



**INTERNET OF THINGS (IOT) BASED SMART MONITORING SYSTEM
FOR FISH FARMING**

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**A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR
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DECLARATION

I MR. OTUOLE Uchechukwu Emmanuel hereby declare that this is my own thesis titled "INTERNET OF THINGS (IoT) BASED SMART MONITORING SYSTEM FOR FISH FARMING" an original record done by me towards the partial fulfillment of requirement for the award of degree of Bachelor of Engineering (B.ENG) in the Department of Computer Engineering during the period of 2019-2020 academic session in University of Benin, Benin City. Materials of work found by other researchers are mentioned by references. This Thesis, neither in whole nor in part, has been previously submitted for any degree award.

CERTIFICATION

This is to certify that **OTUOLE UCHECHUKWU EMMANUEL (ENG1503608)** an undergraduate student in the Department of Computer Engineering, Faculty of Engineering, University of Benin, Edo state, satisfactorily completed this work on his own as a partial fulfillment of the requirement for the award of **Bachelor Degree in Engineering (B.ENG) in Computer Engineering.**

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DATE

DEDICATION

This project is dedicated to Jehovah almighty for the inspiration and direction throughout this project and to our parents for their unending support. This project is also dedicated to my mom Mrs Patricia Ogwu, my lovely sisters Jennifer and Linda, my little cousin Ify and my aunt Mrs stella Enudi, then my funny friends Bongo, Omor, Ebuski, Gidi Gid, Damak, Chibuzor, Sir Eddie, Charlie Man, Aisosa, Onyeka, Ricky.

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I would like to thank Jehovah God for his guidance, grace, and strength to start and complete this thesis, and also my mom and aunt for their financial and moral support.

I also wish to appreciate the University of Benin for allowing us to exercise and explore our technical and academic know-how. Special thank you to my supervisor Engr. Dr. Mrs. O. Okosun for her guidance and input through the entire research process and for believing in my works. My gratitude also goes to the entire staff at Department of Computer Engineering for their support whenever it was required.

ABSTRACT

The aim of this paper is to design and develop an IoT based Smart Monitoring System. The purpose of the current method is to create a safe and secure fish farming that helps the fish pond owners in producing high quality fish by maintaining normal water levels in the fish tank. (Sajal Saha, 2007).

In order to implement this design, the Atmega 328p microcontroller is used as well as sensors and actuators such as the DSB18b20 temperature sensor, HC-sr04 ultrasonic sensor, HC-sr501 motion sensor and a solenoid valve to automate the process of controlling the water quality parameters, such as the water level, temperature which is best at 24-27°C (Johnson et al., 2007) and PH range which is acceptable at 6.5 to 9.0 (Will Mosley, 2009). These sensor values are stored in cloud so that farmers can see on their mobiles through mobile app or web application anywhere remotely. Android phone is used as the terminal device. A user can monitor the water condition using an android app through Wi-Fi within Wi-Fi range of 2400-2484 MHz and through Internet from anywhere in the world,

A significant cost reduction is achieved as a result of farm equipment and water pumps being operated only when required using optimization schemes to maintain desired water level in fish tank with efficient energy consumption through appropriate selection of pumps and tank filling level (Nirosha et al, 2017). The system consists of various sensors that measure important factors of the water like temperature, pH and water level and the data from these sensors can be accessed by an application through firebase (Weber et al, 2010). The farmer can then act as per the information relayed or the model can automatically act on behalf of the farmer as per the

predefined actions. The real time information enables timely intervention by the farmers which eventually helps minimizing or eliminate wastages.

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LIST OF ABBREVIATIONS

PH – Potential of Hydrogen.

Wi-Fi – Wireless Fidelity.

TCP/IP – Transmission Control Protocol/Internet Protocol.

IOT – Internet of Things.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Fish farming can be defined as the use of a man-made artificial eco-system to breed fish primarily for commercial purposes (FAO, 2014). Ponds can be made of concrete, earthenware, or plastic, but they all require the farmer to keep track of the environmental stress they generate, such as water acidity or alkalinity (pH), temperature, light intensity, and water level, which can be demanding.

The focus of this project is on ponds that breed fish for food, which are typically built and maintained in remote eco-clean areas, near water springs, or artificially made ponds of concrete, earthen, or plastic, and the use our IoT-based Smart Monitoring system to allow the farmer to monitor, use the internet to obtain data on the acidity or alkalinity (pH) of the water, temperature, and water level, as well as remotely (i.e. through the internet) modify the water in the tank, and detect the presence of predators or intruders around the pond when the farmer is not present.

Fish farming is one of the most profitable types of farming, and it has been studied extensively over the years to determine the many conditions required to optimize the growth and development of fish in ponds. Temperature, light intensity, oxygen level, acidity or alkalinity of the water, i.e. pH of the water, and water level are among the factors required for optimal growth and development of fish. Temperature affects not just the internal body heat of the fish, but also the growth of plants in the pond and the oxygen content in the water (John Cheyne, 2019). The day and night system or cycle that the fish experiences beneath water has an impact on their reproductive behavior as well as how they go about their daily activities like eating and sleeping, their color, territorial placement, and also affect plant

photosynthesis and the oxygen level in the water. The amount of oxygen in the pond has a considerable impact on the fish's growth and development, as well as the rate at which they can suffocate. The manner in which the fishes in the pond react to the living conditions provided to it is affected by the raising or lowering of the water level in the pond. If the water level decreases or is lowered to an undesirable level, it causes a battle for survival among the fishes as movement is restricted and oxygen levels are greatly reduced, however, with enough water, the fish in the pond have enough area to roam about, feed, and even relax (Irina et al. 2018). All of these factors must be in constant interaction with one another to provide the best growth and development for the fishes in the pond, necessitating a complex interconnection of multiple sensors to ensure that these conditions are constantly monitored and data/information is collected and fed to the farmer in real-time.

Communication is critical in fish farming because the farmer must be constantly informed about the state of the water in the pond in order to know what actions to take in response to each piece of information that is communicated to him. In order to ensure proper communication between the farmer and the pond's water state, the concept of Internet of Things (IoT), a Wi-Fi module, and a third-party application called "Blynk" is employed. As a result, information can be sent to the farmer through the internet, and the farmer can make changes and control some of the equipment remotely. The Internet of Things (IoT) is a network of physical items that are integrated with sensors, software, and other technologies in order to connect and exchange data and information with other devices and systems via the internet. Because the fish farm may be placed in rural places without a telecommunication mast for GSM messaging and internet connectivity, real-time monitoring of the water status in the pond would be impossible, but the internet mitigates this by employing Wi-Fi, Lora WAN, or even satellite communication.

1.2 PROBLEM STATEMENT

Many fish farmers rely on traditional water quality monitoring methods such as notes writing and observation which are prone to errors (Helfrich et al, 2009). Most farmers are yet to embrace technology in the monitoring of water quality in the fish ponds. According to (Idachaba et al, 2017) fish pond operators are faced with the challenge of constantly monitoring water quality and changing the water in case the quality is compromised.

The proposed model in this work shall aid fish farmers in monitoring fish ponds using IoTs. The integration of sensor and internet technology combined with a user-friendly interaction interface via a smartphone to provide real time monitoring of the fish ponds; could make a significant contribution in reducing the risk of losses and improve efficiency (Neethirajan, 2016).

1.3 AIMS AND OBJECTIVES

1.3.1 AIMS:

The aim of this paper is to design and develop an IoT based Smart Monitoring System.

1.3.2 OBJECTIVES:

The objectives are;

- To design a Smart Monitoring System for Fish Ponds.
- To develop a model for real time monitoring of water quality in fish ponds.

1.4 SCOPE OF STUDY

The scope of study of this project revolves around fish farming, its necessary conditions for fish growth and development and how the use of IoT, specialized sensors and devices can be used and help to further improve the growth and development of the fishes through the provision of real-time information and control of hardware devices while also

providing some level of comfortability and flexibility for the end user or fish farmer while ensuring that the former is carried out effectively.

1.5 RELEVANCE OF STUDY

Globally, aquaculture supplies more than 50 percent of all seafood produced for human consumption, according to NOAA, which estimated the value of the market at about \$160 billion back in 2014. And, if you believe the random market reports generated by unemployable MBAs, the aquaculture industry will be worth north of \$200 billion by the next decade. Meanwhile, seafood and aquaculture tech startups reeled in \$193 million in 2016, up nearly 300 percent from previous years, according to AgFunder News. It's only a matter of time before we pull the last bluefin tuna out of the ocean, so we'll once again need technology to save the day.

Fish farming has been identified as the viable solution for stocking fish in this era where the wild fish stock from rivers and lakes are declining due to environmental pollution that result in fish kills. The farming of in facilities such as ponds can guarantee to some level, a conducive environment where the fish can survive to maturity and thus contribute to the country's food security. The fact that fish live in water and respond quickly to environmental changes means that it is important to monitor the water quality to guarantee survival. In this study it was observed through the data collection and interviews that most fish farmers or those responsible for monitoring the fish rarely monitor the status of the water for changing conditions. This has resulted to loss and has made fish farming an expensive venture because the farmers invest in expensive inputs such feeds that do not translate to profits. Real time monitoring and timely intervention to these environmental changes is therefore key to providing the solution to this problem.

CHAPTER TWO

LITERATURE REVIEW

2.1 AQUACULTURE IN NIGERIA

Fish is a major source of food in Nigeria, as it is in many other coastal poor countries. Nigeria's population is estimated to be 186 million people (World Bank 2016).

Aquaculture, which is primarily monoculture of large species like catfish and tilapia, is considered as a means for Nigeria to close the supply-demand gap in the fish industry. More fish species being cultivated would increase the nutrient diversity needed to feed the rising population. However, aquaculture in general can assist supply domestic demand for fish; over 600,000t of fish—primarily marine species—are imported each year to meet Nigeria's expanding population demand (FAO 2007).

Nigeria's enormous inland water bodies and coastline stretch for over 800 kilometers, supporting almost 1.5 million people who rely on fishing for a living (FAO 2007; World Fish 2017b). Fish consumption in the home is higher in urban regions than in rural ones, and persons with a higher socioeconomic status consume fish more frequently than those with a lower socioeconomic status (Onumah et al. 2020). Fish demand is expected to rise in Nigeria as earnings rise. The species consumed is not included in the nationally representative data on fish consumption. Crayfish, sardines (freshwater and saltwater), bonga, and mackerel, as well as farmed fish species such as tilapia, carp, and catfish, are all consumed in Nigeria (DFID and FAO 2002).

2.1.1 FACTORS THAT AFFECT FISH GROWTH WITHIN THE POND

1. **TEMPERATURE:** Fish feeding patterns and growth are influenced by water temperature. When a fish's temperature is consistently near or above its optimum

tolerance, stress and illness outbreaks are common. Warm water has a lower concentration of dissolved oxygen than chilly water. Fish size, feeding rate, activity level, and pond temperature all influence oxygen consumption. When the temperature drops, the amount of dissolved oxygen in the water increases, and when the salinity rises, it decreases. In aquaculture animals, low dissolved oxygen content is a primary cause of stress, poor appetite, slow growth, illness susceptibility, and mortality. The minimum daily dissolved-oxygen content in pond culture systems is widely acknowledged as the most important factor to consider. Not only is dissolved oxygen necessary for fish respiration, but it is also necessary for phytoplankton life, the organism that converts poisonous ammonia into safe forms.

2. **POTENTIAL OF HYDROGEN:** For fish culture, a pH range of 6.5 to 9.0 is normally considered suitable. Ammonium in water is transformed to poisonous ammonia, which can kill fish, when water is highly alkaline (pH > 9). Acidic water (pH 5) on the other hand, leaches metals from rocks and sediments. These metals have a negative impact on the fish's metabolism and capacity to take in water through their gills, and they can also be lethal. Because any component failure might result in catastrophic losses in a short period of time, the system must be dependable and regularly monitored. For an intense aquaculture system to succeed, accurate measurements and controls are required.

3. **WATER LEVEL:** The amount of water in the pond has a significant impact on the survival of the fishes in the pond since a low water level implies less oxygen and less area for movement, which can stifle growth and lead to fishes fighting for oxygen and space. As a result, the water level should be monitored and maintained at a comfortable level for optimum development and survival.

2.1.2 FACTORS AFFECTING FISH GROWTH OUTSIDE THE POND

1. **PREDATORS:** Some animals prey on fish for survival, and this could have a negative economic impact on the fish farmer, so precautions must be taken, such as installing a motion sensor and a buzzer around the pond area to alert the fish farmer of any unauthorized entry.
2. **THEIVES:** Some people are promiscuous and may attempt to take fish from the pond; our motion sensor and buzzer will notify the farmer to such acts, and it will be up to the farmer to install extra security measures.

2.2 IOT CONCEPT

Recent advancements in communication technology and the mobile sector have aided the development and application of ICT in agriculture (Banhazi et al., 2012). IoT is a relatively new ICT technology that has played a key role in the implementation of IoT in agriculture. It provides the ICT infrastructure that allows 'things' to securely and reliably communicate information over the internet (Weber et al, 2010). It's a complicated platform built on the interconnection of items like tagged objects, sensors, actuators, and various technologies (Weber et al, 2010). IoT has been characterized in a variety of ways by various authors. (Vermesan et al, 2011) defined IoT as a "interaction between the physical and digital worlds" in their book. A variety of sensors and actuators interact with the real environment in the digital world."

