Ultrasonic Sensor based Water Level Monitoring and Control using IoT

A Project report submitted in partial fulfillment
of the requirements for the degree of B. Tech in Electrical Engineering

by

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled **Ultrasonic Sensor based Water Level Monitoring and Control using IoT**is the bonafide work carried out by**SouvikNaskar (11701616021), Tanmoy Samanta (11701616014), Sk Md Ramize Raja (11701616026),Rajchandra Banerjee (11701616043),**the students of B.Tech in the Department of Electrical Engineering, RCC Institute ofInformation Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015,affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), WestBengal, India, during the academic year 2019-20, in partial fulfillment of therequirements for the degree of Bachelor of Technology in Electrical Engineeringand that this project has not submitted previously for the award of any otherdegree, diploma and fellowship.

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To

The Head of the Department
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Respected Sir,

In accordance with the requirements of the degree of Bachelor of Technology in the Department of Electrical Engineering, RCC Institute of Information Technology, We present the following thesis entitled "**Ultrasonic Sensor based Water Level Monitoring and Control using IoT**". This work was performed under the valuable guidance of Mr. Budhadtiya Biswas, Assistant Professor in the Dept. of Electrical Engineering.

We declare that the thesis submitted is our own, expected as acknowledge in the test and reference and has not been previously submitted for a degree in any other Institution.

Yours Sincerely,

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ABBREVIATIONS AND ACRONYMS

IOT–Internet of Things
FCC **-** Federal Communications Commission
HVAC–Heating Ventilation and AirConditioning
IC **-** Integrated Circuit
PCB – Printed Circuit Board
µC – Micro Controller
BJT **-** Bi-polar Junction Transistor
SPDT **-** Single Pole Double Throw
NO **-** Normally Open
NC **-** Normally Closed
COM – Common
LCD – Liquid Crystal Display
LED **-** Light Emitting Diode
POT – Potentiometer
AT – Attention Command
SMPS – Switch Mode Power Supply
RF– ***R***adio Frequency
ISM – Industrial, scientific and medical
USB – Universal serial bus
SPI – Serial Peripheral Interface
I^2C **–** Inter-Integrated Circuit
GPIO – General Purpose Input Output
API–ApplicationProgram Interface

ABSTRACT

Wireless Water Level Monitoring & Control Using Ultrasonic sensor & NODE MCU is an amazing and very useful project. The objective of this project is to notify the user the amount of water that is present in the overhead water tank. This project is further enhanced to control the water level in the tank by turning the water pump ON, when the water level is LOW, and turning the pump OFF when the water level is HIGH. Thus, the MODE MCU water level indicator& control helps in preventing wastage of water in overhead tank. This project wirelessly send the data to the user mobile using Blynk IoT app.It is easy to install, cost effective and it can work from anywhere in the world.

In this project a transmitter circuit consists of an ultrasonic sensor to measure the water level in terms of distance. This data is sent to the microcontroller and a local OLED display is there to monitor the water level all time. The controller is attached with a relay driver which further controls the water pump. The controller decides when the pump should be ON and OFF according the level of the water present in the overhead tank. It simultaneously sends the data to the Blynk clouds using internet. User can monitor the water level in a smart phone using Blynk app.

CHAPTER 1

(Introduction)

1.1 INTRODUCTION

The process requirement in many industries,farms, hostels, hotels etc includes an overheadtank for water, which is usually fed through anelectric pump that is switched off when the tankis filled up, and on when it becomes empty. Assuch, the most common way of knowing when thetank is filled is by observing when it overflowsthe brim. Depending on the type of liquid beinghandled, the overfilling of such a tank could leadto heavy material losses. These losses can beprevented if the tank is regulated automaticallyby incorporating a feed-back control mechanism,which would be capable of tripping the pump onor off as required. Although pumps equippedwith variable speed motors could be more efficientthan on/off mechanisms, the former are expensiveto procure and maintain, especially for small andmedium enterprises. Furthermore, commerciallyavailable water level sensors are expensive beingimported into the country and as such cannot bedeployed in every household.Control systems are classified as open loop orclosed loop. In open loop systems a command isgiven to a system and it is assumed the systemperforms properly. A closed loop system, on theother hand, compares the result or output of thesystem to a desired output and takes appropriatecorrective actions. Closed loop systems therefore,generally exhibit more accurate performance butcost more and tend to be more unstable. Here the sensor used is Ultrasonic sensor, it's a non contact based distance sensor. Due to the not contact properties of the sensor it can be used for any type of liquid in the tank. The level of the tank is monitor continuously and sends to the user mobile through internet. The pump can be controlled anywhere using the internet.

NodeMCU is an open source IoT platform. The user has a clear idea about the water level in the overhead tank every time in the mobile using the internet. Also the user can control (ON/OFF control only) the water pump through the mobile using IoT. When water goes below a certain level the pump will automatically switched ON and gives an indication to the user mobile and after a certain level the pump will switched OFF automatically. In this way this system ensures continuity of water throughout the day and it also saves the spillage of water.

1.2 Ultrasonic Module HC-SR04

The ultrasonic sensor works on the principle of SONAR and RADAR system which is used to determine the distance to an object.

An ultrasonic sensor generates the high-frequency sound (ultrasound) waves. When this ultrasound hits the object, it reflects as echo which is sensed by the receiver as shown in below figure 1.

By measuring the time required for the echo to reach to the receiver, we can calculate the distance. This is the basic working principle of Ultrasonic module to measure distance.

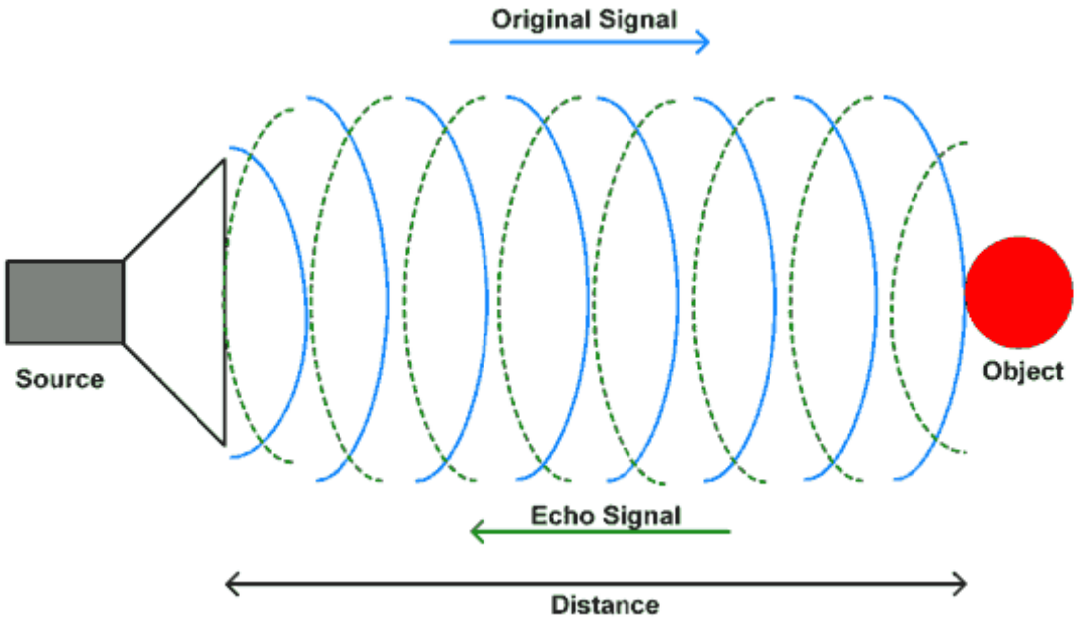


Figure 1: Ultrasonic Working Principle

1.3 HC-SR04 Ultrasonic Module Timing Diagram

1. We need to transmit trigger pulse of at least 10 us to the HC-SR04 Trig Pin.
2. Then the HC-SR04 automatically sends Eight 40 kHz sound wave and wait for rising edge output at Echo pin.
3. When the rising edge capture occurs at Echo pin, start the Timer and wait for falling edge on Echo pin.
4. As soon as the falling edge is captured at the Echo pin, read the count of the Timer. This time count is the time required by the sensor to detect an object and return back from an object.

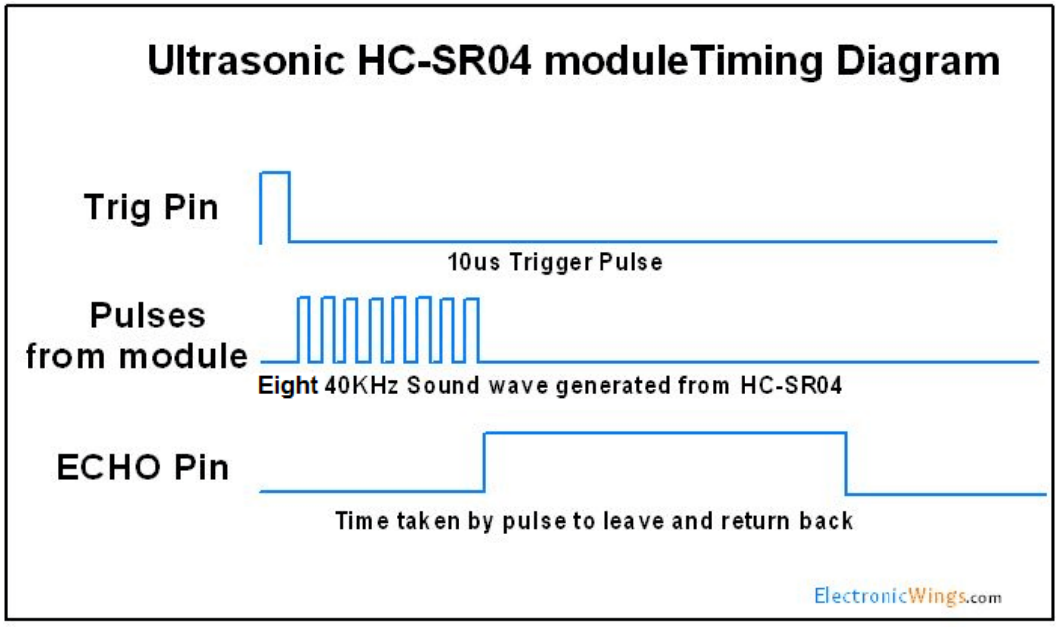


Figure 2: Ultrasonic Module Timing Diagram

1.4 Distance Calculation using HC SR 04

We know that,

Distance = Speed x Time

The speed of sound waves is 343 m/s.

So,

$$\text{Total Distance} = \frac{343 \text{ x Time of High(Echo) Pulse}}{2}$$

Total distance is divided by 2 because signal travels from HC-SR04 to object and returns to the module HC-SR-04.

1.5 Overview and benefits of the project

1.5.1 Advantages of Water Level Indicators & Float Switches

There are many advantages of water level controls, also known also water level indicators, including:

1. Power Saver

Living in an age where we need to be more conscious of the energy that we use, a water level controller is ideal at saving power. Normally, regulating water levels can consume electricity and wastewater. However, with automatic controllers, the electricity usage is limited as well as less water needed to regulate supply.

2. Money Saver

A water level controller helps save money by limiting the waste of water and electricity. These devices accurately regulate how much energy is used to protect against any unnecessary water/electricity usage. Over time, the money saved is quite substantial.

3. Automatic

Another notable advantage with these devices is that they regulate on their own. Eliminating manual operations with a timer switch, the frustrations of manual monitoring water tanks are minimized. Water levels are maintained at the appropriate levels thanks to the automatic operations of these devices.

4. Water Maximization

On average, water pumps are used more during midday. A water level controller can maximize the water usage provided during midday while automatically lessening the water usage at night. This results in an appropriate level of water at all times being maintained, while providing you with the maximum use of your water at the appropriate times.

5. Reliable Electronic Design

Addressing the durability problems found in earlier designs, the solid-state electronics in the newer models help to eliminate them. Not only do they help to eliminate the durability issues, but they also create considerable savings of the life span of the unit with an advanced modular design. In order to minimize problem areas of these designs, the only moving parts are the relays. These relays are easily replaced and tested by any skilled operator or electrician while being an inexpensive part.

6. New Control Minimize Fouling & Deterioration

Proving to be less costly, over time, than the original float design for the 'toilet tank'. The solid-state electronics are designed to minimize volt usage (less than 1 volt). This directly minimizes the mineral fouling, plating, rusting, and deterioration of probes, proving to be safer and more efficient. These factors extend the life span of the controllers significantly, which saves money and energy.

7. Easy Installation with LED Monitoring

These new solid-state electronics and integrated electronics offer superior performance, hassle-free installation, and lower cost to operate over time when compared to the lifespan of the original design. For continuous monitoring, the integrated firmware and digital dry-contact circuitry easily and quickly connect to the automation systems of a building. Each function of the integrated electronics and relays use LED lights to offer operators the ability to visually scan them in order to verify proper operations.

1.5.2 Applications & Uses of Water Level Indicator

The uses of a water level indicator include the following applications:

- Can be used in water tanks to control water levels
- Automatically turn ON/OFF pumps
- Can be used in factories, commercial complexes, apartments, home,
- Fuel tank level gauging
- Oil tank level control
- High & low-level alarms
- Pool water level control
- Life station switches
- Leachate level control
- Cooling tower water level control
- Sewage pump level control
- Remote monitoring liquid
- Water level control
- Pump controller
- Stream level monitoring
- Sump pump

- Tsunami warning and sea level monitoring
- Process batch control & monitoring
- Irrigation control

1.5.3 Benefits of Water Level Indicators & Water Alarms

There are many benefits of water level indicators and water alarms including:

- Easy installation
- Minimal maintenance
- Sends an alert to let you know water is too high or too low
- Low & High alarms
- Compact design
- Automatically adjusts water levels
- Save money by using less electricity and water
- Can help avoid seepage of roofs and walls due to tanks overflowing
- Automatic operation saves you manual labor time
- Consumes a small amount little energy, perfect for on-going operations
- Indicates water levels in any type of storage tank or body of liquid
- A water alarm is loud so you can easily hear it

.

1.6 Organization of thesis

The thesis is organised into five chapters including the chapter of introduction. Each chapter is different from the other and is described along with the necessary theory required to comprehend it.

Chapter2 deals with the literature reviews. From this chapter we can see before our project who else works on this topic and how our project is different and advance from those projects.

Chapter 3 deals with the theory required to do the project. The basic of operation of HC SR 04 ultrasonic distance sensor and how to interface with node mcu microcontroller are described there.

Chapter 4 deals with the hardware modelling of the projects. The main features, photographs, step by step operation of the prototype, component listing and the hardware interfacing of the required components are described here.

Chapter 5 describes the operation of the prototype circuit. A flow chart is presented on the actions which describes the principle of operation of the prototype. HC SR 04 senses the water level and sends it to the user mobile using wifi.

Chapter 6 concludes the work performed so far. The possible limitations in proceeding research towards this work are discussed. The future work that can be done in improving the current scenario is mentioned. The future potential along the lines of this work is also discussed.

Chapter 7 References are listed in this chapter

Appendix A, B & C Hardware description, software coding and datasheets are listed here.

CHAPTER 2

(Literature Review)

[1]

Charles A, "IOT BASED WATER LEVEL MONITORING SYSTEM USING LABVIEW",International Journal of Pure and Applied Mathematics, Volume 118 No. 20 2018, 9-14 ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version).

This paper illustrates a solution of water scarcity faced by many societies and world in 21st century. The proposed paper focused on IOT based monitoring system, implementation, management of water distribution in large areas. The monitoring system was implemented by Ultrasonic sensors and Node MCU. This is non-contact water level management. By the system, water is transferred to several tanks from the ground water or dam, there water is pumped to tanks by motors. Each pump connected to each tank by solenoid valves, used to control the water flow to each tanks. The solenoid valves get turned on by USB6009 (DAQ Assist) with LABVIEW. The main function of DAQ is sending digital pulses to get valves ON. Ultrasonic sensors that measures the distance of water level in the tank & the data is displayed in the IoT devices. The received date is sent to google cloud platform. We can also retrieve the data from the webpage that will display in LAB VIEW front panel. Network of sensors has been used to buffer efficient water circulations. The included NI-DAQmx driver and configuration utility simplify configuration and measurement.

[2]

S. V. Manikanthan and T. Padmapriya "Recent Trends In M2m Communications In 4g Networks And Evolution Towards 5g", International Journal of Pure and Applied Mathematics, ISSN NO: 1314-3395, Vol115, Issue -8, Sep 2017.

Machine-to-Machine (M2M) communications involvemachines communicating with each other and exchanginginformation with remote servers, possibly over a cellularnetworkinfrastructure.Currently, in LTE-Advanced systems, themain focus has been on supporting massive deployment of lowcost devices, with enhanced radio access network coverage.One key requirement for supporting M2M in LTE is theavailability of low cost devices. Typical LTE devices havebeen designed to provide broadband services. For example,
the least capable LTE device, called Category-1 device, has 2receive antennas, RF bandwidth of 20 MHz, and can supportdata rates of 10 Mbps in the downlink and 5 Mbps in theuplink.One key requirement for supporting M2M in LTE is theavailability of low cost devices. Typical LTE devices havebeen designed to provide broadband services. For example,the least capable LTE device, called Category-1 device, has 2receive antennas, RF bandwidth of 20 MHz, and can supportIt is predicted that in 2020 the total number of connected
devices will be about 50 billion , almost double comparingto today's number.data rates of 10 Mbps in the downlink and 5 Mbps in theuplink.Machine-to-Machine communication, with its capability ofproviding diverse set of applications and services, isconsidered to be a key technology enhancement for 4G LTEAdvancedsystems, and is anticipated to maintain itsdominance in 5G systems as well.

[3]

Neena Mani, Sudeesh T.P, Vinu Joseph, Titto V.D, Shamnas P.S, "Design and Implementation of a Automated Water Level Indicator", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering 2014 Vol 3 Issue 2, February 2014.

Water level indicator is widely used in many industries and houses .In this paper a programmed microcontroller is the basic component for the water level indicator. ATmega 32A microcontroller is helps to indicate the level of water or any other conducting liquid.. With the help of anlcd display we can see all the level of the water contained in a tank or in any other vessels. A liquid level sensor (transistor circuit) detects the present level of the liquid in the tank in terms of the voltage across transistor and feeds it to the microcontroller and the microcontroller generates a corresponding output text which in then displayed in the LCD. If the water level is full, then the circuits beeps through the buzzer notifying that the water level is full.The circuit is divided into two parts. First one is the microcontroller section which is kept on the breadboard and second is the transmitter section and its base is kept inside the water tank.The collector terminals of each of these transistors are connected to a +5 volt level. The emitter terminals are connected to input pins of PORT A of the microcontroller. The microcontroller continuously monitors the state of each of these input pins.If the first pin, which is the one corresponding to the quarter level of the tank is high then LCD displays "quarter". If both the first and second pins are high, then LCD displays "half full". Similarly if the first three pins are high then we infer from the LCD that the water level is three quarters of the tank. Likewise a high on all four pins displays the message "full". Once the water tank is full, the buzzer produces a short audible sound warning the user to switch off the motor.

[4]

Jadhav, G. J, "Design and Implementation of Advanced ARM Based Surveillance System using Wireless Communication, International Journal of Advance Research in Computer Science and Management Studies" Vol 2, 2014.

This proposed paper is focused on the notion of water level monitoring and management within the context of electrical conductivity of the water. More specifically, It illustrates investigation of the microcontroller based water level sensing and controlling in a wired and wireless environment. Water Level management approach would help in reducing the home power consumption and as well as water overflow.it can indicate the amount of water in the tank that can support Global Water types including cellular dataloggers, satellite data transmission systems for remote water monitoring system.At the first stage of design a water level sensor is been made for sensing water level accurately. Microcontroller is used to control the overall system automatically that reduces the design and control complexity. Microcontroller takes input from the sensor unit which senses the water level through inverter. After processing input variables, resultant output decides the water pump's action (on/off) with respect to current water status of the tank.The main intension of this research work was to establish a flexible, economical and easy configurable system which can solve our water losing problem. We have been used a low cost PIC 16F84A microcontroller in this system which is the key point to reduce.

[5]

Priya B. Patel, Viraj M. Choksi, Swapna Jadhav, M.B. Potdar, "Smart Motion Detection System using Raspberry Pi", International Journal of Applied Information Systems (IJAIS), Vol10 – No.5, February 2016.

