EC280: Mini Project

Project Title: Microcontroller Based Robotic Fish

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Table of Contents

ROBOTIC FISH

Introduction

Ocean covers the majority of the earth’s surface, containing a huge variety of biological resources. The robot is developed to achieve better efficiency, controlling mechanisms.

The uses of robotic fish over the submarine are that robots are more efficient, flexible and operate in critical conditions and the huge difference in size is a massive advantage for many applications. It can not only be used for underwater monitoring such as pollution check, it also can be used in surveillance for military and defense applications.

We are modifying our robotic fish towards civilian and ecological uses to monitor the different water bodies’ pollution and composition of various elements and chemicals.To know about the amount of composition we use the water quality sensors and the types of water quality sensors are as follows:

- pH Sensor.
- Conductivity Sensor.
- Residual Chlorine Sensor.
- Turbidity Sensor.
- ORP Sensor.
- COD Sensor.
- Ammonia Nitrogen Ion Sensor.
- Temperature Sensor.

As ammonia sensors and DO sensors are not available and they are expensive to purchase , the parameter of temperature is only measured in our proposed design and Other water parameters would not be included in this system. Our sensor unit comprises only the temperature sensor.Since water temperature has a great effect on fish, metabolic rates, biological filter activity and oxygenation. Fish are cold-blooded living creatures; they have approximately the same temperature as their surroundings. Therefore, the temperature must be retained within a certain range in order for the cultured species to reach optimum growth .

General temperature ranges for different species of fish :

Species		**Temperature Range(◦c)**
Cold water	-	12.77-18.33
Cool water	-	18.33-23.88
Warm water	-	23.88-32.22

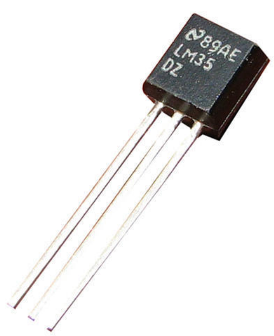


Fig 1:LM35 temp

This sensor is the input to the system. The temperature sensor indirectly helps to collect the water sample for the further test.

Servo motors are attached to the fish for smooth locomotion. Servo motors are connected which helps for the directional changes. WiFi is the communication mode for the fish to move in Automatic mode or in manual mode. If the fish should move in manual mode, then there are 3 ways i.e forward, left, right.

Fig2:microservo

Microcontroller used is NodeMCU ESP8266, but arduino uno can also be used. It has 3.3V output pins and GND(ground). We connect various Sensors and motors and other devices to the GPIO ports which are renamed as D* where *-(0-8). For our project we are not using any serial interfaces, instead using inbuilt WiFi modules to send and receive the data and instruction signals to the various peripheral devices connected to the microcontroller.

If we use Arduino Uno board instead, we have to keep in mind we can use more and varied peripherals that also use 5V input which is not available in NodeMCU ESP8266.

