Microprocessor, Microcontroller, and Assembly Language Final Project Report

Project Title: Underwater Survey Boat

Group Number: 11

Submission Date:

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Group Members:

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Jawadur Rahman (202114049)

Md. Sadiqul Alam (202114064)

Introduction

Our project on “Underwater Survey Boat” is devised to conduct surveys, collect information on the water bodies and spatial environment of a particular area (such as temperature, pressure, turbidity etc.) using a wide range of sensors, and present a graphical chart to summarize the overall findings to the user. A fully functional and locomotory survey boat facilitates easier maneuvering in water bodies using RC controller and houses the sensors and power supplies.

Our project primarily aims at providing an abstract view of the overall water conditions to facilitate water body research-based projects.

Components

Component Model	Quantity	Cost
ESP32 Camera Module	1	700/-
BMP180 Barometric sensor	1	170/-
DS18B20 Temperature sensor	1	130/-
RCWL-0516 Microwave sensor	1	120/-
pH sensor	1	2000/-
Turbidity sensor	1	840/-
ESP8266 nodeMCU	1	400/-
Arduino UNO	1	500/-
12V LiPo Battery	1	500/-
Net cost = 5360/-		

Methodology

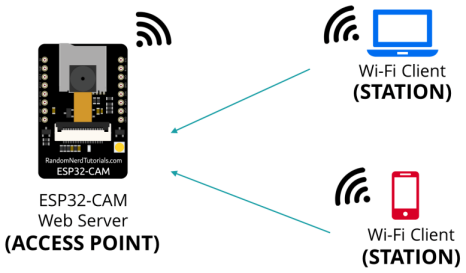
The water survey boat has several sensors such as barometers, temperature, pH sensors, and turbidity sensors. The sensors are mounted on a 3D-printed boat structure, which stays afloat on the water surface and houses the customized PCB. The boat can be manually driven using an RC-controlled remote to move to any preferred destination quickly. The data collected by the sensors are presented on an open-source IoT platform using nodeMCU.

In the boat structure, one Arduino UNO primarily process the sensors, while one Arduino MEGA runs the boat. When an input is given through the RC controller, the receiver receives the signal and sends PWM pulses to the EDF motor connected at the bottom of the boat. The pulses control the angular position of the camera module fixated inside a transparent case with an SG90 servo motor, thus allowing a 360 degrees omnidirectional field of vision.. For forward and backward movement, both the EDF motors are kept functional while for diagonal movement, one of the motors is kept inactive and the other is kept functional, which creates an angular torque in the trajectory.

The sensor modules of our project are either housed inside the survey boat or submerged in the water for accurate measurement. Their functionalities and methodologies are provided below.

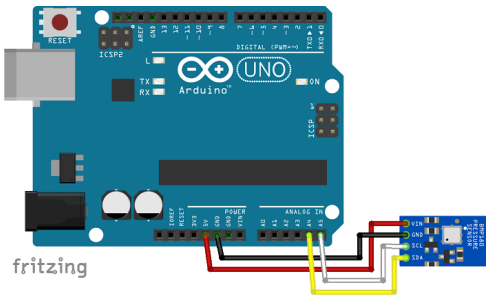
- **ESP32 Camera Module**

ESP32 Camera Module transmits real-time underwater wireless video streaming to the ESP32 Cam web server. It is powered by a 12V LiPo battery and fixed inside a transparent case at the bottom of the boat. Here the cam module acts as a station and transmits data via a hotspot connection.



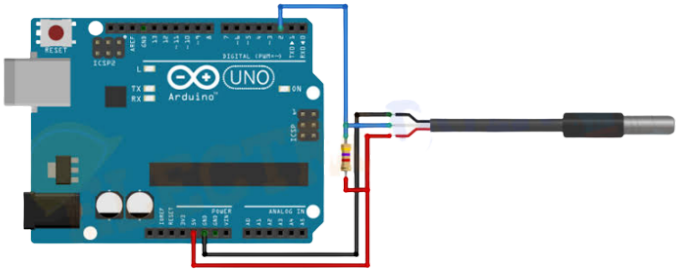
- **BMP180 Barometric sensor**

SCL and SDA of BMP180 Barometric sensor are connected to Arduino UNO pins A4 and A5. With 5V analog power supply, the sensor periodically senses the atmospheric temperature and pressure of its surroundings with its built-in piezoresistive sensor. When the pressure of the atmosphere fluctuates, resistance of BMP180 increases/decreases, and thus it becomes responsive to temperature changes.