The paper illustrates to make a smart surveillance system which can be monitored by owner remotely. As it is connected with the system with IOT, system will send the notifications when an intrusion is detected inside the room. It is required to develop and implement affordable low cost web-camera based surveillance system for remote security monitoring. Authorized user can access to their monitoring system remotely via internet with the use a mobile phone and monitor the situation on application. This project describes the use of low-cost single – board computer Raspberry Pi with wireless internet. This work is focused on developing a surveillance system that detects stranger and to response speedily by capturing and relaying images to admin office based wireless module and thus activate the alert system both at intruder location and office admin. Surveillance System consists of mainly two parts: A. Hard-wired surveillance systems: These systems use wires to connect the cameras, motion detectors, power supply and LAN cable with the pi., Remote Access Systems. 2. USB Camera, Raspberry Pi, Android device, PIR sensor whose sensitivity range up to 20 feet (6 meters) 110 degrees * 60 degrees.Softwares like Python,NOOBS, PUTTY, RASPBIAN OS are to be used.Therefore this kind of real time Surveillance system has great prospect of in building a secured digital world.

[6]

S. M. Khaled Reza, Shah Ahsanuzzaman Md. Tariq, "Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue", Proceedings of the World Congress on Engineering and Computer Science 2010 Vol I WCECS 2010, October 20-22, 2010, San Francisco, USA.

This paper introduces the notion of water level monitoring and management within the context of electrical conductivity of the water. More specifically, It investigate the microcontroller based water level sensing and controlling in a wired and wireless environment.From the users perspective, it is required to reuse such valuable resource in a mobile application. Finally, It proposes a web and cellular based monitoring service protocol would determine and senses water level globally.To implement the system we should use some necessary parts such as PIC 16F84A microcontroller, Crystal Oscillator, 2 capacitor having capacitance 22 pF and 27 pF, inverter, LED, water tank, water level sensor, water pump, transistor, inductor and some capacitor should be implemented. When the water is decreasing from the tank by home use, the display LED should start to become OFF one after another from the top to bottom. If all the LEDs becomes OFF that means the tank becomes empty again and the water pump should becomes automatically ON again exactly after the last LED becomes OFF. These operations should automatically perform as a cycle. This article focuses on displaying the available local connections and the stored remote connections through the internet&Designing interactive application software for remote PC or mobile should display data in table format or in the graphical interface for integration of the wireless water level monitoring.

[7]

R. S. SUNMONU, M. A. SODUNKE, O. S. ABDULAI & E. A. AGBOOLA "DEVELOPMENT OF AN ULTRASONIC SENSOR BASED WATER LEVEL INDICATOR WITH PUMP SWITCHING TECHNIQUE", International Journal For Research In Electronics & Electrical Engineering ISSN: 2208-2735

The liquid levels determination is done by electronically converting the time of arrival of echo as recorded by the receiver (R) of the ultrasonic sensor from incident waves from transmitter (T). Arduino UNO, an active microprocessor in this design is commercially available which is electronically and mechanically fragile, hence the needs to replace Arduino UNO with rugged and cost effective fabricated units from available cheap components.This paper looks into the development and implementation of such a simple and cost effective feedback regulator for use in applications where there are needs to real timely monitor the water levels.The aim of this present work is to develop an independent water level control system with design based on ultrasonic transducer (sensor) thereby addressing problems of untimely response and frequent breakdown of contact sensors due to surface coating and corrosion from the water medium which characterized existing water level control based contact sensors. Our developed system controls, monitors and maintains the water level in the tank (overhead or surface) and ensures the continuous flow of water round the clock without the labor stress of manually switching the pump ON or OFF thereby saving time, electrical energy, water, and prevent overworking of the feed pump.Thenon contact ultrasonic sensor is strategically positioned on the peak of the vessel thereby solving the problems of frequent replacement of contact and submersible sensor which characterize existing commercial and expensive water indicator. The module detected, controlled and maintained the level of water. The level of the water in the vessel is indicated in % of the volume holding capacity of the tank which is displayed on the Liquid Crystal Display (LCD) unit.

CHAPTER 3

(Theory)

3.1 IoT (Internat of Things)

IoT (Internet of Things) 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.

IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

3.1.1 IoT − Key Features

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below

- **AI** − IoT essentially makes virtually anything "smart", meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.
- **Connectivity** − New enabling technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.
- **Sensors** − IoT loses its distinction without sensors. They act as defining instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- **Active Engagement** − Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.
- **Small Devices** − Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

3.1.2 IoT − Advantages

The advantages of IoT span across every area of lifestyle and business. Here is a list of some of the advantages that IoT has to offer

- **Improved Customer Engagement** − Current analytics suffer from blind-spots and significant flaws in accuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.
- **Technology Optimization** − The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.
- **Reduced Waste** − IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to more effective management of resources.

- **Enhanced Data Collection** − Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces, and places it exactly where humans really want to go to analyze our world. It allows an accurate picture of everything.

3.1.3 IoT − Disadvantages

Though IoT delivers an impressive set of benefits, it also presents a significant set of challenges.Here is a list of some its major issues

- **Security** − IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers.
- **Privacy** − The sophistication of IoT provides substantial personal data in extreme detail without the user's active participation.
- **Complexity** − Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.
- **Flexibility** − Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locked systems.
- **Compliance** − IoT, like any other technology in the realm of business, must comply with regulations. Its complexity makes the issue of compliance seem incredibly challenging when many consider standard software compliance a battle.

3.1.4 IotSoftware

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 with critical 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, 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.

- **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 viable 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 industry.

- **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.

3.1.5 Internet of Things - Technology and Protocols

IoT primarily exploits standard protocols and networking technologies. However, the major enabling technologies and protocols of IoT are RFID, NFC, low-energy Bluetooth, low-energy wireless, low-energy radio protocols, LTE-A, and WiFi-Direct. These technologies support the specific networking functionality needed in an IoT system in contrast to a standard uniform network of common systems.

NFC and RFID

RFID (radio-frequency identification) and NFC (near-field communication) provide simple, lowenergy, and versatile options for identity and access tokens, connection bootstrapping, and payments.

- RFID technology employs 2-way radio transmitter-receivers to identify and track tags associated with objects.
- NFC consists of communication protocols for electronic devices, typically a mobile device and a standard device.

Low-Energy Bluetooth

This technology supports the low-power, long-use need of IoT function while exploiting a standard technology with native support across systems.

Low-Energy Wireless

This technology replaces the most power hungry aspect of an IoT system. Though sensors and other elements can power down over long periods, communication links (i.e., wireless) must remain in listening mode. Low-energy wireless not only reduces consumption, but also extends the life of the device through less use.

Radio Protocols

ZigBee, Z-Wave, and Thread are radio protocols for creating low-rate private area networks. These technologies are low-power, but offer high throughput unlike many similar options. This increases the power of small local device networks without the typical costs.

LTE-A

LTE-A, or LTE Advanced, delivers an important upgrade to LTE technology by increasing not only its coverage, but also reducing its latency and raising its throughput. It gives IoT a tremendous power through expanding its range, with its most significant applications being vehicle, UAV, and similar communication.

WiFi-Direct

WiFi-Direct eliminates the need for an access point. It allows P2P (peer-to-peer) connections with the speed of WiFi, but with lower latency. WiFi-Direct eliminates an element of a network that often bogs it down, and it does not compromise on speed or throughput.

3.1.6 Internet of Things - Common Uses

IoT has applications across all industries and markets. It spans user groups from those who want to reduce energy use in their home to large organizations who want to streamline their operations. It proves not just useful, but nearly critical in many industries as technology advances and we move towards the advanced automation imagined in the distant future.

Engineering, Industry, and Infrastructure

Applications of IoT in these areas include improving production, marketing, service delivery, and safety. IoT provides a strong means of monitoring various processes; and real transparency creates greater visibility for improvement opportunities.

The deep level of control afforded by IoT allows rapid and more action on those opportunities, which include events like obvious customer needs, nonconforming product, malfunctions in equipment, problems in the distribution network, and more.

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 city planners have a clearer view of the impact of their design, and governments have a better idea of the local economy.

Home and Office

In our daily lives, IoT provides a personalized experience from the home to the office to the organizations we frequently do business with. This improves our overall satisfaction, enhances productivity, and improves our health and safety. For example, IoT can help us customize our office space to optimize our work.

Health and Medicine

IoT pushes us towards our imagined future of medicine which exploits a highly integrated network of sophisticated medical devices. Today, IoT can dramatically enhance medical research, devices, care, and emergency care. 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.

3.2 NODE MCU

NodeMCU is an open source IoT platform. It includes firmware which runson the ESP8266 from Espressif, and hardware which is based on the ESP12 module.The term "NodeMCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It 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.

Figure 3: NODE MCU Development board

NodeMCU was created shortly after theESP8266 came out. On December 30, 2013,Espressiv system beganproduction of the ESP8266. The ESP8266 is a Wi-Fi SoCintegrated with a TensilicaXtensa LX106 core,widely used in IoT applications

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.

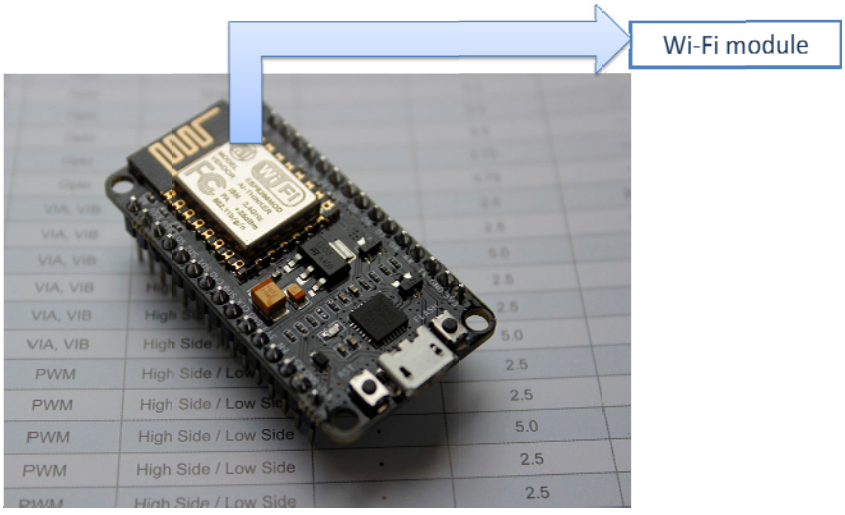


Figure 4: NODE MCU with inbuilt wifi module

3.2.1 Pin configuration of NODE MCU development board

This module provides access to the GPIO (General Purpose Input/Output) subsystem.All access is based on the I/O index number on the NodeMCU dev kits, not the internal GPIO pin. For example, the D0 pin on the dev kit is mapped to the internal GPIO pin 16.
Please refer to the below GPIO pin maps for the index↔gpio mapping.

Table 1: Node MCU index↔gpio mapping

IO index	ESP8266 pin	IO index	ESP8266 pin
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		

[*] D0(GPIO16) can only be used as GPIO read/write. No support for open-drain/interrupt/pwm/i2c

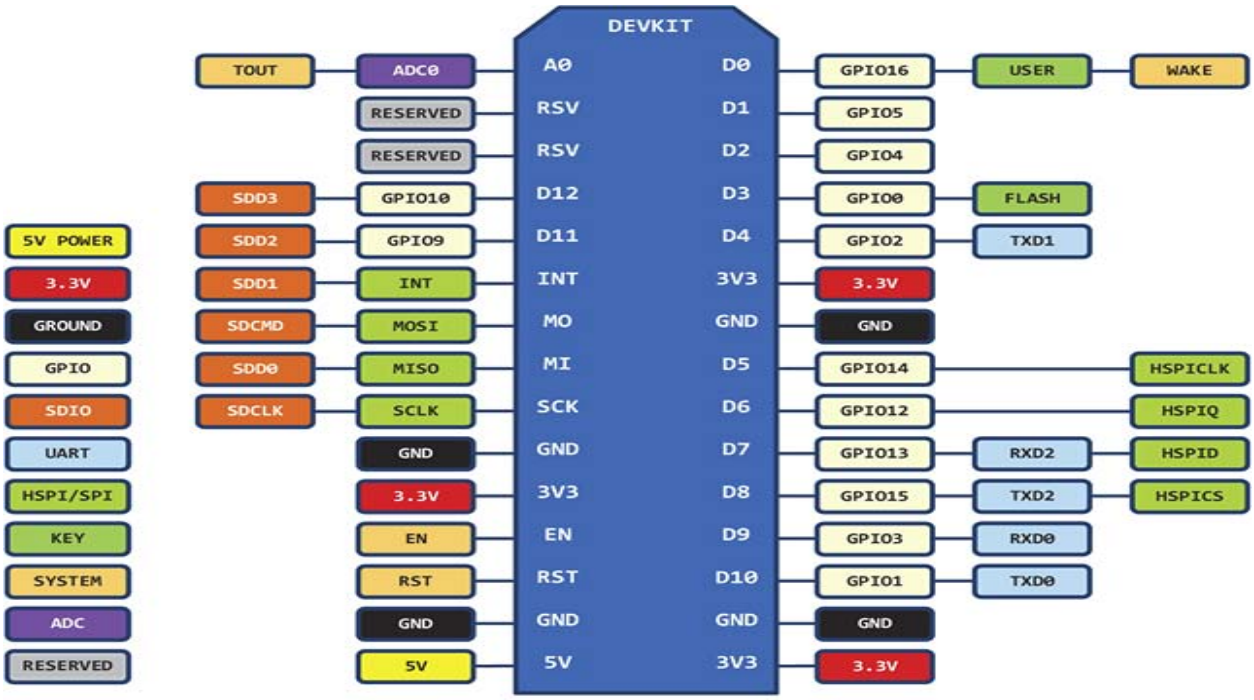


Figure 5: NODE MCU pin configuration

3.2.2 Installation of Node MCU & Coding

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.

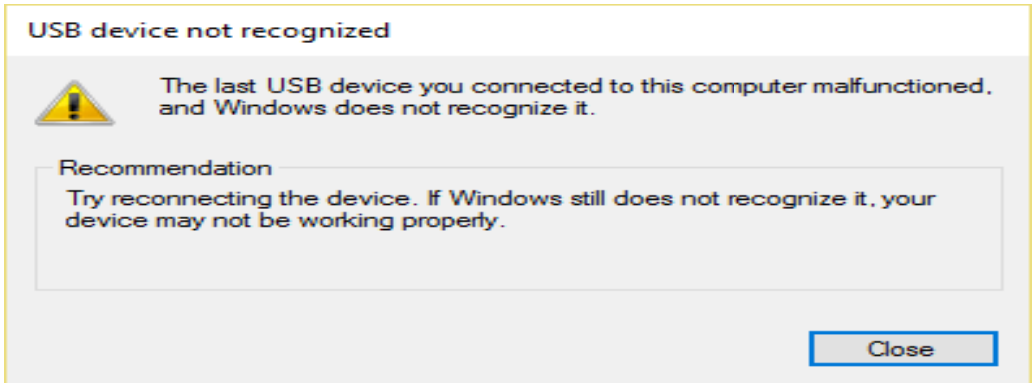


Figure 6: Snapshot of the installation process of NODE MCU

- Node MCU Amica is a ESP8266 wifi Module based development board. It has got Micro USB slot that can be directly 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 breadboard and the micro USB slot is for connection to USB host device that may be a computer. It has got CP2102 USB to serial converter.
- In order to install CP2102 (USB to Serial Converter), user will need to download the driver for the same.
- Once user downloaded drivers as per the proper operating system; the system has got connected with the node MCU.
- From the device manager of the computer note down the COM port allocated to the newly connected USB device i.e. the node MCU Amcia. This com port number will be required while using Node MCU Amica.

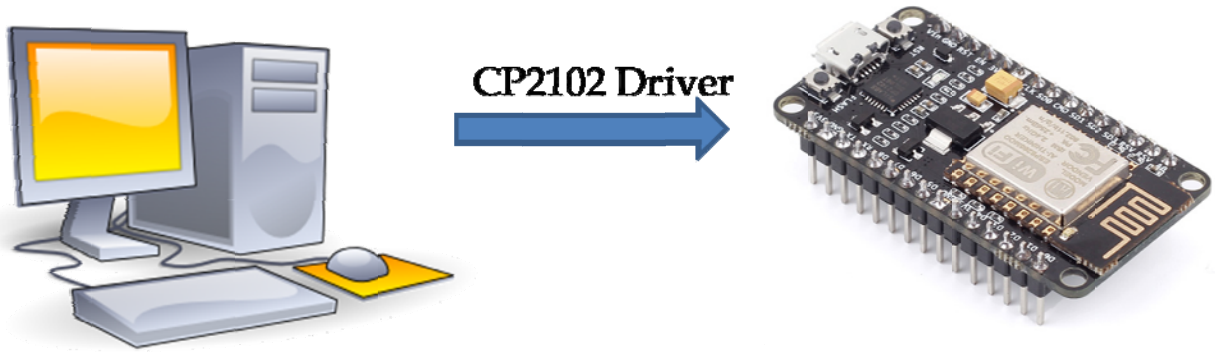


Figure 7: Driver Installation for NODE MCU

3.2.3 Interfacing of node mcu with arduino IDE

Firstly open the Arduino IDE. Go to files and click on the preference in the Arduino IDE

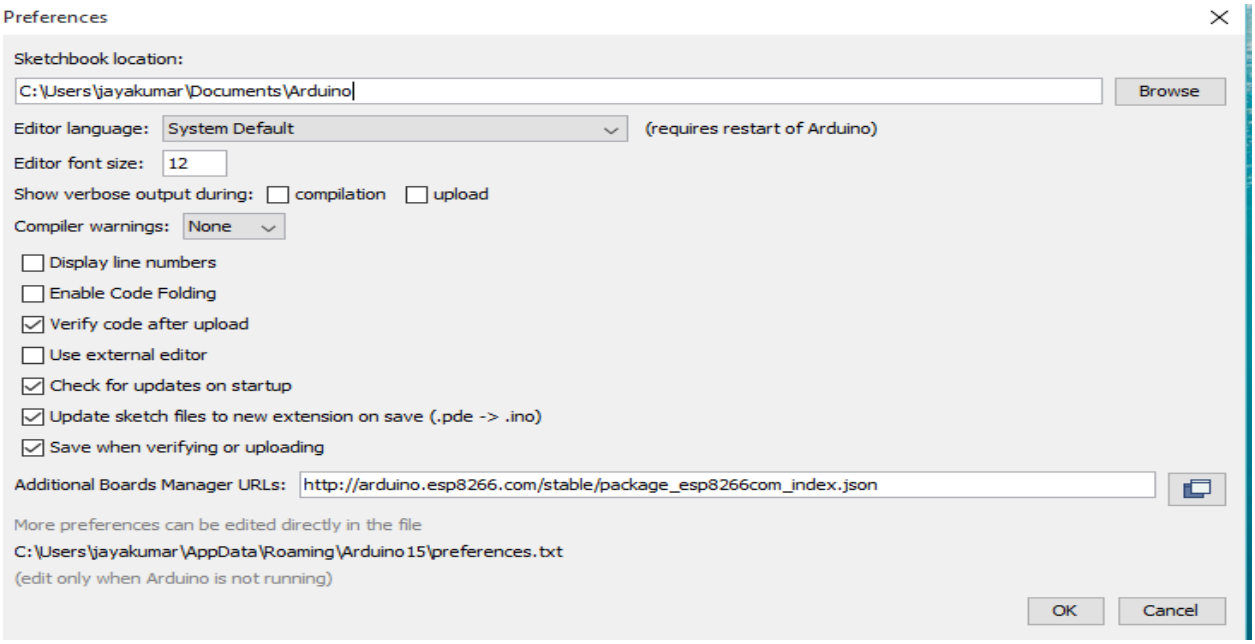


Figure 8: Arduino IDE preferences

copy the below code in the Additional boards Manager
http://arduino.esp8266.com/stable/package_esp8266com_index.json
click OK to close the preference Tab