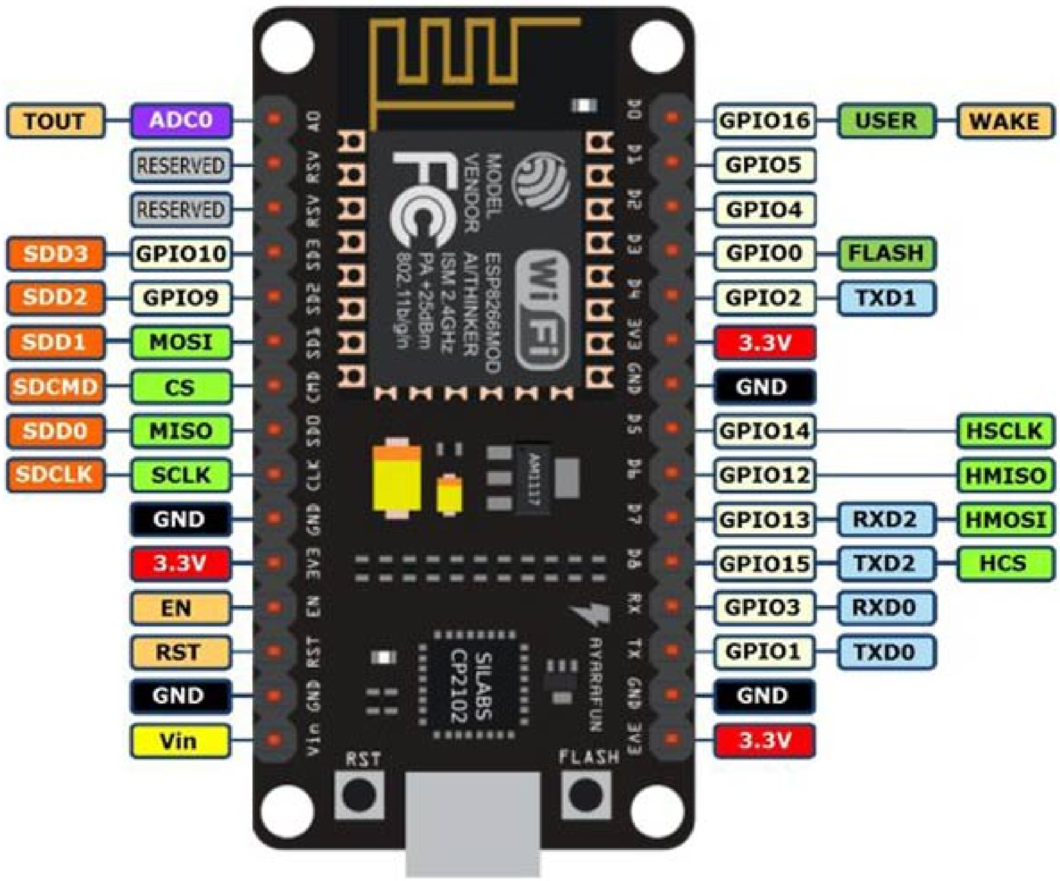


Fig3: NodeMCU pinout

The relay is connected to the microcontroller and also to the water pump. The relay will operate according to the controller decisions based on that it will collect the sample.

With all the potentials and advantages elaborated in the previous section, the research and development of the robotic fish with soft actuation structure have just started in the recent decade and is still in the primary stage. Most of the existing laboratory-level soft actuator-based robot (SARs) fish designs could only operate at a certain depth instead of moving along the 3D trajectory. Meanwhile, there are currently no commercial level products.

For the applications of scientific aquatic creature habitats and behavioral observation, an agile robot capable of swimming along a 3D trajectory and closely interacting with aquatic creatures with long operating time is necessary. A biomimetic soft robotic fish is capable of achieving such functionality better than servo motor actuated robotic fish and propeller-powered ROVs.

The motivation of the project is to investigate the possible design and performance of soft actuator-powered robotic fish for the next-generation underwater autonomous robot for aquatic creature study. The significance of the research does not solely come from its potential to provide a new form of interaction with underwater creatures, it could inspire future robotic designs that combine biological structure and robotics to achieve extraordinary functionality.