In general, the internet of things is defined as the linking of devices to accomplish tasks that require intelligence (Sethi et al, 2017). A Sensor-Based IoT architecture consists primarily of a group of sensors (deployed in "edge devices") that collect various sorts of data and transmit it to a gateway that uploads it to the cloud. From there it can be accessed by users and/or businesses as actionable intelligence (Saldanha, 2015). These components can be described as follows:

- Low Power Smart Sensors/Edge Devices which function as data collectors that seat at the edge of the network hence their name. They gather minute information that are require by the intelligent system. They operate on low power which enables them to support wireless installation and communication.
- Local Sensor Network which provide various ways in which the sensors can connect edge devices such as Bluetooth, Radio frequency and Wi-Fi.
- The Gateway which functions as a bridge between the sensor network and the cloud. It supports advanced data 12 processing and transmission functions. It collects data from the sensors, decides what information is actionable business intelligence and forwards it to the cloud server via internet or cellular network connection.
- Cloud Server which receives periodic signals from the gateway that indicate the status of the sensor network. The cloud can push down commands, configuration and software updates to the gateway and support application-level system management and analytics software.

2.3 MATERIALS USED

The methodology adopted for this project work is the Internet of Things system where we embed physical objects with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices or systems over the internet.

The hardware methodology would have to do with major components such as the

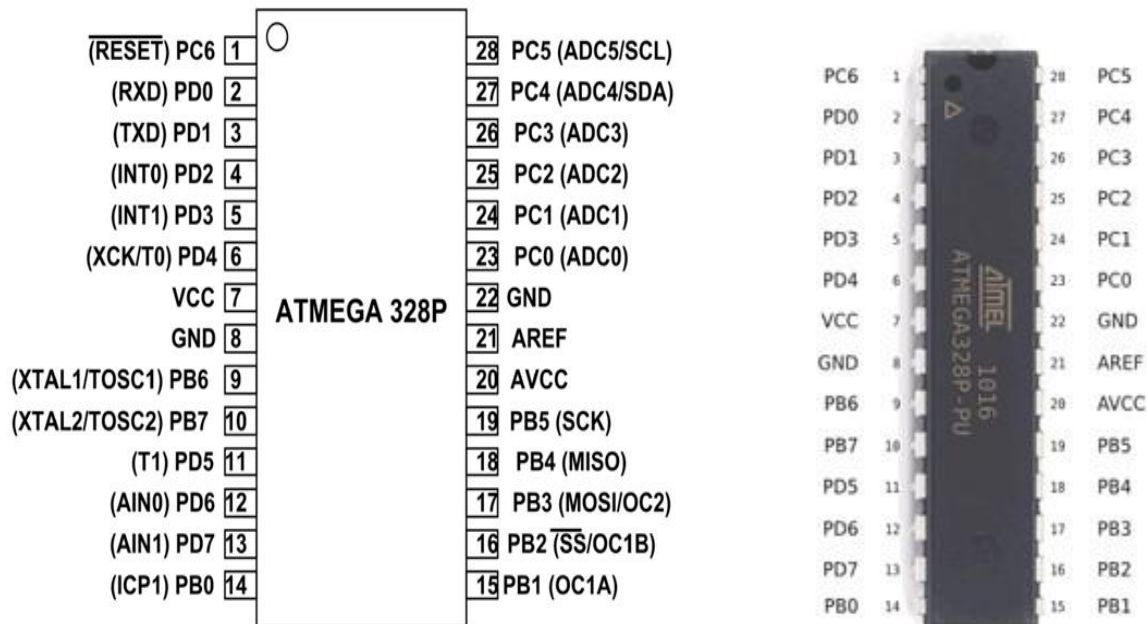
1. Atmega328p chip
2. esp8266 WIFI Module
3. Power Supply
4. pH Sensor
5. Water Level sensor
6. Temperature Sensor

7. Motion Sensor.

The software adopted in this project was the third-party application known as BLYNK. It facilitates the effective and easy monitoring of fish ponds. It allows us to also detect changes and gather data to suit the various environmental changes around the fish pond perimeter.

Atmega328p Chip

It is a single-chip high performance, efficient microcontroller with an 8-bit AVR RISC-based microcontroller chip. It consists of 32KB ISP flash memory with read-while-write capabilities 2KB SRAM (static RAM) 1 KB of EEPROM 23 general-purpose I/O pin, a 16MHz clock, 32 general purpose working registers, three flexible timers/counters with compare modes interface pins, SPI serial port, 6-channel 10-bit Analog to Digital converter, programmable watchdog timer with internal oscillator and five software selectable power



saving modes. The device operates between a voltage range of 1.8-5.5volts.

Figure 2.0.1: Atmega 328p Microcontroller

ESP8266 MODULE

It is a low-cost Wi-Fi microchip with a full TCP/IP stack and microcontroller capability. It is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each module comes pre-programmed with an AT command set firmware, it is extremely cost effective with a growing community.



Figure 2.0.2:Wi-Fi Module ESP8266

POWER SUPPLY

A power supply is an electrical device that supplies electric power to an electrical load. The primary function of a power supply is to convert electric current from a source to the correct voltage current and frequency to power the load. It is sometimes referred to as electric power converters.



Figure 2.0.3:Power Supply Adapter

MOTION SENSOR

A motion sensor is an electronic device that is designed to detect and measure movement within its selected range. Motion sensors are used in homes and businesses but they can also be found in phones paper towel dispensers game consoles, etc. Unlike many other types of sensors motion sensors are typically embedded systems with three major components namely; a sensor unit an embedded computer and its mechanical part.

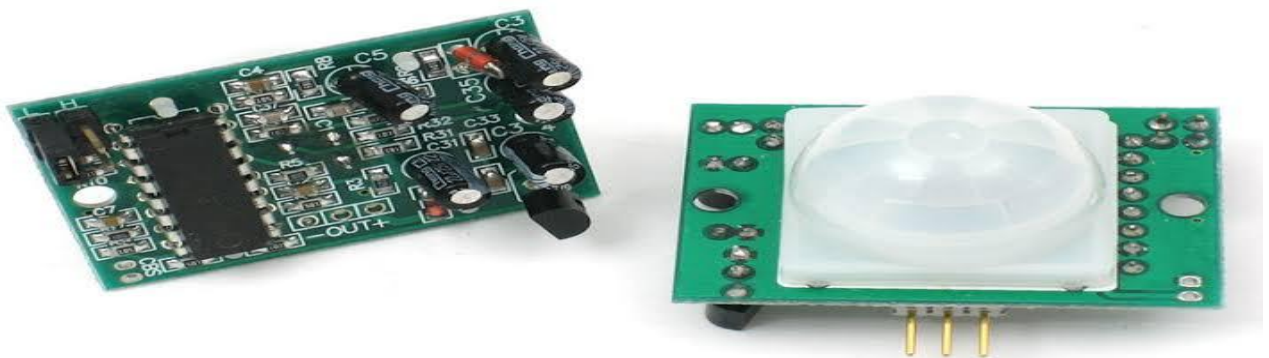


Figure 2.0.4:Motion Sensor

TEMPERATURE SENSOR

Temperature sensor is an integrated circuit sensor. The output voltage is linearly proportional to the centigrade temperature. The sensor shown below is compatible with Atmega328p device. The applications of the temperature sensor are in microwave ovens fridges household devices, etc. it can measure both hot and cold bodies.



Figure 2.0.5:Temperature Sensor

WATER LEVEL SENSOR

Water level sensors are used in detecting the particular level of water in a voluminous item. The below sensor has a series of ten exposed copper traces five of which are power traces and five are sense traces. These traces are interlaced so that there is one sense trace between every two power traces. Usually these traces are not connected but are bridged by water when



submerged.

Figure 2.0.6: Water Level Sensor

PH SENSOR

It is an electric device used to measure the hydrogen ion activity be it acidity or alkalinity in a solution. Basically, a pH sensor consists of a voltmeter attached to a pH responsive electrode and a reference electrode. The pH responsive electrode is usually glass, and the reference is usually a silver-silver chloride electrode, alternatively, a calomel electrode is sometimes used.



Figure 2.0.7: pH Sensor

2.2.1 BLYNK IOT PLATFORM

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 interesting things.

There are three major components in the platform:

- **Blynk App** - allows to you create amazing interfaces for your projects using various widgets that are provided.

- **Blynk Server** - responsible for all the communications between the smartphone and hardware. You can use the 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 out coming commands.

It includes features such as

- Similar API & UI for all supported hardware & devices
- Connection to the cloud using:
 - Wi-Fi
 - Bluetooth and BLE
 - Ethernet
 - USB (Serial)
 - GSM
- Set of easy-to-use Widgets.
- Direct pin manipulation with no code writing.
- Easy to integrate and add new functionality using virtual pins.
- History data monitoring via Super Chart widget.
- Device-to-Device communication using Bridge Widget.
- Sending emails, tweets, push notifications, etc.

2.3 RELATED WORKS

- 1. NOCHESKI et al., 2018, WATER MONITORING IOT SYSTEM FOR FISH FARMING PONDS, FACULTY OF COMPUTER SCIENCE AND ENGINEERING, UNIVERSITY SS. CYRIL AND METHODIUS IN SKOPJE1, LABORATORY OF ECO-INFORMATICS, REPUBLIC OF MACEDONIA.**

He presented a smart IoT system that is used to automate the monitoring and maintenance of a fish farming pond in remote locations, with a goal to bring it closer to its natural form by the most effective means using remote monitoring via wireless communication technologies like cellular, Lora WAN, Wi-Fi or Satellite communication. This smart system aims to reduction of the environmental stress that affects the fish population in the fish farming pond. This is a very active research area and researchers have developed similar systems, that try to automate the monitoring of the fish farm environment.

It includes sensors such temperature sensors, water level sensors, pH sensors and light sensors. It also makes use of a heater to regulate the water temperature and a Wivity module (interchangeable modem) to allow for an IoT connectivity.

- 2. SAJAL et al., 2018, IOT BASED AUTOMATED FISH FARM AQUACULTURE MONITORING SYSTEM, 2ND INTERNATIONAL CONFERENCE ON INNOVATIONS IN SCIENCE, ENGINEERING AND TECHNOLOGY (ICISSET).**

An outline for monitoring of water quality for aquaculture is used using Arduino, Raspberry pi and various sensors, android application and smartphone camera. The parameters for water quality used in this paper are pH, color, temperature and electrical conductivity. The sensor acquisition is performed by Raspberry pi and

Arduino which is used as server and data processing device. To detect the color of the water photo acquisition is conducted using Raspberry pi with the help of smartphone camera. Any user can check the water condition using an android application through Wi-Fi within Wi-Fi threshold range and internet from anywhere in the world. To check the water condition some analysis is performed with these four parameters and necessary action can also be taken.

3. MONIRA et al., 2019, IOT BASED SMART WATER QUALITY MONITORING SYSTEM, IEEE 4TH INTERNATIONAL CONFERENCE ON COMPUTER AND COMMUNICATION SYSTEMS (ICCCS).

It emphasizes an IoT based smart water quality monitoring system that is implemented to help in continuous monitoring of the water condition based on four physical parameters: temperature, turbidity, electric conductivity & pH properties. Arduino Uno is connected with four sensors separately to find the water parameters. The acquired data is transmitted to an application developed using .NET platform and it is compared with the standard values of WHO (World Health Organization). The water parameters can be analyzed based on the measured parameters to determine if the water sample is fit for drinking.

4. MUHAMMAD et al., 2018, IOT-BASED WATER QUALITY MONITORING SYSTEM FOR SOFT-SHELL CRAB FARMING, DEPARTMENT OF INFORMATICS, FACULTY OF ENGINEERING, HASSAN UDDIN UNIVERSITY, INDONESIA.

A design is proposed for water quality monitoring system for crab farming based on IoT which gives awareness to farmers for maintaining threshold levels of water quality in the pond. The system makes use of light weight Message Queuing Telemetry Transport (MQTT) protocol and LoRa based wireless sensor network for

exchanging messages between mobile devices, sensors & embedded devices. The system mainly includes Raspberry Pi MQTT broker, sensor node as publisher and mobile client devices as subscribers. Sensor nodes are built using LoRa wireless interface, small embedded devices and water quality sensors like pH sensor, temperature sensor and salinity sensor. Also, a web-based monitoring application using node-red dashboard for acquiring water quality parameters remotely is built.

5. SIMITHA et al., 2019, IOT AND WSN BASED AIR QUALITY MONITORING AND ENERGY SAVING SYSTEM IN SMART CITY PROJECT, 2ND INTERNATIONAL CONFERENCE ON INTELLIGENT COMPUTING, INSTRUMENTATION AND CONTROL TECHNOLOGIES (ICICICT).

This system gives a low range, low cost, low power and scalable approach for water quality monitoring using LoRa module with the help of LoRa WAN protocol which uses Low Power Wide Area Network technology (LPWAN). The system has wireless LoRa module for sending and receiving sensor values, adding sensors to the microcontroller and Thing Speak IoT platform for testing and visualizing water quality sensor values.

6. CORENTIN et al., 2017, IOT, BIG DATA, AND CLOUD PLATFORM FOR RURAL AFRICAN NEEDS, 2017 IST-AFRICA WEEK CONFERENCE (IST-AFRICA).

A big data platform and open IoT is presented here to accelerate changes in rural Africa. The technology is not limited only for the rural cases. It is designed for any application of IoT. This platform allows applications of IoT to be coupled with big data capacities. Besides, the platform can adapt to the constraints and specific requirements of African users. This paper gives an overview of big data platform and

IoT, details its technical aspects and finally introduce three cases to prove the platform architecture validity.

7. YUHWAN et al., 2018, REALIZATION OF IOT BASED FISH FARM CONTROL USING MOBILE APP

A smart fish farm of a remote control and monitoring system is developed by using IoT technology. The system senses and monitors several sensors such as temperature, water level, pH, oxygen level. Also, a closed loop water control of the aquarium is controlled by a microcontroller and supported by Message Queue Telemetry Transport (MQTT) protocol on the website application or mobile application.