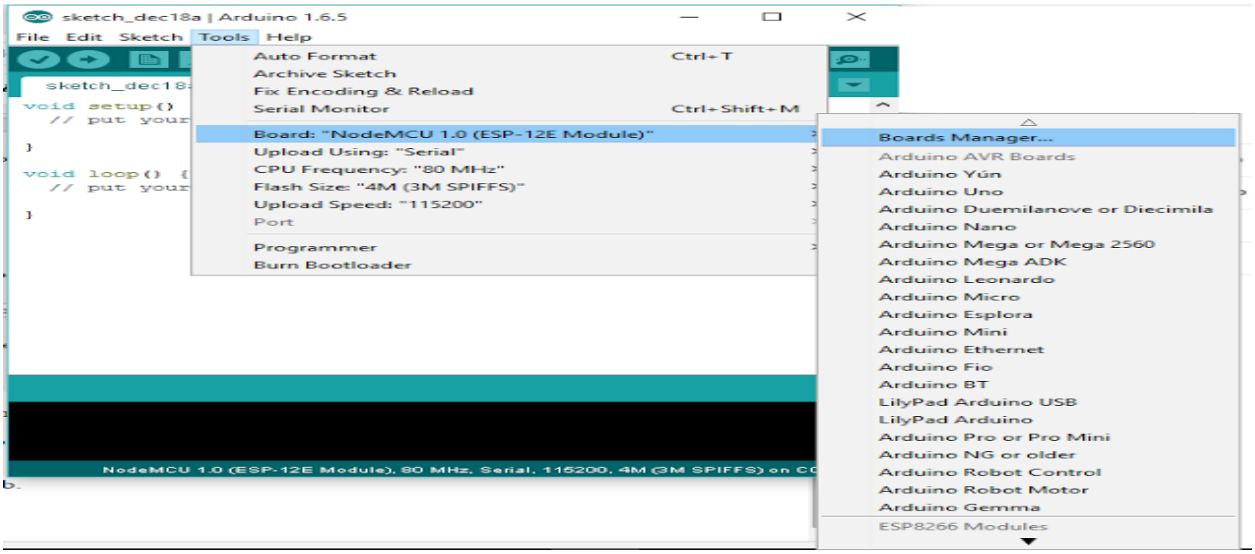


Figure 9: Arduino IDE board manager installation

After completing the above steps , go to Tools and board, and then select board Manager

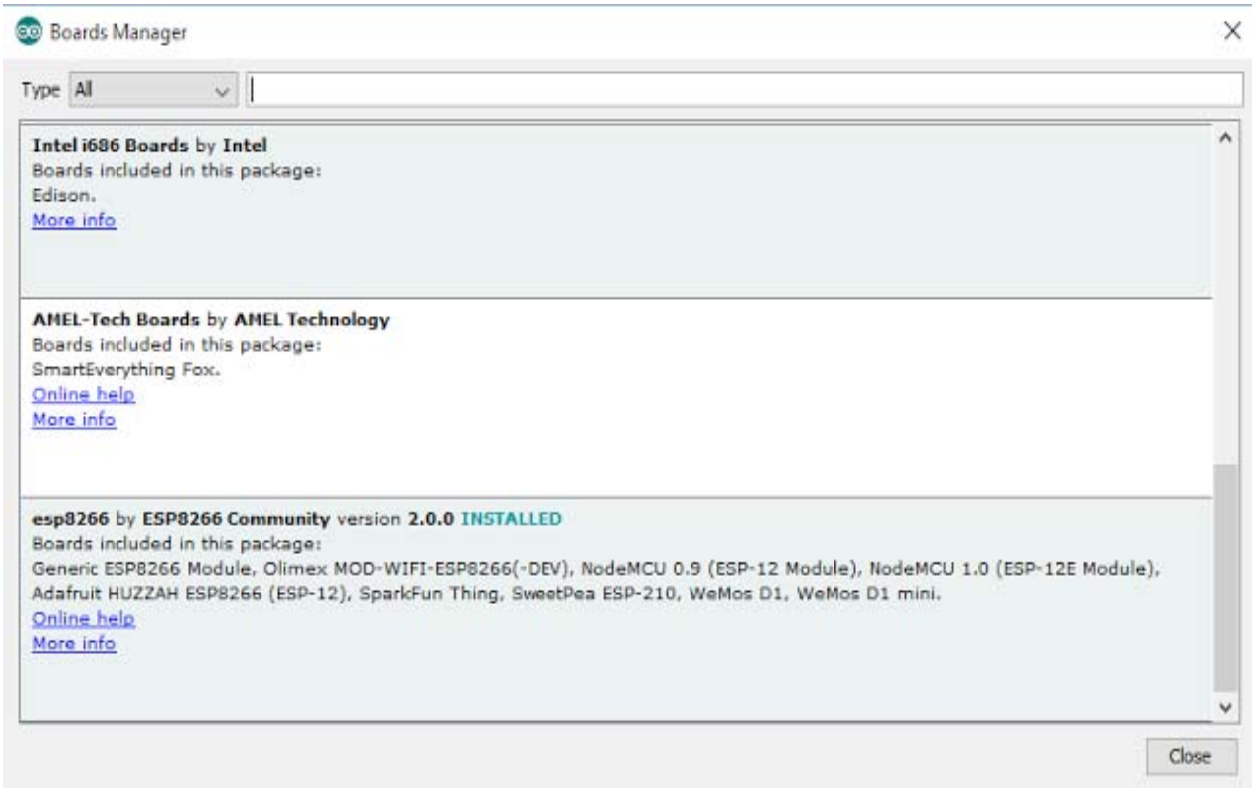


Figure 10: ESP 8266 board installation in Arduino

Navigate to esp8266 by esp8266 community and install the software for Arduino. Once all the above process had been completed we are ready to program our esp8266 with Arduino IDE.

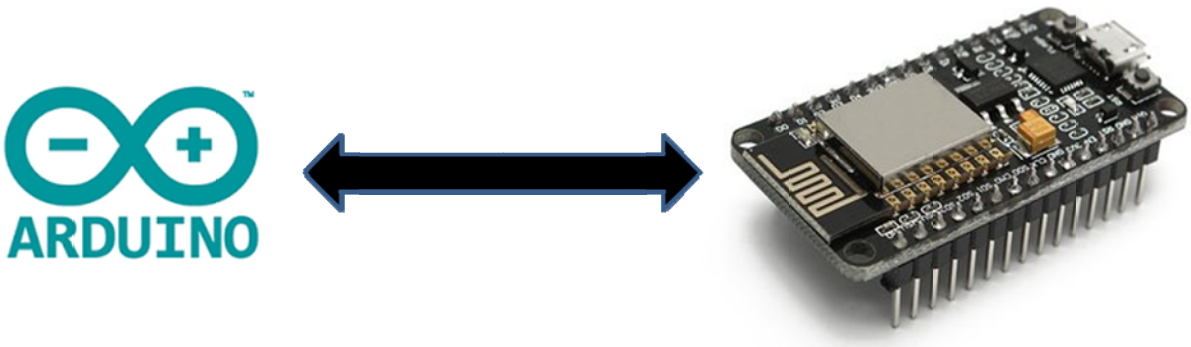


Figure 11: NODE MCU interfacing with Arduino

3.3 Ultrasonic Module HC-SR04

The ultrasonic sensor works on the principle of SONAR and RADAR system which is used to determine the distance to an object.

An ultrasonic sensor generates the high-frequency sound (ultrasound) waves. When this ultrasound hits the object, it reflects as echo which is sensed by the receiver as shown in below figure 1.

By measuring the time required for the echo to reach to the receiver, we can calculate the distance. This is the basic working principle of Ultrasonic module to measure distance.

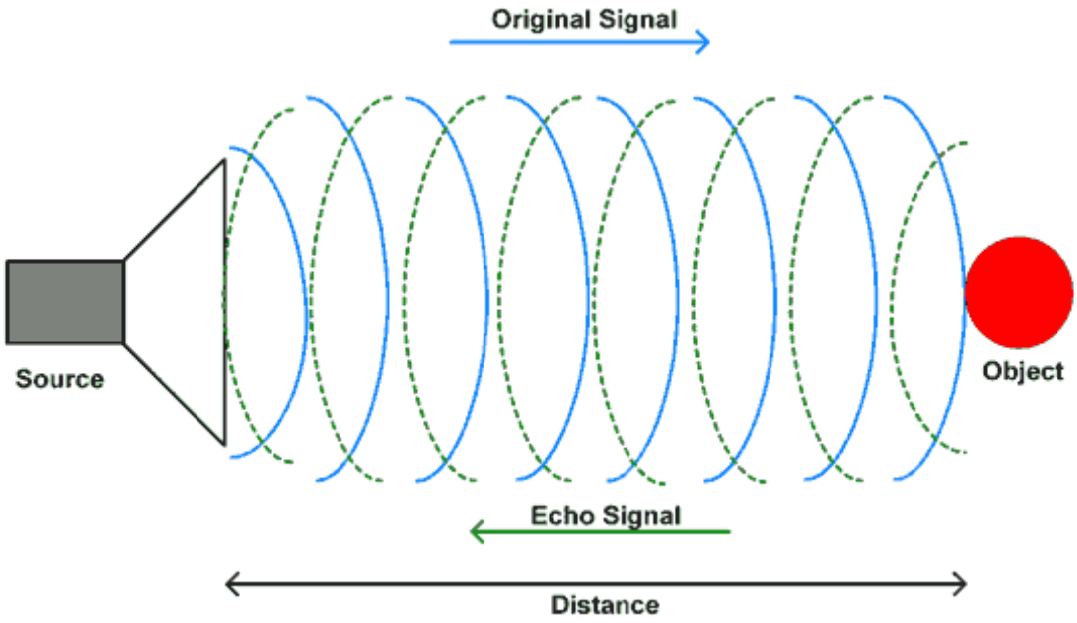


Figure 12: Ultrasonic Working Principle

3.3.1 HC-SR04 Ultrasonic Module Timing Diagram

5. We need to transmit trigger pulse of at least 10 us to the HC-SR04 Trig Pin.
6. Then the HC-SR04 automatically sends Eight 40 kHz sound wave and wait for rising edge output at Echo pin.
7. When the rising edge capture occurs at Echo pin, start the Timer and wait for falling edge on Echo pin.
8. As soon as the falling edge is captured at the Echo pin, read the count of the Timer. This time count is the time required by the sensor to detect an object and return back from an object.

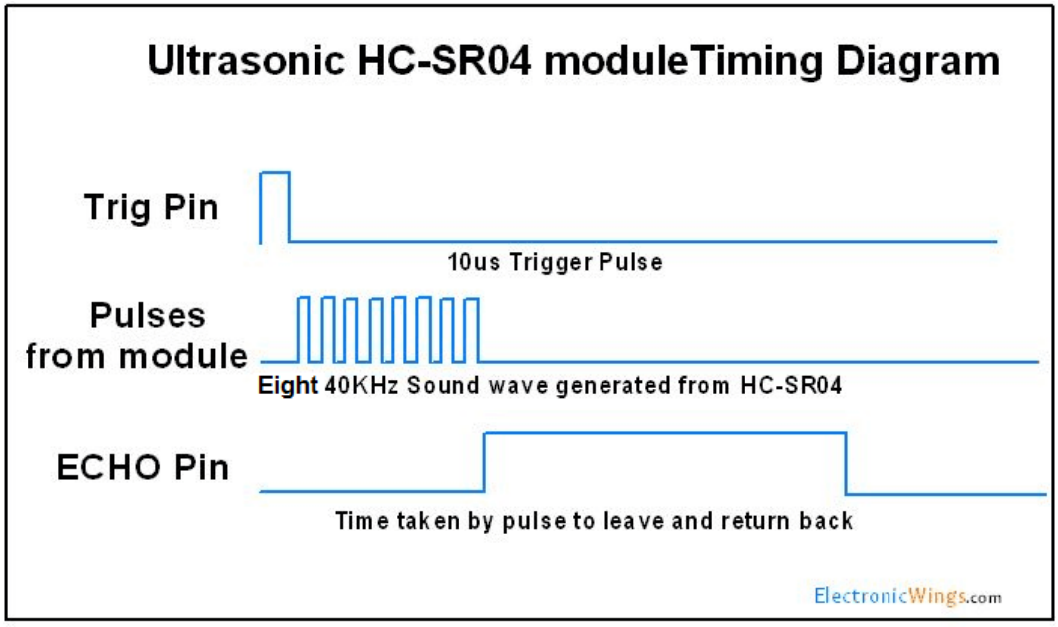


Figure 13: Ultrasonic Module Timing Diagram

3.3.2 Distance Calculation using HC SR 04

We know that,

Distance = Speed x Time

The speed of sound waves is 343 m/s.

So,

$$\text{Total Distance} = \frac{343 \text{ x Time of High(Echo) Pulse}}{2}$$

Total distance is divided by 2 because signal travels from HC-SR04 to object and returns to the module HC-SR-04.

3.3.3 Interfacing the Ultrasonic sensor with the microcontroller

Hcsr04 ultrasonic sensor is composed of ultrasonic transmitter, ultrasonic receiver and a control circuit. Hscr04 ultrasonic transmitter transmits ultrasound waves at 40,000 Hz. Transmitted waves bounce back if they hit any flat surface/object in their path. Bounced back waves reach the ultrasonic receiver. Ultrasonic receiver receives the bounced back waves and notifies the control circuit about it. Control circuit than calculates the time taken by waves to reach back after transmission. Time is than manipulated to approximate the distance travelled by waves or what is the distance between the sensor and the object? from which ultrasound waves bounced back.

Hcsr04 can measure distance between an active range of 2 cm to 4 meters. Hcsr04 requires 5 volts and 15 mA of power for operation. Hcsr04 has four pins. Two are power pins. Vcc is +ve pin apply 5v to this pin and Gnd is ground pin connect -ve of 5v power source with it. The other two pins are **Trigger** and **Echo**.

- **Trigger pin** is triggered by external controller to out burst an ultrasound wave.
- **Echo pin** notifies external controller when receiver receives back the bounced back wave.

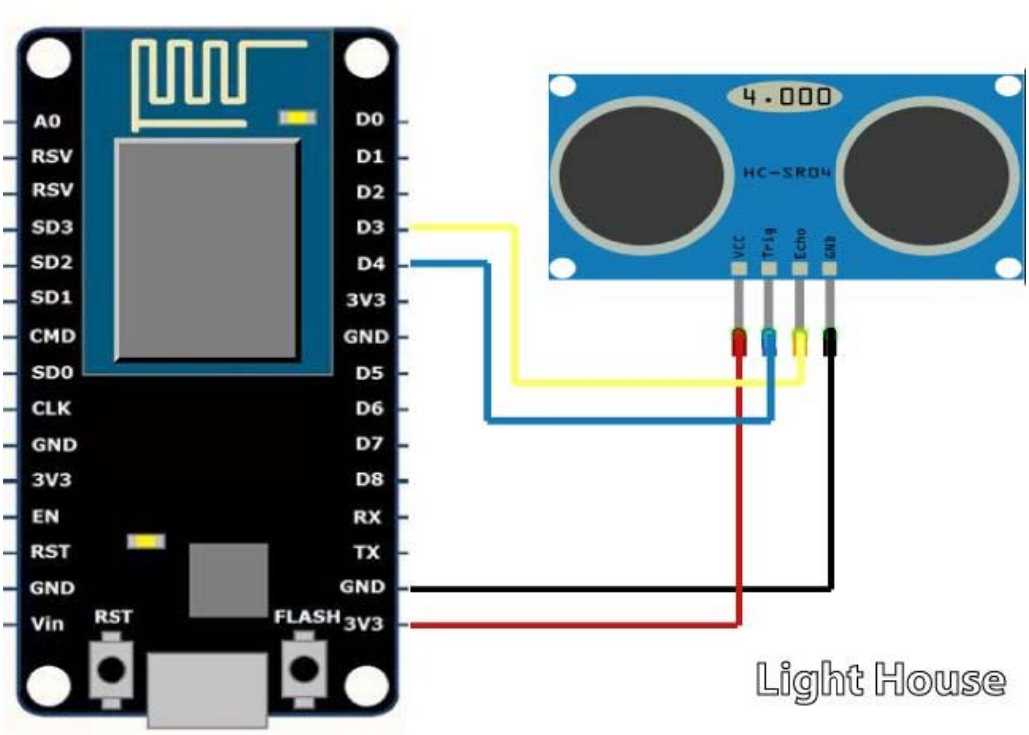


Figure 14: Interfacing HC SR 04 with NODE MCU

3.4 Overview of the project

The following process describes how to create an account in Blynk and generate a unique ID against a particular device. The ID is the identifier for the particular device in the Blynk server.

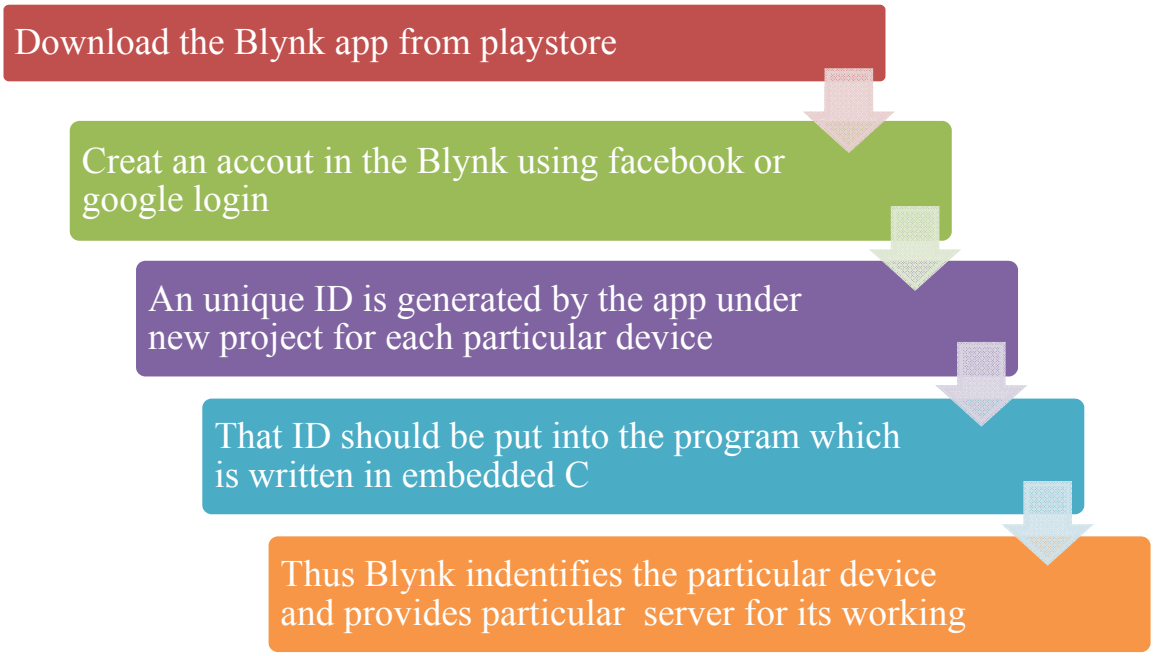


Figure 15: Account creation and generation of unique ID in Blynk server

Once the unique ID is generated the next step is to include that key in the coding which is written in embedded C for communication between the NODE MCU and Blynk server. The process is described below.