Fish Model

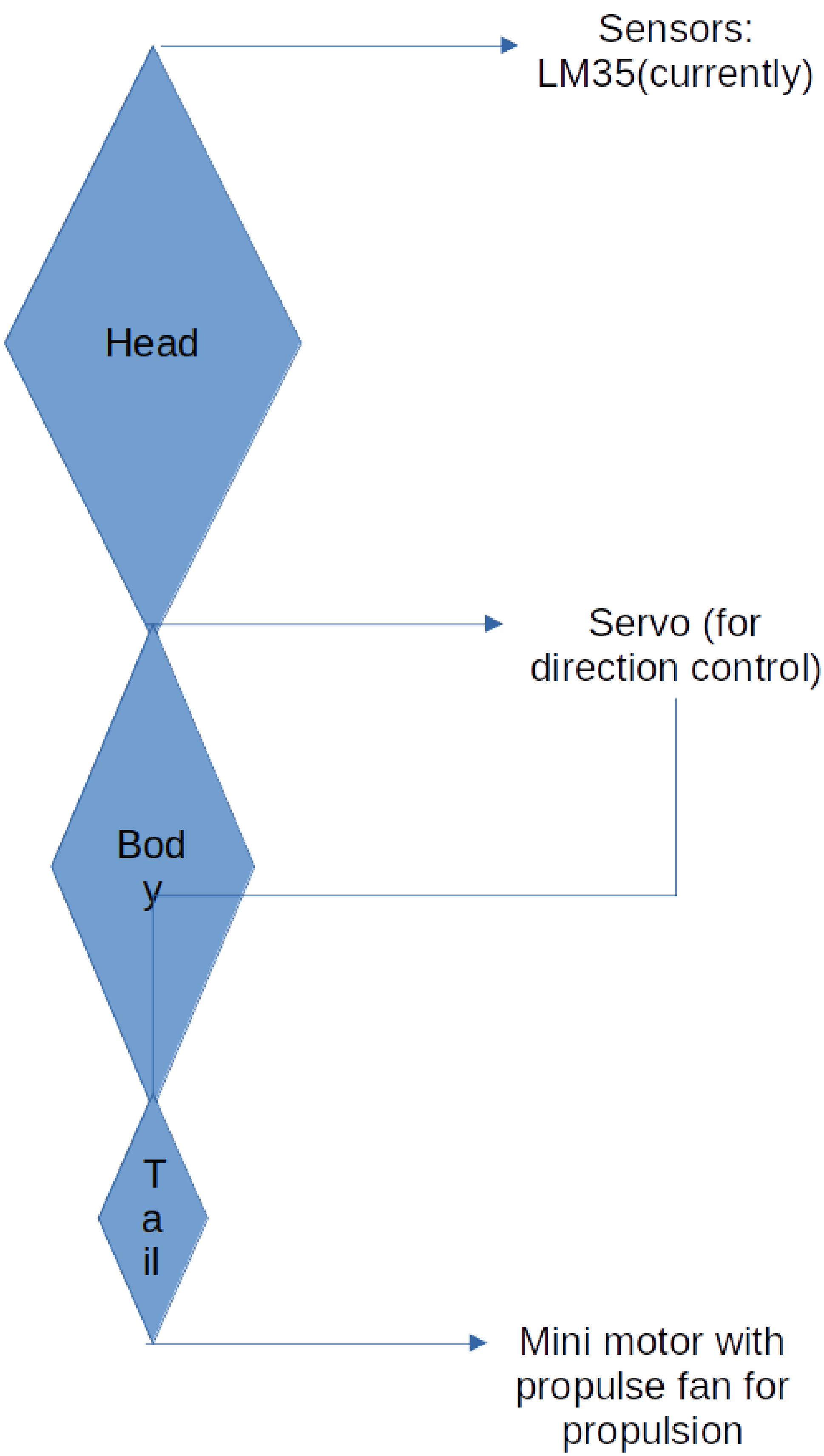
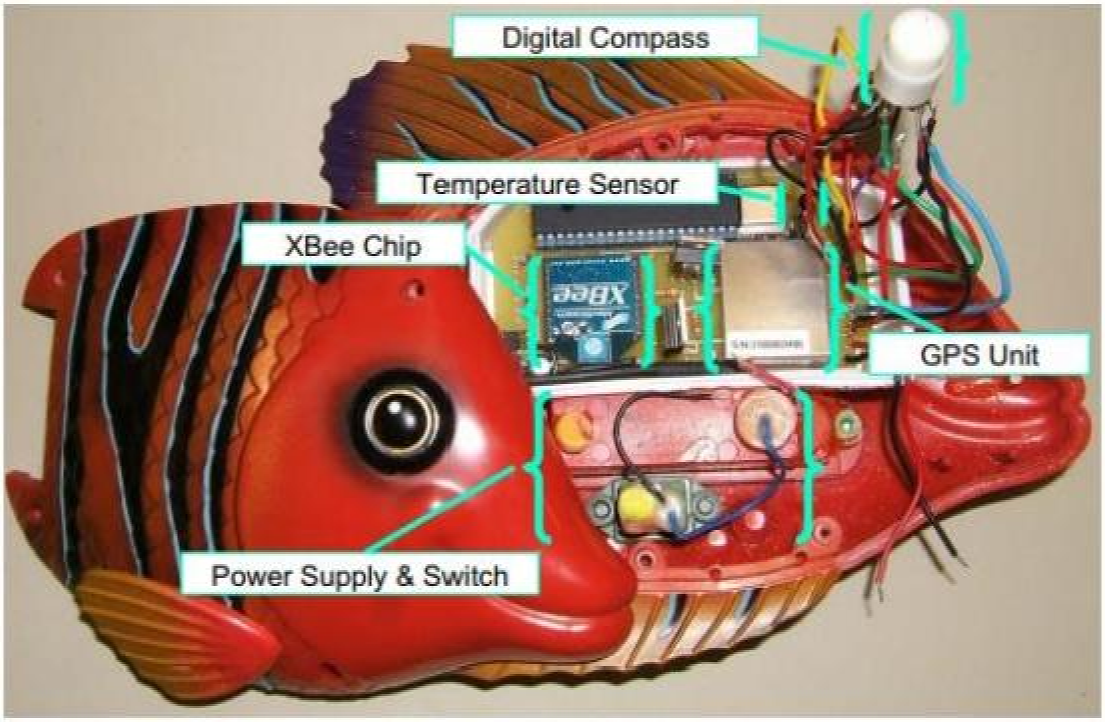