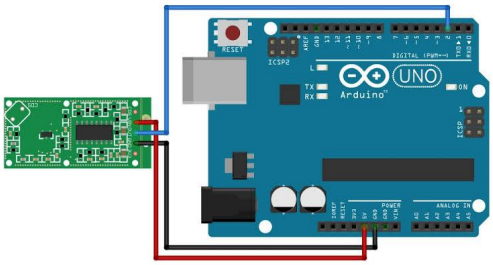
- **DS18B20 Temperature sensor**

The waterproof DS18B20 Temperature sensor is connected to Arduino UNO and mounted on one side of the survey boat with the metal probe submerged in the water. This temperature sensor gives direct digital output of water temperature, which is then transmitted to nodeMCU. The two metal legs generate electrical voltage or resistance by calculating the voltage difference between the two diodes when there is a temperature fluctuation.



- **RCWL-0516 Microwave sensor**

RCWL-0516 Microwave sensor is connected to Arduino UNO with a 5V power supply. The RCWL-0516 module employs Doppler radar, which detects motion and triggers proximity alerts within the range of 5-7 meters. The sensor transmits low-level microwave radiation of 3.175 GHz at the target area and analyzes the reflected signal. If any lifeform is detected, the OUT pin transitions from low to high (3.3V) and the digital output is then transmitted to the nodeMCU.

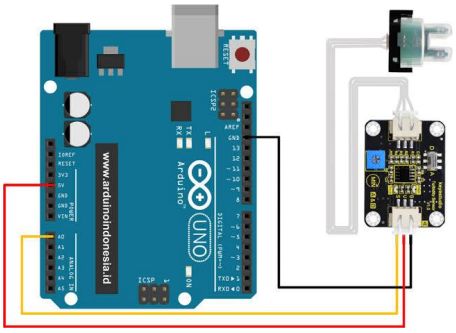


- **pH sensor**

A pH sensor has been mounted on a side of the boat with its tip submerged in the water. The pH sensor measures the pH of the water and sends the data to nodeMCU.

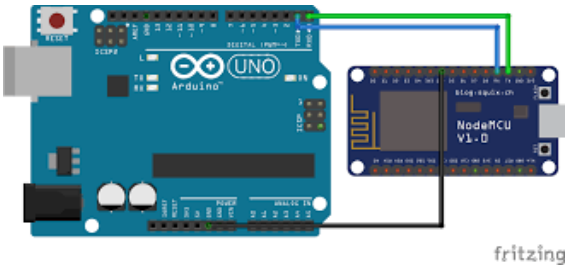
- **Turbidity sensor**

Turbidity sensor is connected to Arduino UNO and submerged partially in the water. The optical sensor of the module measures the clarity and particle content of the water, such as whether the water is turbid or clear by using optical transistors and optical diodes.