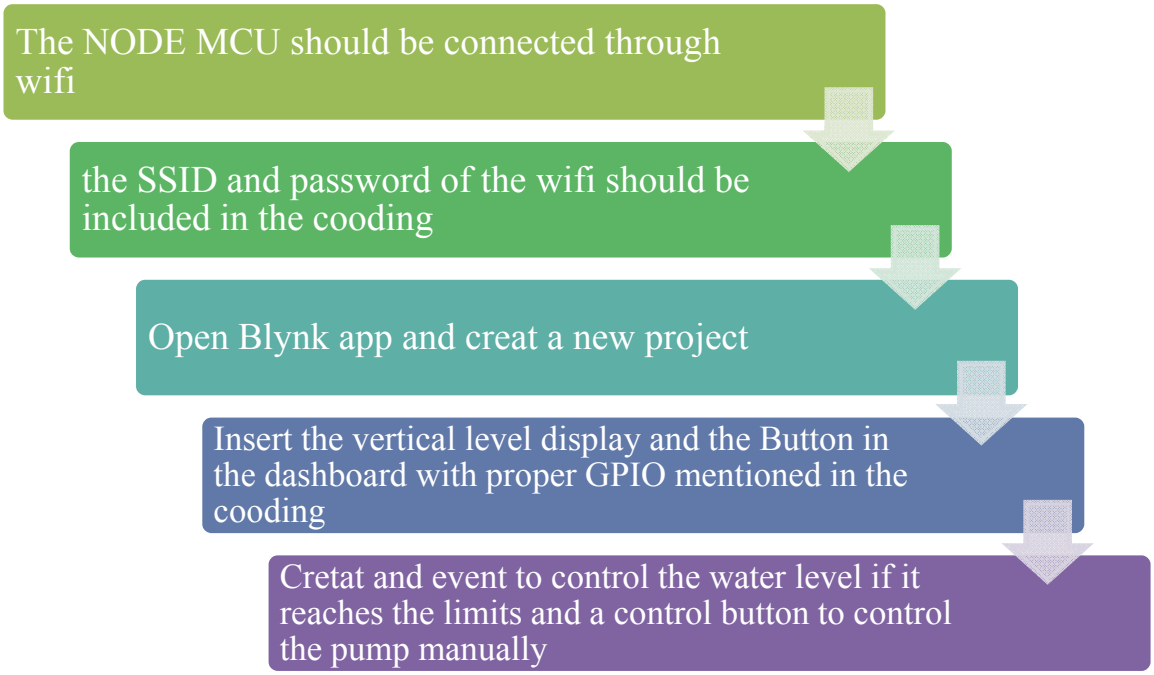


Figure 16: working process of the water level control device

3.5 Circuit Diagram

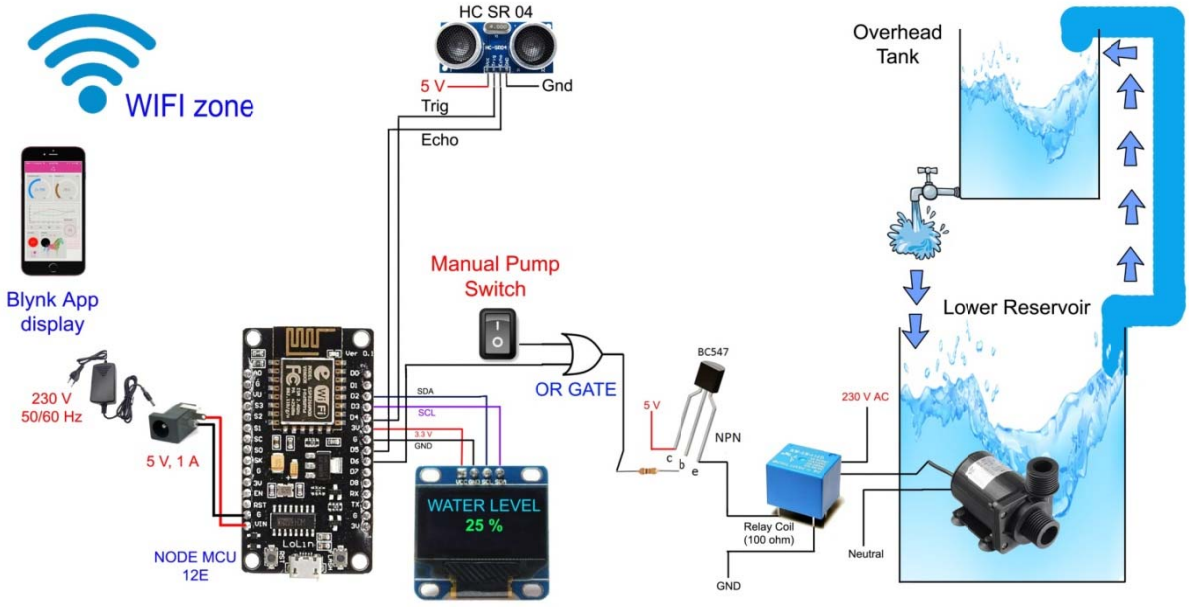


Figure 17: Connection diagram of the project

Figure 18: Blynk app user interface

CHAPTER 4

(Hardware Modeling)

4.1 Main features of the prototype

The features of the developed prototype are:

- Automatic and manual control of the water pump
- Real time water level percentagedisplay in the OLED and mobile screen
- Static relay can handle the water pump easily (250 volt, 7 amp max, ON/OFF control)
- Maintain the water level to ensure all time availability of water
- Not contact sensor increases the life of the sensor
- Secure control
- 5 Volt operation (both control board and relay board)

4.2 Photographs of the prototype

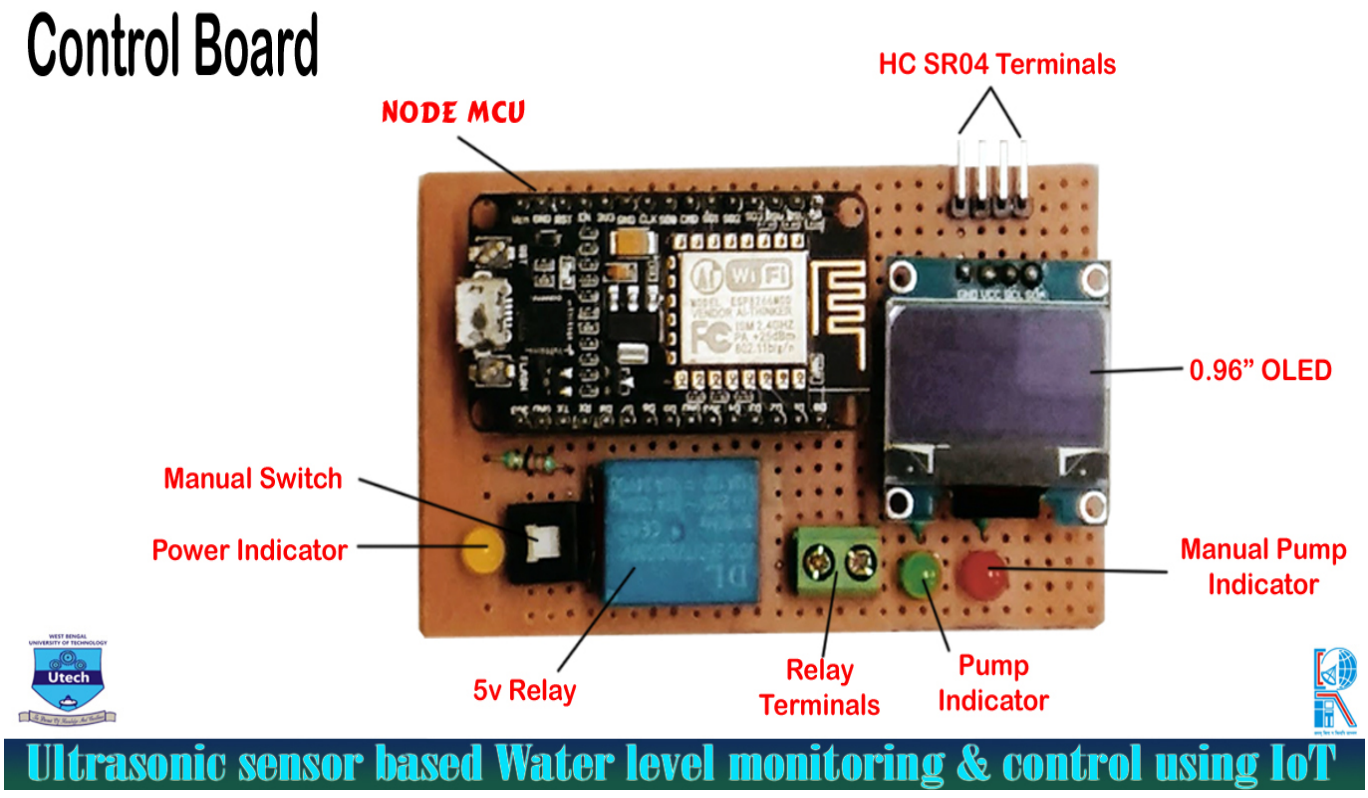
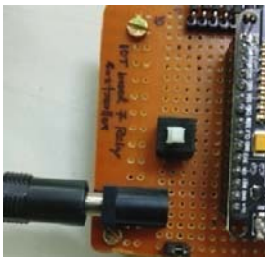


Figure 19: Main Controller with relay and OLED display module

4.3 Step by step operation of the prototype



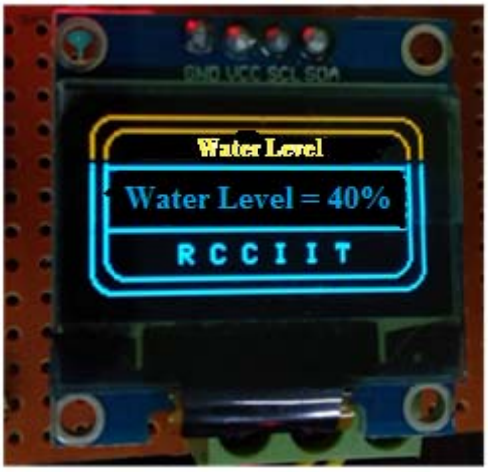
1. Connect the DC adapter (5V, 1A) to the DC jack.

2. Enable the pre-specified wifi (known SSID and password mentioned in the code)

3. After enabling the wifi check the circuit OLED display.

Before connection

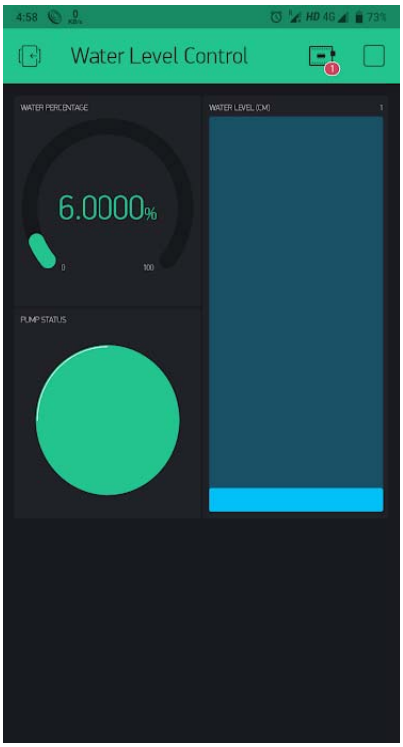
After connection



4. Power On
4. Open the blynk app in the mobile and check the water level.

5. In the 'Eventer' wizard of the Blynk app set the water level limits and the corresponding IO to operate the controlling water pump.

6. Monitor the water level.



4.4 Components required

Table 2: Component listing

Sl. No.	Component	Qtn
1.	HC SP 04	1
2.	NODE MCU	1
3.	Static Relay (5 volt)	1
4.	0.96” OLED	1
5.	Water Pump	1
6.	BC 547	1
7.	1k Resistor	1
8.	5mm Led	3
9.	Relay terminals	1
10.	Single strand wire	2m
11.	IC base (14 pin)	1
12.	Female PCB Header Connector	1
13.	IC 7432	1
14.	Latch Switch	1

4.5 Hardware connection

4.5.1 Relay Driver interfacing with microcontroller

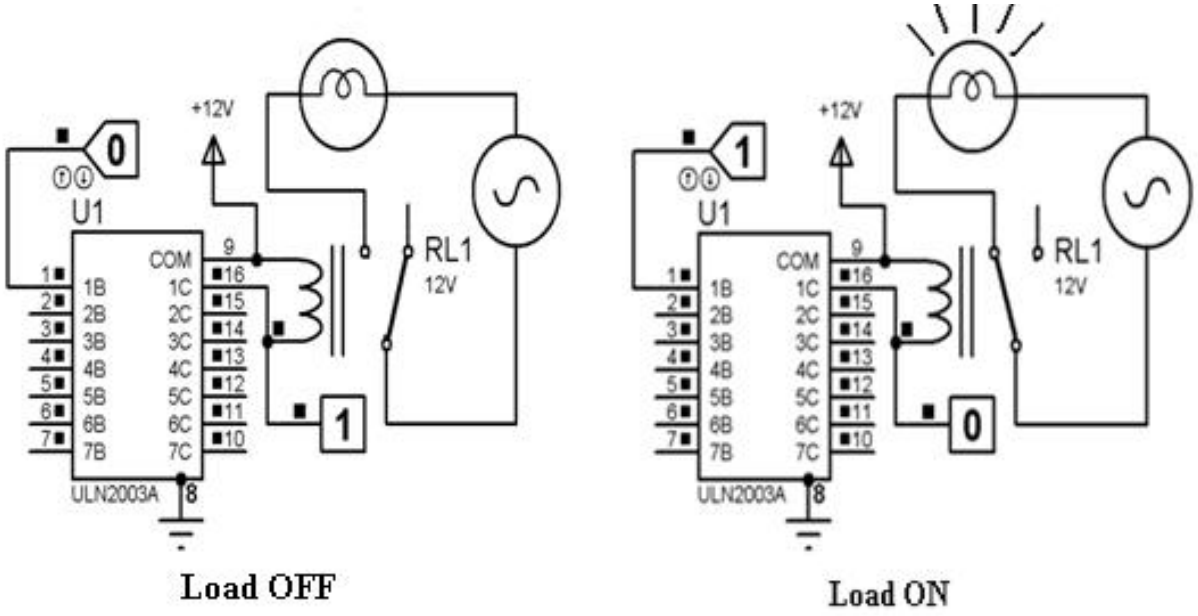


Figure 20: ULN2003A interfacing with microcontroller

The ULN2003A is a active high relay driver. 7 relays are controlled by this relay driver. Pin 1-7 are for controlling the relays which are connected to pin 10-16. For a ‘0’ from microcontroller the corresponding relay is turned off and a ‘1’ from microcontroller is turned on the relay.

4.5.2 HC SR 04 interfacing with NODE MCU

Hcsr04 ultrasonic sensor is composed of ultrasonic transmitter, ultrasonic receiver and a control circuit. Hscr04 ultrasonic transmitter transmits ultrasound waves at 40,000 Hz. Transmitted waves bounce back if they hit any flat surface/object in their path. Bounced back waves reach the ultrasonic receiver. Ultrasonic receiver receives the bounced back waves and notifies the control circuit about it. Control circuit than calculates the time taken by waves to reach back after transmission. Time is than manipulated to approximate the distance travelled by waves or what is the distance between the sensor and the object? from which ultrasound waves bounced back.

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- **Trigger pin** is triggered by external controller to out burst an ultrasound wave.
- **Echo pin** notifies external controller when receiver receives back the bounced back wave.

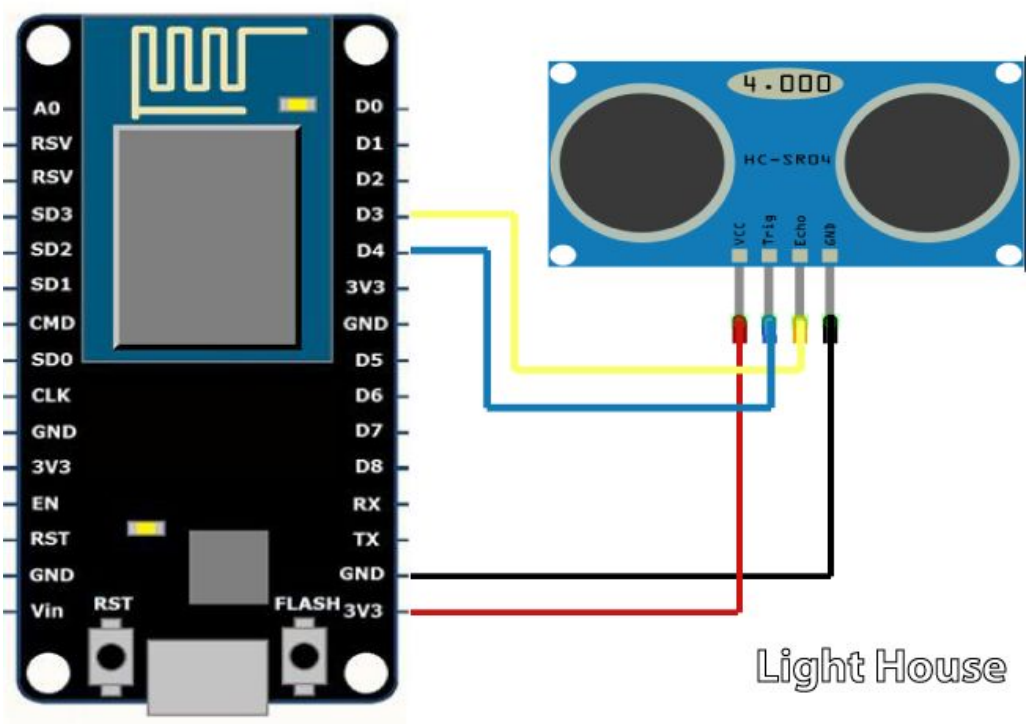


Figure 21: Interfacing HC SR 04 with NODE MCU

4.5.3 OLED Graphic Display Interfacing with NodeMCU

OLED Display Module

The OLED module shown in the figure 22 is a very popular module available in the market.There are many variants of this module available in market, having different resolutions, communication protocol or pixel colors.They do not require backlight since the display creates its own light. Hence, they consume less power. Both I2C and SPI based OLED modules are available in market.

A NodeMCU can communicate with this module using I2C communication protocol.

Pin Description

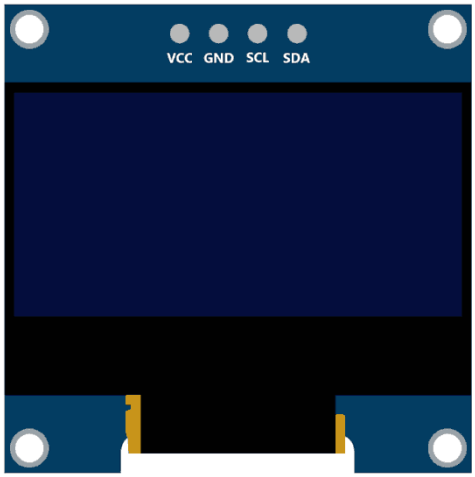


Figure 22: 128x64 I2C based OLED module.

VCC: This is the power pin for the module. A supply of 3.3V or 5V can be provided to this pin to power the display.

GND: This is the ground pin for the module.

SCL and SDA: These are the serial clock and serial data pins for I2C Interface.

Interfacing Diagram

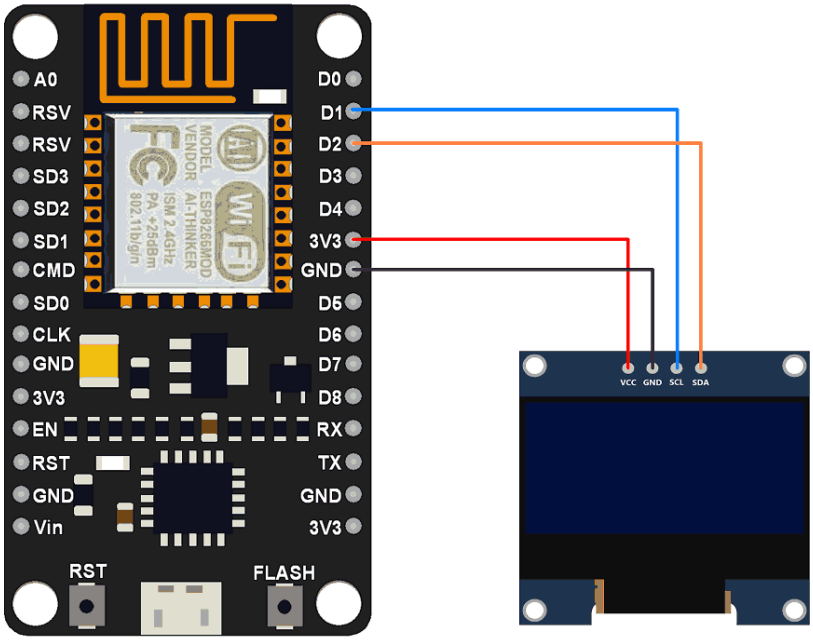


Figure 23: Interfacing OLED Display with NodeMCU

CHAPTER 5

(Logic & Operation)

5.1 INTRODUCTION

After assembling the system, what remains is to observe its operation and efficiency of the system. The total system is divided in several sub systems, like

- Node MCU Section
- HC SR04 Section
- OLED Section
- Relay Section

The operation of the whole circuit is depending on every sections performance.