Fig4: Fish model

Literature Survey :

A multi-agent school of robotic fish "Ichthus V5.5" as shown in Figure 2.7 for mariculture monitoring. The moving motion of the robotic fish mimicked the swimming motion of a real fish. Thus, the robotic fish was adopted with multi-joint tail to generate the same swimming motion of a real fish. There were many types of swimming patterns in the robotic fish. The patterns were all according to the swimming morphologies including cruise straight, cruise in turning, sharp-turn, ascent-descent and others. The movement of each joint was controlled by servo motor attached on it.

The initial robotic fish design used latex rubber to mould a real fish appearance as the material is flexible and waterproof. The circuit board was placed inside the rubber fish.A new housing was developed because the latex rubber turned out is not waterproof . The second generation of fish was to place the circuit board with sensors into a toy fish as shown below figure.



Problem Statement

- To design a microcontroller based robotic fish to assess water pollution based on pH and temperature.

Objective

- To design a miniature, low-cost, biomimetic robotic fish for the purpose of checking the water pollution based on pH and temperature.

- Hardware design and characterization of a novel biomimetic robotic fish with a modular caudal fin.

- This miniature robot utilizes a servo-motor-based direction controlled mini motor based propulsion system controlled via a microcontroller and is wirelessly operated via bluetooth and wifi using a wireless device like a smartphone

Methodology

System overview

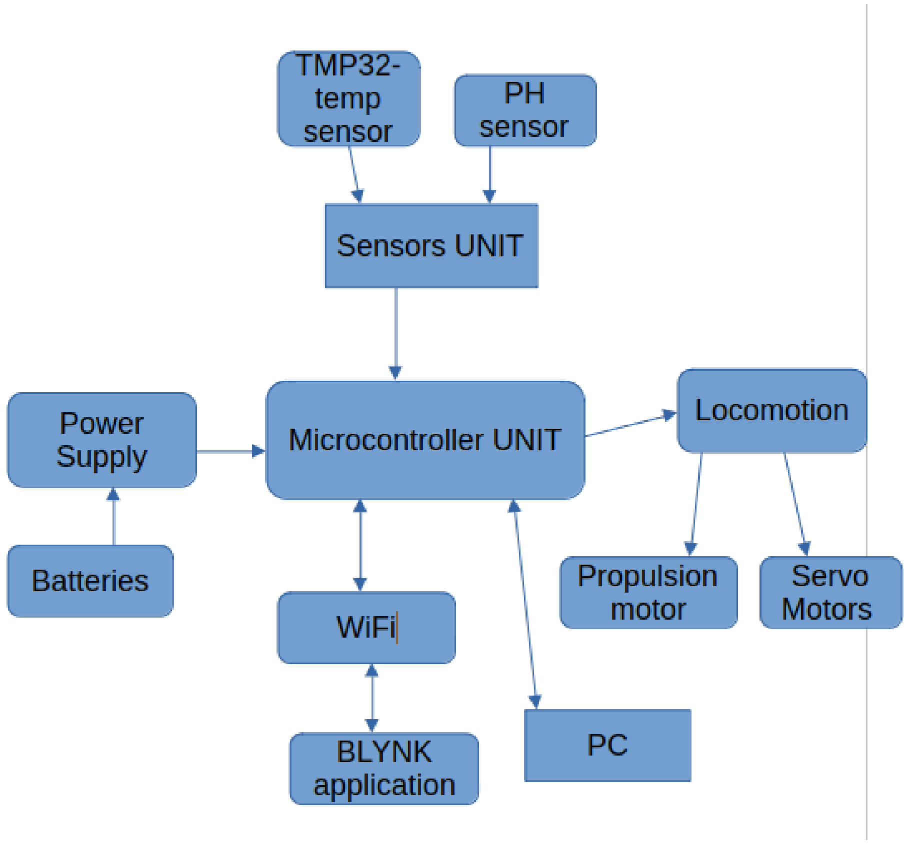


Fig5: sys overview

The sensors and motors are connected to the microcontroller as explained below.