8. FAHIM et al., 2019, WATER QUALITY MONITORING SYSTEM

Water quality is monitored using IoT based design is proposed in this paper. The power required by the sensors is provided using solar energy. This system is designed using Arduino Mega 2560 to measure turbidity and pH level using sensors. Data gathered from these sensors are sent to the cloud by means of Wi-Fi module. The collected information is analyzed further and is shown in visual format on LCD & displayed using Thingspeak which is a cloud server. This system can be monitored from anywhere in the World using internet and also implemented to the overhead and roof top tank.

CHAPTER THREE

METHODOLOGY

3.2 RESEARCH DESIGN

3.2.1 Hardware Implementation

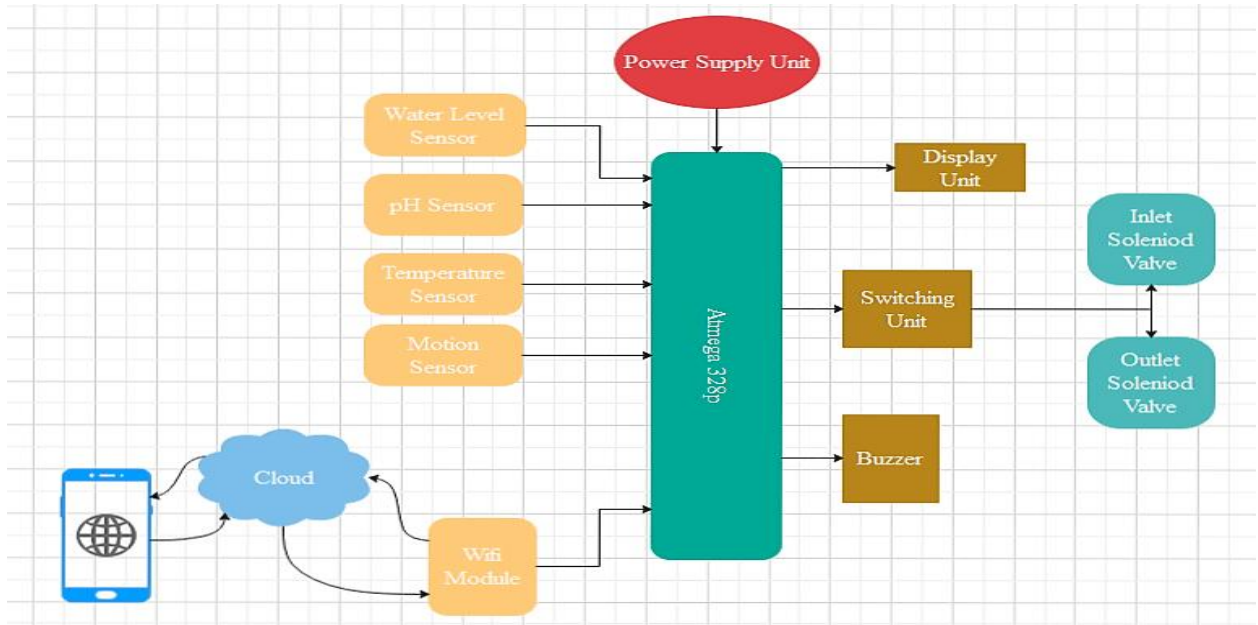


Figure 3.2.1 Block Diagram of the Connection of the Various Components of our IoT Smart fish Monitoring System

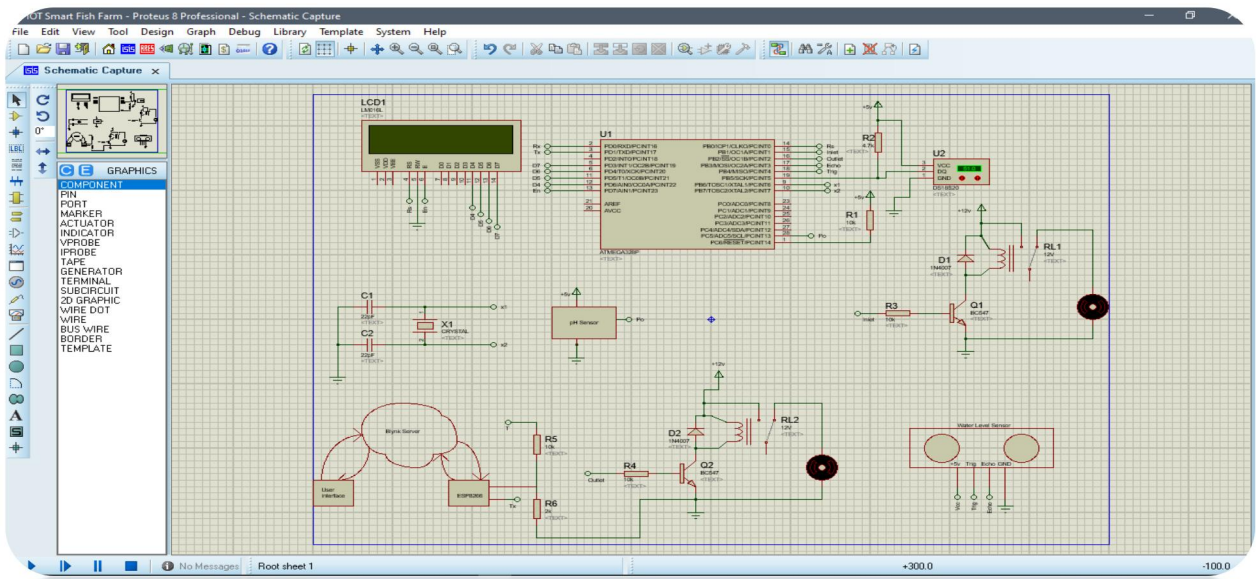


Figure 3.2.2: Circuit Diagram

INTERFACING ATMEGA 328p WITH THE 16x2 LCD DISPLAY.

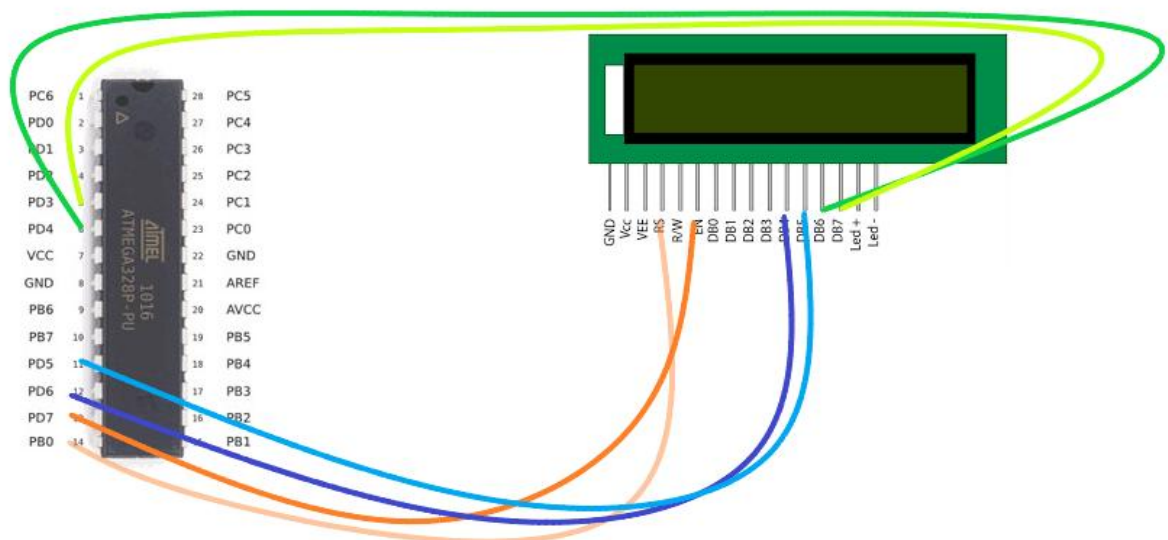


Figure 3.2.3: Interface between Atmega and LCD Display

LCDs (Liquid Crystal Displays) are used for displaying status or parameters in embedded systems.

LCD 16x2 is a 16-pin device which has 8 data pins (D0-D7) and 3 control pins (RS, RW, EN). The remaining 5 pins are for supply and backlight for the LCD.

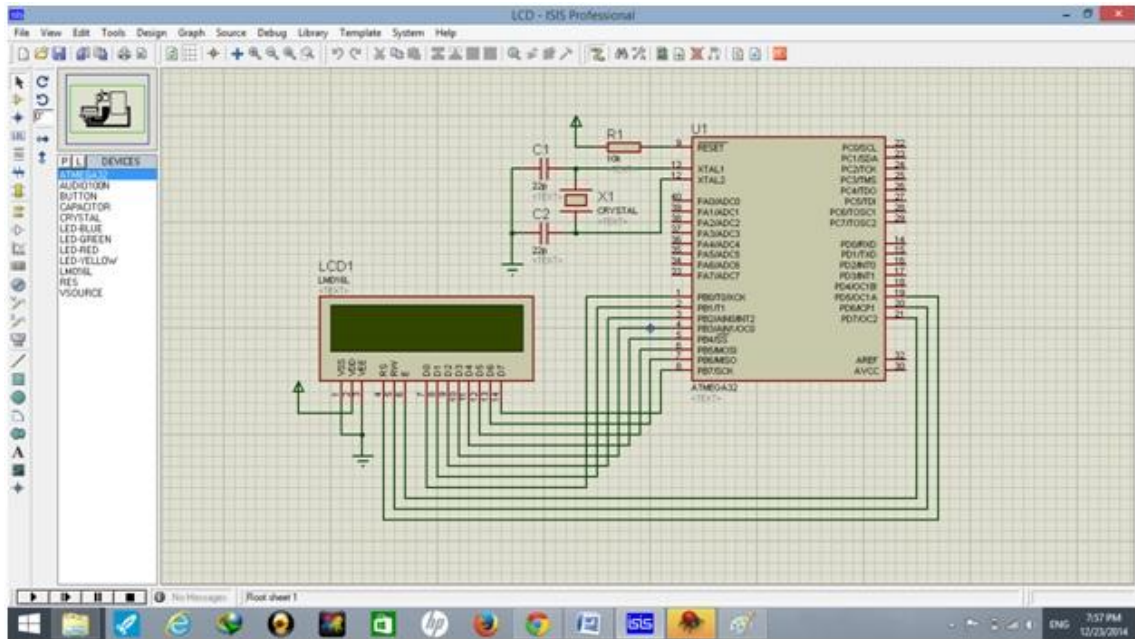
The control pins help us configure the LCD in command mode or data mode. They also help configure read mode or write mode and also when to read or write.

LCD 16x2 can be used in 4-bit mode or 8-bit mode depending on the requirement of the application. In order to use it, we need to send certain commands to the LCD in command mode and once the LCD is configured according to our need, we can send the required data in data mode

4-bit Mode

- In 4-bit mode, data/command is sent in a 4-bit (nibble) format.
- To do this 1st send a Higher 4-bit and then send a lower 4-bit of data/command.
- Only 4 data (D4 - D7) pins of 16x2 of LCD are connected to the microcontroller and other control pins RS (Register select), RW (Read/write), E (Enable) is connected to other GPIO Pins of the controller.

Therefore, due to such connections, we can save four GPIO pins which can be used for another application.



Here;

- Pin RS of the LCD is connected to Pin14 of the Atmega 328p Micro Controller.
- Pin EN of the LCD is connected to Pin13 of the Atmega 328p Micro Controller.
- Pin D4 of the LCD is connected to Pin12 of the Atmega 328p Micro Controller.
- Pin D5 of the LCD is connected to Pin11 of the Atmega 328p Micro Controller.
- Pin D6 of the LCD is connected to Pin6 of the Atmega 328p Micro Controller.
- Pin D7 of the LCD is connected to Pin5 of the Atmega 328p Micro Controller.
- Pin VCC of the LCD is connected to power.
- Pin GND of the LCD is connected to ground.

INTERFACING WI-FI MODULE ESP8266 WITH THE ATMEGA 328p MICRO CONTROLLER.

Here;

- The TxD Pin5 of the Wi-Fi Module is connected to pin 2 of the Atmega 328p Micro controller.
- The RxD Pin4 of the Wi-Fi Module is connected to pin 3 of the Atmega 328p Micro controller.
- The GND Pin1 of the Wi-Fi Module is connected to Ground.
- The VCC Pin8 of the Wi-Fi Module is connected to Power.

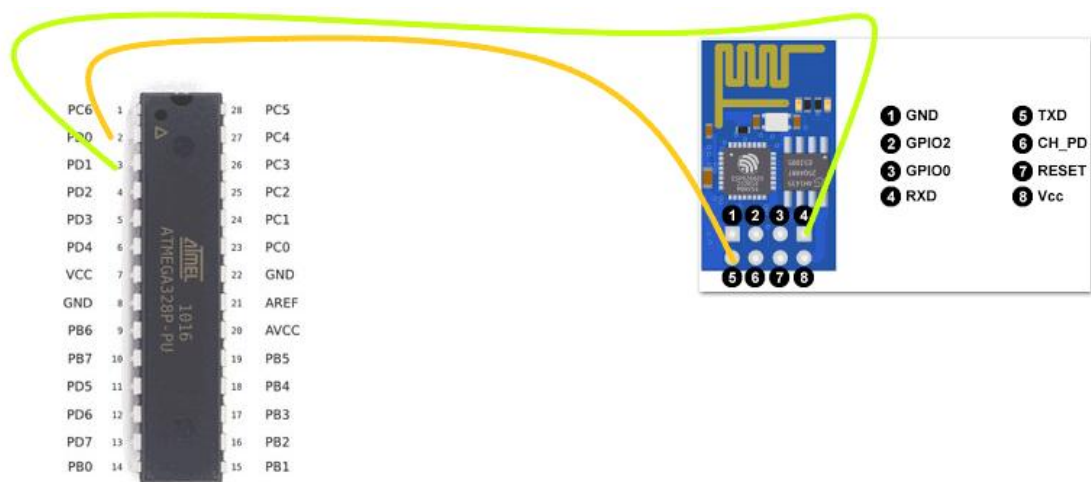


Figure 3.2.4: Interface between Atmega and Wi-Fi Module

To communicate with the ESP8266 WiFi module, the microcontroller needs to use a set of AT commands. The microcontroller communicates with the ESP8266-01 WiFi module using UART having a specified Baud rate (Default 115200)

TCP Client using ESP8266 Wi-Fi Module

Let's program AVR ATmega16 to configure the ESP8266 wifi module as TCP Client and Receive/Send data from/to Server using WIFI. Here, we are using the Blynk server for TCP Client demo purposes. Blynk is an open IOT platform where anyone can visualize and

analyze live data from their sensor devices. Also, we can perform data analysis on data posted by remote devices with Matlab code in Blynk To learn more about Blynk refer link https://Blynk.com/pages/learn_more.