5.2 Flow Chart

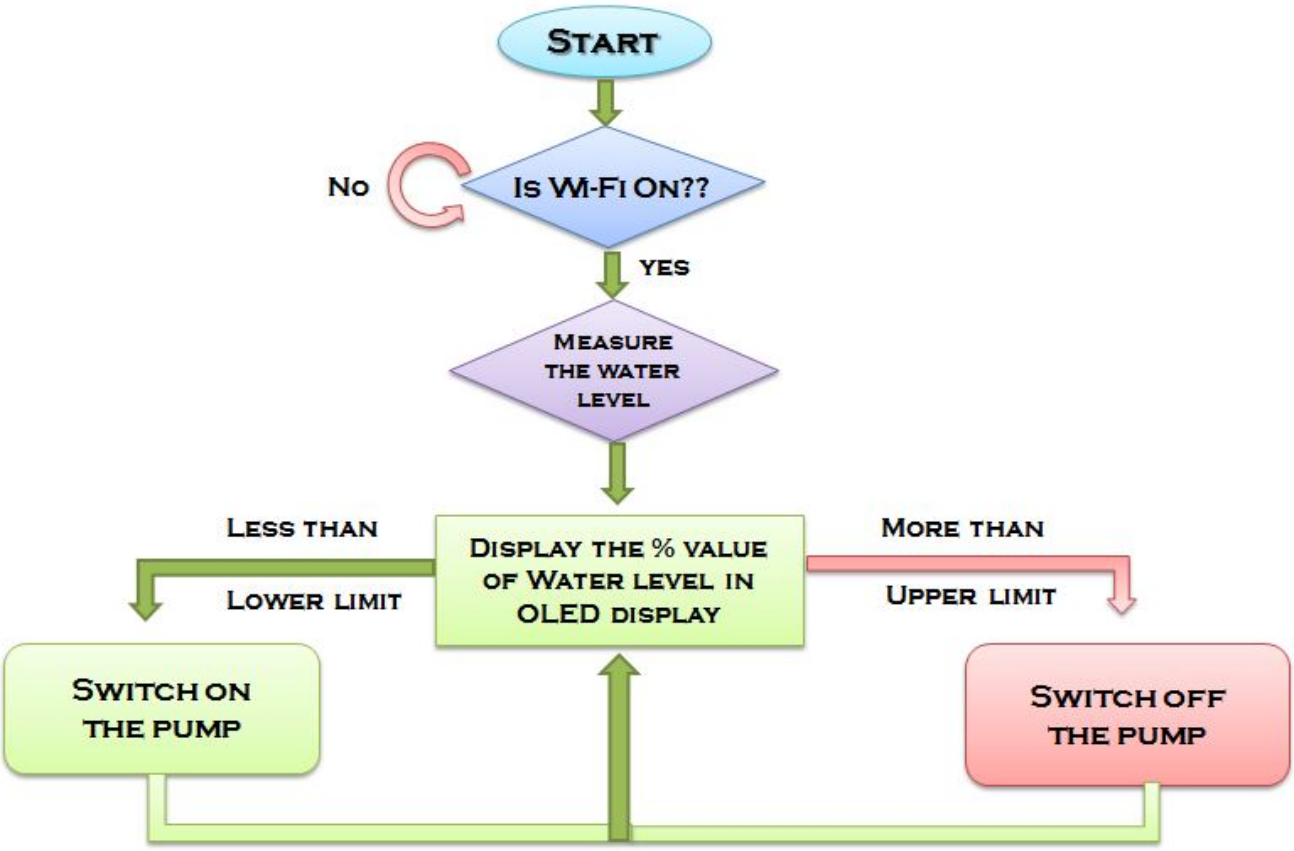


Figure 24: Flow chart of the program

5.3 Principle &Operations

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

5.3.1 Advantages of the NODE MCU

- ***Low cost :*** The Node MCU is less costlier than any other IOT based Devices.Because the wifi module which is used in it is of lowest cost.

- ***Hardware Part:*** It 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.

- ***Network API:*** Node MCU has easily configurable network API.

- ***Integrated Wifi Module:*** ESP 8266 is incorporated in NODE MCU.It is an easily accessiblewifi module.

5.3.2 Disadvantages

- The operation of the circuit depends on the working internet connection. If the working internet connection is not available then it will not run.
- It 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 resourcesof official documentation

5.4 Blynk app

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other things.
There are three major components in the platform:

- **Blynk App** - 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.

Now imagine: every time you press a Button in the Blynk app, the message travels to space the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blynk of an eye.

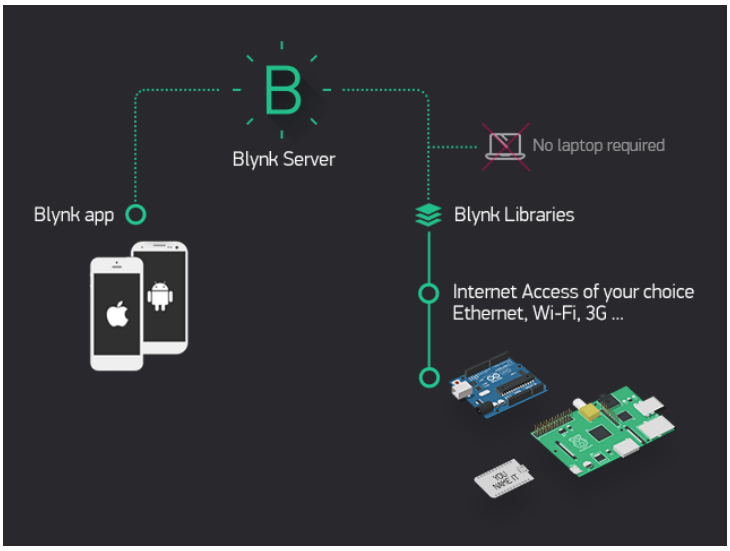


Figure 25: Blynk working principle

5.5 HC SR04 Ultrasonic sensors features

- Input Voltage: 5V
- Current Draw: 20mA (Max)
- Digital Output: 5V
- Digital Output: 0V (Low)
- Working Temperature: -15°C to 70°C
- Sensing Angle: 30° Cone
- Angle of Effect: 15° Cone
- Ultrasonic Frequency: 40kHz
- Range: 2cm - 400cm
- Dimensions
    - Length: 43mm
    - Width: 20mm
    - Height (with transmitters): 15mm
    - Centre screw hole distance: 40mm x 15mm
    - Screw hole diameter: 1mm (M1)
    - Transmitter diameter: 8mm

5.6 Cost estimation of the project

In this project we have used the cheapest IOT module NODE MCU. So the total cost of the project is reduced compare to the other IOT project. The total estimated cost of the complete project is listed in table 3.

Table 3: Costing of the projects

Sl. No.	Component	Cost
1.	HC SP 04	120
2.	NODE MCU	330

3.	Static Relay (5 volt)	25
4.	0.96” OLED	400
5.	Water Pump	290
6.	BC 547	2
7.	1k Resistor	1
8.	5mm Led	3
9.	Relay terminals	5
10.	Single strand wire	30
11.	IC base (14 pin)	5
12.	Female PCB Header Connector	8
13.	IC 7432	10
14.	Latch Switch	5
15.	General Blank PCB (KS100)	40
Total		**1274/-**

5.7 Photographs of the prototype

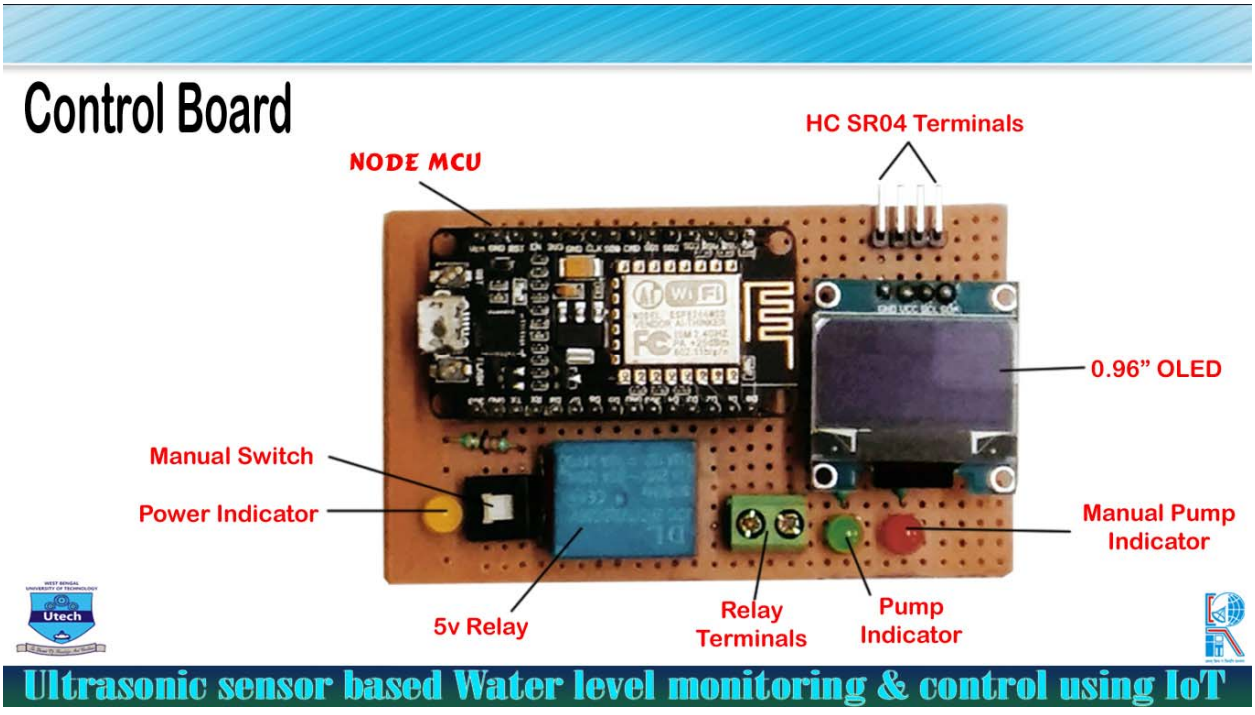


Figure 26: Main Controller Board

Figure 27: The whole prototype

Figure 28: The Blynk app user interface

Chapter 6

(Conclusion & Future Scope)

6.1 Conclusion

Here we developed a circuit which will control and monitor the water level of an overhead tank usingIOT. It also limits the wastage of water problem due to lack of proper monitoring in the home. It consists mainly following parts wifidevice,NodeMcu, OLED, ultrasonic sensor(HC SR 04). First it needs to be check whether our module is connected to wifi or not. If it is connected, it will directly show the water level on OLED as well as on mobile. It continuously monitors the water level of the tank. Whenever the level crosses the predefined set lower, water pump will automatically start and if the water level crosses the upper limit of the tank then the pump will automatically stop to prevent wastage of water.

6.2 Result

The experimental model was made according to the circuit diagram and the results were as expected. The blink app and the OLED show the water level of an overhead tank as soon as it is connected to the wifi. After proper monitoring it switch on water pump according to the situation.

6.3 Future work

Ultrasonic sensor based Water level Monitoring & Control using IoT:

1) **Monitoring the lower reservoir level:**

In our project, we have used 19W submersible centrifugal water pump which is installed in the lower reservoir, but there is no sensor or setup which can measure lower reservoir water level. If water is dried out and the water level becomes below the pump set up. Then pump would not be submerged in the lower water reservoir, diffuser could not suck the water by backward curved vanes. As a result, Motor may burn. So this is the main limitation of our project.

2) **Measuring the water quality:**

For the industry usage, when water pump will be allowed to uplift water from lower reservoir or local pond, river, then mud, sand, pebbles, household junks, wastes, plastics can block the water pipe attached with the motor. So we must check the basic quality of water by**Turbidity sensors. It** measures the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's **turbidity** level (and cloudiness or haziness) increases. On another hand, ph. meter is also used to make sure of the acidity of the water.

3) Measuring the water temperature

Hot water can harm the valves, vanes and pumps efficiency. Some thermocouple sensors or thermistors can measure the lower level reservoirs water temperature. The thermocouple is prepared by two dissimilar metals which generate the electrical voltage indirectly proportional to change the **temperature**. By this process, we can implement some IoT devices to show temp data in both upper and lower reservoir and upload it in the server.

4) **Including the rain water storage**

By 2020 about 30-40% of the world will have water scarcity, and according to the researchers, climate change can make this even worse.By 2025, an estimated 1.8 billion people will live in areas plagued by water scarcity, with two-thirds of the world's population living in water-stressed regions.Collecting **rainwater** has many advantages. When **harvesting rainwater** on a slope or hill, it can prevent soil erosion caused by water runoff after heavy rains. **Rainwater harvesting** structures are easy to build, do not require expensive materials and are low-maintenance. So distilled water saving is very necessary. Rain water is the huge source of it. So our future plan is to make a rain water reservoir for additional purpose.

Chapter 7

(References)

[1] Charles A, “IOT BASED WATER LEVEL MONITORING SYSTEM USING LABVIEW” ,International Journal of Pure and Applied Mathematics,Volume 118 No. 20 2018, 9-14 ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version).

[2] S.V.Manikanthan and T.Padmapriya “Recent Trends In M2m Communications In 4g Networks And Evolution Towards 5g”, International Journal of Pure and Applied Mathematics, ISSN NO:1314-3395, Vol115, Issue -8, Sep 2017.

[3] Neena Mani, Sudeesh T.P, Vinu Joseph, Titto V.D, Shamnas P.S, “Design and Implementation of a Automated Water Level Indicator”, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering 2014 Vol 3 Issue 2, February 2014.

[4] Jadhav, G. J, “Design and Implementation of Advanced ARM Based Surveillance System using Wireless Communication, International Journal of Advance Research in Computer Science and Management Studies”Vol 2,2014.

[5] Priya B. Patel, Viraj M. Choksi, SwapnaJadhav, M.B. Potdar, “Smart Motion Detection System using Raspberry Pi”, International Journal of Applied Information Systems (IJAIS), Vol10 – No.5, February 2016.

[6] S. M. Khaled Reza, Shah Ahsanuzzaman Md. Tariq, “Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue”, Proceedings of the World Congress on Engineering and Computer Science 2010 Vol I WCECS 2010, October 20-22, 2010, San Francisco, USA.

[7] R. S. SUNMONU, M. A. SODUNKE, O. S. ABDULAI & E. A. AGBOOLA “DEVELOPMENT OF AN ULTRASONIC SENSOR BASED WATER LEVEL INDICATOR WITH PUMP SWITCHING TECHNIQUE”,International Journal For Research In Electronics & Electrical Engineering ISSN: 2208-2735

Appendix A

(Hardware description)

Transformer less AC to DC power supply circuit using dropping capacitor

Production of low voltage DC power supply from AC power is the most important problem faced by many electronics developers and hobbyists. The straight forward technique is the use of a step down transformer to reduce the 230 V or 110V AC to a preferred level of low voltage AC. But *SMPS* power supply comes with the most appropriate method to create a low cost power supply by avoiding the use of bulky transformer. This circuit is so simple and it uses a voltage dropping capacitor in series with the phase line. Transformer less power supply is also called as capacitor power supply. It can generate 5V, 6V, 12V 150mA from 230V or 110V AC by using appropriate zener diodes.

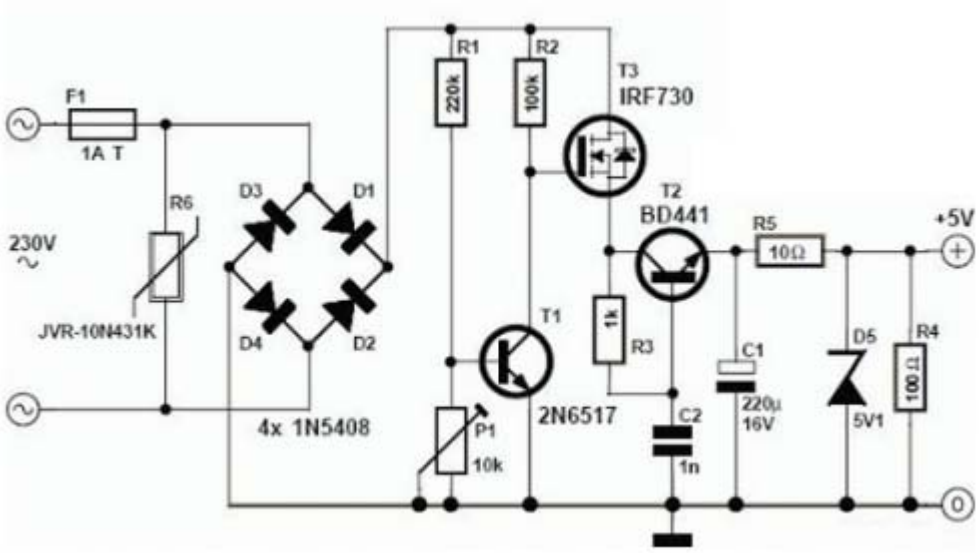


Figure 29: Transformer less SMPS 5 volt power supply

Working of Transformer less capacitor power supply

- This transformer less power supply circuit is also named as capacitor power supply since it uses a special type of AC capacitor in series with the main power line.
- A common capacitor will not do the work because the mains spikes will generate holes in the dielectric and the capacitor will be cracked by passing of current from the mains through the capacitor.
- X rated capacitor suitable for the use in AC mains is vital for reducing AC voltage.
- A X rated dropping capacitor is intended for 250V, 400V, 600V AC. Higher voltage versions are also obtainable. The dropping capacitor is non polarized so that it can be connected any way in the circuit.
- The 470kΩ resistor is a bleeder resistor that removes the stored current from the capacitor when the circuit is unplugged. It avoids the possibility of electric shock.
- Reduced AC voltage is rectified by bridge rectifier circuit. We have already discussed about bridge rectifiers. Then the ripples are removed by the 1000µF capacitor.

- This circuit provides 24 volts at 160 mA current at the output. This 24 volt DC can be regulated to necessary output voltage using an appropriate 1 watt or above zener diode.
- Here we are using 6.2V zener. You can use any type of zener diode in order to get the required output voltage.

Relay Driver

- The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays.
- It consists of seven NPN Darlington pairs that features high-voltage outputs with common-cathode clamp diode for switching inductive loads.
- The collector-current rating of a single Darlington pair is 500mA.
- The ULN functions as an inverter.
- If the logic at input 1B is high then the output at its corresponding pin 1C will be low.

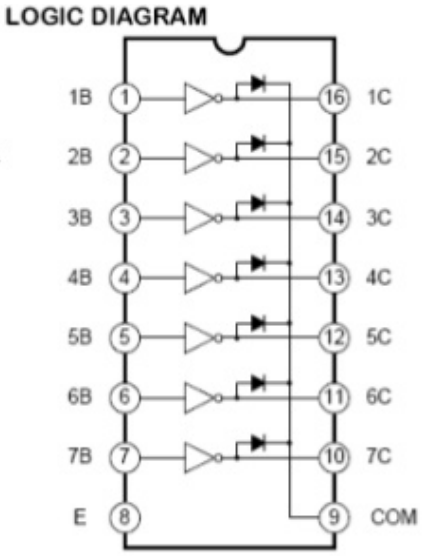


Figure 30: ULN2003A Internal Block Diagram

Resistor

Figure 31: Resistor

Resistance is the opposition of a material to the current. It is measured in Ohms Ω. All conductors represent a certain amount of resistance, since no conductor is 100% efficient. To control the electron flow (current) in a predictable manner, we use resistors. Electronic circuits use calibrated lumped resistance to control the flow of current. Broadly speaking, resistor can be divided into two groups viz. fixed & adjustable (variable) resistors. In fixed resistors, the value is fixed & cannot be varied. In variable resistors, the resistance value can be varied by an adjuster knob. It can be divided into (a) Carbon composition (b) Wire wound (c) Special type. The most common type of resistors used in our projects is carbon type. The resistance value is normally indicated by color bands. Each resistance has four colors, one of the band on either side will be gold or silver, this is called fourth band and indicates the tolerance, others three band will give the value of resistance (see table). For example if a resistor has the following marking on it say red, violet, gold. Comparing these colored rings with the

color code, its value is 27000 ohms or 27 kilo ohms and its tolerance is ±5%. Resistor comes in various sizes (Power rating).The bigger the size, the more power rating of 1/4 watts. The four color rings on its body tells us the value of resistor value.