Servo motor:

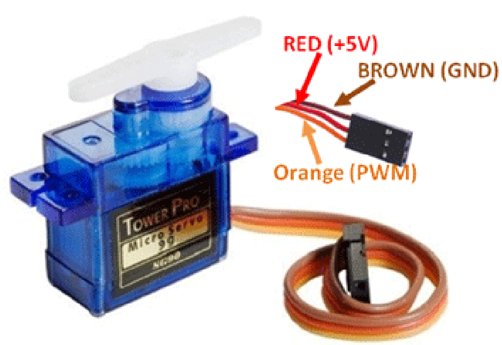


Fig6: MicroServo pinout

Servo motor has 3 pins as shown in figure. Red one connected to 3v3 pin in nodeMCU as it is the only output voltage available in the microcontroller being used, brown is connected to ground and the Orange through which we send the signal is connected to pin 15 or GPIO 15 which is D8 in the board as shown in the boards pinout.

Temperature Sensor :

The temperature sensor model used to show the mobile sensing application of the autonomous robotic fish was the National Semiconductor LM335 AZ. It has accuracy of 1 °C and wide operating temperature range. This device can operate from 400μA to 5mA with less than 1-2 dynamic impedance (Tan et al., 2006). Vanmore et al. (2017) used LM35 temperature sensor which is the same type of sensor as LM335. These type of sensors are integrated circuit temperature sensors; they are not water proof. Even if it is sealed with silicon adhesive, the accuracy of results will be affected.

They adopted the temperature probe from Atlas Scientific in the system to check the temperature of water. It can function up to 5 V and the full temperature sensing range is between -20 °C and 133 °C, with accuracy of +1 °C. This temperature probe was attached with BNC connector, thus, it was able to connect to Arduino controller via adapter. It is also non reactive to salt water and can be fully submerged in water, up to the BNC connector (Rao et al., 2013).

DS18B20 thermometer was used and Its operating voltage range is between 3 V and 5.5 V, detect temperature range from -55 °C to +125 °C, with accuracy of ±0.5 °C. The DS18B20 digital thermometer supports 9-bit to 12-bit temperature measurements and the information collected is sent to central microprocessor via 1-Wire interface.

They used TMP102 digital temperature sensor to detect temperature. It used inter integrated circuits (FC) bus of the Arduino for communication. TMP102 can measure temperature range from -55 °C to 150°C with accuracy of +1 °C. However, this type of sensor is also not waterproofed. They used waterproofed LE-438 3-in-1 pH electrode to measure temperature. It is a combination of pH electrode and temperature probe.Based on the report thermistor thermometer to measure water temperature. It is a thermometer which measures temperature with a resistor and can be used indoors or outdoors. The signal from the sensor is transmitted to the Web-based monitoring chip with the objective of converting analog signal into digital signal.

In the proposed design, the sensors must be contacted with water in order to take measurement under water. Thus, the temperature sensor must be waterproofed and can be connected to Arduino controller. The DS18B20 temperature probe was the best choice for this proposed system.

Temperature sensor used is LM35 whose pinout is shown in Fig7. pin1 is connected to 3v3 pin of NodeMCU, pin2 to Analog Pin A0 of NodeMCU, and pin3 to ground.

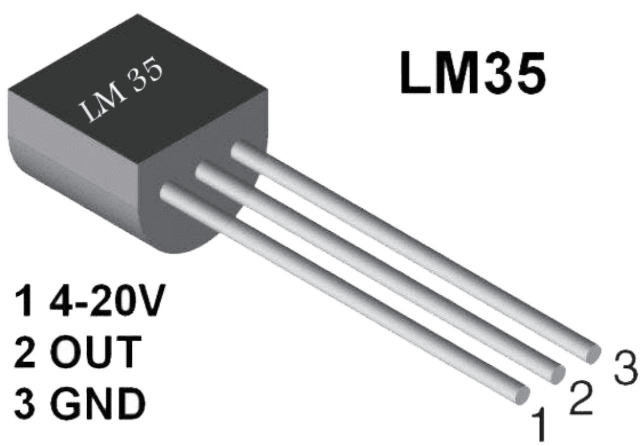


Fig7: LM35 pinout

System working and connections:

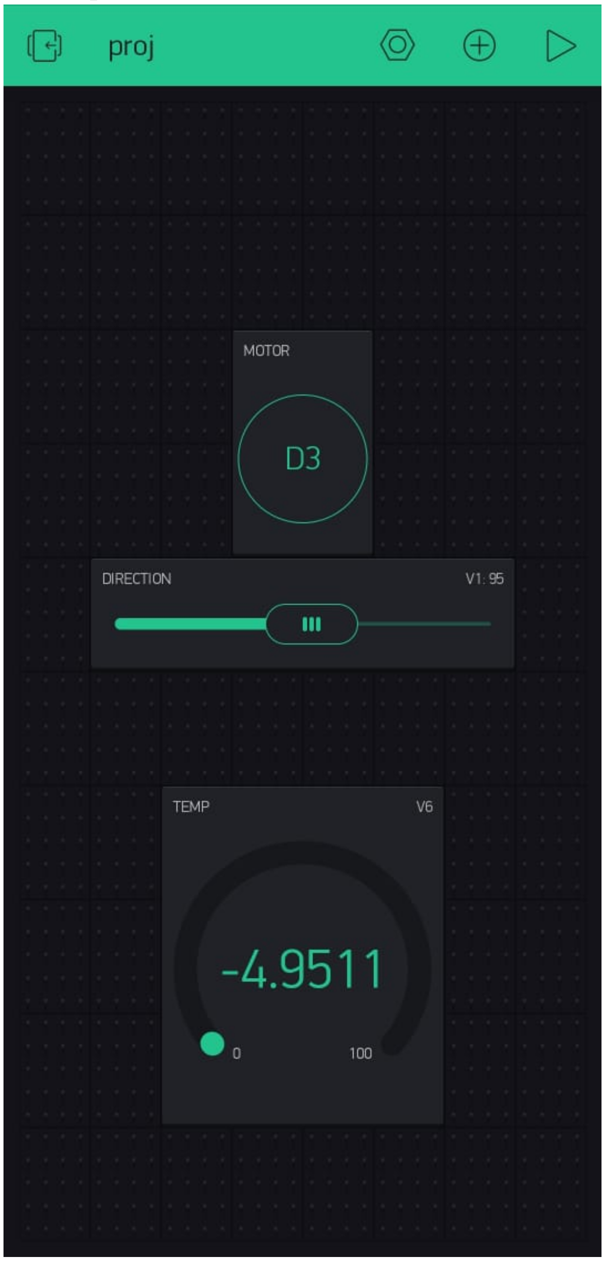
```
#include <ESP8266WiFi.h>
 #include <BlynkSimpleEsp8266.h>
#define BLYNK_PRINT Serial
```

}

```
#include <Servo.h>

char auth[] = "Auth Token";

char ssid[] = "wifi name"

char pass[] = "password";

BlynkTimer timer;

Servo servo;



int var;

double temp;



void setup() {

   pinMode(12,OUTPUT);

   Serial.begin(115200);
   Blynk.begin(auth,ssid, pass);
   servo.attach(15);

}

void loop() {

   Blynk.run();

   timer.run();

   var = analogRead(A0);

   temp =(double)var/1024;
   temp = temp *5;
   temp = temp - 0.5;
   temp = temp * 10;

   Blynk.virtualWrite(V6,temp);

   //delay(1000);


}
```

```
BLYNK_WRITE(V1)
{

    servo.write(param.asInt());

}
```

Output :



