PROJECT REPORT
on

LIMNOLOGICAL RAFT

submitted by

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ABSTRACT

The primary intent of this project is to provide assurance that the deterioration of lake water does not take place below a pre-decided threshold level. To monitor the lake water quality, the major components involved in this project are:

- Raspberry-Pi Model 3
- Temperature sensor
- PH level sensor
- Turbidity sensor TSD-10
- MCP ADC3008
- IOT Cloud

The Raspberry Pi acting as the core of the project will be congregating the readings from these above mentioned sensors and will be uploading the data on an IOT cloud so that the real time data can be constantly perceived on official Government websites, NGOs or even on the social media pages.

Steps involved in implementation of Limnological Raft:

- To float on the water body by itself and take samples of the water pollutants with the help of sensors attached
- To take an average of the water pollutants detected
- To send and store the data acquired to the monitoring centre using IOT and hence help them monitor all the water bodies at the central level continuously

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CHAPTER 1

INTRODUCTION

CHAPTER1: INTRODUCTION

Limnology is the study of fresh water bodies either natural or manmade. It covers the biological, chemical, physical, geological, and other attributes of all inland waters. This includes the study of lakes and ponds, rivers, springs, streams and wetlands. A more recent sub-discipline of limnology, termed landscape limnology, studies, manages, and conserves these aquatic ecosystems using a landscape perspective.

Limnology is closely related to aquatic ecology and hydrobiology, which study aquatic organisms in particular regard to their hydrological environment. Although limnology is sometimes equated with freshwater science, this is erroneous since limnology also comprises the study of inland salt lakes.

A raft is any flat structure for support or transportation over water.[1] It is the most basic of boat design, characterized by the absence of a hull. Although there are cross-over boat types that blur this definition, rafts are usually kept afloat by using any combination of buoyant materials such as wood, sealed barrels, or inflated air chambers (such as pontoons), and are typically not propelled by an engine. Raft makes use of positive buoyancy principle.

Buoyancy Formula:

Liquid exerts a force on objects immersed or floating in it. This force is equal to the weight of the liquid that is displaced by an object. This is also known as Archimedes' principle.

$$\mathbf{F_b = \rho g V = \rho g h A}$$

where,

F_b = buoyant force of a liquid acting on an object (N)

ρ = density of the liquid (kg/m^3)

g = gravitational acceleration (9.80 m/s^2)

V = volume of liquid displaced (m^3 or litres, where 1 m^3 = 1000 L)

h = height of water displaced by a floating object (m)

A = surface area of a floating object (m^2)

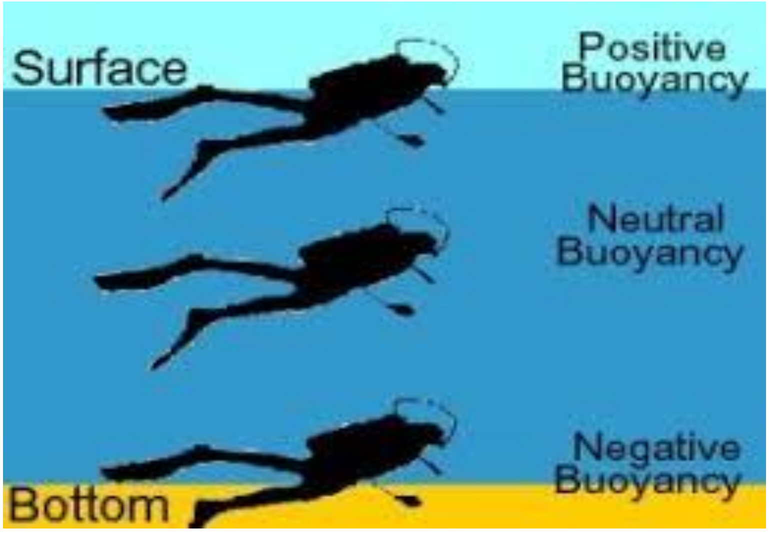

Fig 1.1: Types of buoyant forces

Stability of a Submerge Bodies has two conditions:

Stable equilibrium: if when displaced, it returns to its original equilibrium position

Unstable equilibrium: if when displaced, it returns to a new equilibrium position

In this case (body is fully immersed in water) when the body is tilted, the shape of the displaced fluid doesn't change, so the centre of buoyancy remains unchanged relative to the body. The weight of the body is located at the centre of gravity of the body (G) and the buoyant force located at the centre of buoyancy (B).

Stable Equilibrium: A small angular displacement υ from the equilibrium position will generate a moment equals: (W x BG x υ). The immersed body is considered Stable if G is below B, this will generate righting moment and the body will tend to return to its original equilibrium position.

Unstable Equilibrium: The immersed body is considered Unstable if G is above B, this will generate an overturning moment and the body will tend to be in new equilibrium position.

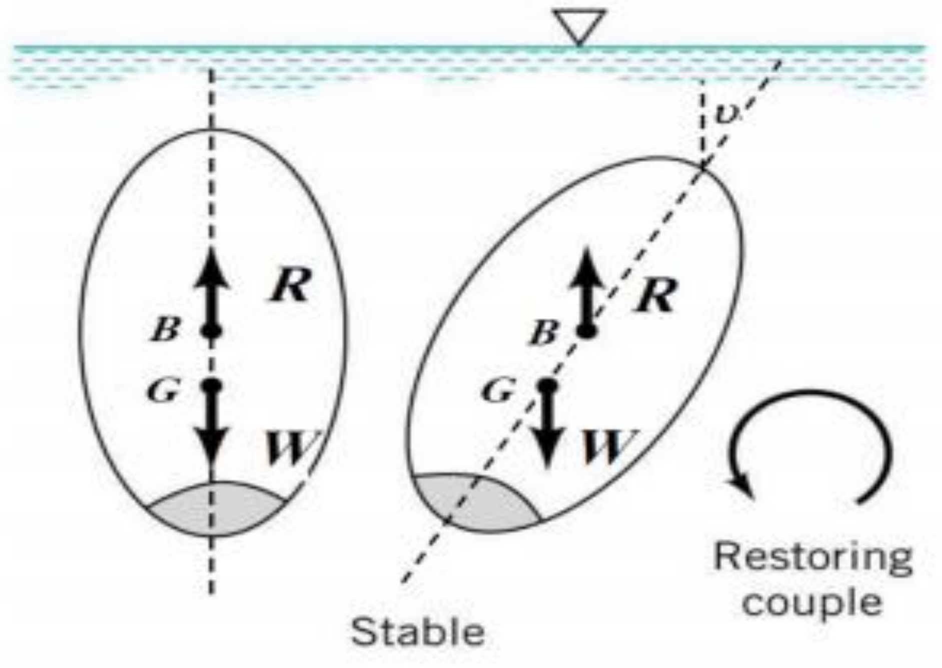

Fig 1.2: Stable equilibrium

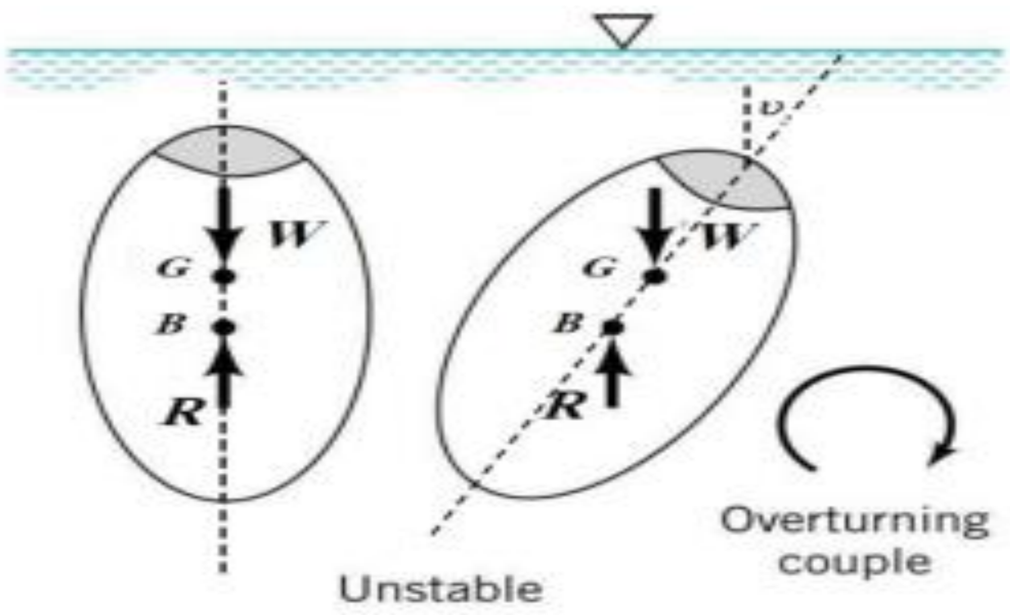

Fig1.3: Unstable equilibrium

Procedures for Evaluating the Stability of Floating Bodies:

1. Determine the position of the floating body (Draft) using the principles of buoyancy (Total Weights = Buoyant Force).

2. Locate the centre of buoyance B and compute the distance from some datum to point B (yB). The bottom of the object is usually taken as a datum.