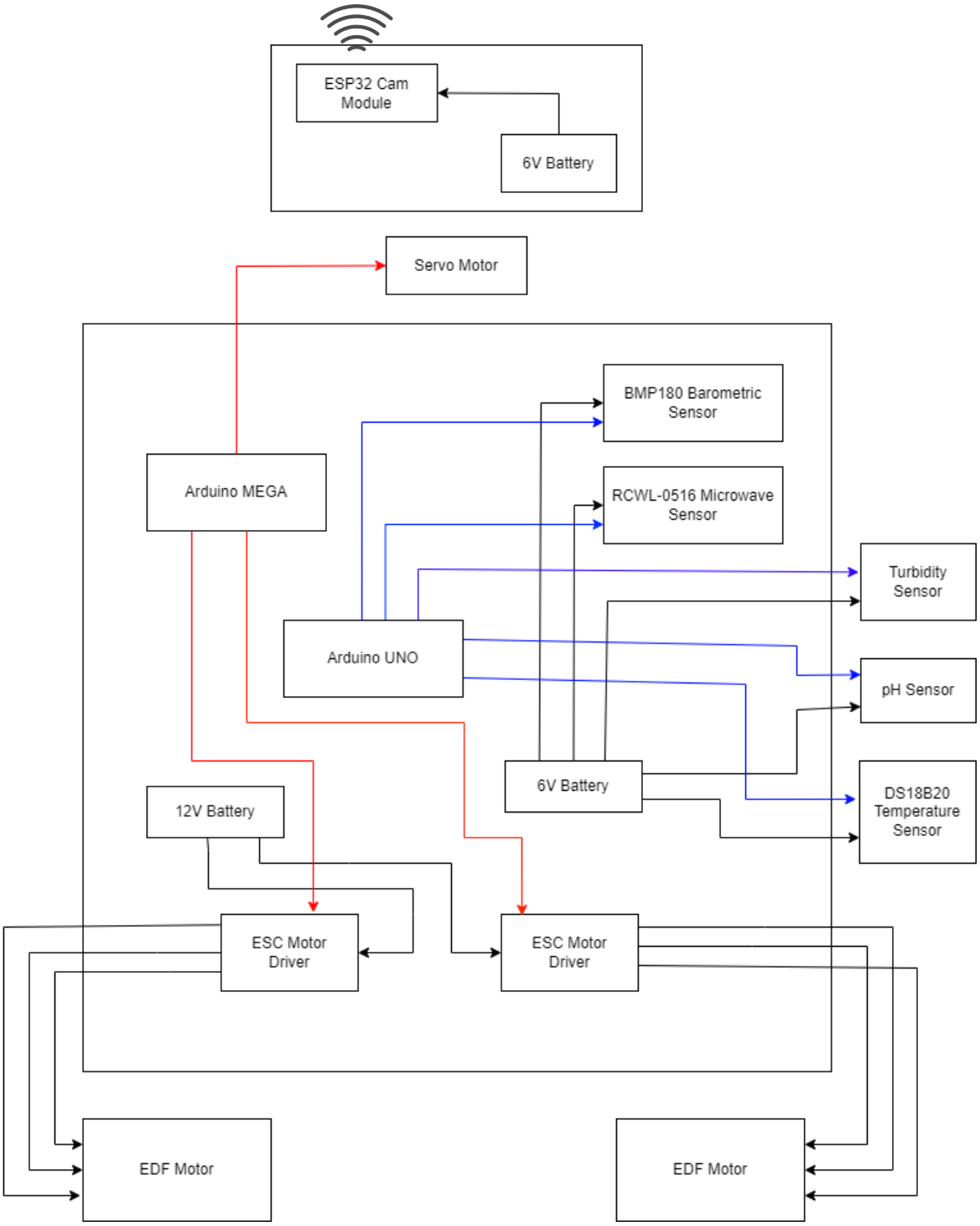


- **ESP8266 nodeMCU**

The ESP8266 module of nodeMCU enables the microcontroller to connect to 2.4 GHz wi-fi. The data is then transmitted to a data analytics server(ThingSpeak) which shows a graphical output using matlab from the data received from each sensor.