Just sign up and create a channel. We have below the channel and write key on Blynk for data send and receive.

- **channel ID** is = 119922
- **Write Key** is = C7JFHZY54GLCJY38

Note: Do not forget to tick the **Make Public** field in the **channel setting** option on your Blynk channel. It makes channels available to use as public. This allows any user to access channel data without any username & password.

For **TCP RECEIVE** method use below AT command steps shown in the screenshot of RealTerm Serial Terminal.

The below screenshot consists of AT commands (Green) and Responses (Yellow).

```
RealTerm: Serial Capture Program 2.0.0.70
ATE0
OK
AT+CWMODE=3
OK
AT+CIPMUX=0
OK
AT+CIPMODE=0
OK
AT+CWJAP="EW-WIFI","mh163687"
WIFI DISCONNECT
WIFI CONNECTED
WIFI GOT IP
OK
AT+CIPSTART="TCP","api.thingspeak.com",80
CONNECT
OK
AT+CIPSEND=37
OK
> GET /channels/119922/feeds/last.txt
Recv 37 bytes
SEND OK
+IPD,66:<"created_at":"2017-07-07T13:36:33Z","entry_id":1117,"field1":"1">CLOSED
```

For the TCP SEND method use below AT command steps shown in the screenshot of RealTerm Serial Terminal.

```
RealTerm: Serial Capture Program 2.0.0.70
ATE0
OK
AT+CWMODE=3
OK
AT+CIPMUX=0
OK
AT+CIPMODE=0
OK
AT+CWJAP="EW-WIFI","mh163687"
WIFI DISCONNECT
WIFI CONNECTED
WIFI GOT IP
OK
AT+CIPSTART="TCP","api.thingspeak.com",80
CONNECT
OK
AT+CIPSEND=47
OK
> GET /update?api_key=C7JFHZY54GLCJY38&field1=1
Recv 47 bytes
SEND OK
+IPD,4:1117CLOSED
```

INTERFACING THE MOTION SENSOR AND BUZZER TO THE ATMEGA 328p MICRO CONTROLLER.

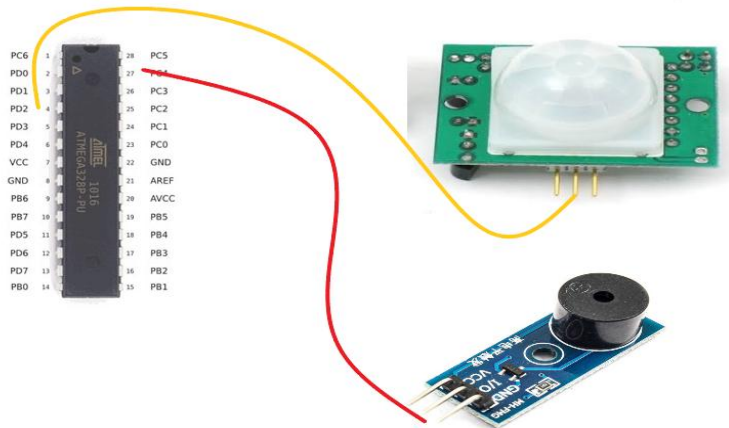
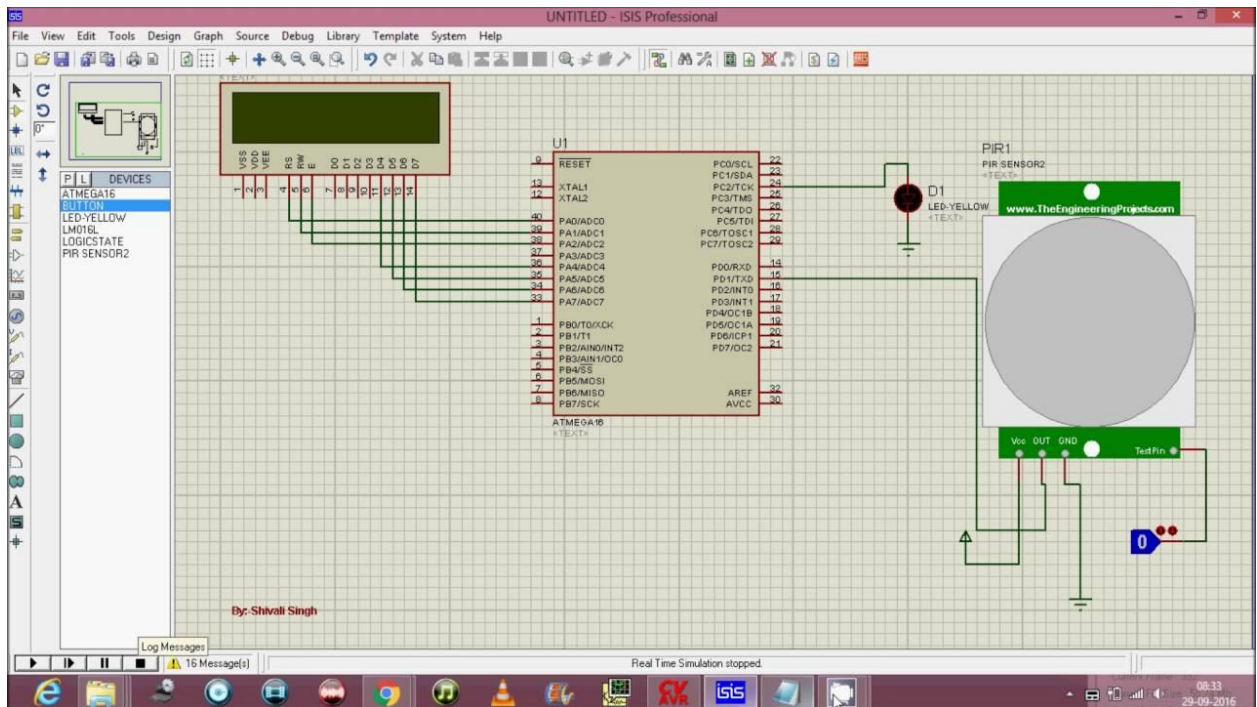


Figure 3.2.5: Interface Atmega with Motion Sensor and Buzzer

PIR sensor detects infrared heat radiations. It can be used to detect the presence of living objects that emit infrared heat radiation.

The PIR sensor is split into two slots. The two slots are connected to a differential amplifier. Whenever a stationary object is in front of the sensor, the two slots receive the same amount of radiation and the output is zero. Whenever a moving object is in front of the sensor, one of the slots receives more radiation than the other slot. This makes the output swing high or low. This change in output voltage is the result of the detection of motion.



Here;

- The I/O Pin of the Buzzer Module is connected to Pin27 of the Atmega Micro controller.
- The output signal Pin of the Motion Sensor is connected to Pin4 of the Atmega Micro Controller.
- Pins VCC on the Motion Sensor and Buzzer Module are connected to Power.
- Pins GND on the Motion Sensor and Buzzer Module are connected to Ground.

INTERFACING THE WATER SENSOR (Ultrasonic sensor) WITH THE ATMEGA 328p MICRO CONTROLLER.

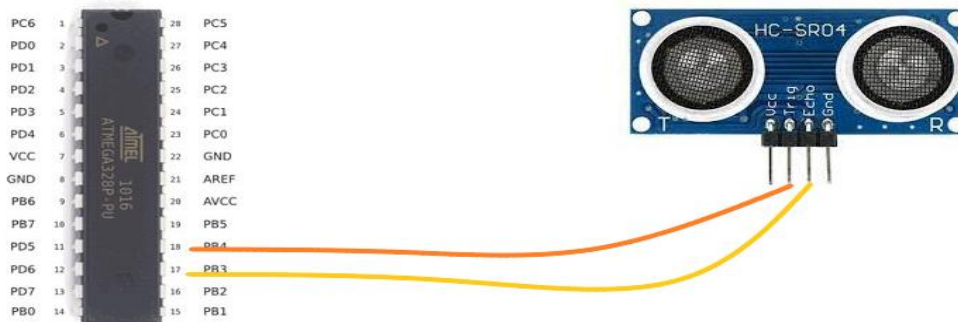
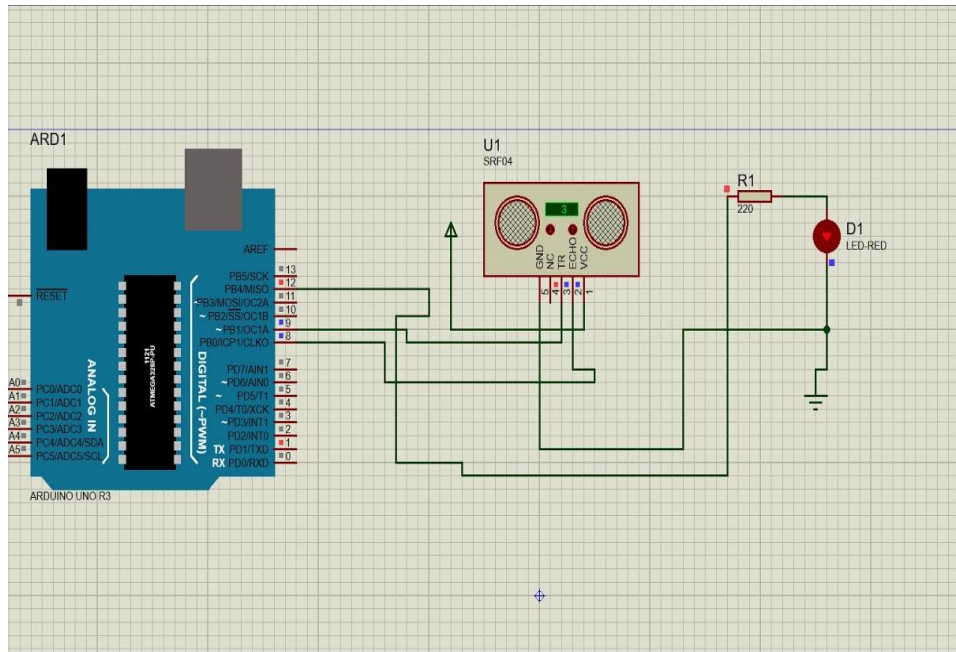


Figure 3.2.6: Interface Atmega with Ultrasonic sensor

Ultrasonic Module HC-SR04 works on the principle of SONAR and RADAR system. HC-SR-04 module has an ultrasonic transmitter, receiver, and control circuit on a single board. The module has only 4 pins, Vcc, Gnd, Trig, and Echo.

When a pulse of $10\mu\text{sec}$ or more is given to the Trig pin, 8 pulses of 40 kHz are generated. After this, the Echo pin is made high by the control circuit in the module. The echo pin remains high till it gets an echo signal of the transmitted pulses back. The time for which the echo pin remains high, i.e. the width of the Echo pin gives the time taken for generated ultrasonic sound to travel towards the object and return. Using this time and the speed of sound in air, we can find the distance of the object using a simple formula for distance using speed and time.



Here:

- Pin 2 of the ultrasonic Sensor(Trigger) is connected to pin 18 of the Atmega 328p micro controller.
- Pin 3 of the Ultrasonic Sensor(Echo) is connected to pin 17 of the Atmega 328p micro controller.
- Pin 1 of the ultrasonic Sensor(VCC) is connected to power.
- Pin 4 of the Ultrasonic Sensor(GND) is connected to ground.

INTERFACING THE TEMPERATURE SENSOR TO THE ATMEGA MICRO CONTROLLER.

Here;

- Pin1 of the Temperature Sensor is connected to the Ground.
- Pin2 of the Temperature Sensor is connected to Pin19 of the Atmega Micro Controller.
- Pin3 of the Temperature Sensor is connected to the Power.