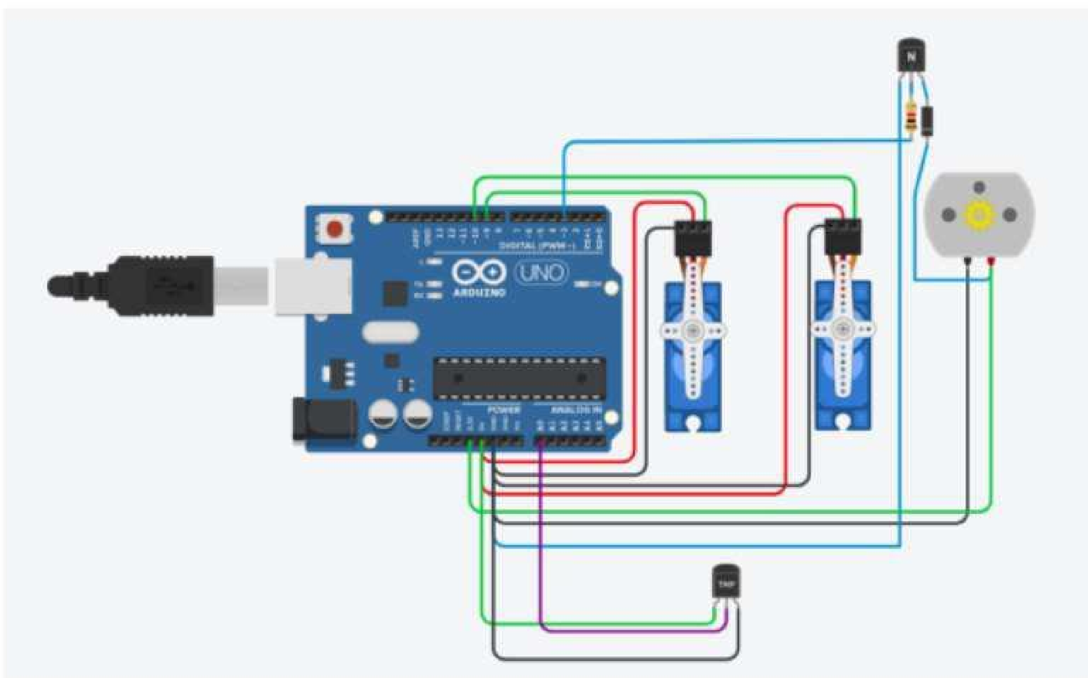
Results and Conclusion

Temperature is displayed on the Blynk application via WiFi.

The motors are running and the direction and propulsion are controlled manually from the Blynk app via WiFi.

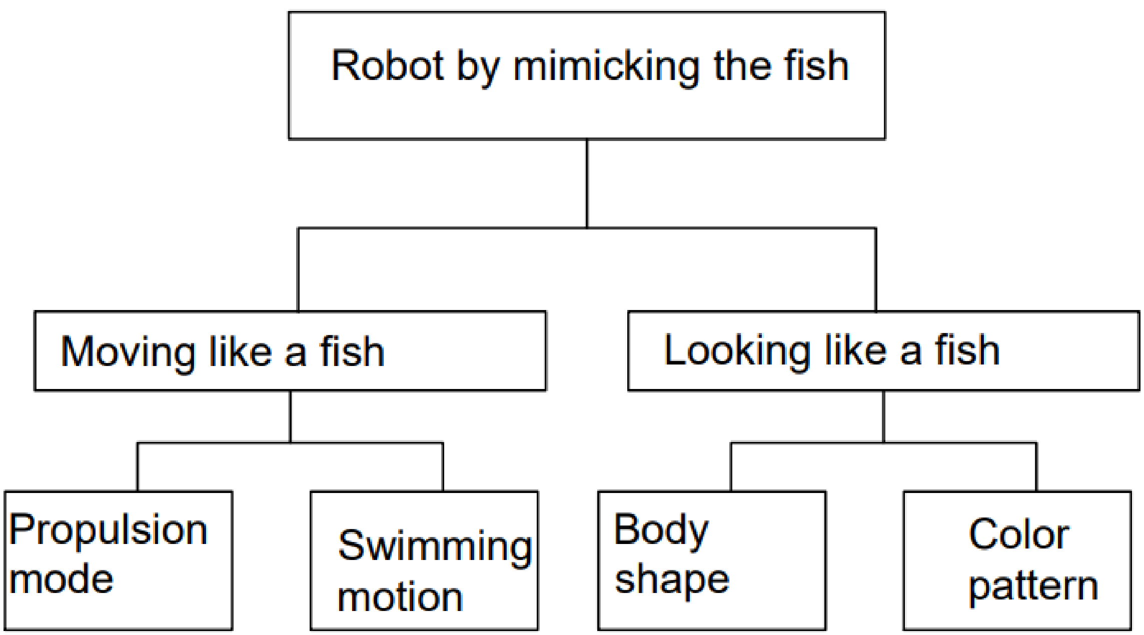
We have

Simulation-Done in tinkercad



Future Scope

- The robot can be further developed by adding GPS tracker for the navigation.
- Video and image capture facility can also be added.
- The following is the flowchart of our future robotic fish which has these following features.



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