3. Locate the centre of gravity G and compute (yG) measured from the same datum.

4. Determine the shape of the area at the fluid surface (plane view) and compute I for that shape.

5. Compute the displace volume (Vd)

6. Compute BM distance (BM = I / Vd). 7. Compute (yM = yB+BM)

8. If (yM > yG) >> the body is stable. (GM = +ve)

9. If (yM < yG) >> the body is unstable. (GM = –ve)

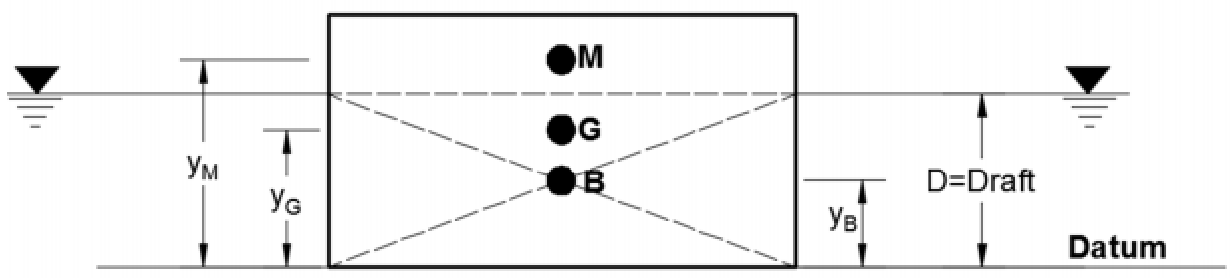

Fig 1.4: Procedures for Evaluating the Stability of Floating Bodies

Water Pollution

Water pollution refers to the blend of such substances in river, lakes, ponds, underground and sea water that invalidates water for the use by humans, flora and fauna. It affects the whole of the world, as water is the basis of life.

The major causes of rising levels of water pollution in India are as follows:

- Industrial waste and its inadequate disposal.
- Improper methods of cultivation (including use of chemical fertilisers and pesticides) in agriculture.
- Decline in the water quality of rivers flowing through the plains.
- Social and religious rituals, such as floating dead bodies in the water, bathing, littering.
- The oil spills from ships.
- Acid rain.
- Global warming.
- Eutrophication (the depletion of oxygen in a water body, which kills aquatic animals).
- Inadequate sewage water treatment.

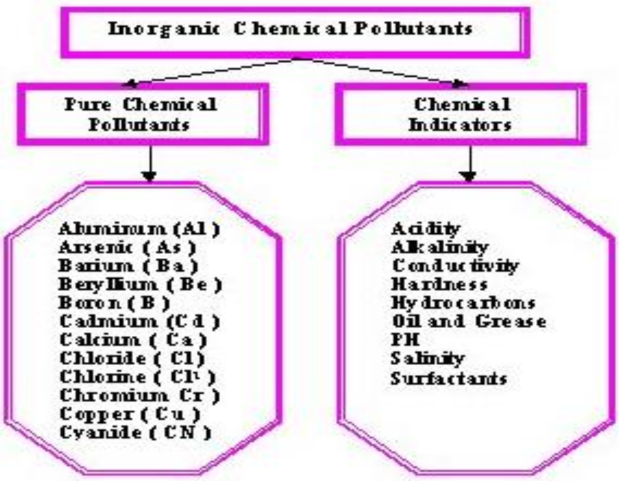

Fig1.5: Inorganic chemical pollutants

TYPES OF WATER POLLUTION:

Water pollution can be divided into two main parts:

1. **Physical water pollution**: Physical water pollution is pollution of water by physical actions, which are mentioned below:

(i) Thermal pollution – When water is used in cooling industrial plants and power stations, the hot water that comes out leads to depletion of oxygen in environment, which is extremely harmful for fish and other animals.

(ii) Taste and odour pollution – The water that smells bad or even if it does not give good taste, such contaminated water is not meant for drinking. But the scarcity of water does not allow people to abandon it completely.

(iii) Colour pollution – Pure drinking water's natural colour is light brown, but the coloured water streaming out of factories and industries, is tainted. Unfortunately, clean, pure water has become a rare phenomenon today.

(iv) Domestic effluent pollution: The water which is used for domestic purpose such as bathing, washing, etc. passes into the rivers, ponds, etc. through drains. It carries forward other hazardous materials too along with it. The situation remains critical due to the pressure of uncontrolled population on water resources. Toxic substances emitted from factories pollute entire river/ pond etc.

2. **Chemical water pollution**: A variety of chemical substances get merged into different sources of water, leading to water pollution. Polluted water leaves a highly negative impact on man as also on trees-plants, and animals. Its use leads to the outbreak of deadly diseases such as cholera, TB, jaundice, Typhoid, paralysis, polio etc. We should never use contaminated water even by oversight.

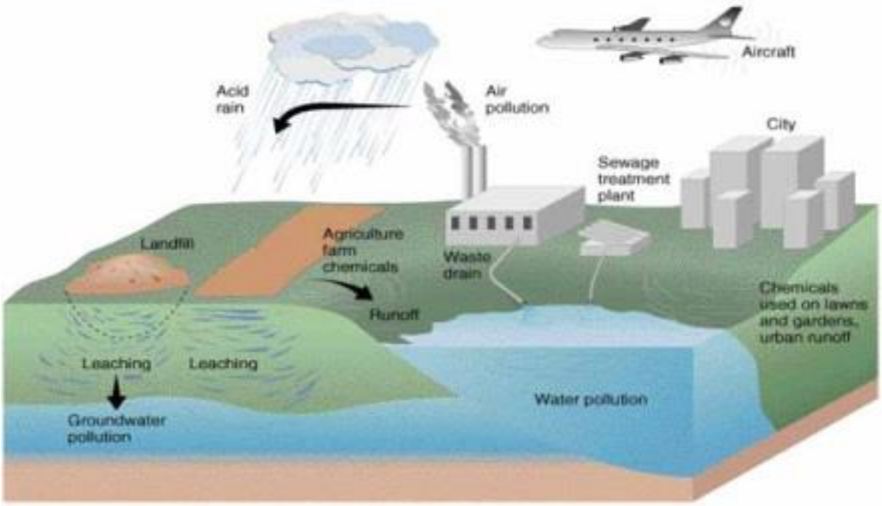

Fig 1.6: Types of water pollution

Sources of water pollution:

There are various classifications of water pollution. The two chief sources of water pollution can be seen as Point and Non Point. Point refers to the pollutants that belong to a single source. An example of this would be emissions from factories into the water. Non -point on the other hand means pollutants emitted from multiple sources. Contaminated water after rains that has travelled through several regions may also be considered as a Non-point source of pollution.

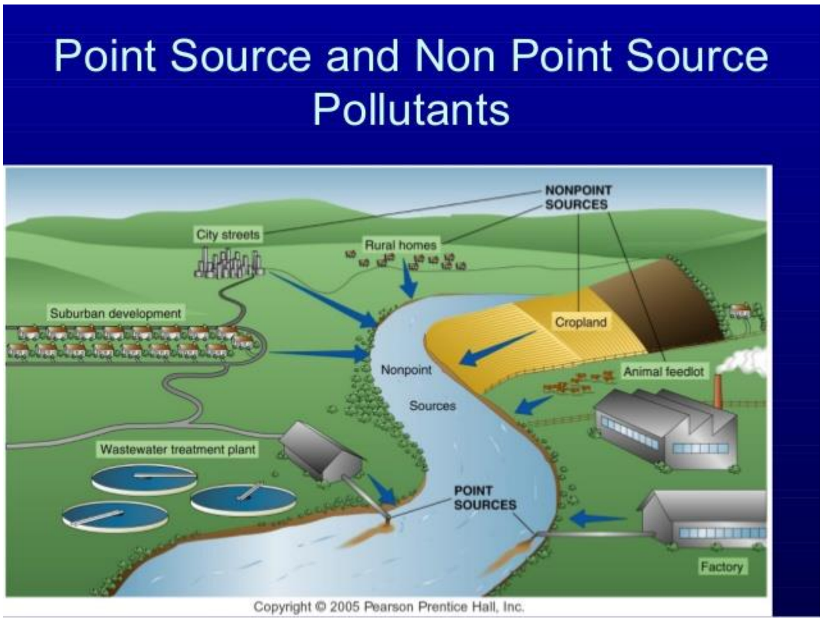

Fig 1.7: Sources of water pollution

Effects of water pollution:

Water pollution has adverse effect on every life around the water resource, which is even somewhat polluted. At a certain level, polluted water proves harmful to crops too. This depletes the fertility of the land. Overall, it affects agriculture and the country. If sea water is polluted, it has a negative impact on marine life too. Water pollution is the biggest cause of the decline in water quality. Its intake can cause many diseases.

In fact, water pollution is a major cause of the low level of health in India, in both urban and rural areas. Diseases such as cholera, tuberculosis, jaundice, vomiting, diseases like diarrhoea may occur due to polluted water. In India, 80 percent of patients suffering from disorders of the stomach have fallen sick due to drinking polluted water.

Fig 1.8: Water quality trend of river Ganga

Health Aspects of Water Quality:

Consumption of polluted water is a major cause of ill health in India. Polluted water causes some of the deadly diseases like cholera, dysentery, diarrhea, tuberculosis, jaundice, etc. About 80 per cent of stomach diseases in India are caused by polluted water.

Effect of Organic Pollution on Water Quality:

All organic materials can be broken down or decomposed by microbial and other biological activity (biodegradation). Organic and some of the inorganic compounds exhibit a biochemical oxygen demand (BOD) because oxygen is used in the degradation process. Oxygen is a basic requirement of almost all aquatic life. Aquatic life is adversely affected if sufficient oxygen is not available in the water. Typical sources of organic pollution are sewage from domestic and animal sources, industrial wastes from food processing, paper mills, tanneries, distilleries, sugar and other agro based industries.