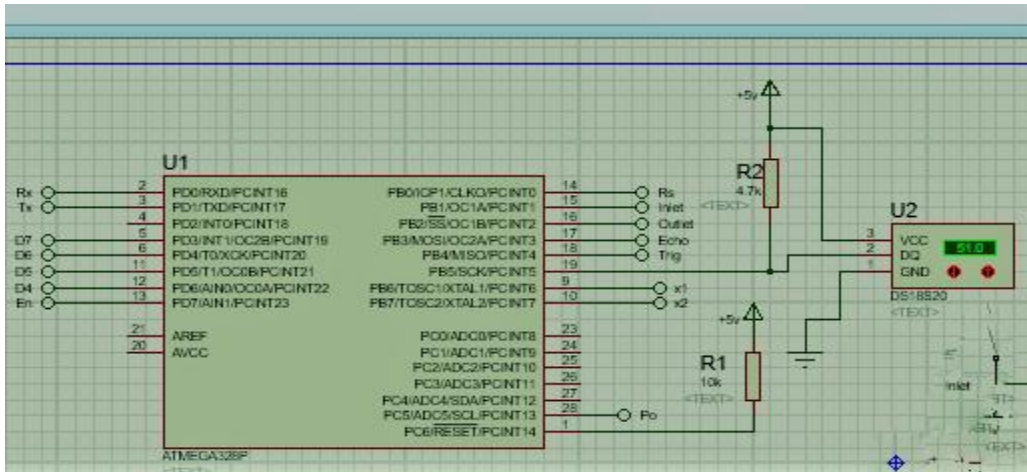


Figure 3.2.7: Interface Atmega with Temperature Sensor

INTERFACING THE PH SENSOR TO THE ATMEGA MICRO CONTROLLER

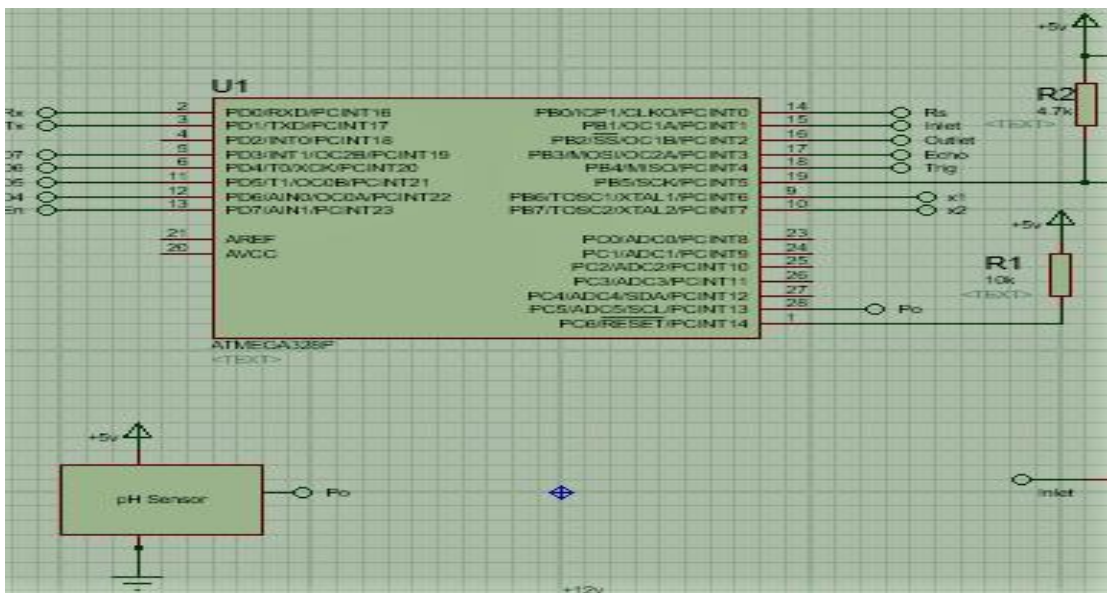


Figure 3.2.8: Interface Atmega with pH sensor.

Here;

- Pin29 of the Atmega Micro Controller is connected to the pH sensor.
- The remaining Pins of the pH is connected to Ground and Vcc respectively.

3.2.2 Software Implementation Using Blynk IoT Platform

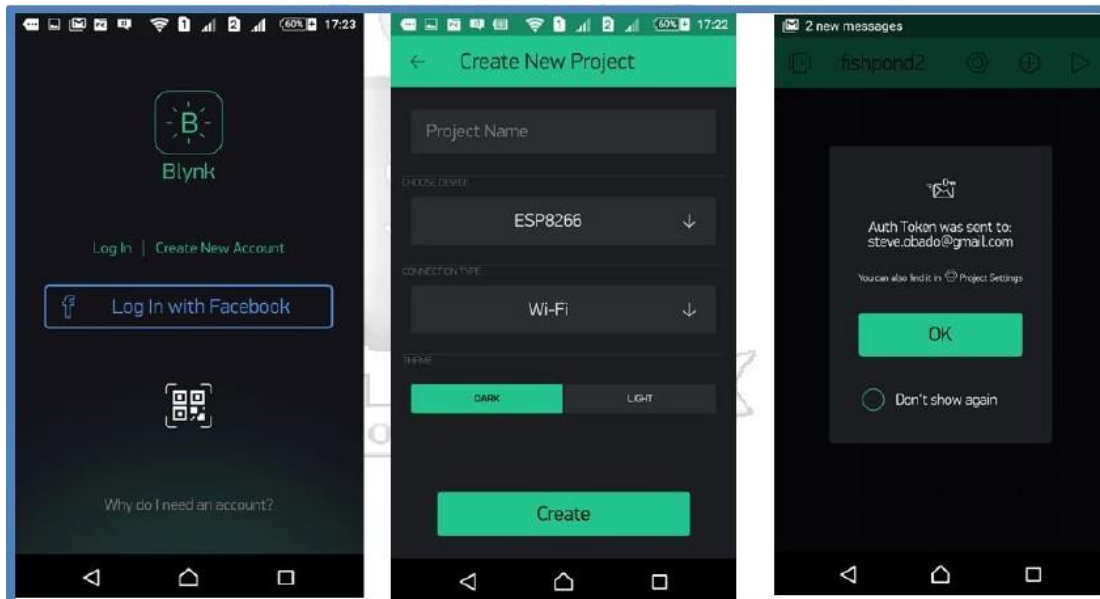


Figure 3.3.1: Creating a new Blynk Project

CREATING A NEW PROJECT WITH BLYNK

Install the program from the Google Play Store on your Android device. Authentication tokens for secure app access are generated and sent to the administrator's email address.

DASHBOARD

Users will interact with program components via the application dash board, which is a graphical user interface. The application has widgets that the administrator can customize based on the intended use. Users can browse the application using the menus and widgets on the dashboard.

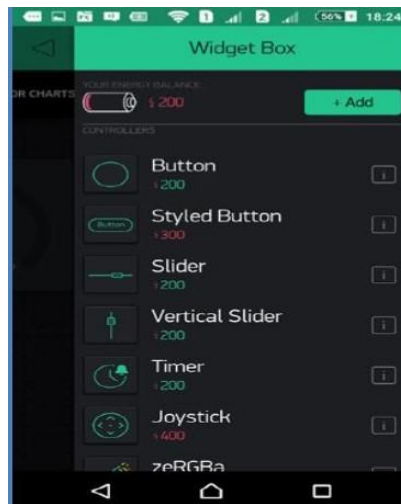


Figure 3.3.2: Dashboard View

CODING OUR COMPONENTS AND DATA VALIDATION

The major purpose of the system was to keep track of the fish pond's water quality characteristics. The sensors would monitor many aspects of water quality. The system administrator must write code on the IDE to provide instruction code to the sensors. The hardware must be initialized using the appropriate libraries, and a secure connection to the server must be established by providing the authentication code. The primary execution function runs in a loop, constantly probing the sensors at predetermined intervals. The Blynk app runs a function in PUSH mode that updates the water level widget.

From the initialization procedure to the notification, the algorithm is implemented in a series of commands. The parameters' thresholds are established during initialization, and any variation from the set threshold generates an alarm that is sent to the users' smartphone. Data validation techniques were also included in the application to verify that the right information is provided.

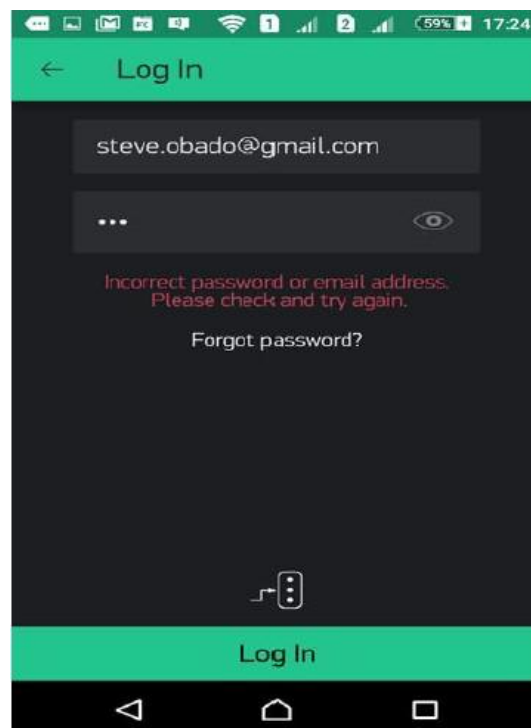
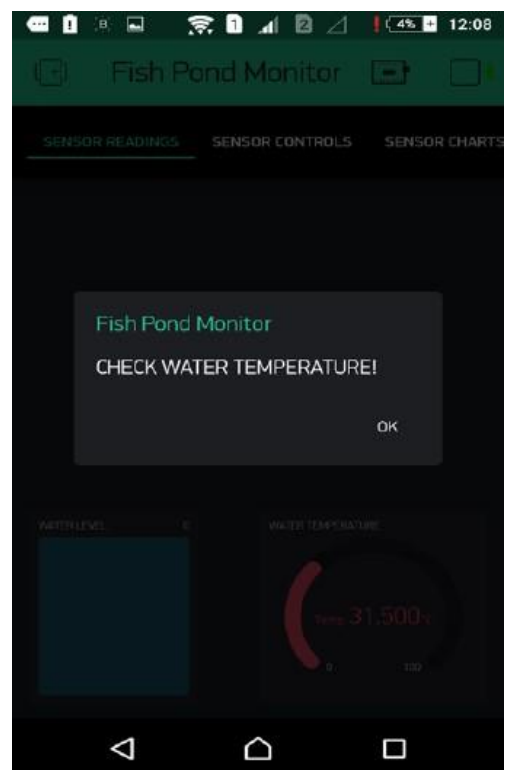
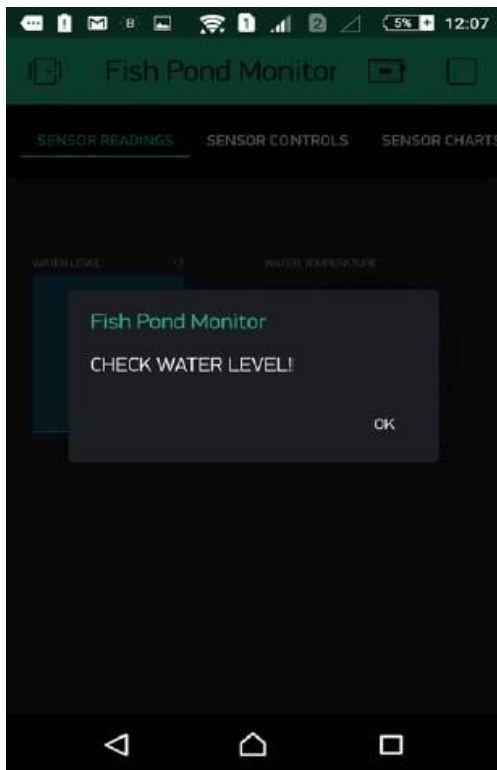