Block Diagram



Circuit Diagram

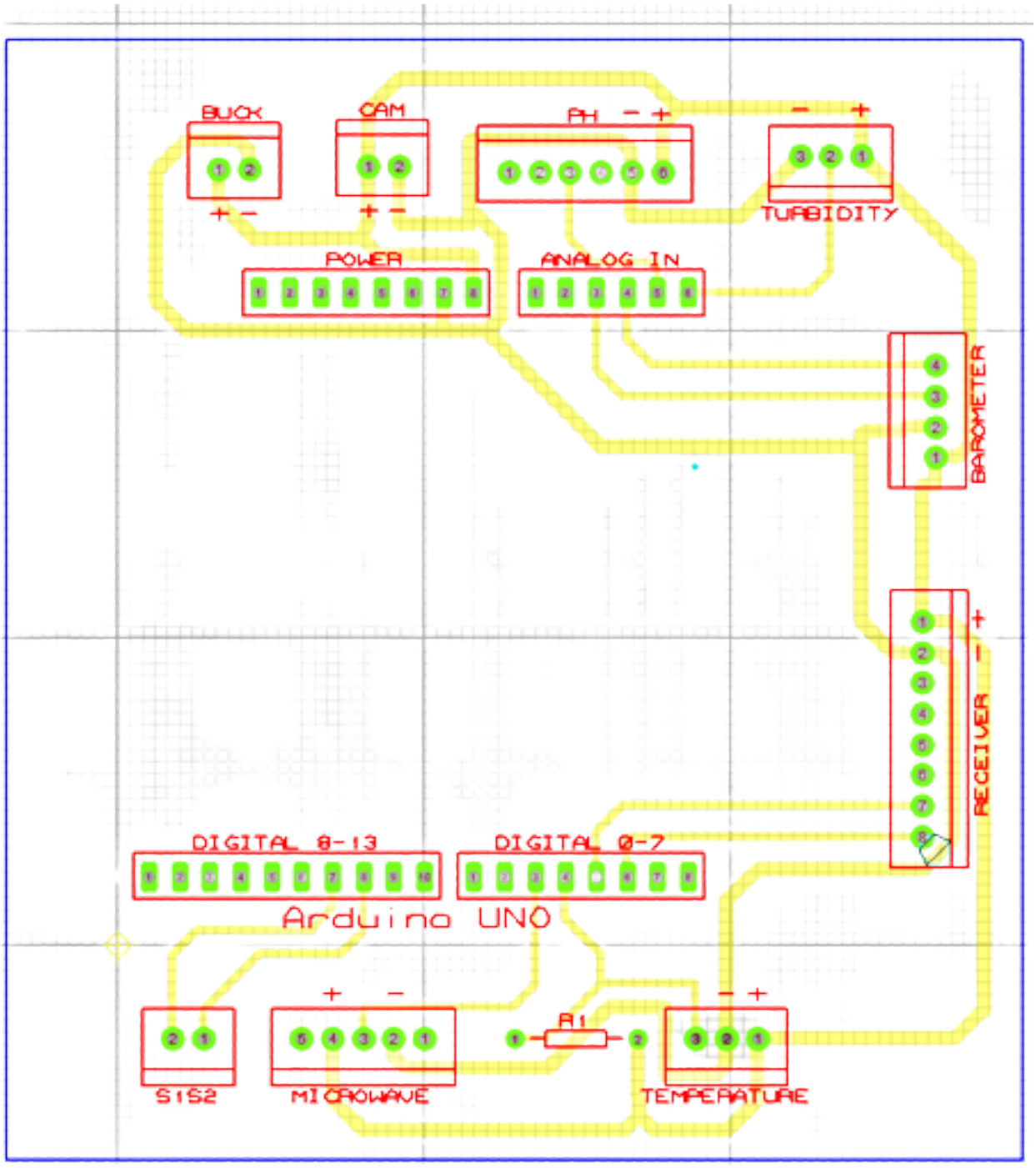


Fig: Circuit layout of water survey boat

Outcome

The project works as expected. The boat can be properly controlled using the RC controller. The sensors transmit updated data in real time to the Thingspeak server every 15 seconds.

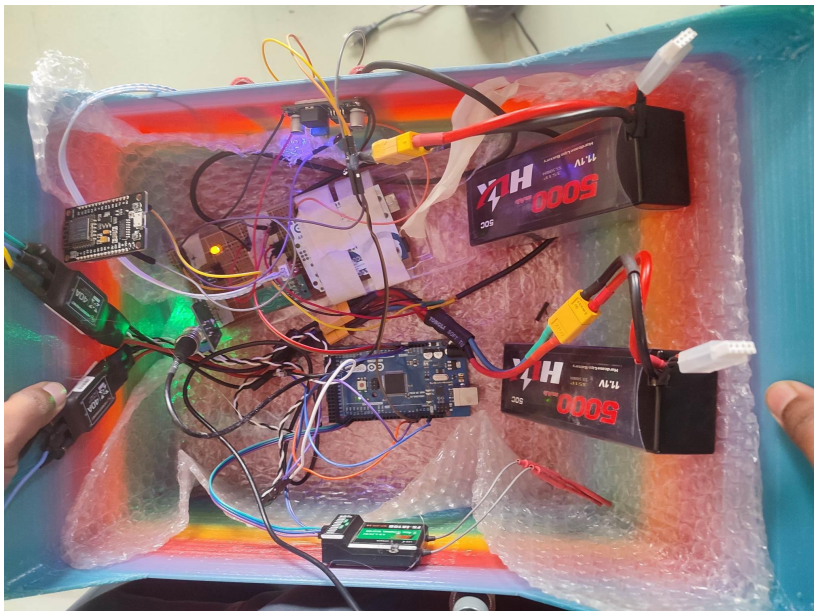


Fig: Water survey boat (Top view)

Fig: Water survey boat (Side view)

Fig: Water survey boat (Full setup)