Effect of Nutrients on Water Quality:

Water supports aquatic life because of the presence of nutrients in it. Here the primary focus is on fertilizing chemicals such as nitrates and phosphates. Although these are important for plant growth, too much of nutrients encourage the overabundance of plant life and can result in environmental damage called ‘eutrophication’. This can occur at both microscopic level in the form of algae and macroscopic level in the form of aquatic weeds. Nitrates and phosphates are contributed by sewage, agricultural run-off and run-off from un-skewered residential areas.

Effect of High Dissolved Solids (TDS) in Water Quality:

Water is the best solvent and can dissolve a large variety of substances which come in its contact. The amount of dissolved solid is a very important consideration in determining its suitability for drinking, irrigation and industrial uses. In general, waters with total dissolved solids of less than 500 mg/litre are most suitable for drinking purposes. Higher amount of dissolved solids may lead to impairment of physiological processes[2] in human body. Dissolved solid is a very important criterion for irrigation. This is due to the fact dissolved solid accumulates on the ground resulting in salinization of soil. In this way it renders the agricultural land non-productive. Dissolved solids are harmful for industries also because they form scales, because foaming in boilers, accelerate corrosion and interfere with the colour and taste of many finished products.

Effect of Toxic Pollutants on Water Quality:

Toxic pollutants mainly consist of heavy metals, pesticides and other individual xenobiotic pollutants. The ability of a water body to support aquatic life, as well as its suitability for other uses depends on many trace elements. Some metals e.g., Mn, Zn and Cu present in trace quantity are important for life as they help and regulate many physiological functions of the body. Some metals, however, cause severe toxicological effects on human health and the aquatic ecosystem.

Effect of Thermal Discharges on Water Quality:

The discharge of cooling water from industrial and commercial operations generally heats up the aquatic environment. Organisms may become physiologically stress or may even be killed when exposed to heated water. If water heating is supplemented by the summer heat, the impact on aquatic environment can be disastrous. Thermal pollution also causes a decrease on the driving force or oxygenation which may directly kill aquatic life through asphyxiation. If toxic pollutants are present in the aquatic environment, thermal pollution may increase their toxicity to the aquatic life. Bioavailability of many pollutants may also increase due to thermal pollution, which may ultimately adversely affect the aquatic life.

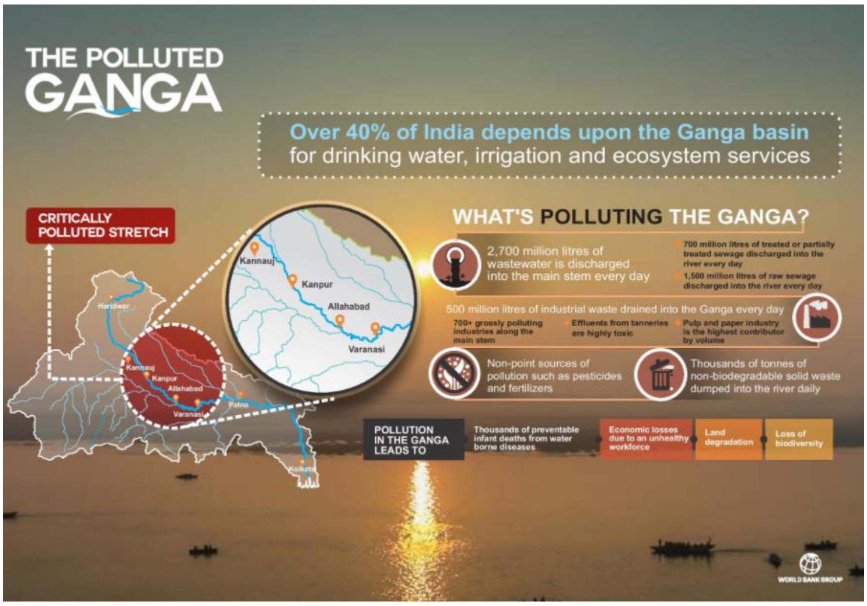

Fig 1.9: Water quality analysis at Ganga basins

CHAPTER 2

LITERATURE SURVEY

From the Encarta encyclopedia 2010 Water pollution is any chemical, physical or biological change in the quality of water that has a harmful effect on any living thing that drinks or uses or lives in it. Dr. Shachin Cartlon (2009) states Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. The sources of water pollution are categorized as being a point source or a non-source point of pollution. Point sources of pollution occur when the polluting substance is emitted directly into the waterway. A pipe spewing toxic chemicals directly into a river is an example. A non-point source occurs when there is runoff of pollutants into a waterway, for instance when fertilizer from a field is carried into a stream by surface runoff.

Agriculture plays a considerable role in the quality of water. U.W.I. faculty of health and science (2009) in an online article outlined that we need the agriculture industry, obviously to sustain our food supply. However, the practices used have harmful effects on neighboring watersheds. Three factors come into play when considering agriculture and human wastes: Pesticides, fertilizers and the waste produced by our farm animals, and non-existent sewage disposal systems. When pesticides or fertilizers are applied to crops, there is evident probability that there will be runoff. The excess materials will either run off the land, or seep into the groundwater, with an eventual ending in bodies of water such as rivers. Fertilizer, pesticides, and excess nutrient wastes by farm animals, and non-existent sewage management plans may contaminate freshwater ecosystems and harm plants, animals, insects, and fish that rely on this freshwater for their habitats.(Boxall and Maltby 1995; Hatch and Burton 1999; Lieb and Carline 2000).

CHAPTER 3

PROPOSED METHODOLOGY

RASPBERRY PI

Fig 2.1: R-Pi 3 model

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards, mice and cases). However, some accessories have been included in several official and unofficial bundles.

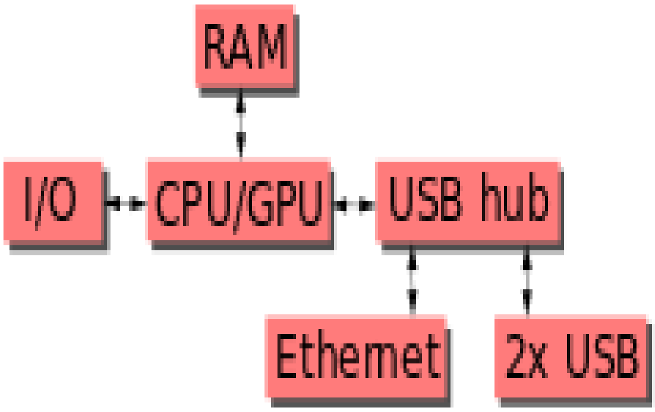

Fig 2.2: Internal circuitry of R-Pi3

The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support. This block diagram depicts Models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the system on a chip (Soc). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

Processor:

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7 processor. The Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones its CPU is an older ARMv6 architecture) which includes a 700 MHz ARM1176JZF-S processor, Video Core IV graphics processing unit (GPU), and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.

Overclocking:

Most Raspberry Pi chips could be overclocked to 800 MHz, and some to 1000 MHz. There are reports the Raspberry Pi 2 can be similarly overclocked, in extreme cases, even to 1500 MHz (discarding all safety features and over-voltage limitations). In the Raspbian Linux distro the overclocking options on boot can be done by a software command running "sudo raspi-config" without voiding the warranty. In those cases the Pi automatically shuts the overclocking down if the chip reaches 85 °C (185 °F), but it is possible to override automatic over-voltage and overclocking settings (voiding the warranty); an appropriately sized heat sink is needed to protect the chip from serious overheating.

Newer versions of the firmware contain the option to choose between five overclock ("turbo") presets that when used, attempt to maximise the performance of the SoC without impairing the lifetime of the board. This is done by monitoring the core temperature of the chip, the CPU load, and dynamically adjusting clock speeds and the core voltage. When the demand is low on the CPU or it is running too hot the performance is throttled, but if the CPU has much to do and the chip's temperature is acceptable, performance is temporarily increased with clock speeds of up to 1 GHz depending on the individual board and on which of the turbo settings is used.

The seven overclock presets are:

- none; 700 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting
- modest; 800 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting,
- medium; 900 MHz ARM, 250 MHz core, 450 MHz SDRAM, 2 overvolting,
- high; 950 MHz ARM, 250 MHz core, 450 MHz SDRAM, 6 overvolting,
- turbo; 1000 MHz ARM, 500 MHz core, 600 MHz SDRAM, 6 overvolting,
- Pi 2; 1000 MHz ARM, 500 MHz core, 500 MHz SDRAM, 2 overvolting,
- Pi 3; 1100 MHz ARM, 550 MHz core, 500 MHz SDRAM, 6 overvolting. In system information CPU speed will appear as 1200 MHz. When in idle speed lowers to 600 MHz.

In the highest (turbo) preset the SDRAM clock was originally 500 MHz, but this was later changed to 600 MHz because 500 MHz sometimes causes SD card corruption.

Simultaneously in high mode the core clock speed was lowered from 450 to 250 MHz, and in medium mode from 333 to 250 MHz.The Raspberry Pi Zero runs at 1 GHz.The CPU on the first and second generation Raspberry Pi board did not require cooling, such as a heat sink or fan, even when overclocking overclocked, but the Raspberry Pi 3 may generate more heat when overclocked.