Figure 3.3.4: Status Checking Using Blynk

USE CASE DIAGRAMS

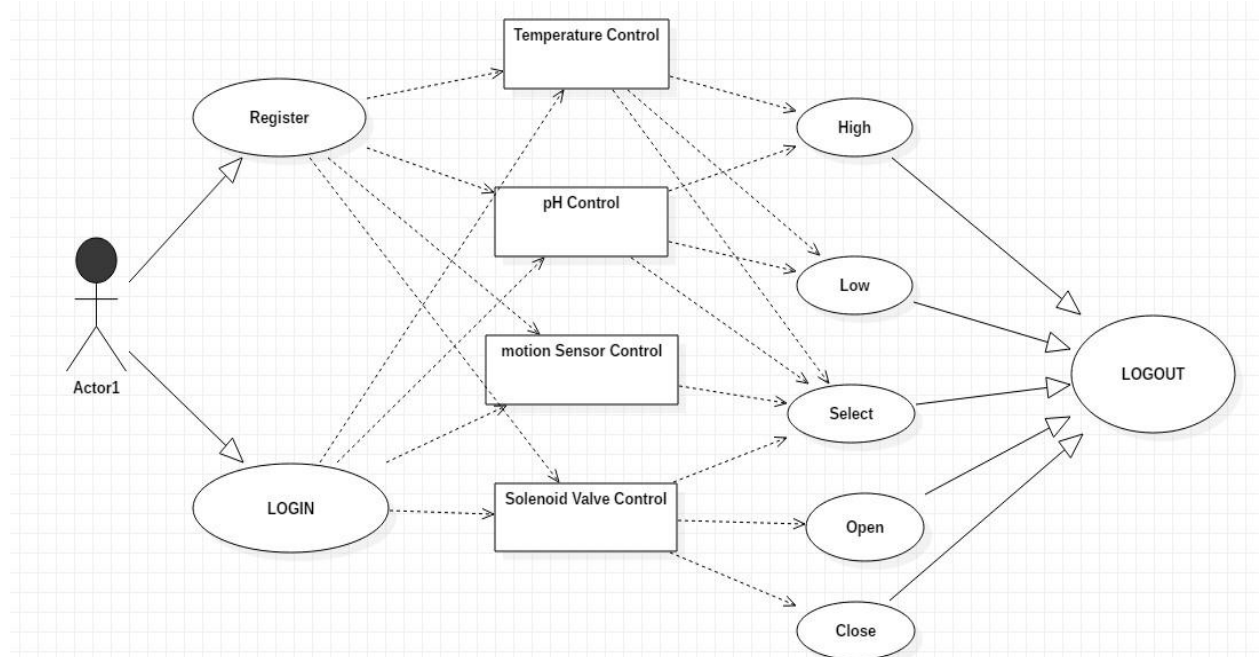


Figure 3.3.5: Use Case Diagram

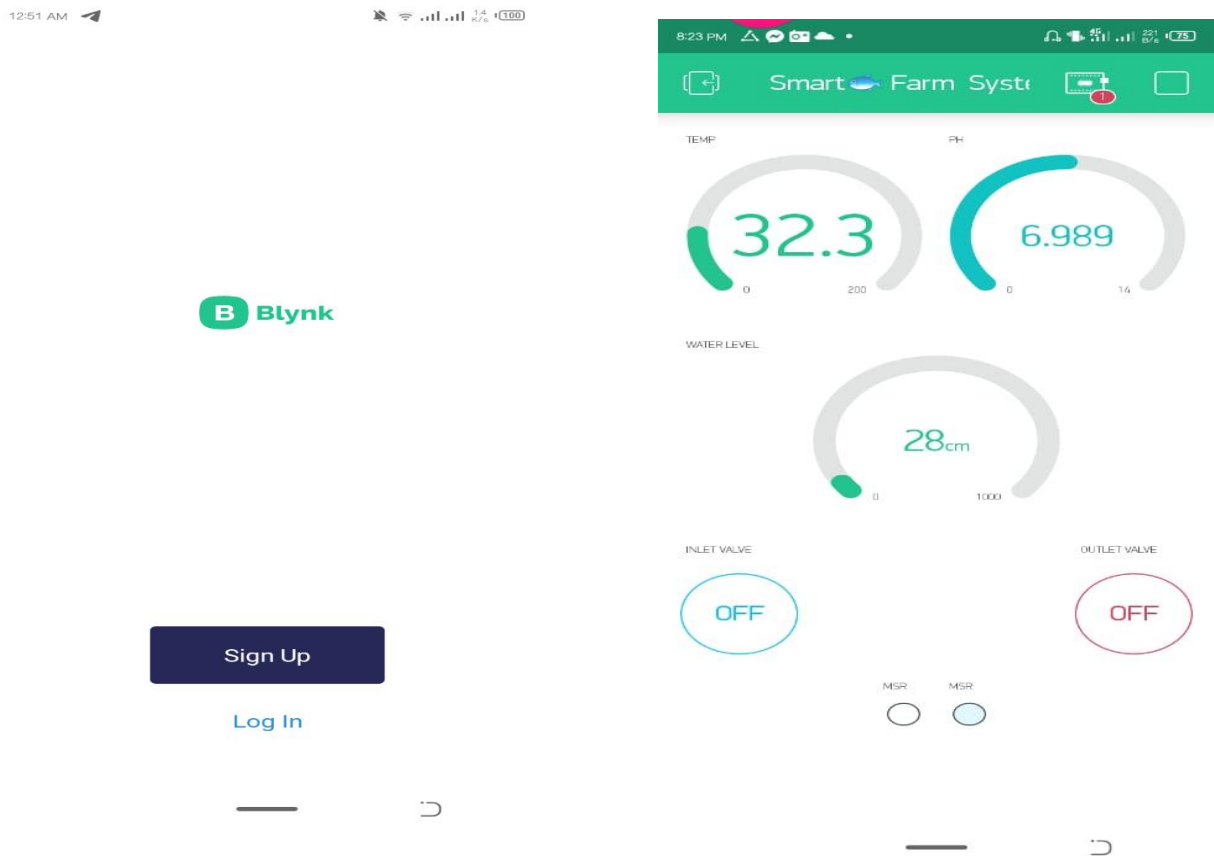


Figure 3.3.5.1: pictorial view use Case Diagram

CLASS DIAGRAMS

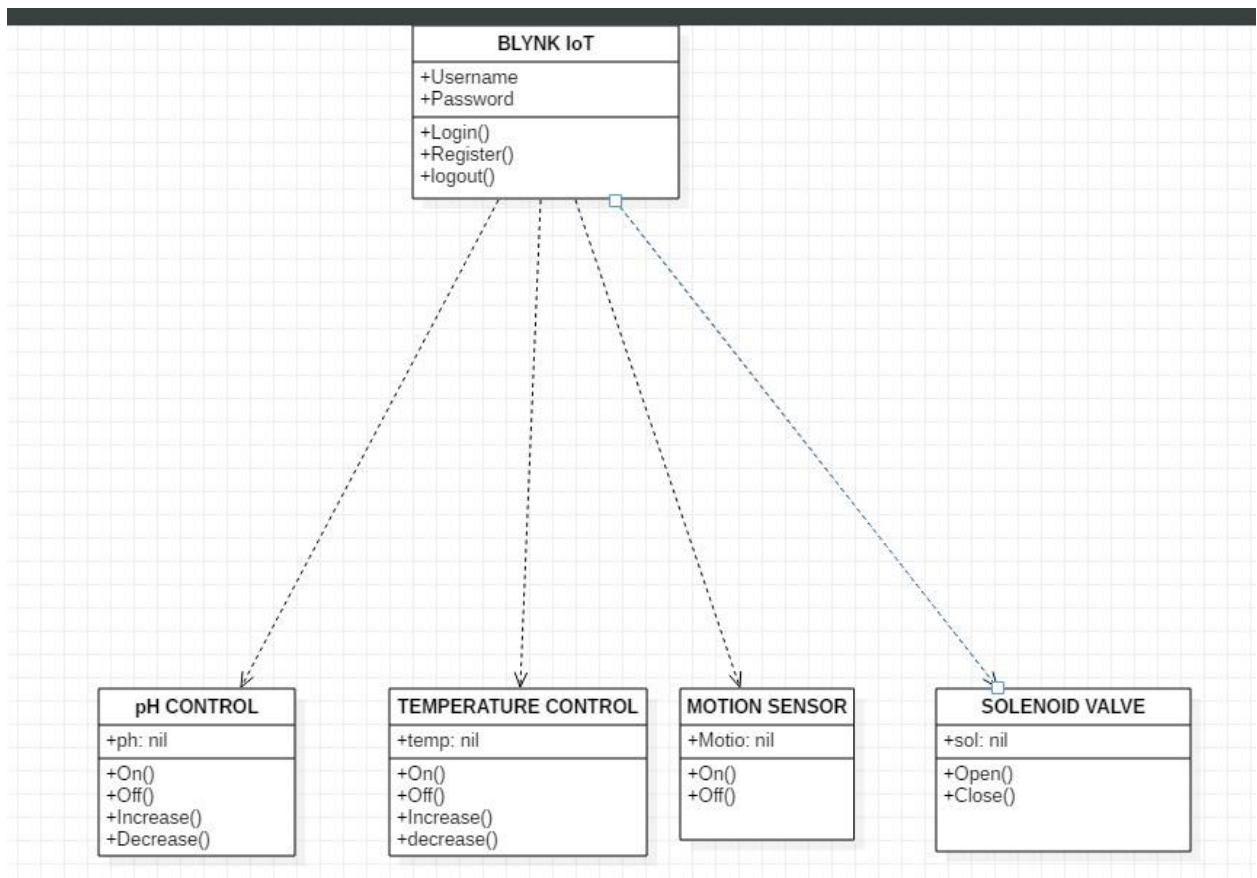


Figure 3.3.6: Class Diagram

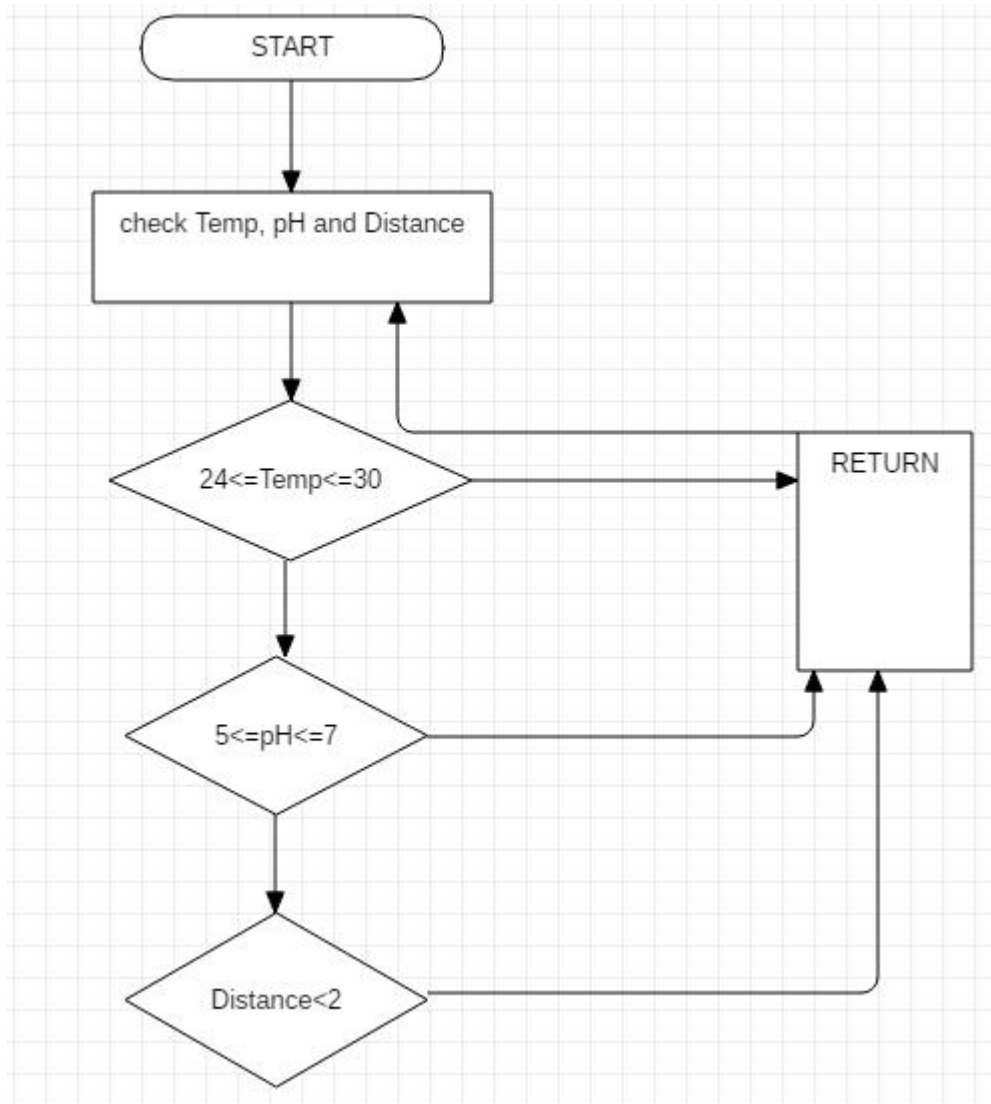


Figure 3.3.7 Flowchart

3.3 REQUIREMENTS

3.3.1 SOFTWARE REQUIREMENTS

- Proteus
- MikroC
- StarUML
- Blynk IoT
- Arduino

3.3.2 HARDWARE REQUIREMENTS

- PIC kit.
- Android (android 8 or higher) or IOS (ios10 or higher) Smartphone.
- 32GB or higher for Internal Smartphone Memory Space.
- 2.1 Dual Core Processor or Higher.

CHAPTER FOUR

TESTING AND RESULTS

The construction of the project involved design and testing on Proteus, programming the micro controller on MikroC, building the microcontroller using PIC kit, implementing design on a Vero Board, drilling of casing and coupling the whole system together.

4.1 CONSTRUCTION

The tools and materials used for the construction of the system include the following;

1. Vero board.
2. Soldering Iron.
3. Soldering Lead.
4. Digital Multi Meter.
5. Wire-Cutter.
6. Plier.
7. Micro controller Programmer Kit.
8. Screw Driver.
9. De-Soldering Pump.
10. Drilling Machine.

4.2 APPLICATION TESTING

The research utilized both unit testing and integration testing methodologies to ensure that the prototype functioned as per the user requirements. The results of test were presented in a score card in table layout as illustrated in table 4.2

S/No.	FUNCTION	EXPECTED RESULT	SCORE
1	Ultra-Sonic Senor measure water level	Accurately measure the level of water in the pond	PASS
2	Water Level Widget	Accurately display the level of water in the pond	PASS
3	Temperature sensor to measure water temperature	Accurately measure the temperature of water in the pond	PASS
4	Water Temperature Widget	Accurately display water temperature	PASS
5	Water pump Switch	Switch the water pump on or off	PASS
6	Sensor charts	Display sensors historical data	PASS

Table 4.1: Application Test

4.3 PERFORMANCE EVALUATION

The following tests were carried out to evaluate the performance of the system.

1. Throughput

Network throughput refers to how much data can be transferred from source to destination within a given timeframe. Throughput measures how many packets arrive at their destinations successfully. It can be measured in packets per second, bytes per second, or bits per second.

Packet arrival is key to high-performance service within a network. When people use programs or software, they want their requests to be heard and responded to in a timely fashion. Esp8266 has two hardware UART which results in 8bits been able to be transmitted and received. In the temperature test 32bps can be and received, while for the PH 40bps can be received and the throughput for the water level is 32bps.

2. END TO END DELAY

End to end delay tests for the maximum amount of time it takes for a packet to be transmitted across a network from source to destination. This particular test was observed alongside the testing of jitter and it was carried out by sending an operation to the system and recording how fast it takes for the system to receive the data immediately it was transmitted. The time observed was recorded in as 2.02seconds, 2.93seconds, 3.42seconds, 3.60seconds and 3.01seconds. From the results, it was concluded that the performance of the system varies and performed well, depending on the strength of the network and distance, at a particular time.

3. LATENCY

Latency tests for the amount of time it takes for the network to respond to a request. Latency test was used to evaluate the amount of time it takes for the device to respond to the command sent to the GSM module. It was observed for 5 consecutive readings as

2.02seconds, 1.93seconds, 1.42seconds, 2.12seconds and 2.01seconds, and the average was calculated as 2.196seconds.

4. JITTER

Jitter is a variation in the time delay between when a signal is transmitted and when it is received, and it is the disruption in the normal sequence of sending data packets. Jitter tests were carried out to measure the delay at which the data can be requested or received and the variation in the response time. This was done by observing the time it takes for the system to transmit and receive data and 5 consecutive readings were taken in seconds as 1.93, 1.22, 2.12, 2.02 and 2.01. Depending on the stability of the network and the region, the time varies, which shows that a lower time response translates to better performance of the system.