Contribution

Jawadur Rahman (202114049)	**Soldering** and **customization of PCB**
	Arduino code and pin diagram for **turbidity sensor**
	Arduino code and pin diagram for **ESP32 camera module**
	Arduino code and pin diagram for **pH sensor**
	Arduino code and integration of **nodeMCU** for wi-fi data transmission
	Arduino code and controlling the boat by **EDF motor**

Md Sadiqul Alam (202114064)	Arduino code and pin diagram for **DS18B20 Temperature sensor**
	Arduino code and pin diagram for **RCWL-0516 Microwave sensor** for motion detection
	Arduino code for **servo motor**

Mayeesha Musarrat (202114040)	Documentation
	Arduino code and pin diagram for **BMP180 Barometric sensor**

Additional Features

- ### Measurement of Pressure and Air Temperature

BMP180 Barometric sensor has been used to measure the pressure and air temperature. This feature has been included to improve the spatial awareness of the water survey boat.

- ### Integration of pH sensor

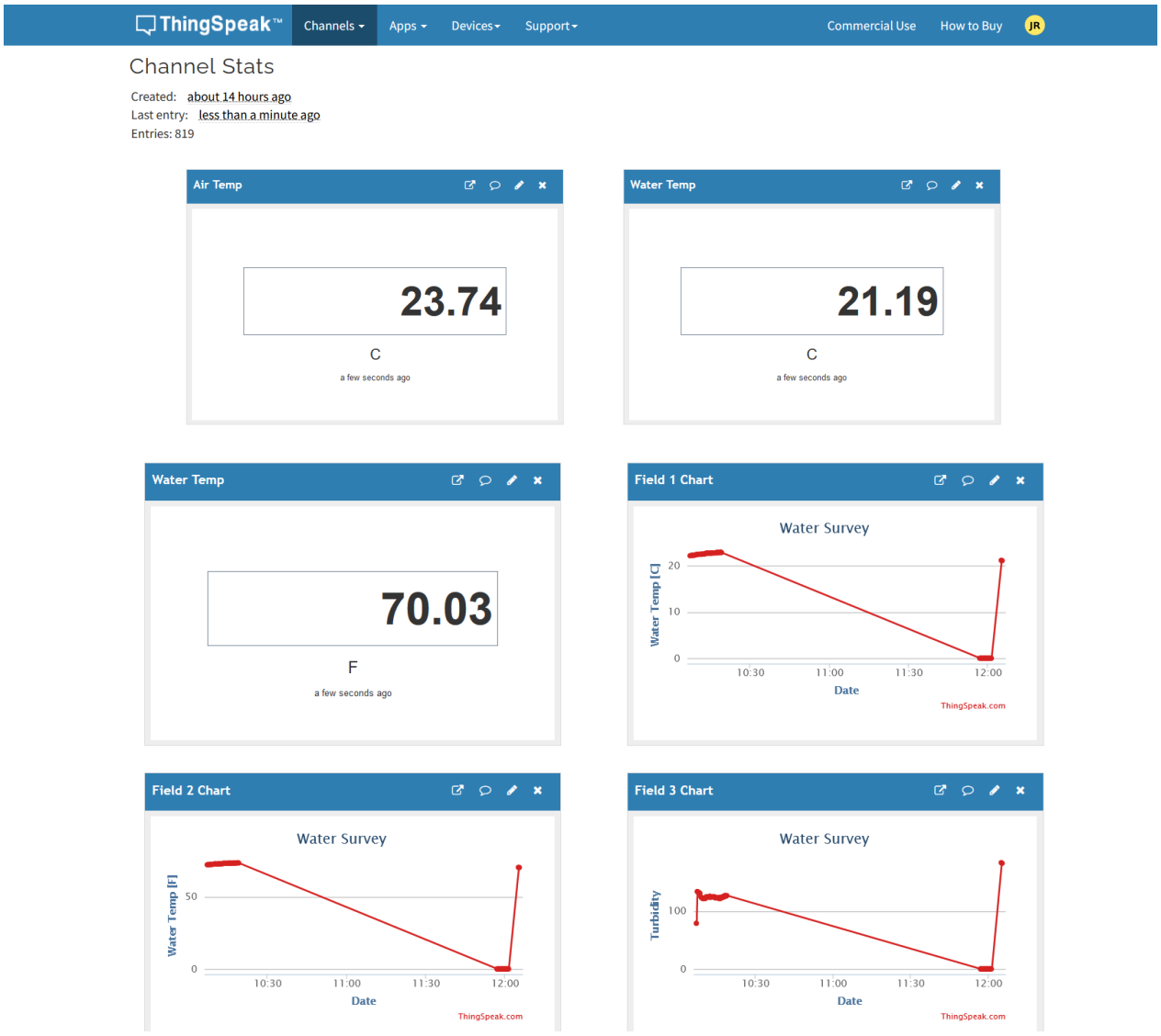
pH sensor has been mounted on the sides of the water-survey boat to measure the pH of water bodies.