RAM:

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

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

Raspberry Pi Model 3 & Raspbian Jessie(OS):

The Raspberry Pi Foundation formally came into existence on February 29, 2012. The main objective of the foundation was to "provide low-cost, high-performance computers that people use to learn, solve problems and have fun". It has launched various boards since its establishment including the Raspberry Pi 2 Model B and Raspberry Pi Model B+. Raspberry Pi 3 Model B - one of the most popular and the latest model - was launched on February 29, 2016.The Raspberry Pi 3 model B is a small portable computer which can be used with and without a proper Graphical Interface includes everything from 1 Gb RAM to a quad core processor, USB Ports, built-in Bluetooth and Wi-Fi, Ethernet Port and an integrated Graphics chip. Raspbian Jessie -one of the most commonly used Operating System for Raspberry Pi - is a Debi a Linux based OS designed specifically for Raspberry Pi.The screenshot shows updating the system via command line once the OS is installed:

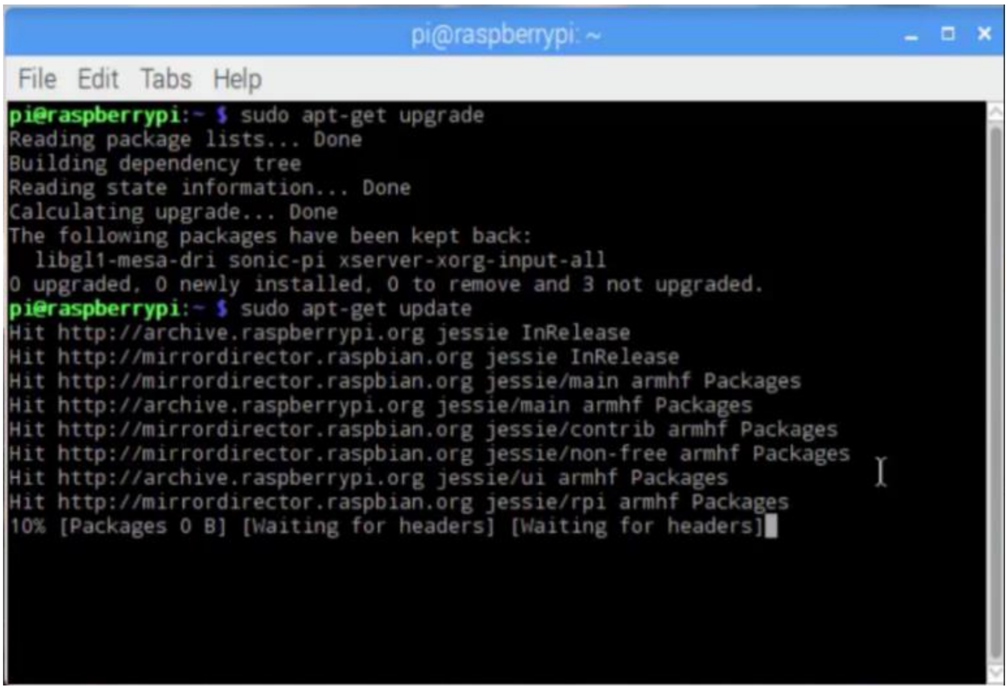

Fig 2.3: Getting The Raspbian Jessie OS packages

After these commands, the reading of package lists take place.

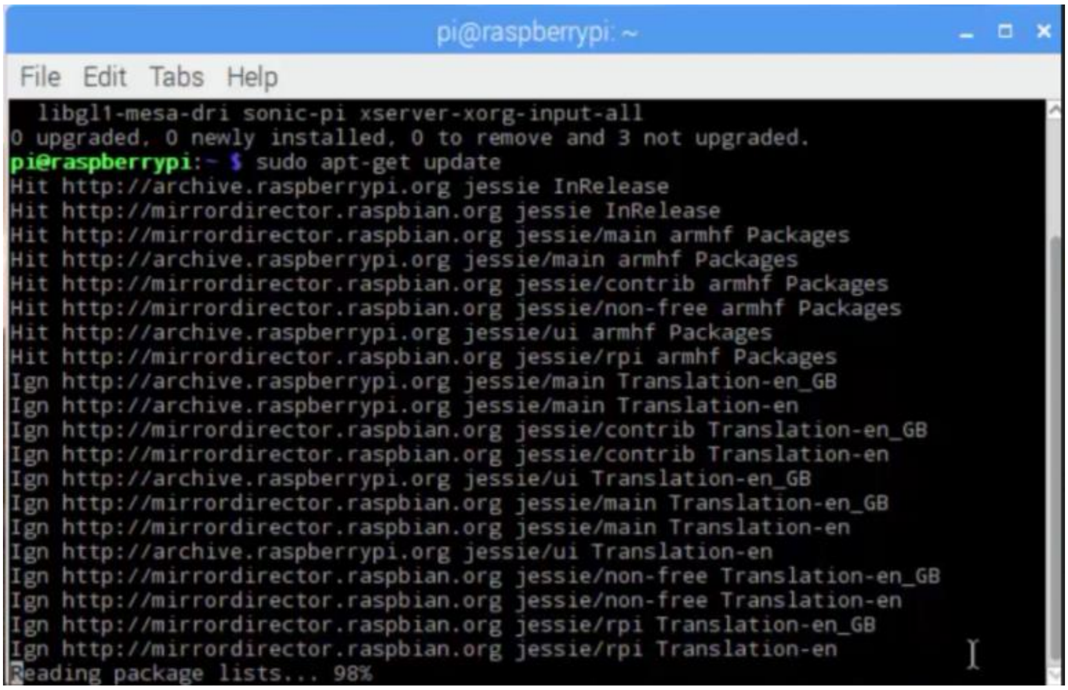

Fig 2.4: Completion of Loading of Raspbian Jessie OS in Raspberry Pi 3

There have been many updates on the performance as compared to the previous version of Raspbian Wheezy. The new OS comes with a host of other features including a fully functional GUI support for programming languages like Java and Python, browsers, email client, command line, office suite, etc.

Structural diagram of Raspberry Pi-3:

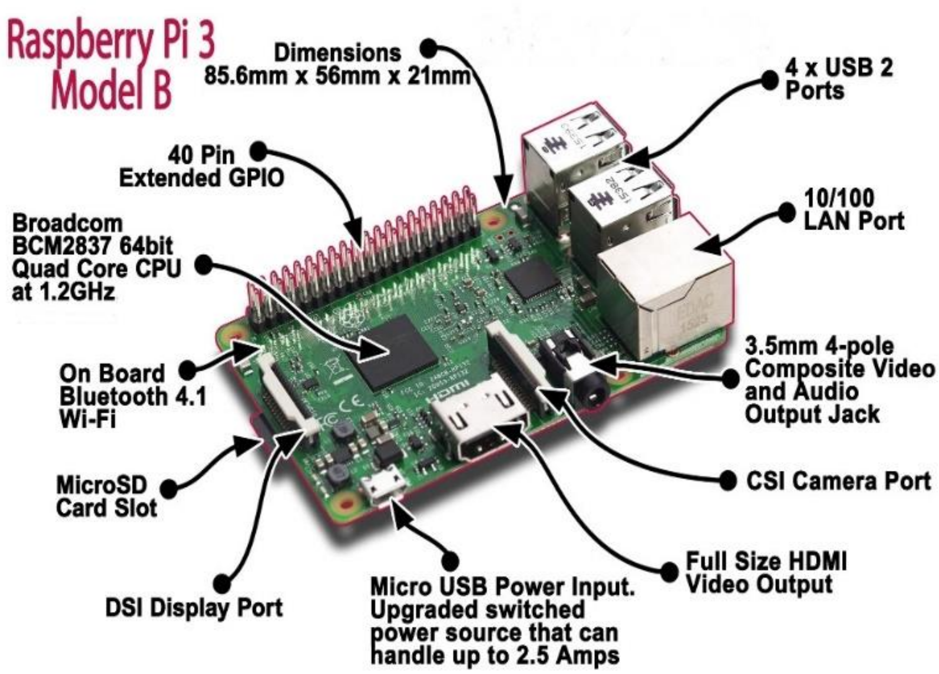

Fig 2.5: Pin and Functional diagram of Raspberry Pi-3

Shown above is the functional diagram of Raspberry pi with different features provided for the data acquisition. Specifications of R-Pi3:

RAM	1 Gb SDRAM
CPU	Quad Core A53 (1.2GHz)
SoC	Broadcom BCM2837
USB Ports	4
GPIO Pin	40 Pins

Table1: Specifications of R-Pi3

Role in Data Acquisition: The Raspberry Pi collects the data received from the sensors and store it in a file from where it can be sent to remotely located servers. The received data can be compared to the previously stored data, analyzed and give an indication about the idea of pollution in the water body. Once the data has been analyzed, appropriate measures can be taken to rectify the situation in the water body.