These tests carried out on this system were tabulated in Table4.3 below:

S/n	Tests	Results	Remarks
1	Throughput of Temp PH Water level	32bps 40bps 32bps	The number bits being transmitted are as a result of the Uart of the Wi-Fi module Esp8266 being able to transmit a maximum of 13mbps
2	Average End to End Delay	2.996 seconds	Very Good
3	Latency	1.9 seconds	Very Good
4	Average Jitter	1.86 seconds	Very Good

4.4 IMPLEMENTED DESIGN

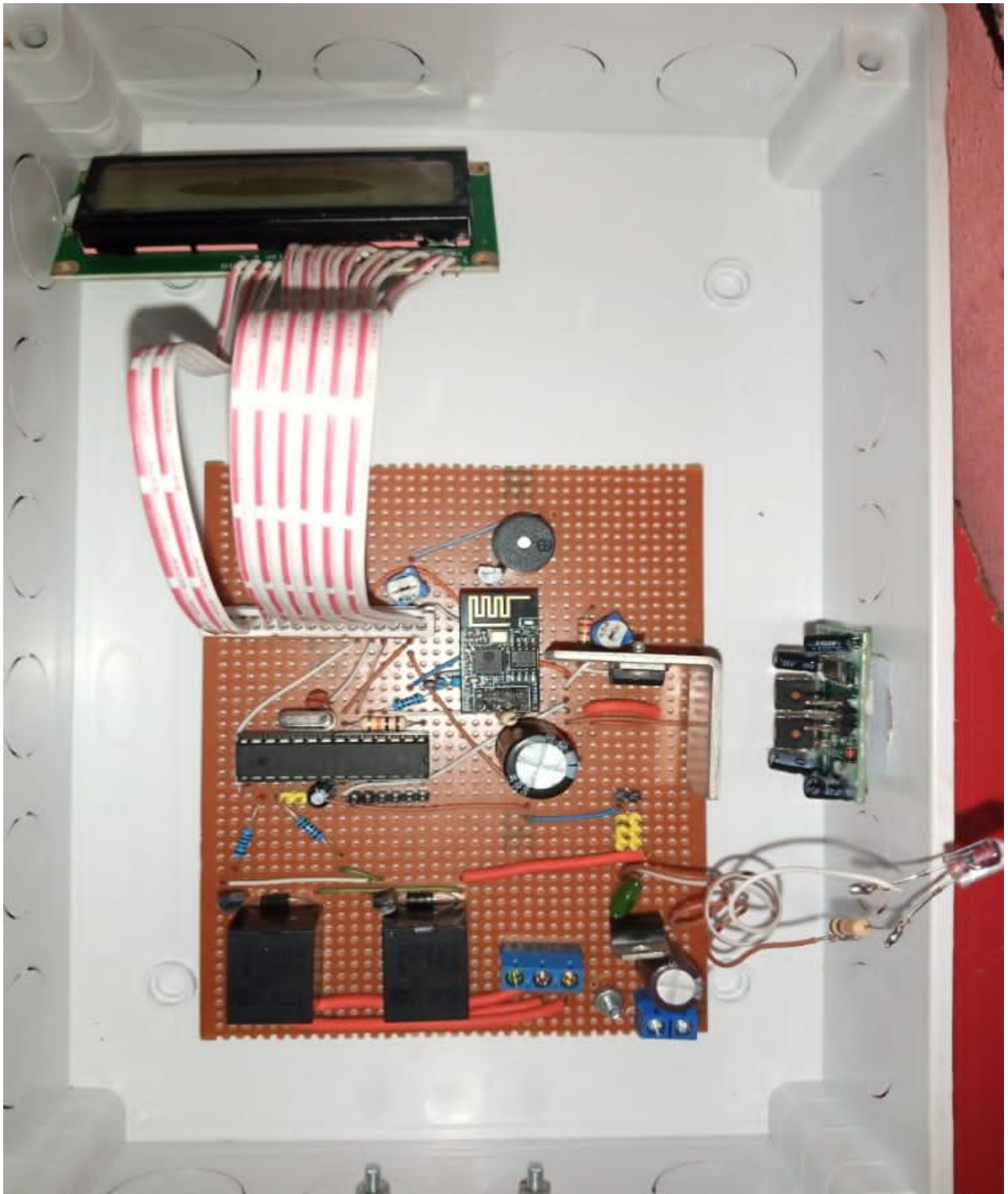


Figure 4.0.1: showing the internal connections



Figure 4.0.2: Initialization



Figure 4.0.3: Solenoid Valve

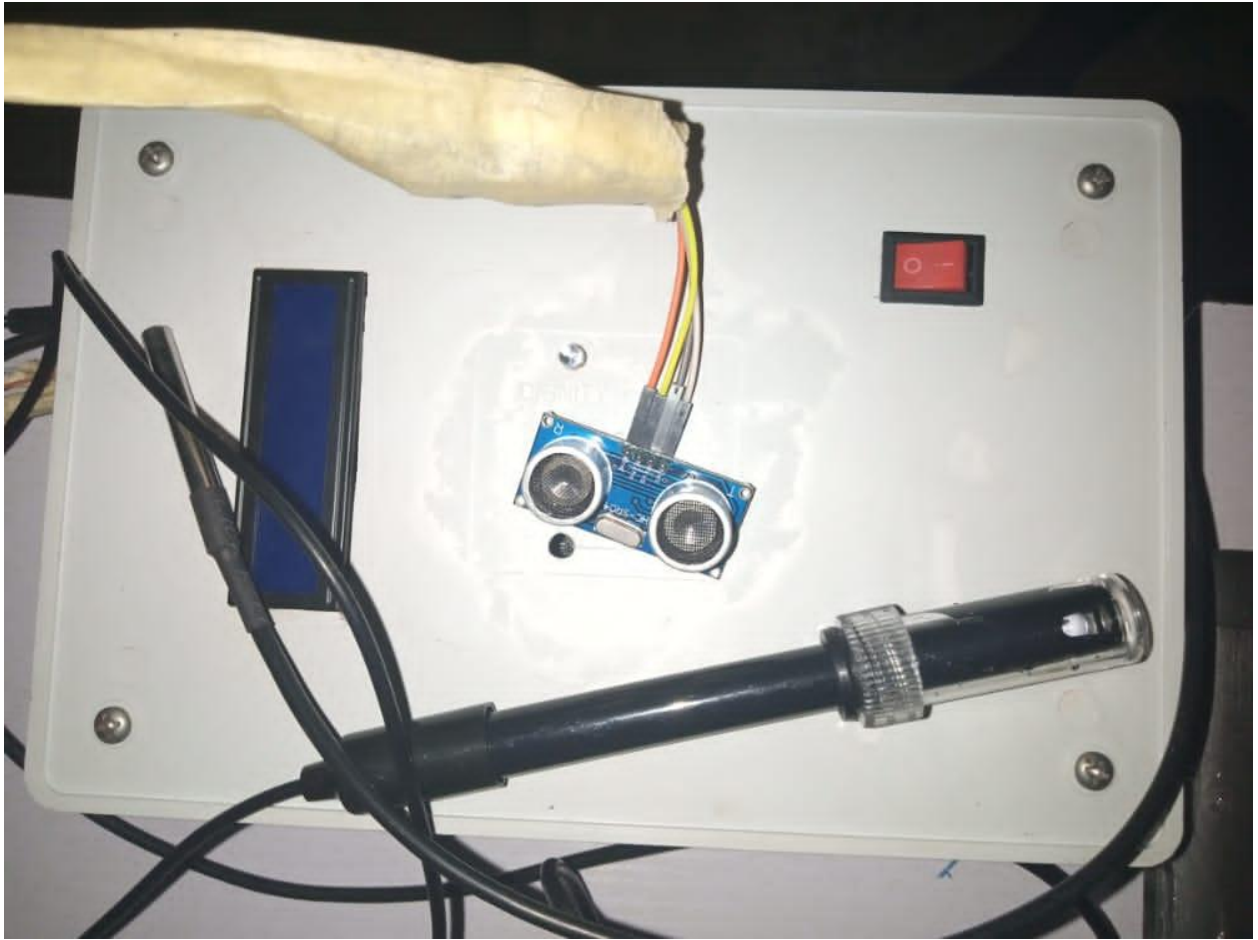


Figure 4.0.4: Showing Ultrasonic Sensor and pH Sensor

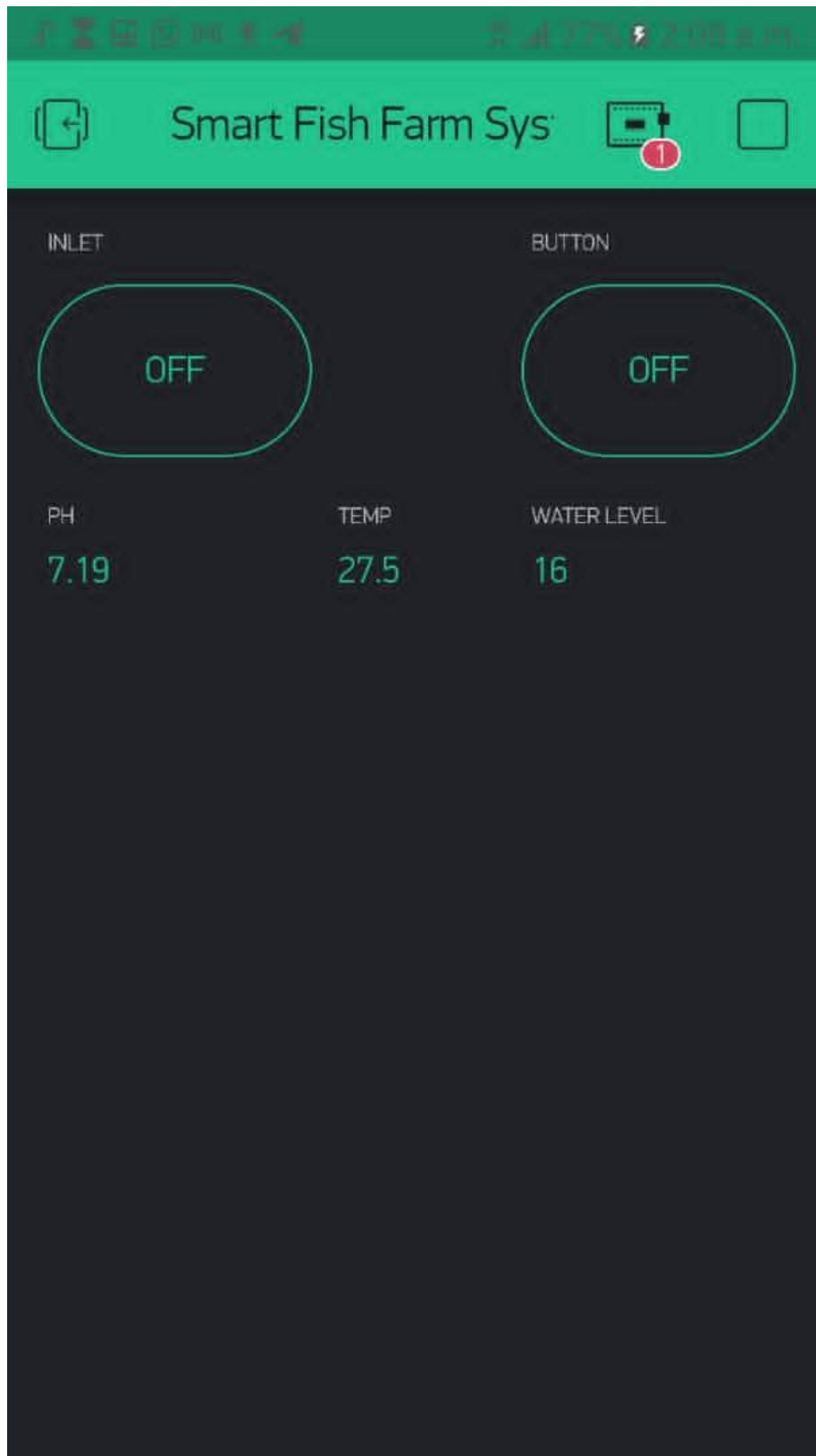


Figure 4.0.5: Blynk Implementation

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Fish farming is the most reasonable and practical solution for stocking fish in these modern times, where wild fish stock from rivers lakes and sometimes oceans and seas are declining due to environmental pollution, global warming etc. resulting in the demise of these fishes dying. The act of fish farming in a controlled environment guarantees that the fishes survives to the desires level of maturity and thus contributes to the country's food security and could even result in exportation. Due to the fact that fishes live in water and respond quickly the and environmental change in the pond, it becomes very detrimental for the farmer to monitor the quality of water in the pond to ensure guaranteed survival.

One of the most significant benefits of employing IOT-based systems is the simplicity with which generated data can be accessed via multiple channels over the internet, regardless of the farm owner's location. Another benefit is the automation of control over the internet, which allows authorized users to transmit instructions from various locations, and the system will respond by reading and executing the data before providing feedback to the user. For example, if the user wants to change the water in the fish pond, the user sends a set of instructions through a third-party app (BLYNK), and the fish pond Wi-Fi module receives, interprets, and executes the command by flushing and refilling the pond with new water from a nearby water source (water tank, river or reservoir).

It also enables for security checks by guaranteeing that intruders are alerted to the fish farmer when they enter the perimeter. In the case of fish farming, the presence of predators might result in significant losses. Because the main objectives will not be realized unless this

major setback is addressed, we have implemented the usage of a proximity sensor to detect predators at a calculated distance from the fish pond. Electric wires may be fencing a few meters away from the fish pond to scare them away, or a regular fish net could be stretched across the top of the pond to keep other predators, particularly birds, at bay.

Finally, it is common knowledge that data is required in the training of some artificial life forms in order for them to learn from previous experiences. This could be an opportunity to collect data on fish behavioral patterns, predators within the pond's perimeter, pH for various fish species, and the effect of light and temperature within and around the pond.