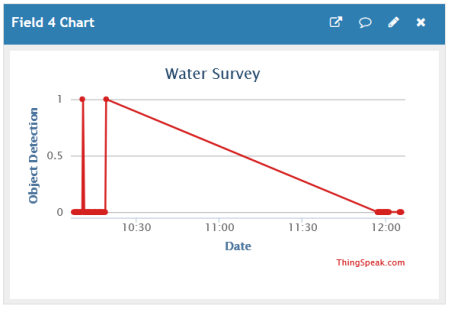
- **Omnidirectional Rotation of Under water Camera Module using Servo Motor**

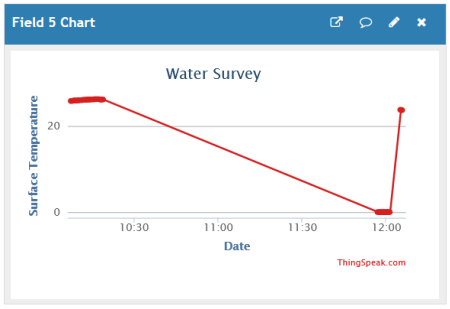
Servo motor has been used to rotate the camera module in 360 degrees for omnidirectional mapping of the surroundings of the device instead of unidirectional vision as proposed in the first proposal.

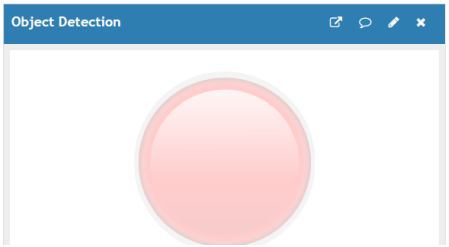
- **Data Aggregation and Analytics using nodeMCU**

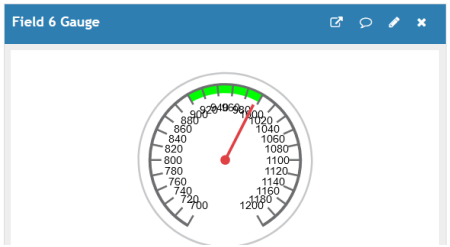
NodeMCU provides Wi-Fi capability and allows the user to see a real-time graph of the sensor data. The extracted data can also be viewed in MATLAB to plot graphs for queries such as finding the minimum, maximum, or average of a parameter.

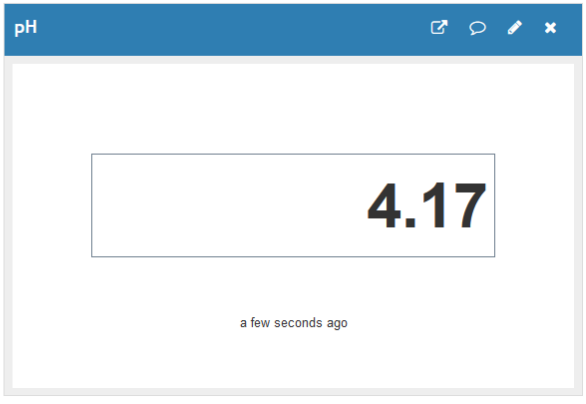



Field 4 Chart
Water Survey
Object Detection
1
0.5
0
10:30
11:00
11:30
12:00
Date
ThingSpeak.com


Field 5 Chart
Water Survey
Surface Temperature
20
0
10:30
11:00
11:30
12:00
Date
ThingSpeak.com


Object Detection


Field 6 Gauge


pH
4.17
a few seconds ago

Limitation

The underwater survey boat may fail to provide correct measurements in salty water. Moreover, the boat body is not sturdy enough to withstand turbulent water bodies. Servo motor may not function as usual if water gets through the transparent case lid.

Future Scope

Underwater survey boat provides a wide range of possibilities for research purposes in the future, such as collection of valuable artifacts or utilizing its functionalities for body recovery in case of any drowning accidents. Water survey boat can also assist in identifying suitable water body for pisciculture.