Explanation of code: Shown below is the code which is implemented in Raspberry Pi 3 for taking temperature sensor readings[6]

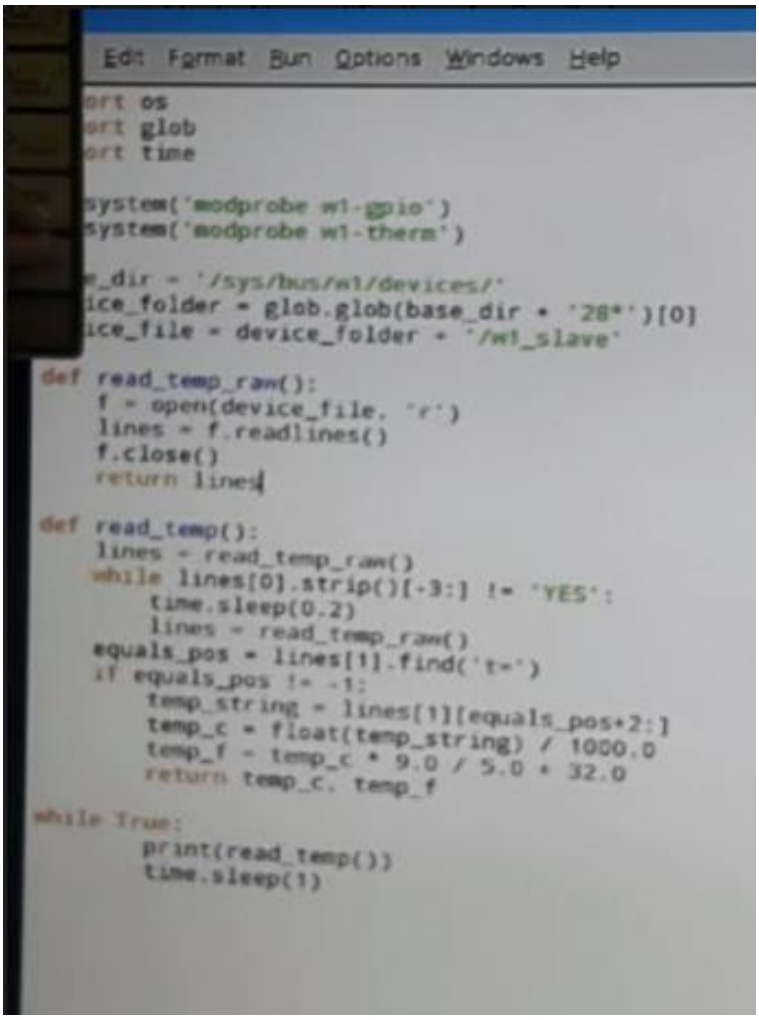

Fig 2.6: Code for sensor data acquisition in R-Pi OS

The code began with importing the required modules like OS, globe, etc. The main body of the code has two functions defined - one to open, read and close the file in which readings are being stored and the second to read the data, get the value from the string read from file, and to calculate and express the reading in Celsius and Fahrenheit scale. It also gives a time delay between consecutive readings. We have provided time delay of 0.2 seconds. The program starts by calling the second function which makes use of the first function for file operations and prints data on the screen. In a similar manner, the program can read and display readings for the pH and the turbidity sensors.

General purpose input-output (GPIO) connector:

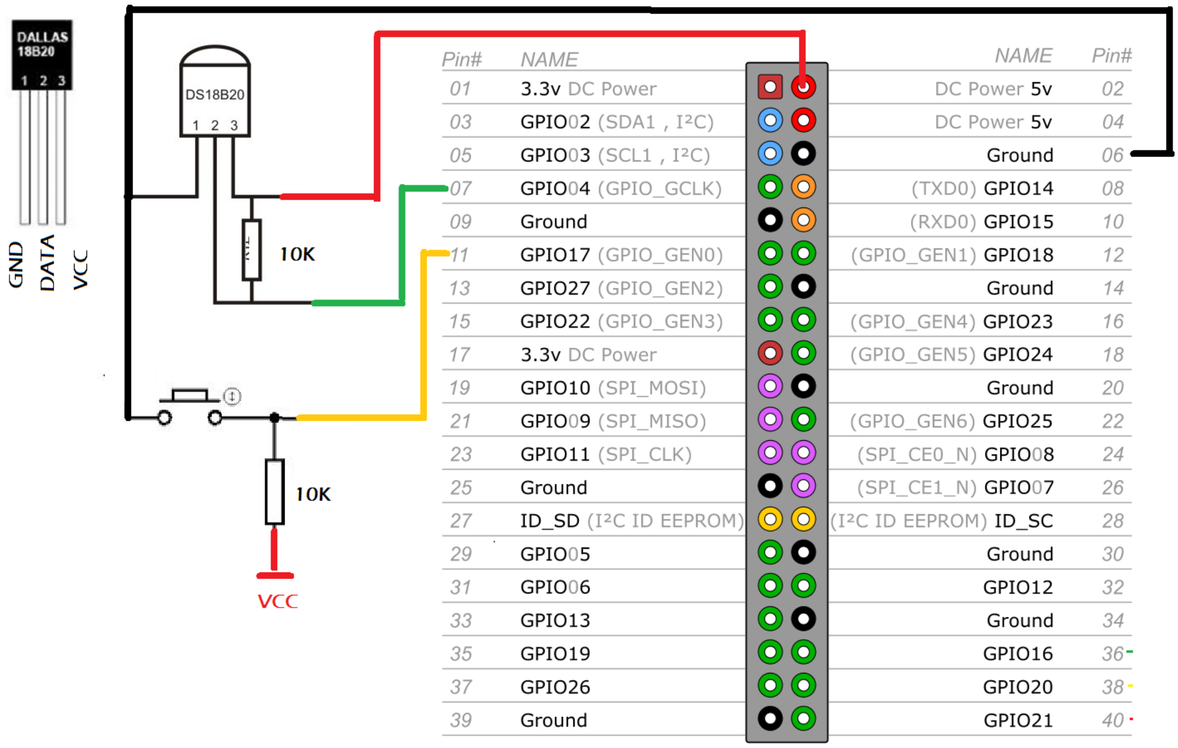

Fig 2.7: Interfacing of GPIO connector

Temperature Sensor DS18B20

1) Technical Diagram

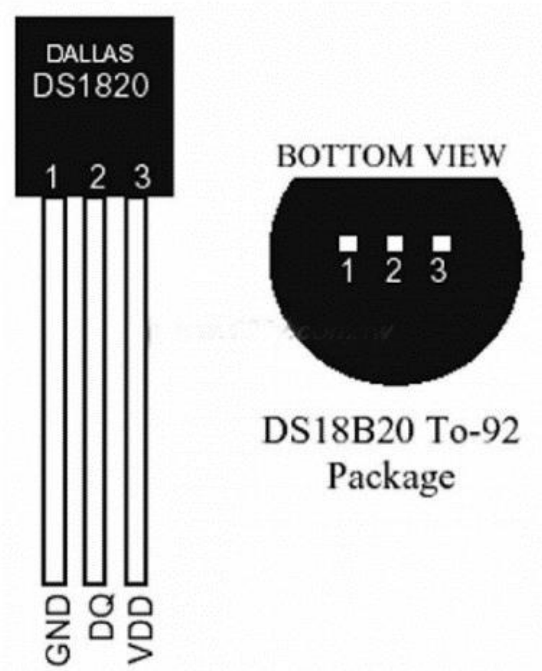

Fig2.8: Pin Diagram of DS18B20 Sensor

Shown above is the three pin configuration of DS18B20 temperature sensor. The first and third pin represents ground and power supply respectively while the second pin represents data pin.

Only two standard copper wires are necessary to connect an RTD to an electrical circuit, however, these connecting wires are also subject to small changes in resistance based on surrounding temperature. For this reason an “extra” third hookup wire is built into most RTDs as a compensation wire to allow the controller or display unit to correct for these variations. Selecting a Temperature Sensor:

Style: Temperature Sensors are available in a variety of styles. The weatherproofed screw cover style provides an electrical conduit connection and can be used to house a transmitter (optional). For open system sensing, a no threaded style is offered. This design is provided with integrated lead wire and can be Teflon covered to protect the stem and lead wire against corrosive environments. A standard plug with a mating jack may also be furnished.

Stem (Sheath): All Thermocouples and RTDs are furnished with a 316 stainless steel stem, with the internal wiring packed in powdered ceramic. The screw head cover style is available in two stem types: welded and spring loaded. The welded stem is suitable for use in liquid applications. The spring loaded stem is designed to bottom out inside a thermo well, providing maximum heat sensitivity. Spring loaded stems are not pressure tight and may allow process media to escape; therefore, they must always be installed in a thermo well.

Insertion (U): Length The insertion (U) length of a thermocouple or RTD represents its depth into the process vessel or thermo well. Thermocouples and RTDs are available in standard U-lengths from 2" to 24". Other lengths are available upon special order, please consult factory.

Measuring (Hot) Junction: Thermocouples are available in Type J and Type K, and use ceramic insulation to provide an ungrounded measuring junction. Other thermocouple types may be available, please consult factory. RTDs are platinum, 3-wire design, and are furnished with either 100Ω or 1000Ω resistance at 32°F (0°C), and a temperature coefficient of 0.00385 Ω/Ω/°C.

Connection (Termination): Thermocouples are provided with terminal block (screw cover head), mating jack, or integrated lead wire connections. The terminal block connection has no lead wire; therefore extension wire must be attached and routed to the electronic measuring device. Thermocouple extension wire must be identical to the thermocouple type; otherwise multiple measuring junctions will be made, causing inaccurate temperature readings. RTDs are provided with a terminal block (screw cover head) or integrated lead wire connection. The terminal block connection has no lead wire; therefore extension wire must be attached and routed to the indicator or controller.

2) Sensor Specifications:

Accuracy level	±0.5°C accuracy from -10°C to +85°C
Dimension	7mm in diameter and roughly 26mm long
Temperature Range	-55°C to+125°C

Output mode	Digital (9-12 bit)
Water resistant	Yes

3) Importance/role in lake water data acquisition

Every chemical reaction is followed by change in enthalpy (energy) this energy is lost or gained by emitting or absorbing heat from the river body. This in turn leads to the change in the temperature of water. The temperature sensor DS18B20 has an accuracy of ±0.5°C. By this accuracy level, the temperature sensor will be able to detect all the chemical effluents being released in water as the react with the salts of water or react with each other. Even from simple chemical reaction like rusting of Iron, which is very common due to rusting of boat's base which affects the marine life drastically, to complex chemical reactions can be detected with the help of DS18B20 and verified with the help of other sensors. As we know that in different times of a day, temperature of the lake water will be different, that wouldn't affect the reading as the temperature is noted every second, so if the overall temperature of lake body rises, all readings will increase due to very short sampling period, and if now there is any chemical reaction detected, there will be a spike increase in the reading.

