Port as indicated on 'Device Manager"

Note: if this is your first time using CH340 " USB-to-Serial " interface, please install the driver first before proceed the above Com Port setting. The CH340 driver can be download from the below site:

https://github.com/nodemcu/nodemcu-devkit/tree/master/Drivers

3.4 Blink Test

We'll begin with the simple blink test.

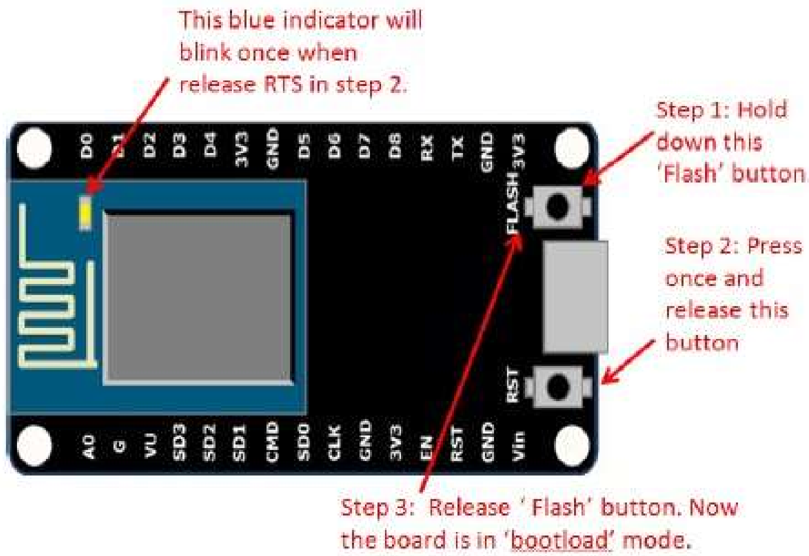
Enter this into the sketch window (and save since you'll have to). Connect a LED as shown in Figure3-1.

```
void setup() {
  pinMode(5, OUTPUT);    // GPIO05, Digital Pin D1
}

void loop() {
  digitalWrite(5, HIGH);
  delay(900);
  digitalWrite(5, LOW);
  delay(500);
}
```

Now you'll need to put the board into bootload mode. You'll have to do this before each upload. There is no timeout for bootload mode, so you don't have to rush!

- Hold down the 'Flash' button.
- While holding down ' Flash', press the 'RST' button.
- Release 'RST', then release 'Flash'

- When you release the 'RST' button, the blue indication will blink once, this means its ready to bootload.



Once the ESP board is in bootload mode, upload the sketch via the IDE, Figure 3-2.