Color Code of the resistor

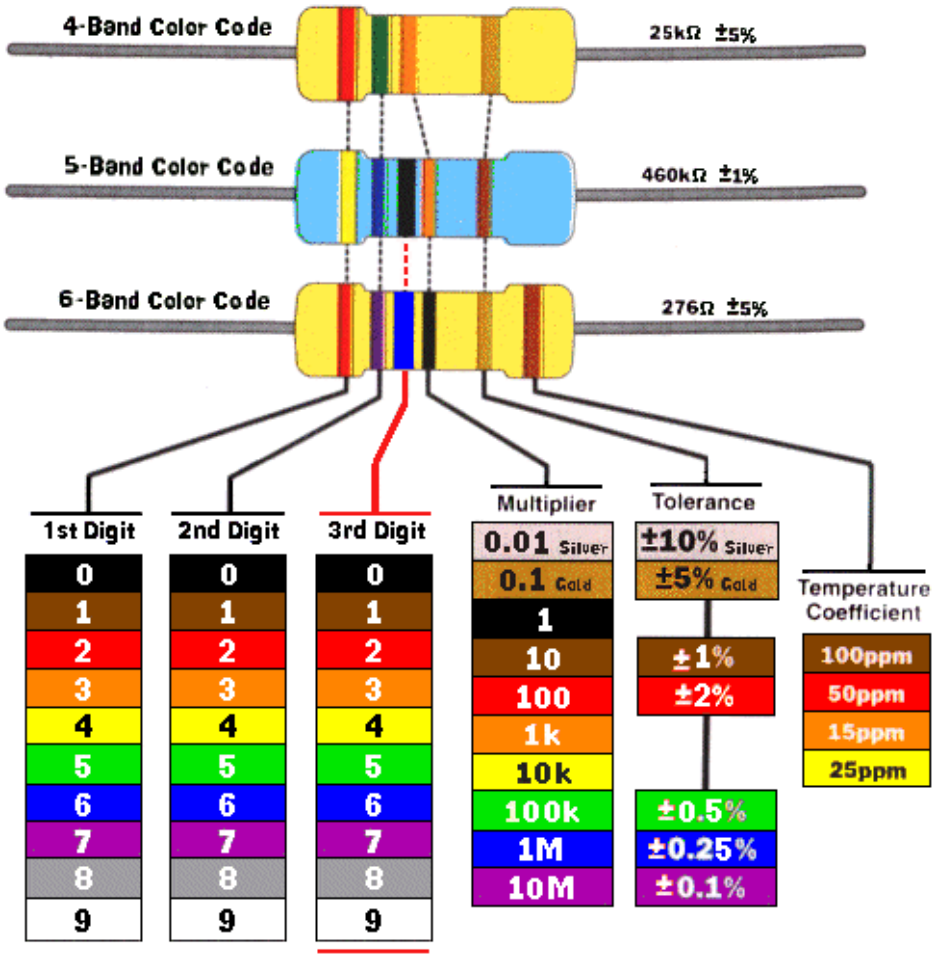


Figure 32: Color Code for resistance

RELAY

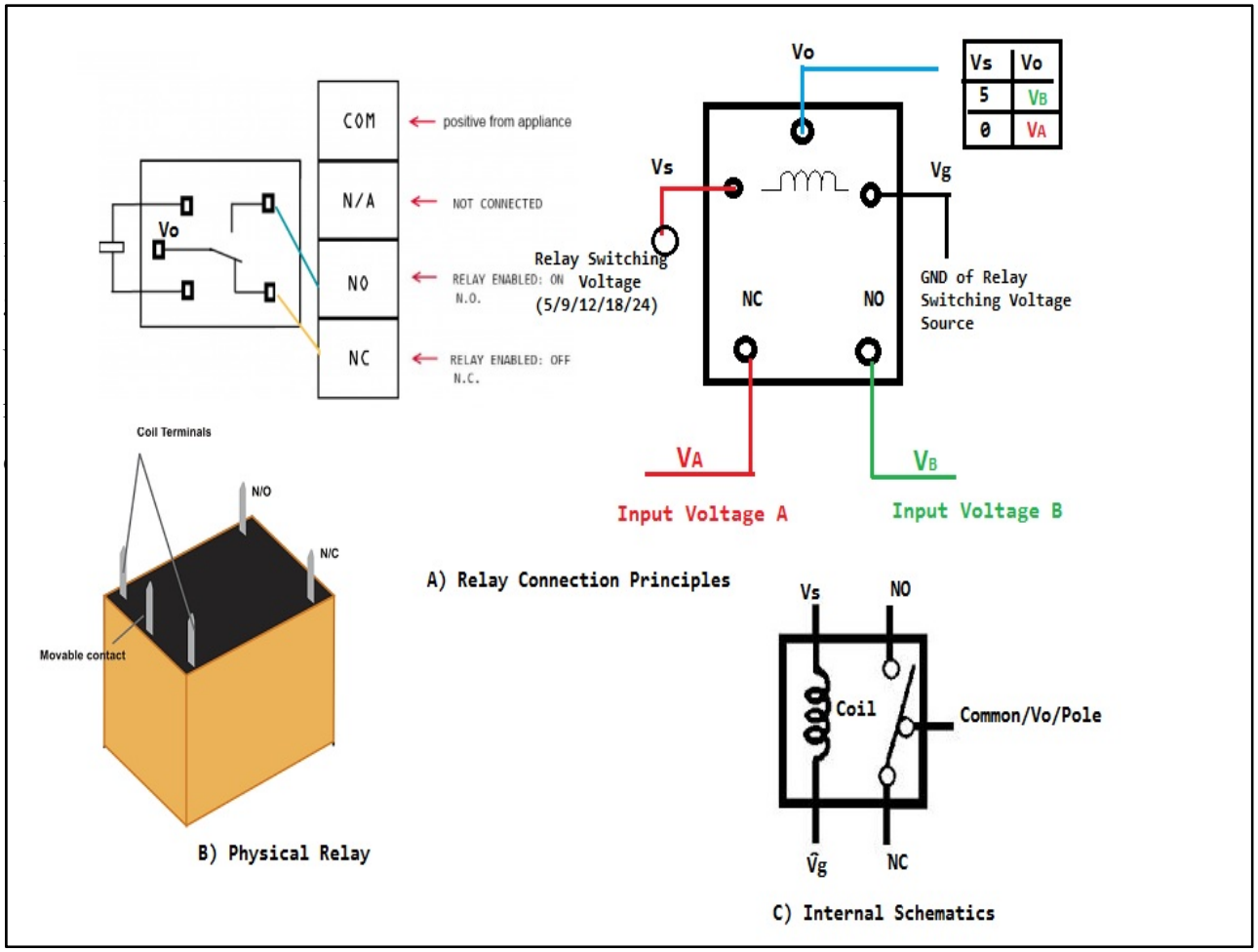


Figure33: 6 volt Cube Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

The relay's switch connections are usually labeled COM (POLE), NC and NO:

COM/POLE= Common, NC and NO always connect to this, it is the moving part of the switch.

NC = Normally Closed, COM/POLE is connected to this when the relay coil is not magnetized.

NO = Normally Open, COM/POLE is connected to this when the relay coil is MAGNETIZED and vice versa.

OLED

An organic light-emitting diode (OLED) is a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current. This organic layer is situated between two electrodes; typically, at least one of these electrodes is transparent. OLEDs are used to create digital displays in devices such as television screens, computer monitors, portable systems such as smart phones, handheld game consoles and PDAs. A major area of research is the development of white OLED devices for use in solid-state lighting applications.

Figure34: 128X64 OLED Module

NodeMCU

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

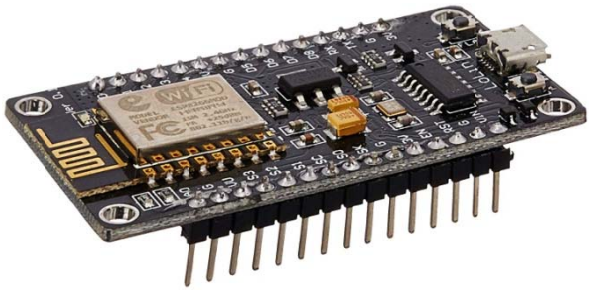


Figure35: Node MCU Module

Piezo buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of

user input such as a mouse click or keystroke. A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.

Figure 36: Piezo Buzzer

Blank PCB

A **printed circuit board** (**PCB**) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCBs can be *single sided* (one copper layer), *double sided* (two copper layers) or *multi-layer* (outer and inner layers). Multi-layer PCBs allow for much higher component density. Conductors on different layers are connected with plated-through holes called vias. Advanced PCBs may contain components - capacitors, resistors or active devices - embedded in the substrate.

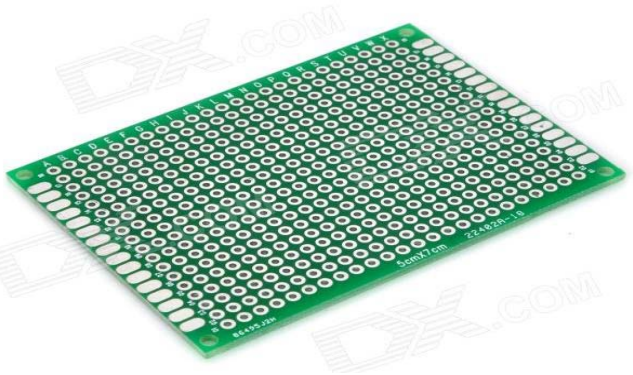


Figure 37: Blank glass epoxy PCB Board

FR-4 glass epoxy is the primary insulating substrate upon which the vast majority of rigid PCBs are produced. A thin layer of copper foil is laminated to one or both sides of an FR-4 panel. Circuitry interconnections are etched into copper layers to produce printed circuit boards. Complex circuits are produced in multiple layers.

Printed circuit boards are used in all but the simplest electronic products. Alternatives to PCBs include wire wrap and point-to-point construction. PCBs require the additional design effort to lay out the circuit, but manufacturing and assembly can be automated. Manufacturing circuits with PCBs is cheaper and faster than with other wiring methods as components are mounted and wired with one single part. Furthermore, operator wiring errors are eliminated.

Appendix B

(Software coding)

PROGRAM CODE:

```
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>*
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define TRIGGERPIN D4
#define ECHOPIN    D5
#define PUMP       D6

char auth[] = "f6zC863whG90ypmSeKGSOUjDeBfhiy7R";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Tanmoy";
char pass[] = "password1234";

/* TIMER */
#include <SimpleTimer.h>
SimpleTimer timer;

#define OLED_RESET D5  //14
Adafruit_SSD1306 display(OLED_RESET);

long duration, distance, distance1;
float percentage;
int pumpstatus;
void setup()
{
display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
display.clearDisplay();
display.setCursor(0,0);
display.setTextSize(1);
display.drawRoundRect(0, 0, 128, 64, 8, WHITE);
display.drawRoundRect(5, 5, 118, 54, 8, WHITE);
// Sets the color to black with a white background
display.setTextColor(WHITE);
display.setCursor(30,8);
display.println("WATER LEVEL");
display.drawLine(6,17,120,17, WHITE);
display.setCursor(20,20);
display.println("Please connect");
display.setCursor(32,30);
display.println("the wifi...");
display.drawLine(6,40,120,40, WHITE);
display.setCursor(33,46);
display.println("R C C I I T");
display.display();
```

```
  // Debug console
Serial.begin(115200);
pinMode(TRIGGERPIN, OUTPUT);
pinMode(ECHOPIN, INPUT);
pinMode(PUMP, OUTPUT);
Blynk.begin(auth, ssid, pass);
timer.setInterval(2000L, getSendData);
Serial.println(" ");
Serial.println("Sensing the Water Level");
}

void loop()
{
timer.run(); // Initiates SimpleTimer
Blynk.run();

//display the level into OLED
display.clearDisplay();
display.setCursor(0,0);
display.drawRoundRect(0, 0, 128, 64, 8, WHITE);
display.drawRoundRect(5, 5, 118, 54, 8, WHITE);

// Sets the color to black with a white background
display.setTextColor(WHITE);
display.setCursor(30,8);
display.setTextSize(1);
display.println("WATER LEVEL");
display.drawLine(6,17,120,17, WHITE);
display.setCursor(15,25);
display.println("LEVEL = ");
display.setTextSize(2);
display.setCursor(65,20);
display.println(distance1);
display.setCursor(100,20);
display.setTextSize(2);
display.println("cm");

display.drawLine(6,40,120,40, WHITE);
display.setCursor(33,46);
display.setTextSize(1);
display.println("R C C I I T");
display.display();

}
/*****************************************************
 * Send Sensor data to Blynk
 *****************************************************/
void getSendData()
{
  // Clears the trigPin
digitalWrite(TRIGGERPIN, LOW);
delayMicroseconds(3);
digitalWrite(TRIGGERPIN, HIGH);
delayMicroseconds(12); // it may be 10 us
```

```
digitalWrite(TRIGGERPIN, LOW);

// Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(ECHOPIN, HIGH);
// Calculating the distance
  distance = (duration/2) / 29.1;
  distance1=20-distance;
  percentage = (distance1*100)/15;
  if (distance1 <= 3)
    {
digitalWrite(PUMP, HIGH);
pumpstatus = 255;
    }
    else if (distance1 >= 13)
      {
digitalWrite(PUMP, LOW);
pumpstatus = 0;
      }
Serial.println(" ");
Serial.print("Free Level : ");
Serial.print(distance);
Serial.print(" cm. Water Level: ");
Serial.print(distance1);
Serial.print(" cm. ");
Serial.print(" percentage = ");
Serial.print(percentage);
Serial.print(" %");
Blynk.virtualWrite(3, distance); //virtual pin V3
Blynk.virtualWrite(2, distance1); //virtual pin V2
Blynk.virtualWrite(4, pumpstatus); //virtual pin V4
Blynk.virtualWrite(5, percentage); //virtual pin V5
delay(500);
}
```

Appendix C

(Data sheets)

Ultrasonic Ranging Module HC - SR04

Product features:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:
(1) Using IO trigger for at least 10us high level signal,
(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
(3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.
Test distance = (high level time×velocity of sound (340M/S) / 2,

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

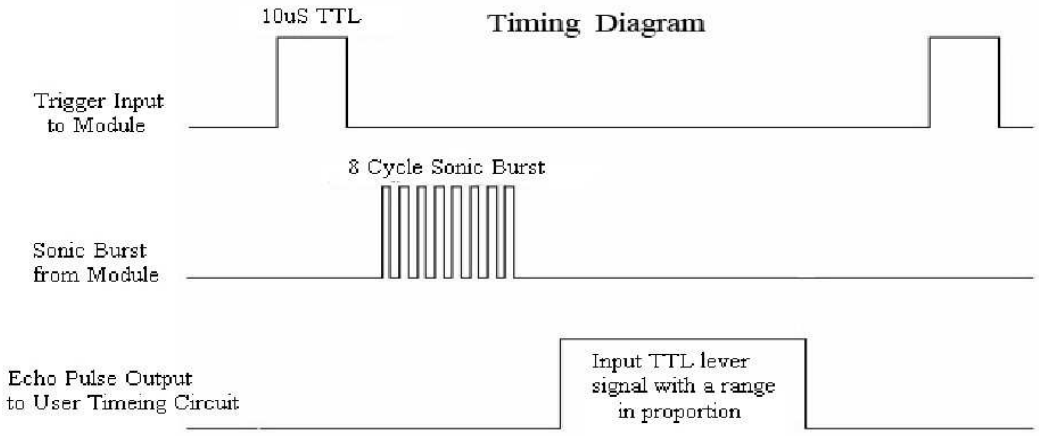
Electric Parameter

Working Voltage	**DC 5 V**
Working Current	**15mA**
Working Frequency	**40Hz**
Max Range	**4m**
Min Range	**2cm**
MeasuringAngle	**15 degree**
Trigger Input Signal	**10uS TTL pulse**
Echo Output Signal	**Input TTL lever signal and the range in proportion**
Dimension	**45*20*15mm**

Vcc Trig Echo GND

Timing diagram

The Timing diagram is shown below. You only need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion .You can calculate the range through the time interval between sending trigger signal and receiving echo signal. Formula: uS / 58 = centimeters or uS / 148 =inch; or: the range = high level time * velocity (340M/S) / 2; we suggest to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.



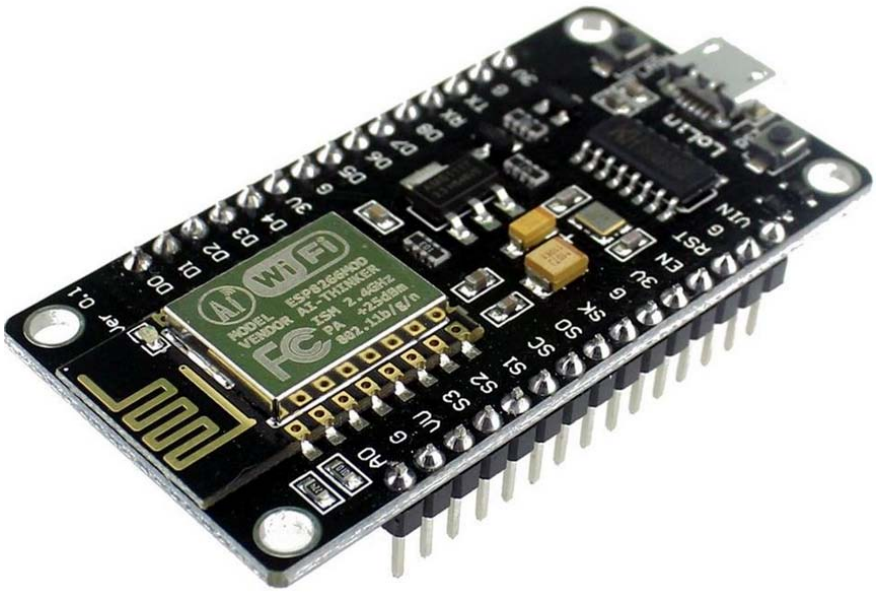
Attention:

- The module is not suggested to connect directly to electric, if connected electric, the GND terminal should be connected the module first, otherwise, it will affect the normal work of the module.
- When tested objects, the range of area is not less than 0.5 square meters and the plane requests as smooth as possible, otherwise ,it will affect the results of measuring.

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.

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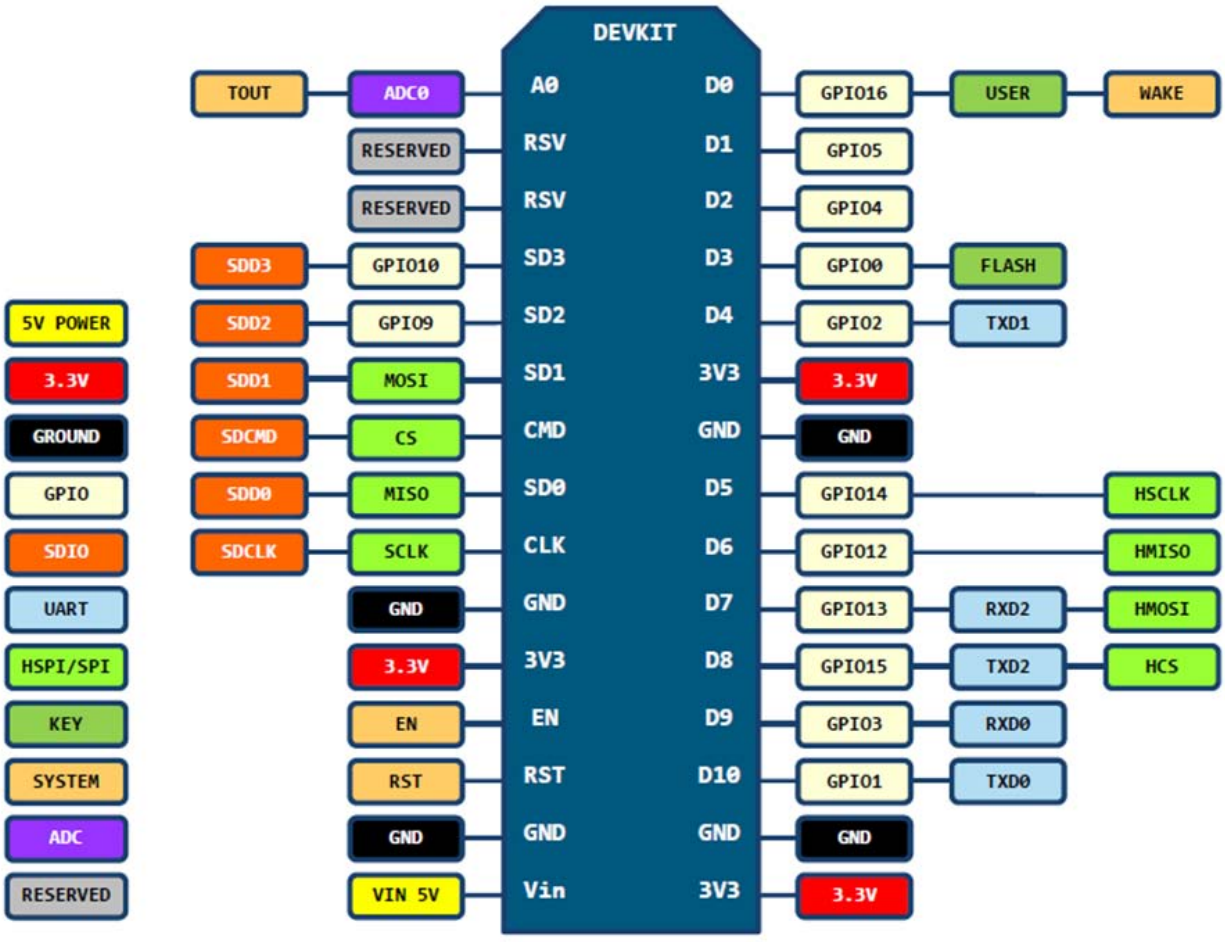
1. Specification:

- 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

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.