Fig2.9: DS18B20 Temperature Sensor Model

LABINDIA PICO pH sensor

The pH level sensor used in this project is a LABINDIA PICO pH sensor that makes use of electrodynamics as its operating principle.

1) Technical Diagram:

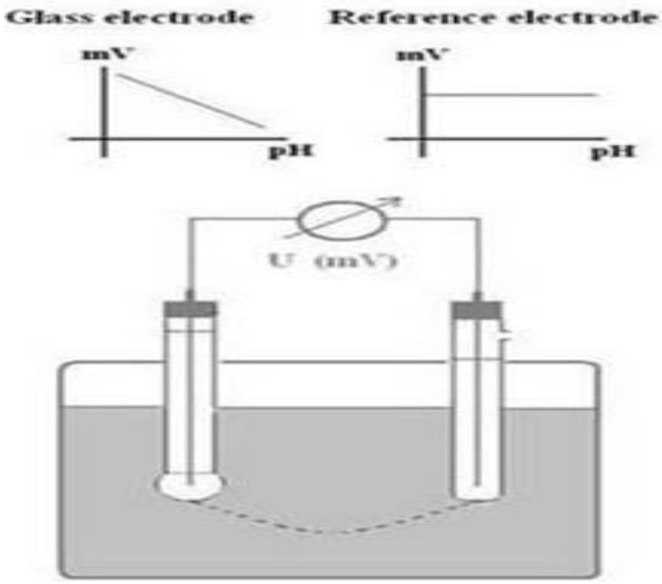

Fig 2.10: Diagrammatic representation of working Principle

A pH sensor comprises of two electrodes: the glass electrode and the reference electrode. The value of pH is the difference between two electrodes measured in (mV).This decides the acidity of the solution. Ideal pH value for water quality should range in between 6-8.[13]The main elements in a pH meter are the probe and an analyser.The Nernst equation converts the potential difference into the pH value and it is given as follows:

$$E= E^{\circ}- 2.3 \times R \times T \times pH \div F$$

E=Potential of the measure electrode

E°=Potential of the reference electrode

R=constant 8.3143(J/M*K)

F=Faraday constant (96485 Coulomb/mol)

T=Temperature (K)

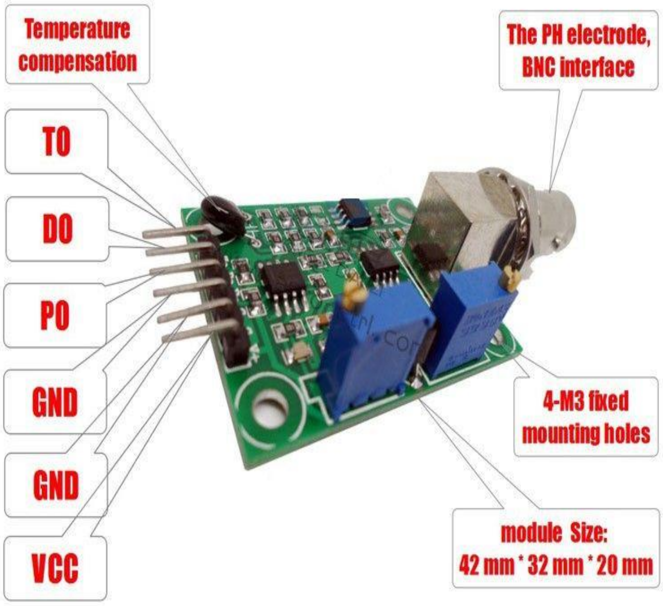

Fig 2.11: Pin and functional Configuration of pH Sensor

2) Specifications:

Measuring Range	0 - 9999 ppm
Conductivity	0 - 9999µs/cm
Accuracy	± 2.5% F.S
Net Weight	45.9g
Size	160x29x14mm
Degrees Celsius	0.09- 50.0°C
Fahrenheit	32.0 - 121.0°F

3) Importance in lake water data acquisition :

The pH is an important aspect in lake water data acquisition as it decides the quality of lake water .The pH scale (0-14) that determines the acidity or basicity of the lake water is a logarithmic scale. This scale can drastically change equilibrium state and speed of many reactions. Getting the accurate readings is necessary for undertaking the countermeasures to maintain the neutrality of the lake. Precise control of pH is a vital parameter as far as aquatic life is concerned. It also adversely affects the biodiversity in the vicinity of lake water.

Fig2.12: Practical view of the PH sensor

Turbidity Sensor TSD-10

1) Structural diagram

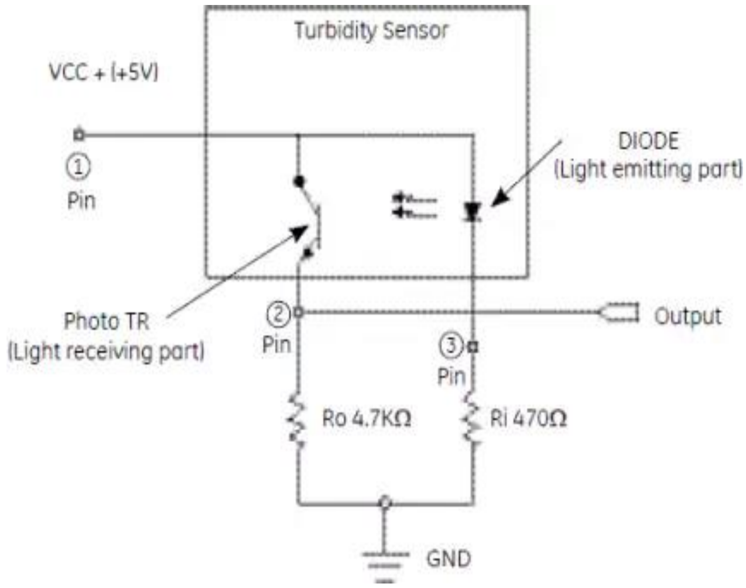

Fig 2.13 TSD-10 Functional diagram

2) Specifications

Table 4:

Differential voltage	3.0V +/- 10%
Operating temperature range	-10°C to 90°C
Operating voltage	DC 5V
Current	30 mV max
Insulation Resistance	Min 100 MΩ by 500V DC

3) Principle of Operation :

Turbidity sensor operates on the principle of transmission of light from one source and reception at the other source. The amount of water present in between is considered as the sample of water which is to be tested. Turbidity basically means the hardness of water, in other words, the amount of salts or dirt particles in water. So more the amount of dirt particles present more will be the scattering of light and lesser will be the intensity of light received at the other end. In this way turbidity is determined.

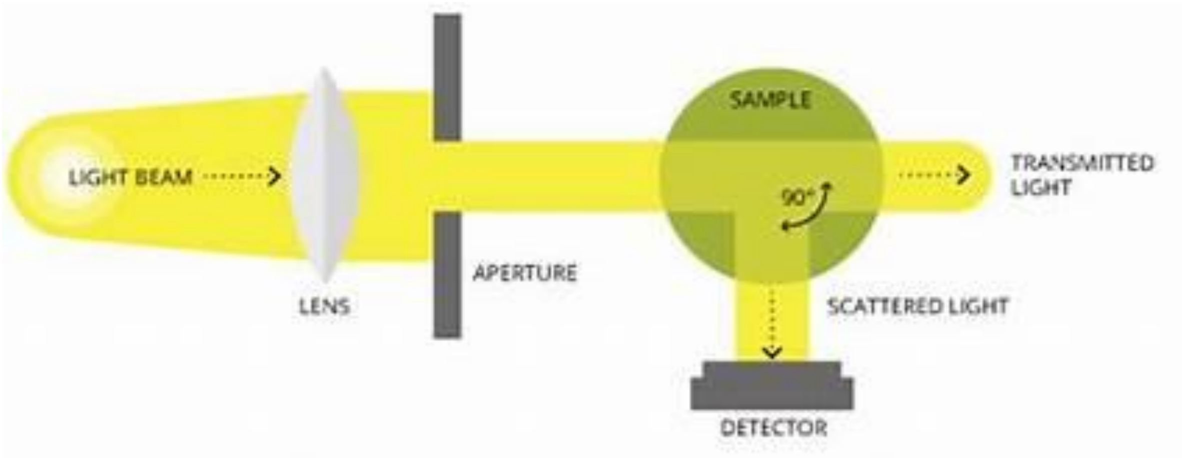

Fig2.14: Working principle of Turbidity sensor

4) Importance/role in lake water data acquisition:

Turbidity is the most essential and the most primary factor in determining the quality of water. Right from the salts of the chemicals to the particles of Plaster used for making Holy Idols are detected with the help of turbidity sensor. Turbidity sensor in combination with Temperature sensor and pH sensor gives us the precise quality or condition of water which in turn helps us in by giving us a foresight of any pollution that is created and can be prevented before it causes any permanent damage to the water body and the aquatic life in it.

Fig2.15: Dimensional view of Turbidity sensor

Sensor readings Results

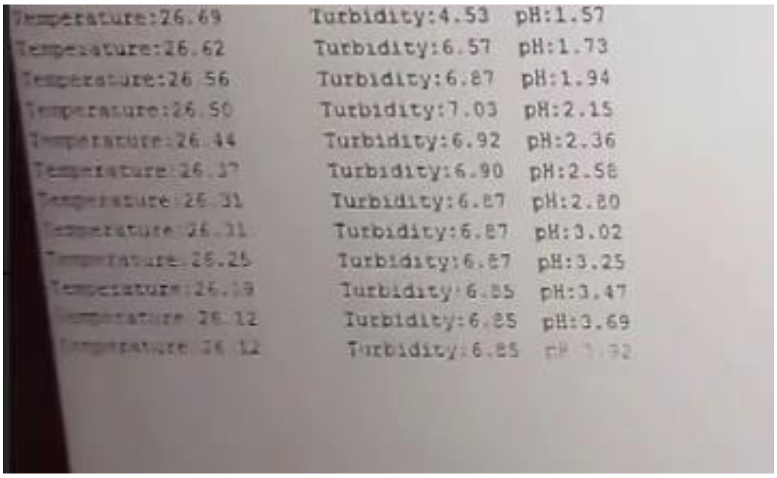

Fig 2.16: Final Sensor Output Readings

As shown above, the data acquisition system generates all the three sensor readings after regular interval of few seconds. The increase in temperature level or the acidity level can be used to insinuate an alert signal indicating need for immediate countermeasures to be undertaken to protect aquatic life.