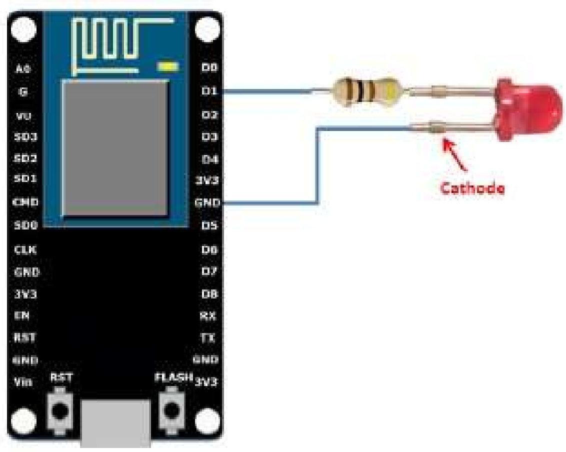


Figure3-1: Connection diagram for the blinking test

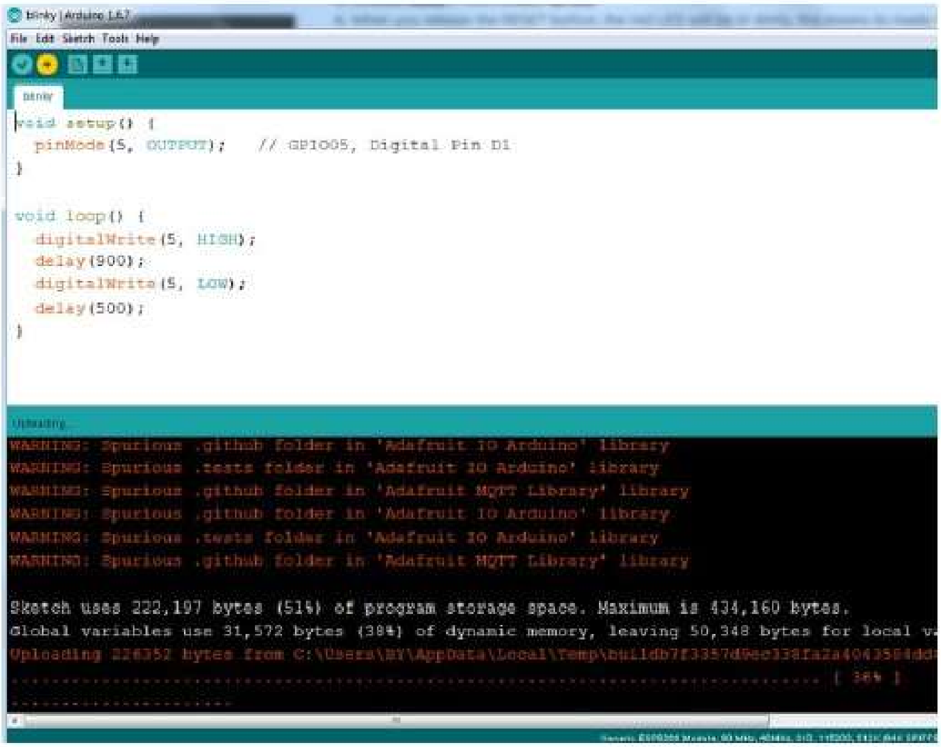


Figure 3.2: Uploading the sketch to ESP8266 NodeMCU module.

The sketch will start immediately - you'll see the LED blinking. Hooray!

3.5 Connecting via WiFi

OK once you've got the LED blinking, let's go straight to the fun part, connecting to a webserver. Create a new sketch with this code:

Don't forget to update:

const char* ssid = "yourssid";

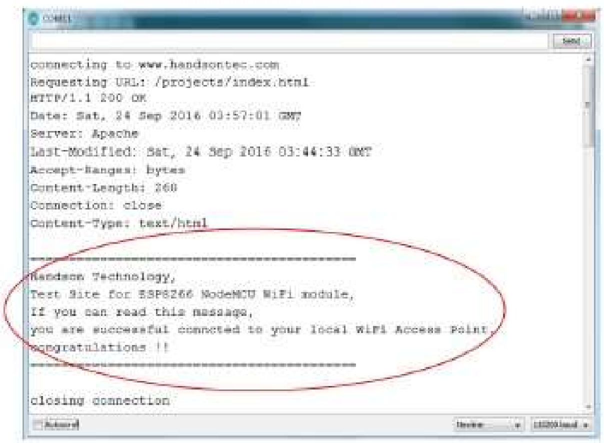
const char* password = "yourpassword";

to your WiFi access point and password, then upload the same way: get into bootload mode, then upload code via IDE.

```
/*
 *  Simple HTTP get webclient test
 */

#include <ESP8266WiFi.h>

const char* ssid     = "handson";      // key in your own SSID
const char* password = "abc1234";      // key in your own WiFi access point
password
```

```
const char* host = "www.handsontec.com";

void setup() {
  Serial.begin(115200);
  delay(100);

  // We start by connecting to a WiFi network

  Serial.println();
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);

  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }

  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

int value = 0;

void loop() {
  delay(5000);
  ++value;

  Serial.print("connecting to ");
  Serial.println(host);

  // Use WiFiClient class to create TCP connections
  WiFiClient client;
  const int httpPort = 80;
  if (!client.connect(host, httpPort)) {
    Serial.println("connection failed");
    return;
  }

  // We now create a URI for the request
  String url = "/projects/index.html";
  Serial.print("Requesting URL: ");
  Serial.println(url);

  // This will send the request to the server
  client.print(String("GET ") + url + " HTTP/1.1\r\n" +
               "Host: " + host + "\r\n" +
               "Connection: close\r\n\r\n");
  delay(500);

  // Read all the lines of the reply from server and print them to Serial
  while(client.available()){
    String line = client.readStringUntil('\r');
    Serial.print(line);
  }

  Serial.println();
  Serial.println("closing connection");
}
```

Open up the IDE serial console at 115200 baud to see the connection and webpage printout!



That's it, pretty easy right ! This section is just to get you started and test out your module.