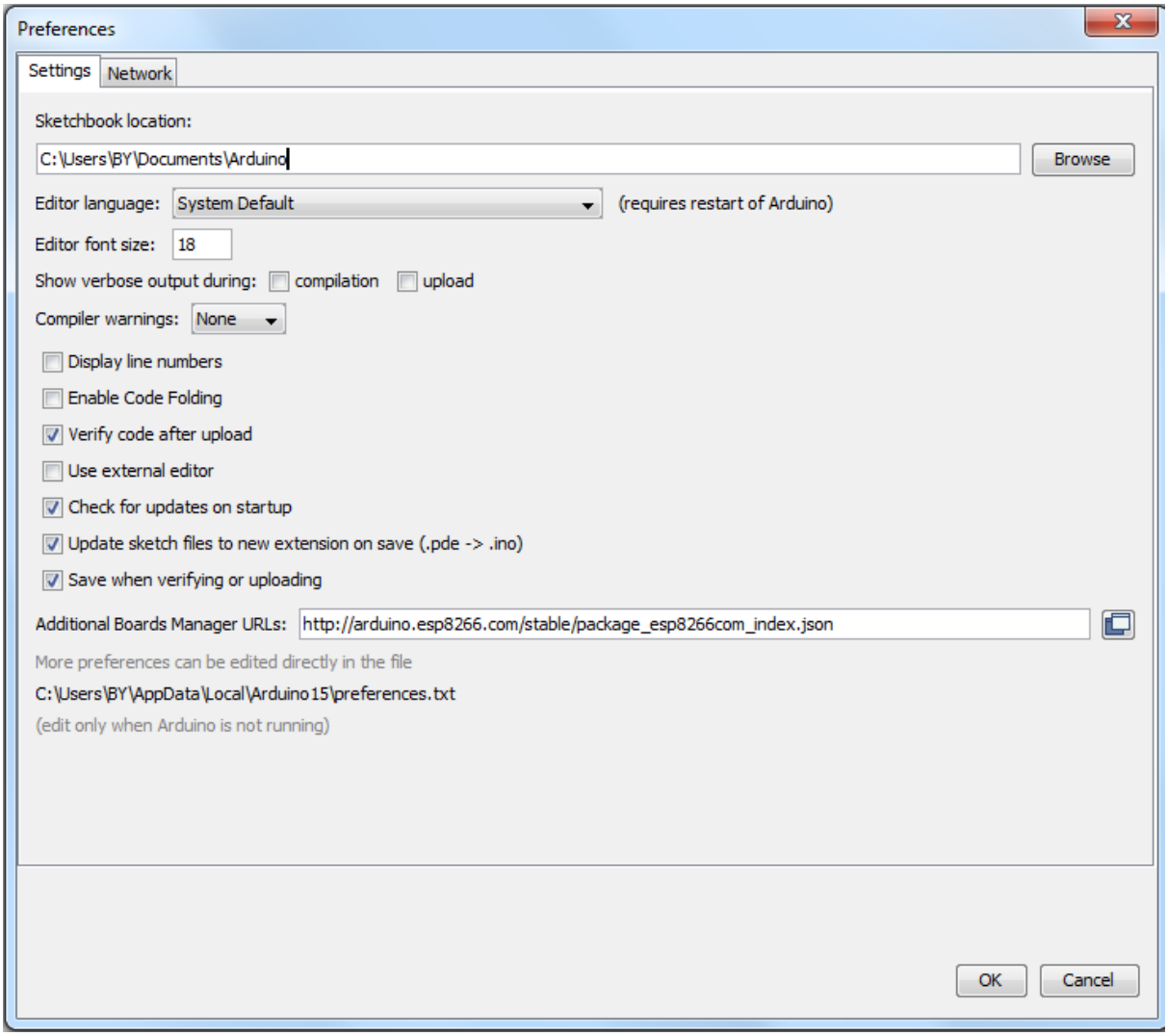
3.1 Install the Arduino IDE 1.6.4 or greater

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.

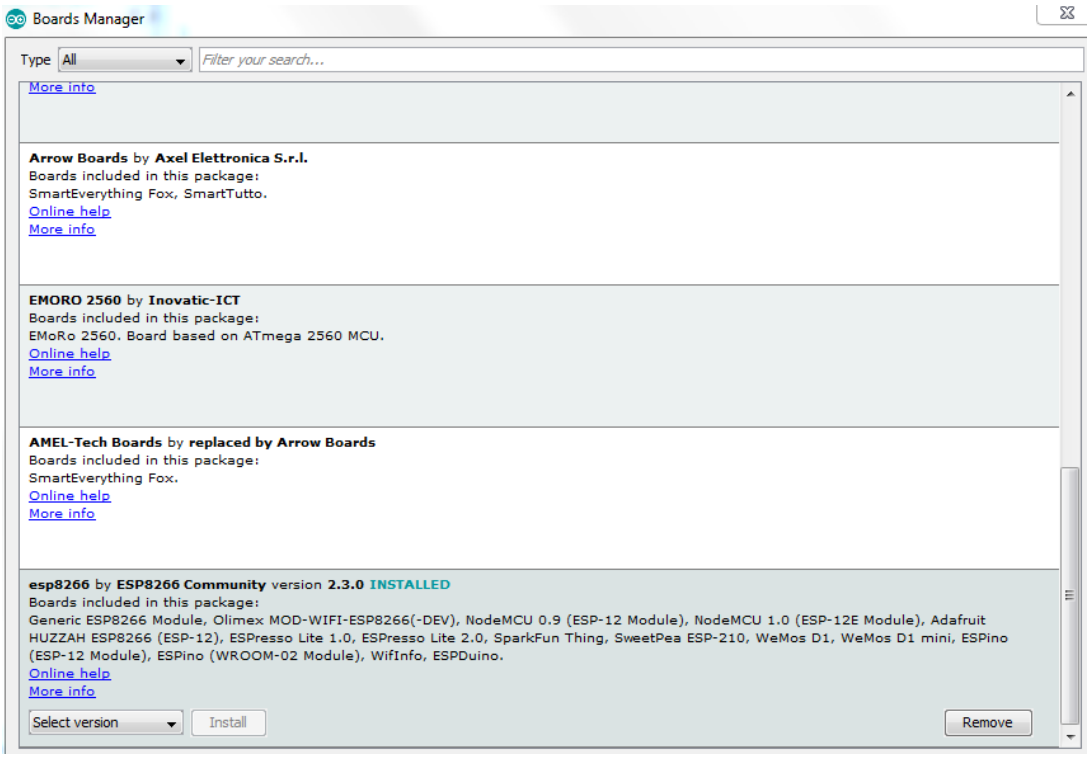
3.2 Install the ESP8266 Board Package

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.

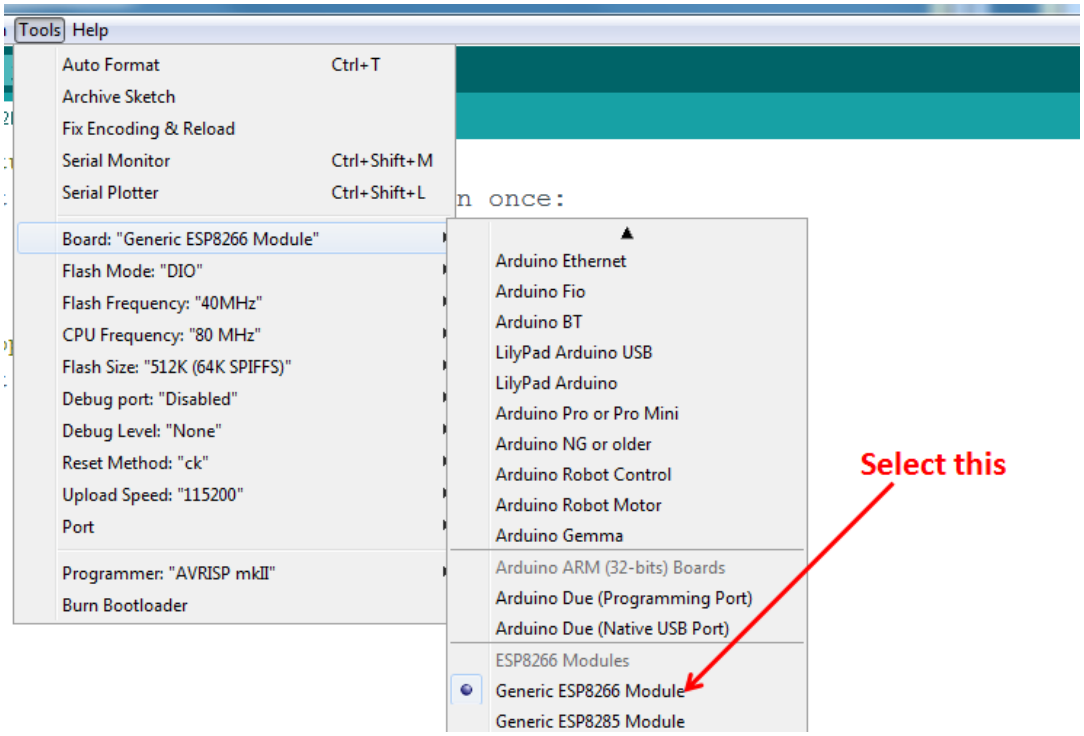


Click 'Tools' -> 'Board:' -> 'Board Manager…' to access this panel.

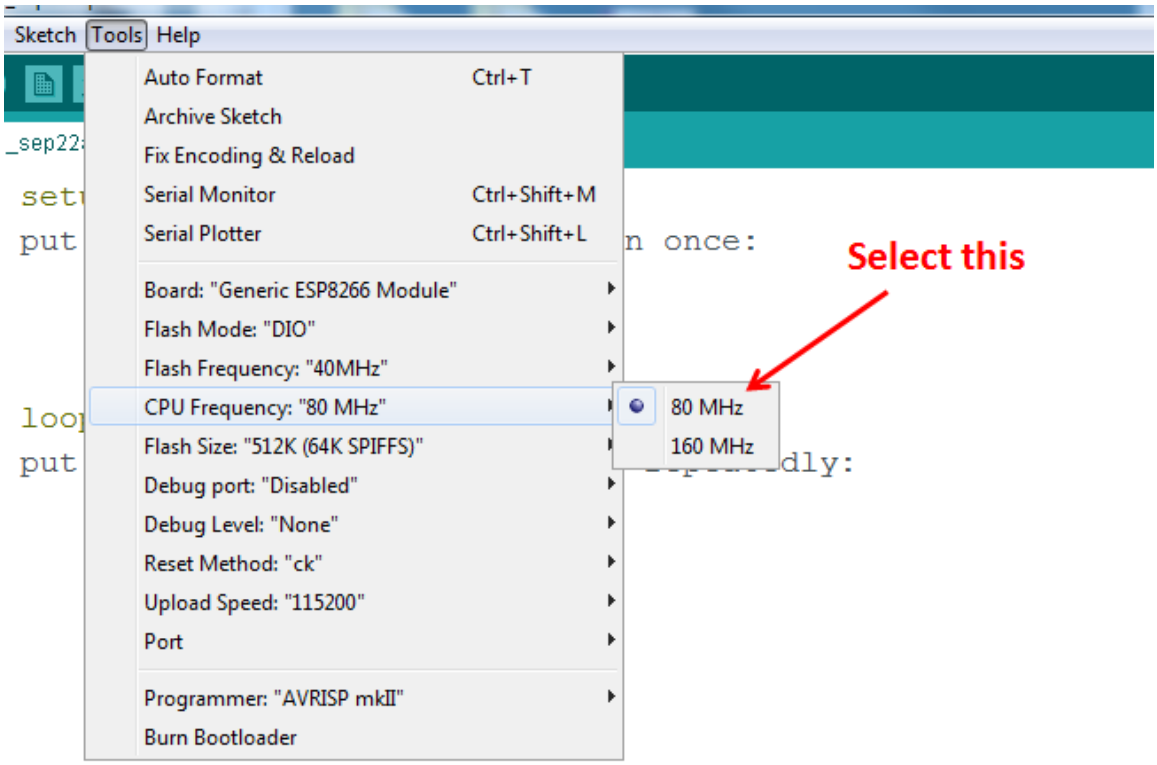
Scroll down to ' esp8266 by ESP8266 Community ' and click "Install" button to install the ESP8266 library package. Once installation completed, close and re-open Arduino IDE for ESP8266 library to take effect.

3.3 Setup ESP8266 Support

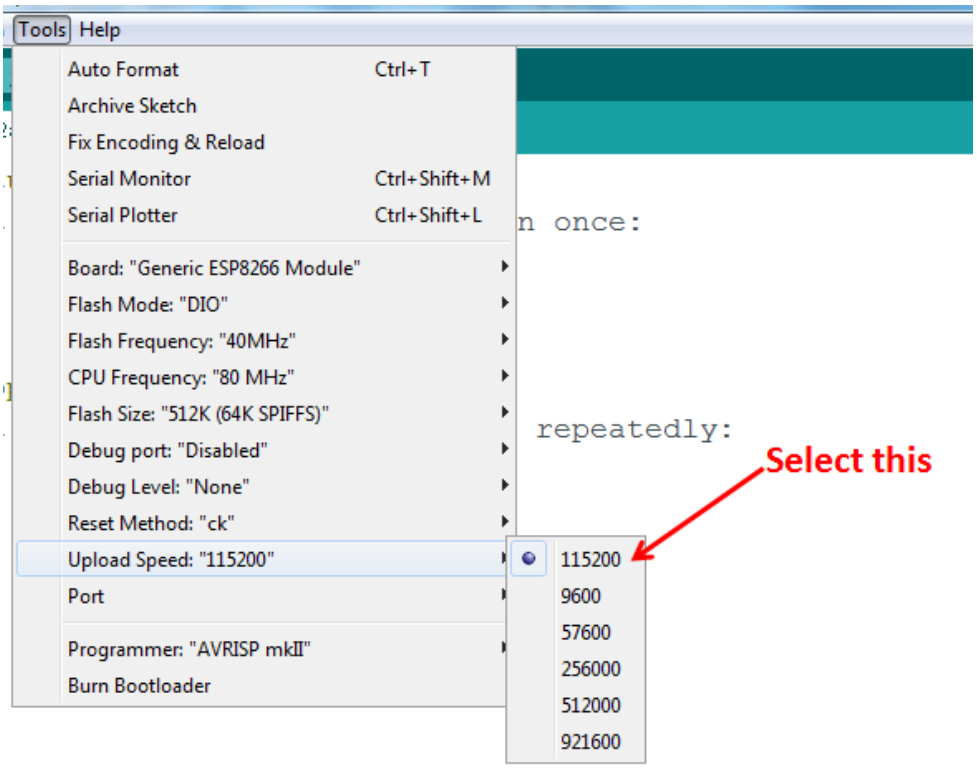
When you've restarted Arduino IDE, select 'Generic ESP8266 Module' from the 'Tools' -> 'Board:' dropdown menu.



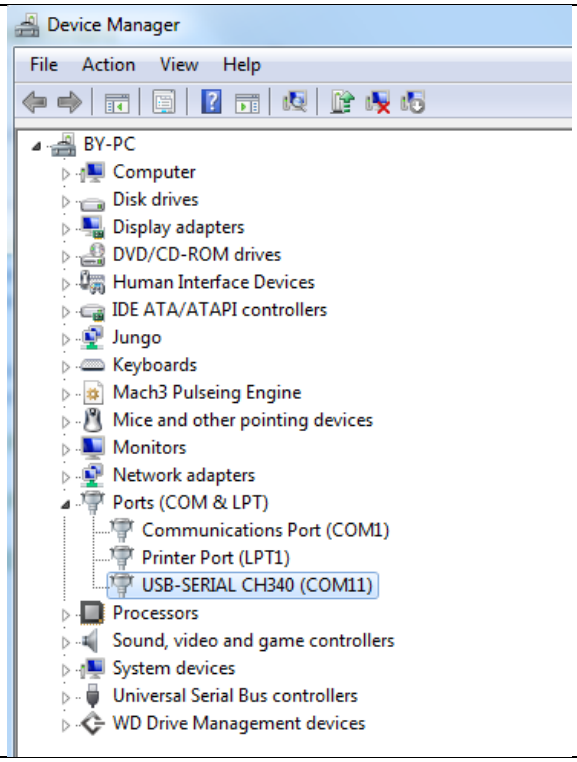
Select 80 MHz as the CPU frequency (you can try 160 MHz overclock later)



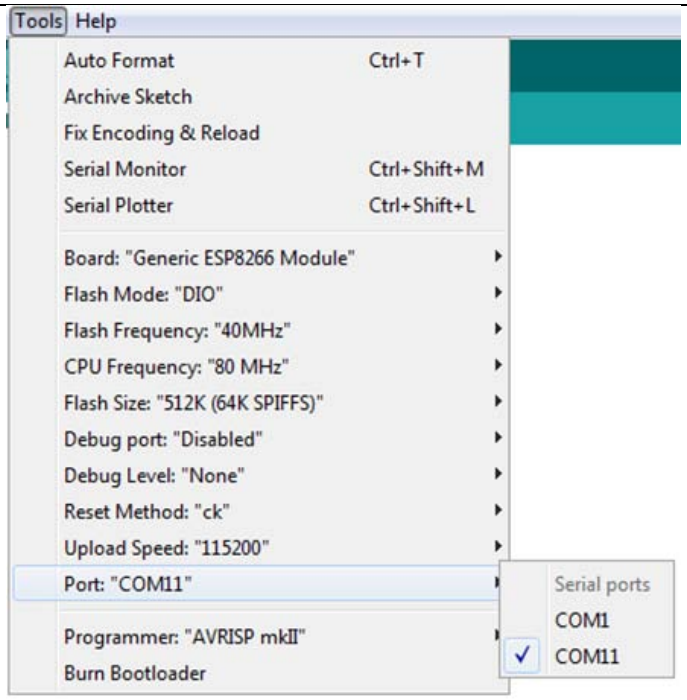
Select '115200' baud upload speed is a good place to start - later on you can try higher speeds but 115200 is a good safe place to start.



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.