I. **Uploading readings on iot cloud:**

After the Raspberry Pi-3 accumulates the data from all the three sensors, this monitored data is uploaded on IOT cloud. Internet of Things enables easy access to these readings from any corner of the world. The IOT cloud which we used to broadcast the data is ThingSpeak.com. Initially ,we will have to create a new channel named as Lake water sensor readings. Under this channel, three field are included with one field for each sensor as shown below.

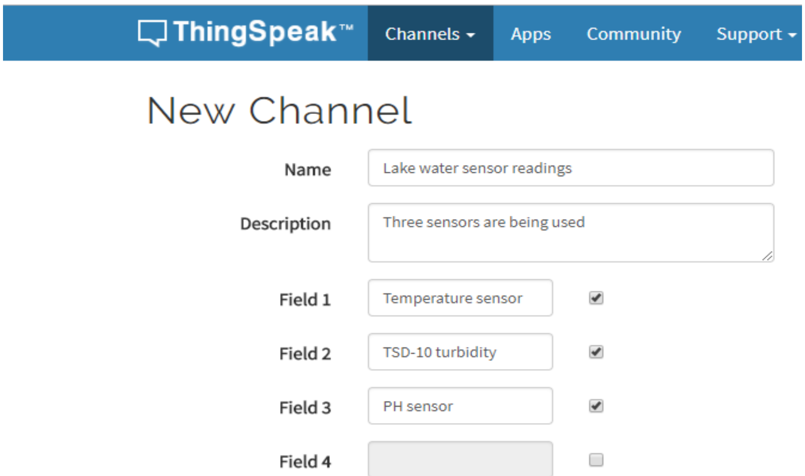

Fig2.17: Creation of Channel with Fields for The Three Sensors

After the establishing of channel with three fields , each field will receive the sensor data from Raspberry Pi-3 and will provide a graphical representation of the sensor readings with respect to time. This statistical representation for each sensor in the form of line graph is shown below:

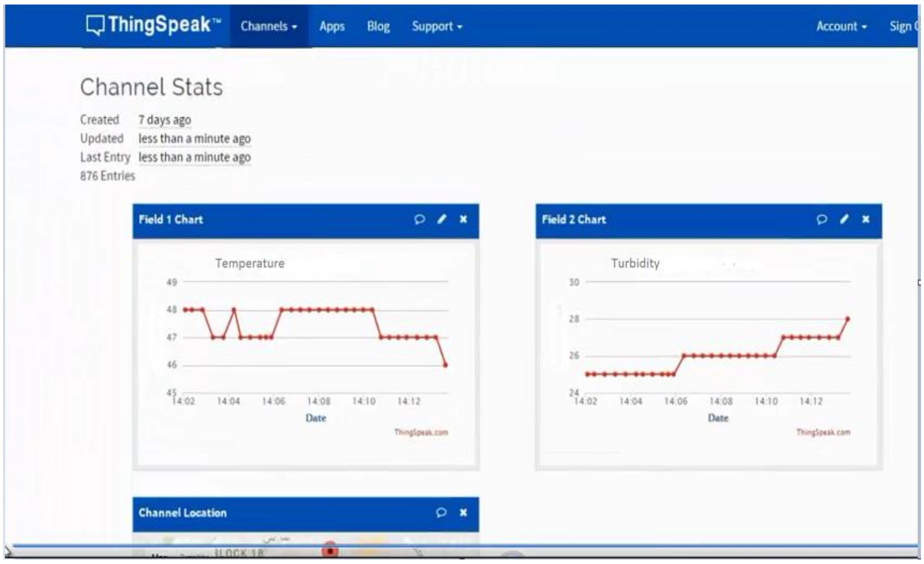

Fig2.18: Real Time Graphical Representation Of Temperature And Turbidity Sensors

The first field represents the temperature readings while the second field represents the turbidity sensor readings. These data can be shared in a similar fashion on government websites to find the level of pollution in water bodies.

MCP3008ADC

1) Technical Diagram

The Microchip Technology MCP3004/3008 devices are successive approximation 10-bit and 8 channel Analog to Digital (A/D) converters with on-board S/H circuitry.It gets connected to Raspberry Pi via a SPI bus.ADC is programmable and offers two pseudo-differential input pairs or four single-ended inputs.Conversion time is also much faster than other ADCs typically maximum of 10 cycles.The sensor used in our project is Adafruit MCP3008ADC.

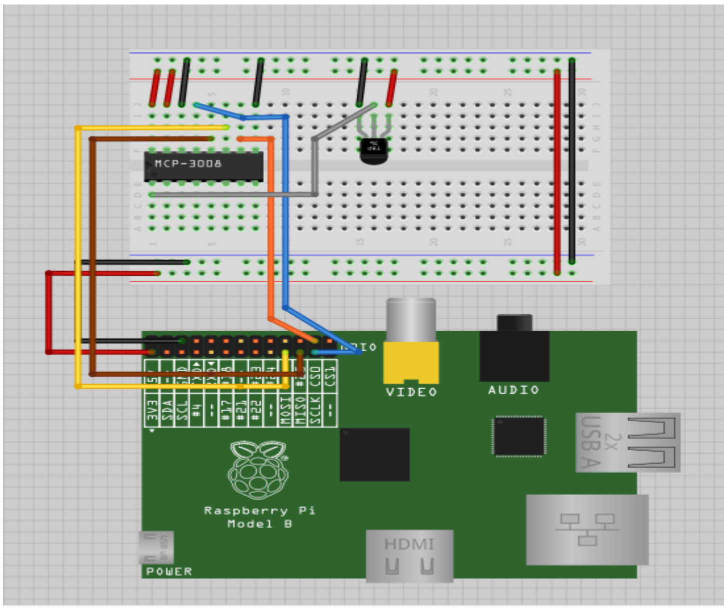

Fig 2.19: Interfacing MCP3008 ADC with Raspberry Pi

The Raspberry Pi and other elements are connected via Male to Female jumper wires or Ad fruit Pi cobbler kits (version 1, 2).For attaching the analog input from a potentiometer to channel 0.Also the SPI peripheral on the Raspberry Pi comprises of two chip selects (CS0,CS1 pins) and can therefore be used to attach two SPI slave devices to the Raspberry Pi. The channel select 0 pin is selected.

Enabling SPI slave on the Raspberry Pi:

- Turn on the Raspberry Pi
- Log in to the Raspberry Pi via SSH
- Command:“sudonano/etc/modprobe.d/raspi-blacklist,to open config file.
- Comment out the “blacklistspi-bcm2708” entry by putting a hash # sign in front of it.
- .Type "sudo reboot".
- Start a new SSH session and type "ls /dev/spidev*"

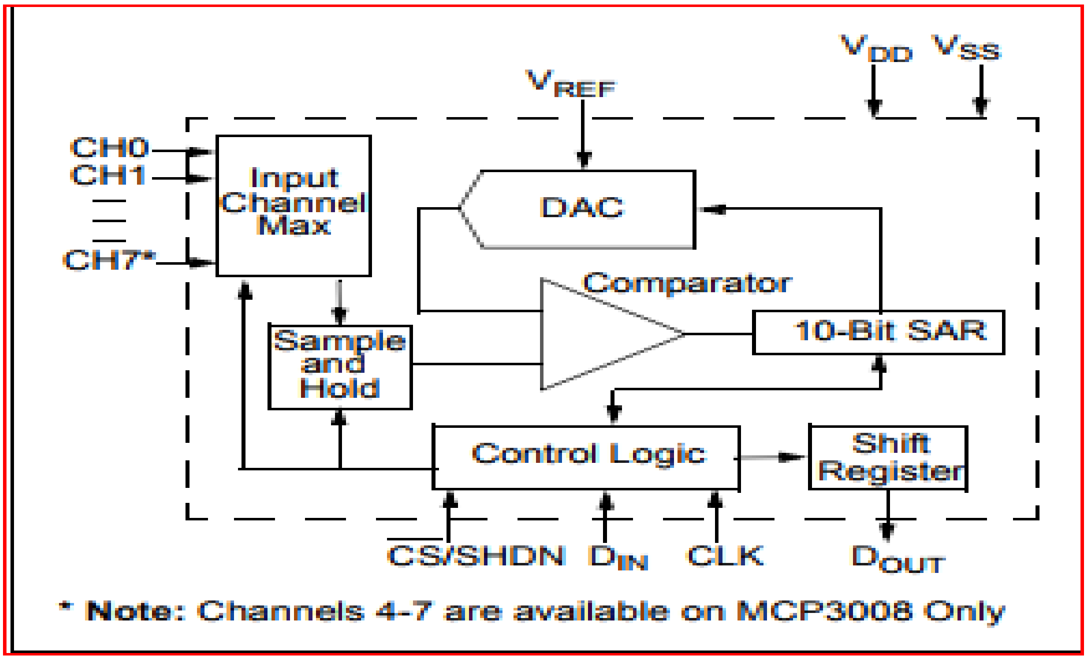

Fig2.20: Operational Block Diagram Of MCP3008 ADC

2) Specifications:

Table 5:

Resolution	10-bit
DNL	max± 1 LSB
INL	max± 1 LSB
Input Channels	8
Single Supply Operation	2.7V - 5.5V
Sampling Rate	200 kbps
Industrial Temp Range	-40°C to +85°C
Typical Standby Current	5 nA

3) Importance/role in lake water data acquisition :

The data acquired by the turbidity sensor and the pH sensor is analog in nature and the Raspberry Pi deals with digital data. Hence analog to digital conversion of information acquired by turbidity sensor and pH sensor is necessary, hence MCP3008 is used. The ADC continuously displays the digitally converted output values to the LCD display. If any sensor value crosses the threshold then the Alarm rings. CLK output gets connected to Pin 14 of the controller, Dout to the Pin 13 and CS to Pin 10.The ADC 3008 is a vital component of the project as it interfaces the analog sensors to the Raspberry Pi which uses only digital data.