5.2 RECOMMENDATION

From the study of literature and interviewing of experts it emerged that there are numerous other variables that could be considered while taking care of the fish welfare. More sensor could be installed to scale up the model to a fully operational system. Powering the devices in remote areas and for longer periods of time can be considered for future implementations. Creating redundant devices can be implemented in case of failure of one of the sensors.

5.3 REFERENCES

- Durga, S. N. (2017). GSM based Fish Monitoring System Using IOT. *International Journal of Mechanical Engineering and Technology* , pp. 1094–1101.
- E. N. Onwuka, A. O. (2011). Design and Construction of a Microcontroller-based Automatic Fish Feeding Device. *The 26th Annual Conference & fair of the Fisheries Society of Nigeria*, (pp. pp.no: 11 – 15).
- Fiona Regan, A. L. (2009). *A demonstration of wireless sensing for long term monitoring of water quality*. Glasnevin: International Workshop on Practical Issues In Building Sensor Network Applications, National Centre for Sensor Research, Dublin City University, Glasnevin, IEEE.
- L. Joon-Taek, C. S.-H.-H.-H. (2003). *Design and Implementation of Fish Farm Monitoring System using Embedded System*. Journal of Contents, Vol.3, No.1, pp.71-79.
- Lee, P. G. (1995). A Review of Automated Control Systems for Aquaculture and Design Criteria for Their Implementation, *Aquacultural Engineering*, Vol. 14, No. 3. pp. 205-227.
- Xiuna Zhu, D. L. (2010). *A remote wireless system for water quality online monitoring in intensive fish culture*, *Computers and Electronics in Agriculture*, (715), 53-59. Retrieved from elsevier: www.elsevier.com/locate/compag.
- GOK. (2016). Water quality management for fish farming – State Department of Fisheries. Retrieved January 25, 2017, from <http://www.kilimo.go.ke/fisheries/index.php/waterquality-management-for-fish-farming/>.

Idachaba, F. E., Olowoleni, J. O., Ibhaze, A. E., & Oni, O. O. (2017). *IoT Enabled Real-Time Fishpond*

Management System. 5.

Sri, B. D., Nirosha, K., Priyanka, P., & Dhanalaxmi, B. (2017). *GSM BASED FISH MONITORING SYSTEM USING IOT*. 8(7), 8.

Mbugua, H. M. (2008). *Aquaculture in Kenya; Status, Challenges and Opportunities*.

Meijberg, A. (2016). *Strategic Environmental Assessment and Environmental Management Plan*. 112.

Ngugi, C. C., Bowman, J. R., & Omolo, B. O. (2007). *A New Guide to Fish Farming in Kenya*. Retrieve

from <http://www.oceandocs.org/handle/1834/7172>.

Banhazi, T. M. (2012). Precision Livestock Farming: An international review of scientific and commercial aspects. *International Journal of Agricultural and Biological Engineering*, 5(3).

FAO. (2005). *FAO Fisheries & Aquaculture - National Aquaculture Sector Overview*. Kenya.

Sethi, P. &. (2017). Internet of Things: Architectures, Protocols, and . *Journal of Electrical and Computer Engineering*, 1–25.

- Shitote, Z. W. (2013). Challenges Facing Fish Farming Development in Western Kenya. *Greener Journal of Agricultural Sciences*, 305–311.
- Sravanth Goud, K. &. (2015). Internet based Smart Poultry Farm. *Indian Journal of Science and Technology*, 8(19).
- Sri, B. D. (2017). *GSM BASED FISH MONITORING SYSTEM USING IOT*.
- Towers, L. (2015, March 18). *How to Achieve Good Water Quality Management in Aquaculture*. Retrieved from <https://thefishsite.com/articles/how-to-achieve-good-water-quality-management-in-aquaculture>
- Vermesan, D. O. (2011). *Internet of Things: Global Technological and Societal Trends (Vol. 1)*. Retrieved from http://www.internet-of-things-research.eu/pdf/IERC_Cluster_Book_2011.pdf
- Abbasi, S. A. (n.d.). Extraction and spectrophotometric determination of vanadium. In *Extraction and spectrophotometric determination of vanadium* (pp. 714-717). Anal. Chem.
- Banhazi, T. M. (2012). Precision Livestock Farming: An international review of scientific and commercial aspects. *International Journal of Agricultural and Biological Engineering*, 5(3).
- C., B. (n.d.). A comparison of several methods of assessing river condition using benthic macroinvertebrate assemblage. In J. Aquat (Ed.), *A comparison of several methods of assessing river condition using benthic macroinvertebrate assemblage* (pp. 135-147).
- Dallas, H. F. (n.d.). *The Effect of Water Quality Variables on Aquatic Ecosystems: A Review*. (Water Research Commission ed.). Pretoria, South Africa.

- Davis, W. S. (n.d.). *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. London: Lewis Publishers.
- FAO. (2005). FAO Fisheries & Aquaculture - National Aquaculture Sector Overview. Kenya.
- Sethi, P. &. (2017). Internet of Things: Architectures, Protocols, and . *Journal of Electrical and Computer Engineering*, 1–25.
- Shitote, Z. W. (2013). Challenges Facing Fish Farming Development in Western Kenya. *Greener Journal of Agricultural Sciences*, 305–311.
- Sravanth Goud, K. &. (2015). Internet based Smart Poultry Farm. *Indian Journal of Science and Technology*, 8(19).
- Sri, B. D. (2017). *GSM BASED FISH MONITORING SYSTEM USING IOT*.
- Towers, L. (2015, March 18). *How to Achieve Good Water Quality Management in Aquaculture*. Retrieved from <https://thefishsite.com/articles/how-to-achieve-good-water-quality-management-in-aquaculture>

SAMPLE CODES

```

/* Comment this out to disable prints and save space */

#define BLYNK_PRINT Serial

#include <ESP8266_Lib.h>

#include <BlynkSimpleShieldEsp8266.h>

#include <OneWire.h>

#include <DallasTemperature.h>

#include <LiquidCrystal.h>

```

```

LiquidCrystal lcd(4, 9, 5, 6, 7, 8);

// You should get Auth Token in the Blynk App.

// Go to the Project Settings (nut icon).

char      auth[]      =      "OjdeTbEsI1BmV7BeG6T7hnxAV3U7EVdq";
//"JjLEFmc0A7SzqQH77bSD674p4kHBEYTv";/"V9b70PLm4TcqVesodzlcnZWTBC1Q03
cW";

// Your WiFi credentials.

// Set password to "" for open networks.

char ssid[] = "hot";

char pass[] = "2020hott";

// Hardware Serial on Mega, Leonardo, Micro...

//#define EspSerial Serial1

// or Software Serial on Uno, Nano...

#include <SoftwareSerial.h>

SoftwareSerial EspSerial(2, 3); // RX, TX

// Your ESP8266 baud rate:

#define ESP8266_BAUD 9600

#define R1 10 //12

#define R2 11 //13

int adcPin = A2;

const float m = -5.436;

ESP8266 wifi(&EspSerial);

```

```
// Data wire is plugged into port 2 on the Arduino, while external pullup P-MOSFET gate into port 3
```

```
#define ONE_WIRE_BUS 12 //10
```

```
// Setup a oneWire instance to communicate with any OneWire devices (not just Maxim/Dallas temperature ICs)
```

```
OneWire oneWire(ONE_WIRE_BUS);
```

```
// Pass our oneWire reference to Dallas Temperature.
```

```
DallasTemperature sensors(&oneWire);
```

```
float val = 0.0;
```

```
float val_2 = 0.0;
```

```
float tempp = 0.0;
```

```
float phh = 0.0;
```

```
#define max_distance 200
```

```
const int trigPin = A4;
```

```
const int echoPin = A5;
```

```
long duraton;
```

```
int distance;
```

```
void setup()
```

```
{
```

```
  // Debug console
```

```
  pinMode(R1, OUTPUT);
```

```
  pinMode(R2, OUTPUT);
```

```
  pinMode(0, OUTPUT);
```

```
pinMode(trigPin, OUTPUT);

pinMode(echoPin, INPUT);

//pinMode(3, OUTPUT);

delay(10);

lcd.begin(16, 2);

// Start up the library

sensors.begin();

// Set ESP8266 baud rate

EspSerial.begin(ESP8266_BAUD);

delay(50);

lcd.clear();

lcd.setCursor(0, 0);

lcd.print("IoT smart monitorn");

lcd.setCursor(5, 1);

lcd.print("System");

delay(1000);

delay(1000);

delay(1000);

delay(1000);

lcd.clear();

lcd.setCursor(3, 0);

lcd.print("Starting...");

delay(1000);
```

```

delay(1000);

delay(1000);

delay(1000);

Blynk.begin(auth, wifi, ssid, pass);

lcd.clear();

}

void ultrasonic(){

digitalWrite(trigPin, LOW);

delayMicroseconds(2);

digitalWrite(trigPin, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin, LOW);

duraton = pulseIn(echoPin, HIGH);

distance = duraton * 0.034/2;

lcd.print("WL: ");

lcd.print(distance);

delay(100);

}

BLYNK_WRITE(V0){

    int pinValue = param.asInt();

    if(pinValue == 1){

digitalWrite(R1, HIGH); // Turn the LED on (Note that LOW is the voltage level

        digitalWrite(0, HIGH);

```

```

    }

else{

    digitalWrite(R1, LOW);

}

lcd.begin(16, 2);

}

BLYNK_WRITE(V2){

    int pinValue = param.asInt();

    if(pinValue == 1){

digitalWrite(R2, HIGH); // Turn the LED on (Note that LOW is the voltage level

        digitalWrite(0, LOW);

    }

else{

    digitalWrite(R2, LOW);

}

lcd.begin(16, 2);

}

BLYNK_READ(V3){

    val = temp();

    Blynk.virtualWrite(V3, val);

}

BLYNK_READ(V4){

    val_2 = pH();

```

```

    Blynk.virtualWrite(V4, val_2);
}

BLYNK_READ(V5){

    Blynk.virtualWrite(V5, distance);
}

float temp(){

    sensors.requestTemperatures();

    float tempval = sensors.getTempCByIndex(0);

    delay(500);

    return tempval;
}float pH(){

    float Po = 0;

    float Poo = 0;

    for (int i = 0; i < 10; ++i){

        Poo = analogRead(adcPin);

        Po = Po + Poo ;

    }

    Po = Po / 10;

    Po = (Po * 5.0) / 1024;

    float phValue = 7 - (2.5 - Po) * m;

    delay(500);

    return phValue;
}

```

```
void loop()

{ temp = temp();

  phh = pH();

  //lcd.clear();

  lcd.setCursor(2, 0);

  lcd.print("Temp: ");

  lcd.print(temp, 1);

  lcd.write(0xDF);

  lcd.print("C");

  lcd.setCursor(0, 1);

  ultrasonic();

  lcd.setCursor(8, 1);

  lcd.print("PH: ");

  lcd.print(phh, 1);

  Blynk.run();

}
```

APPENDIX

META Analysis table

S/N	Author	Year	Technique	Advantages	Shortcomings
1	SAJAL SAHA, RAKI BUL HASAN RAJIB, SUMAIYA KABIR	2018	It uses Raspberry pi, Arduino, various sensors, android application and smartphone camera for water quality monitoring.	It finds a way to give a better result for low cost than any other available systems.	It requires much power as a result of so many sensors being attached to the farm.
2	MONIRA MUKTA, SAMIA ISLAM, SURAJIT DAS BARMAN, AHMED WASIF REZA	2019	The proposed system can analyze successfully water parameters using fast forest binary classifier to classify whether the test water samples are fit for drinking.	Fast forest binary classifier shows better performance to validate systems effectiveness and accuracy in predicting the quality of water.	It is limited to just testing of water quality

3	MUHAMMAD NISWAR, SONNY WAINALANG, et al	2018	It uses LoRa based wireless sensor network and a MQTT lightweight protocol. It also comprises of raspberry pi, sensor node and mobile client.	In this system low cost sensors, small embedded systems and LoRa wireless interface is developed.	It requires internet connectivity which may be hard to come across in rural or isolated areas.
4	ENGR. NOCHESKI S.1, PROF. DR. ENG. NAUMOSKI A	2018	It uses Lora WAN, Wi-Fi or Satellite communication. It uses sensor such as temperature sensor, pH sensor etc. to monitor the pond.	The system is successful in monitoring fish farm ponds and is relatively cheap to implement.	This method is just limited to obtaining water quality parameters, there's no way of controlling activities in the pond.
5	SIMITHA K M, SUBODH RAJ M S	2019	It uses IoT and wireless sensor networks which gives real time data of the quality of water so that water resources can be used effectively.	The system was successful in monitoring turbidity, DO, pH, and temperature. Using LoRa receiver the water quality parameter values could be sent from LoRa sender from several kilometers away.	Data transmission is limited to certain distance

6	CORENTIN DUPONT, MEHDI SHEIKHALISHAHI, ABDUR RAHIM BISWAS, TOMAS BURES	2017	An open IoT and big data platform and its architecture is used.	Open IoT platform were used to get all services needed for simulation and implementation.	It gives an over view of IoT as an emerging concept but is not implemented in fish farming.
7	YI-BING LIN, HUNG-CHUN TSENG	2018	Analytic model, simulation and measurement experiments to check the effects of message delays and loss on water condition using IoT is developed.	For monitoring and controlling a web based application is used which is free.	It is more concerned with monitoring fish for pleasure and not for commercial purposes.
8	YUHWAN KIM, NAMGU LEE, BYEONGJUN KIM, KYOOJAE SHIN	2018	Water quality parameters such as oxygen, pH and so on are controlled by microcontroller which is supported by MQTT communication protocol on the website application or mobile app.	It reduces human effort for the fish farming and unmanned and it is applied to smart fish farm aquariums for future purpose.	It is pretty expensive to implement.

Appendix: Meta-Analysis Table Showing Related Works.