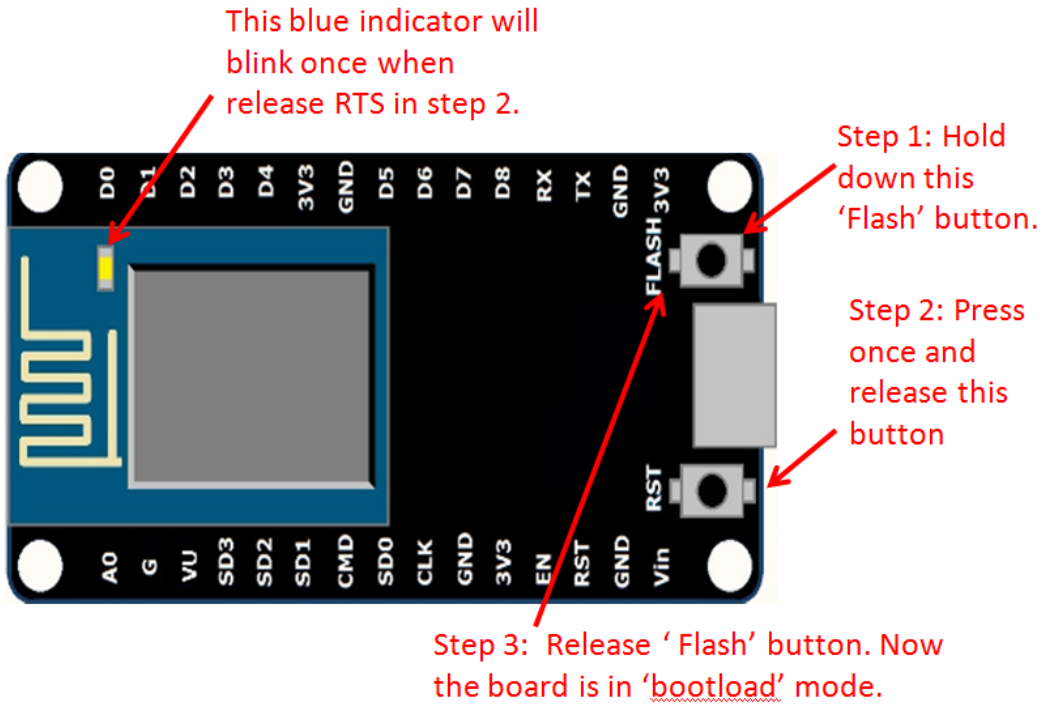
Enter this into the sketch window (and save since you'll have to). Connect a LED as shown in Figure3-1.

```
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.

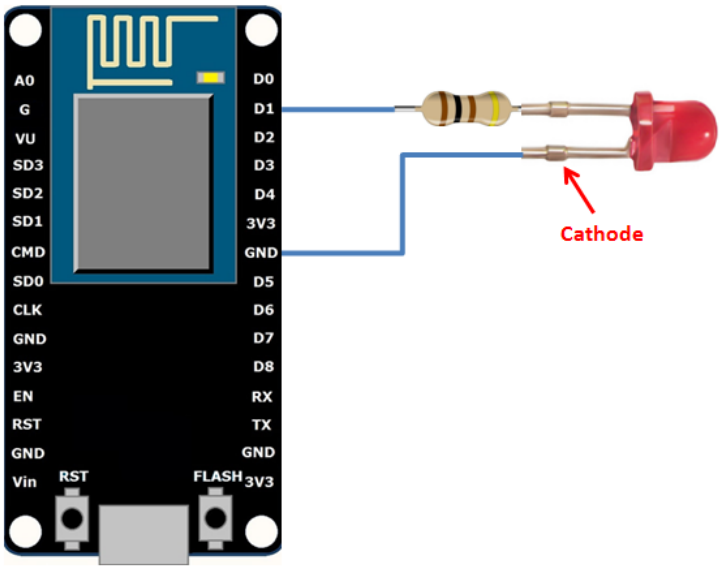


Figure3-1: Connection diagram for the blinking test

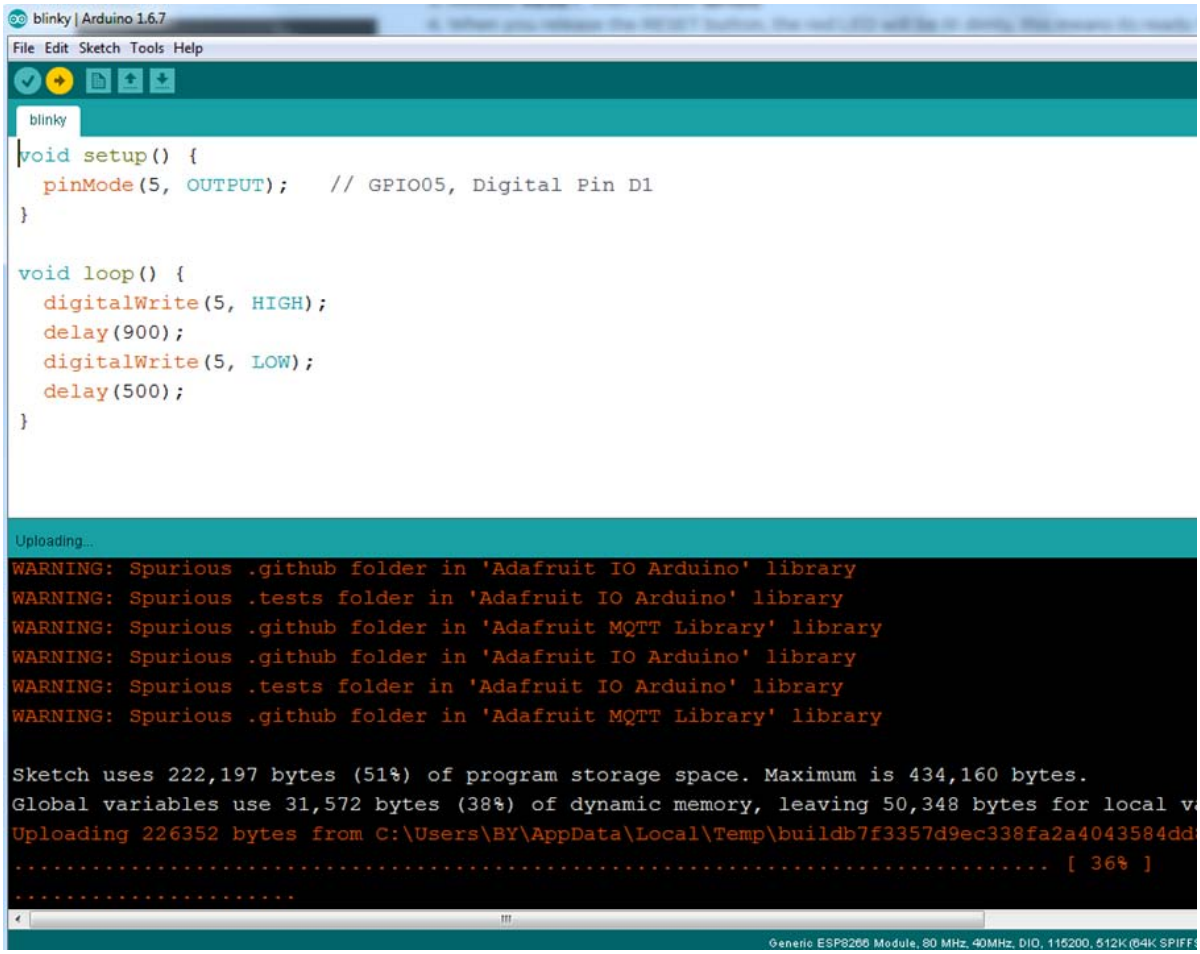


Figure 3.2: Uploading the sketch to ESP8266 NodeMCU module.

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";

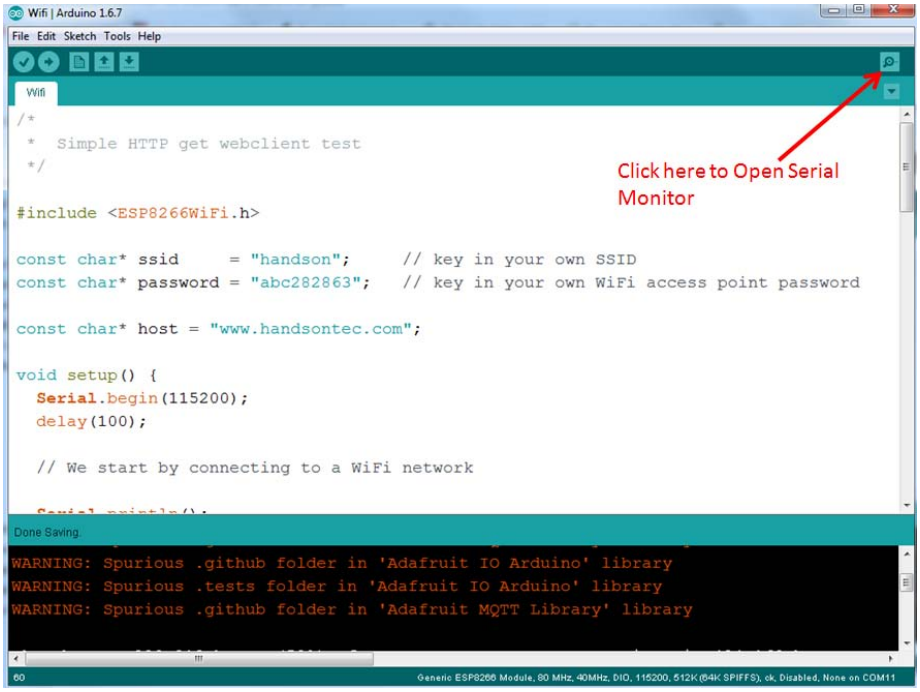
const char* password = "yourpassword";

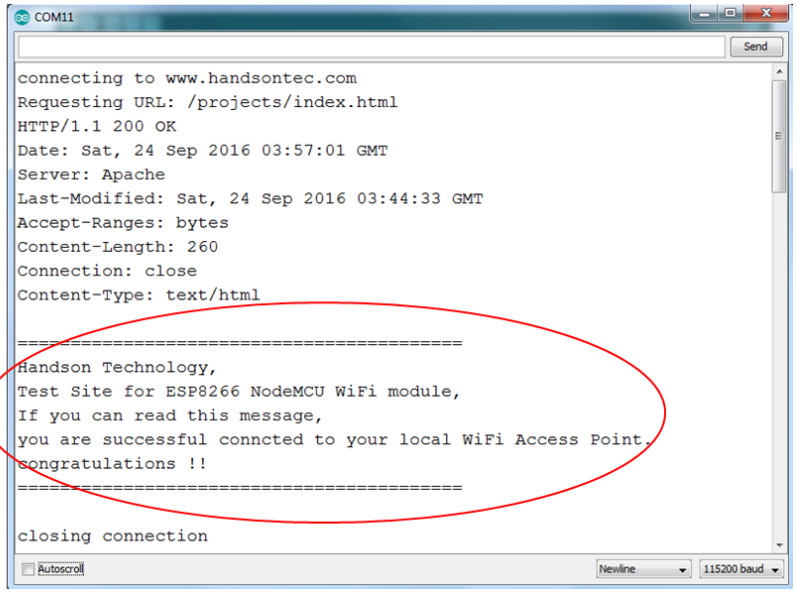
to your WiFi access point and password, then upload the same way: get into bootload mode, then upload code via IDE.

```
/*
 *  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.

TEXAS INSTRUMENTS

ULN2002A, ULN2003A, ULN2003AI
ULQ2003A, ULN2004A, ULQ2004A

SLRS027O – DECEMBER 1976 – REVISED JANUARY 2016

ULN200x, ULQ200x High-Voltage, High-Current Darlington Transistor Arrays

1 Features

- 500-mA-Rated Collector Current (Single Output)
- High-Voltage Outputs: 50 V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic
- Relay-Driver Applications

2 Applications

- Relay Drivers
- Stepper and DC Brushed Motor Drivers
- Lamp Drivers
- Display Drivers (LED and Gas Discharge)
- Line Drivers
- Logic Buffers

3 Description

The ULx200xA devices are high-voltage, high-current Darlington transistor arrays. Each consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads.

The collector-current rating of a single Darlington pair is 500 mA. The Darlington pairs can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. For 100-V (otherwise interchangeable) versions of the ULx2003A devices, see the SLRS023 data sheet for the SN75468 and SN75469 devices.

The ULN2002A device is designed specifically for use with 14-V to 25-V PMOS devices. Each input of this device has a Zener diode and resistor in series to control the input current to a safe limit. The ULx2003A devices have a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

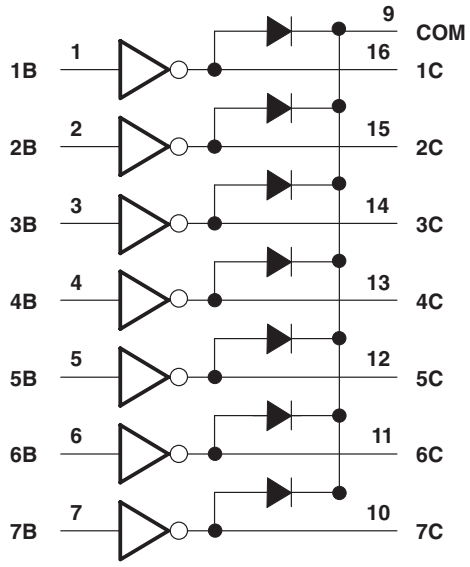
The ULx2004A devices have a 10.5-kΩ series base resistor to allow operation directly from CMOS devices that use supply voltages of 6 V to 15 V. The required input current of the ULx2004A device is below that of the ULx2003A devices, and the required voltage is less than that required by the ULN2002A device.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
ULx200xD	SOIC (16)	9.90 mm × 3.91 mm
ULx200xN	PDIP (16)	19.30 mm × 6.35 mm
ULN200xNS	SOP (16)	10.30 mm × 5.30 mm
ULN200xPW	TSSOP (16)	5.00 mm × 4.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Block Diagram



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision N (June 2015) to Revision O — **Page**

- Changed Pin Functions table to correct typographical error. ... 3

Changes from Revision M (February 2013) to Revision N — **Page**

- Added *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1
- Deleted *Ordering Information* table. No specification changes. ... 1
- Moved *Typical Characteristics* into *Specifications* section. ... 8

Changes from Revision L (April 2012) to Revision M — **Page**

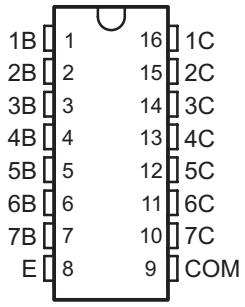
- Updated temperature rating for ULN2003AI in the ORDERING INFORMATION table ... 1

Changes from Revision K (August 2011) to Revision L — **Page**

- Removed reference to obsolete ULN2001 device ... 1

5 Pin Configuration and Functions

D, N, NS, and PW Package
16-Pin SOIC, PDIP, SO, and TSSOP
Top View



Pin Functions

PIN		I/O(1)	DESCRIPTION
NAME	NO.		
1B	1	I	Channel 1 through 7 Darlington base input
2B	2		
3B	3		
4B	4		
5B	5		
6B	6		
7B	7		
1C	16	O	Channel 1 through 7 Darlington collector output
2C	15		
3C	14		
4C	13		
5C	12		
6C	11		
7C	10		
COM	9	—	Common cathode node for flyback diodes (required for inductive loads)
E	8	—	Common emitter shared by all channels (typically tied to ground)

(1) I = Input, O = Output

6 Specifications

6.1 Absolute Maximum Ratings

at 25°C free-air temperature (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_{CC}	Collector-emitter voltage			50	V
	Clamp diode reverse voltage(2)			50	V
V_I	Input voltage(2)			30	V
	Peak collector current, See Figure 4 and Figure 5			500	mA
I_{OK}	Output clamp current			500	mA
	Total emitter-terminal current			–2.5	A
T_A	Operating free-air temperature range	ULN200xA	–20	70	°C
		ULN200xAI	–40	105	
		ULQ200xA	–40	85	
		ULQ200xAT	–40	105	
T_J	Operating virtual junction temperature			150	°C
	Lead temperature for 1.6 mm (1/16 inch) from case for 10 seconds			260	°C
T_{stg}	Storage temperature		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V_{CC}	Collector-emitter voltage (non-V devices)	0	50	V
T_J	Junction temperature	–40	125	°C

6.4 Thermal Information

THERMAL METRIC(1)		ULx200x				UNIT
		D (SOIC)	N (PDIP)	NS (SO)	PW (TSSOP)	
		16 PINS	16 PINS	16 PINS	16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	73	67	64	108	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	36	54	n/a	33.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	n/a	n/a	n/a	51.9	°C/W
ψ_{JT}	Junction-to-top characterization parameter	n/a	n/a	n/a	2.1	°C/W
ψ_{JB}	Junction-to-board characterization parameter	n/a	n/a	n/a	51.4	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics: ULN2002A

T_A = 25°C

PARAMETER		TEST FIGURE	TEST CONDITIONS		ULN2002A			UNIT
					MIN	TYP	MAX	
$V_{I(on)}$	ON-state input voltage	Figure 14	V_{CE} = 2 V,	I_C = 300 mA			13	V
V_{OH}	High-level output voltage after switching	Figure 18	V_S = 50 V, I_O = 300 mA		V_S – 20			mV
$V_{CE(sat)}$	Collector-emitter saturation voltage	Figure 12	I_I = 250 µA,	I_C = 100 mA		0.9	1.1	V
			I_I = 350 µA,	I_C = 200 mA		1	1.3	
			I_I = 500 µA,	I_C = 350 mA		1.2	1.6	
V_F	Clamp forward voltage	Figure 15	I_F = 350 mA			1.7	2	V
I_{CEX}	Collector cutoff current	Figure 9	V_{CE} = 50 V,	I_I = 0			50	µA
		Figure 10	V_{CE} = 50 V, T_A = 70°C	I_I = 0			100	
				V_I = 6 V			500	
$I_{I(off)}$	OFF-state input current	Figure 10	V_{CE} = 50 V,	I_C = 500 µA	50	65		µA
I_I	Input current	Figure 11	V_I = 17 V			0.82	1.25	mA
I_R	Clamp reverse current	Figure 14	V_R = 50 V	T_A = 70°C			100	µA
			V_R = 50 V				50	
C_i	Input capacitance		V_I = 0,	f = 1 MHz			25	pF

6.6 Electrical Characteristics: ULN2003A and ULN2004A

T_A = 25°C

PARAMETER		TEST FIGURE	TEST CONDITIONS		ULN2003A			ULN2004A			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
$V_{I(on)}$	ON-state input voltage	Figure 14	V_{CE} = 2 V	I_C = 125 mA						5	V
				I_C = 200 mA			2.4			6	
				I_C = 250 mA			2.7				
				I_C = 275 mA						7	
				I_C = 300 mA			3				
				I_C = 350 mA						8	
V_{OH}	High-level output voltage after switching	Figure 18	V_S = 50 V, I_O = 300 mA		V_S – 20			V_S – 20			mV
$V_{CE(sat)}$	Collector-emitter saturation voltage	Figure 13	I_I = 250 µA,	I_C = 100 mA		0.9	1.1		0.9	1.1	V
			I_I = 350 µA,	I_C = 200 mA		1	1.3		1	1.3	
			I_I = 500 µA,	I_C = 350 mA		1.2	1.6		1.2	1.6	
I_{CEX}	Collector cutoff current	Figure 9	V_{CE} = 50 V,	I_I = 0			50			50	µA
		Figure 10	V_{CE} = 50 V, T_A = 70°C	I_I = 0			100			100	
				V_I = 6 V						500	
V_F	Clamp forward voltage	Figure 16	I_F = 350 mA			1.7	2		1.7	2	V
$I_{I(off)}$	Off-state input current	Figure 11	V_{CE} = 50 V, T_A = 70°C,	I_C = 500 µA	50	65		50	65		µA
I_I	Input current	Figure 12	V_I = 3.85 V			0.93	1.35				mA
			V_I = 5 V						0.35	0.5	
			V_I = 12 V						1	1.45	
I_R	Clamp reverse current	Figure 15	V_R = 50 V				50			50	µA
			V_R = 50 V	T_A = 70°C			100			100	
C_i	Input capacitance		V_I = 0,	f = 1 MHz		15	25		15	25	pF

6.7 Electrical Characteristics: ULN2003AI

T_A = 25°C

PARAMETER		TEST FIGURE	TEST CONDITIONS		ULN2003AI			UNIT
					MIN	TYP	MAX	
$V_{I(on)}$	ON-state input voltage	Figure 14	V_{CE} = 2 V	I_C = 200 mA			2.4	V
				I_C = 250 mA			2.7	
				I_C = 300 mA			3	
V_{OH}	High-level output voltage after switching	Figure 18	V_S = 50 V, I_O = 300 mA		V_S – 50			mV
$V_{CE(sat)}$	Collector-emitter saturation voltage	Figure 13	I_I = 250 µA,	I_C = 100 mA		0.9	1.1	V
			I_I = 350 µA,	I_C = 200 mA		1	1.3	
			I_I = 500 µA,	I_C = 350 mA		1.2	1.6	
I_{CEX}	Collector cutoff current	Figure 9	V_{CE} = 50 V,	I_I = 0			50	µA
V_F	Clamp forward voltage	Figure 16	I_F = 350 mA			1.7	2	V
$I_{I(off)}$	OFF-state input current	Figure 11	V_{CE} = 50 V,	I_C = 500 µA	50	65		µA
I_I	Input current	Figure 12	V_I = 3.85 V			0.93	1.35	mA
I_R	Clamp reverse current	Figure 15	V_R = 50 V				50	µA
C_i	Input capacitance		V_I = 0,	f = 1 MHz		15	25	pF

6.8 Electrical Characteristics: ULN2003AI

T_A = –40°C to 105°C

PARAMETER		TEST FIGURE	TEST CONDITIONS		ULN2003AI			UNIT
					MIN	TYP	MAX	
$V_{I(on)}$	ON-state input voltage	Figure 14	V_{CE} = 2 V	I_C = 200 mA			2.7	V
				I_C = 250 mA			2.9	
				I_C = 300 mA			3	
V_{OH}	High-level output voltage after switching	Figure 18	V_S = 50 V, I_O = 300 mA		V_S – 50			mV
$V_{CE(sat)}$	Collector-emitter saturation voltage	Figure 13	I_I = 250 µA,	I_C = 100 mA		0.9	1.2	V
			I_I = 350 µA,	I_C = 200 mA		1	1.4	
			I_I = 500 µA,	I_C = 350 mA		1.2	1.7	
I_{CEX}	Collector cutoff current	Figure 9	V_{CE} = 50 V,	I_I = 0			100	µA
V_F	Clamp forward voltage	Figure 16	I_F = 350 mA			1.7	2.2	V
$I_{I(off)}$	OFF-state input current	Figure 11	V_{CE} = 50 V,	I_C = 500 µA	30	65		µA
I_I	Input current	Figure 12	V_I = 3.85 V			0.93	1.35	mA
I_R	Clamp reverse current	Figure 15	V_R = 50 V				100	µA
C_i	Input capacitance		V_I = 0,	f = 1 MHz		15	25	pF