Fig2.21: Practical view Of MCP3008 ADC

CHAPTER 4

IMPLEMENTATION AND RESULTS

Raft

In this section there is a transformation of a simple RC to an Arduino Bluetooth controlled raft. The raft will be able to control through an Android device, smartphone or tablet[11].

Specification of the raft is as follows:

i. Speed control
ii. Battery level icon
iii. 10m of control

Components specified:

i. Arduino uno board
ii. L298D motor driver
iii. HC-06 Bluetooth module
iv. RC Boat that can fit all the above
v. 1x1MOhm & 1x100KOhm resistor to add a battery level control function.
vi. For power, you can use the existing batteries (4x 1.5V AA), or replace them with a LiOn rechargeable battery pack.

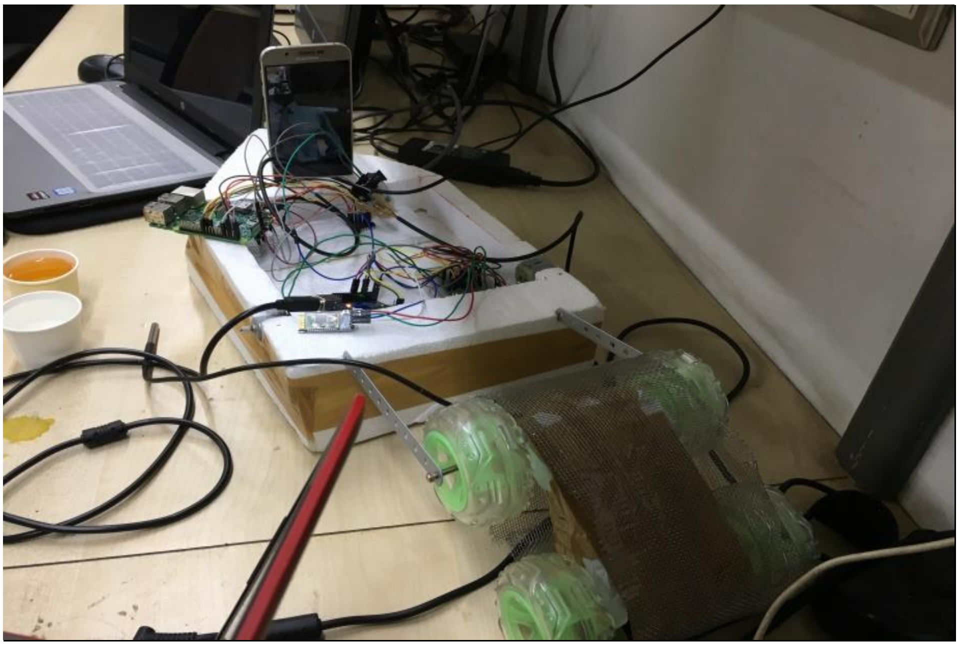

Fig4.1: Practical view Of Raft

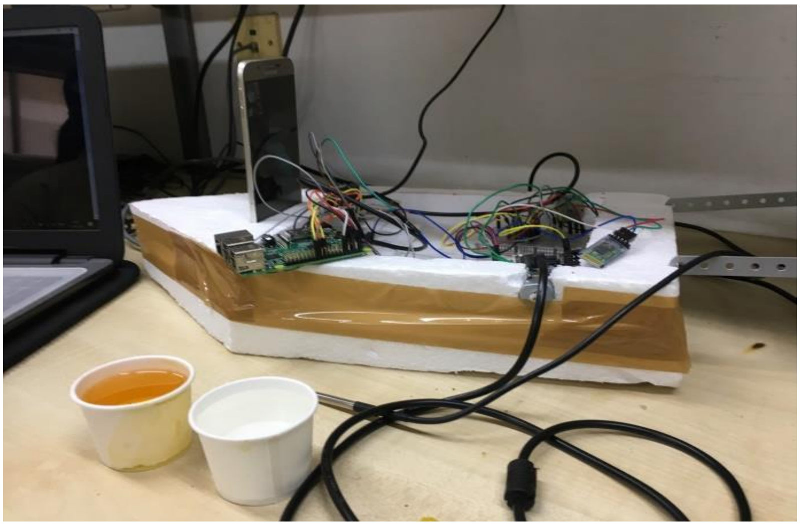

Fig4.2: Overall view of the raft along with sensors

Two propeller navigation system:

The images below help understand how to control motors to navigate raft, the “two propeller navigation system". That means the raft doesn’t need a rudder for changing directions.

Fig4.3: Guide for navigation of the raft

The application is an initiative for fully automated control for data acquisition via a limnological raft. It also controls the navigation of the motors connected and hence Bluetooth advancements are also possible.

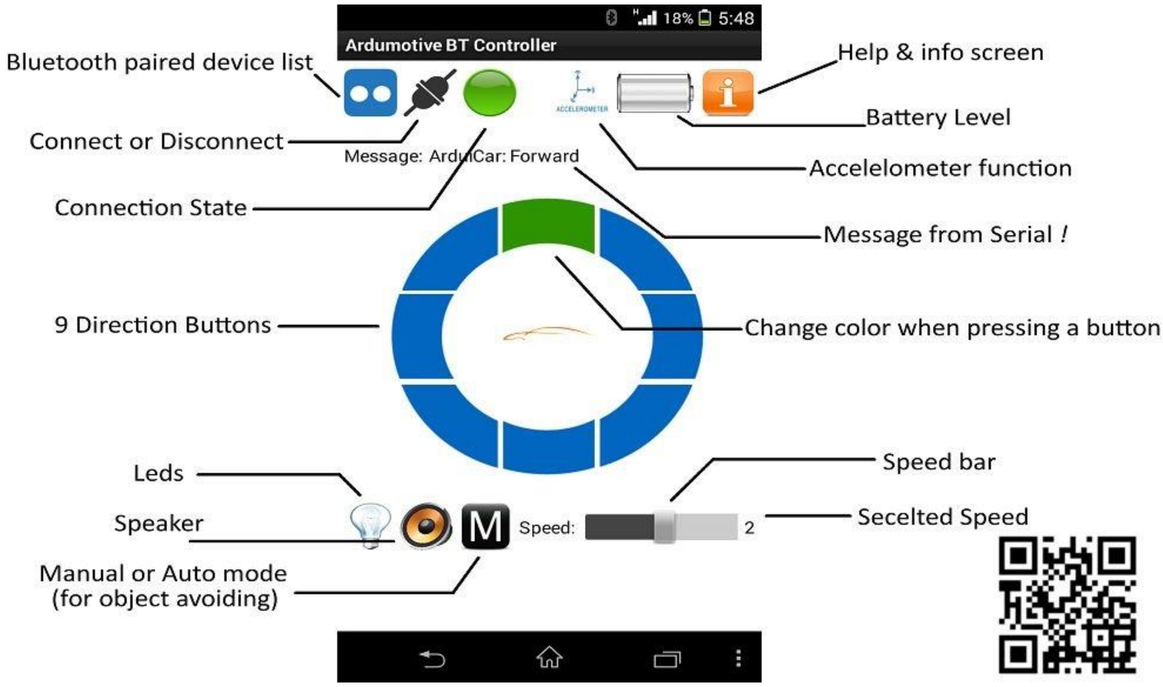

Fig4.4: Bluetooth application for control of raft

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

CONCLUSION

This project introduces a simple device that can be mounted on a floater and can be placed at one end in a water body to monitor the data which can be combined and analyzed to give a better and bigger picture of the water pollution while at the same time enabling to take correct measures as soon as the quality of the water bodies drops below a critical level. The temperature sensor DS18B20 directly provides digital data while we need MCP3008 ADC to convert the analog data from Ph sensor and TSD-10 to obtain precise sensor readings. By getting the data in real time, measures can be customized for different areas keeping in mind the different pollution level in different zones. It’s a lightweight system which will provide a fast and more efficient real time data which can be viewed by anyone in the world using IOT cloud.

FUTURE SCOPE

1. In the future, the floater can be replaced by a self-monitored and autonomous Raft which will revolve in the water body by itself, detecting the obstacles using LASER sensors so that it can cover as larger area of the water body. The data collected from entire water body can be then sent to the centralized computer to obtain more information about the pollutant content.
2. The raft can be powered with solar rechargeable batteries which will not only help in power consumption but also allow the raft to work by itself for months without any maintenance for recharging the battery.
3. The float can be attached with Potassium Permanganate refills and can be mixed in water whenever required.
4. Finally, not one but many such Rafts can be deployed for various water bodies, this will help us monitor the water body from one place, at the same time and also allow us to take immediate action in response to the pollution.

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