Design of Underwater Remotely Operated Vehicle

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***Abstract*—Under the "Archimedes' Principle," this ROV operates. "An item immersed in a fluid experiences a buoyant force that is equal in magnitude to the force of gravity on the displaced fluid, "which is according to Archimedes' principle. Here, we're attempting to create a car prototype that the user will be able to control remotely. We use Node MCU circuit boards to remotely operate this model. The frame design utilises a variety of materials.**

The objective is to create and test a remotely operated underwater vehicle (ROV) that is lightweight, affordable, and capable of conducting surveys in shallow waters (30 m). This focuses on the creation, testing, and design of such a ROV.

Keywords— Remotely operated vehicle, Buoyancy, Foreign bodies, Acrylic tube, CPVC Pipes, PVC Pipes, Node MCU

I. INTRODUCTION

Remotely operated vehicles, also known as ROVs, are unmanned, highly agile vehicles or underwater vehicles that can be used to explore ocean depths and great heights while being controlled from the air or the surface of the sea. Without actually being in the water, remotely operated vehicles, or ROVs, let us explore the ocean. On a surface vessel, usually, a human uses a joystick to operate these underwater equipment, much like how you would play a video game.

The ROV is tethered to the ship by a set of cables, which allows the operator and the vehicle to communicate electronically. The majority of ROVs come with at least a still camera, a video camera, and lighting, enabling them to transmit photos and videos back to the ship.

Vehicles may also be outfitted with additional tools, including a manipulator or cutting arm, water samplers, and measuring devices for things like temperature and water quality. Because operators can stay safe (and dry!) on ship decks, ROV operations are typically simpler and safer to carry out than any form of occupied-submersible or diving operation, even if using ROVs eliminates the "human presence" in the water. Because ROVs can stay underwater for a lot longer than a human diver, they allow us to explore locations that are too deep for humans to safely study on their own.

A remotely operated vehicle used for underwater exploration is called an underwater ROV. Underwater ROVs are used by researchers and scientists to study the ocean's depths, venture where humans are not safe, and carry out a variety of other tasks. The engineering challenge was met in 2015 by 4-H campers at the Great Lakes Natural Resources Camp by creating an underwater ROV. The 4-H organisation is committed to contributing in some way to the growing need for STEM experts. To assist ensure that they will be internationally competitive and ready to be a part of the next generation of STEM leaders, 4-H science programmes are currently providing hands-on learning opportunities to millions of youngsters around the country.

Electrical systems (wiring and circuitry), mechanical structures, sensors and appendages, and task-specific structures are among the many parts that make up the ROV's general operating mechanism.

The ROV's skeleton serves as the support structure for all of these systems. To minimise added weight and drag when in motion, it is built as light as feasible. In order to protect the internal components from inadvertent damage, it is covered by a structure known as the Manifold. Along the frame members are holding clips for supporting wiring and other electrical circuit components.

II. OBJECTIVE

- The objective is to develop a low-cost remotely controlled underwater vehicle (ROV) that can do surveys in shallow waters (30 m). This focuses on the creation, testing, and design of such a ROV.
- We can explore the ocean or any other depth of water using a remotely piloted vehicle without really being in the water or ocean.
- To determine whether any debris or live things are lodged inside the pipe, as well as any bore line faults.
- In addition to structural testing of offshore platforms and internal and external inspections of undersea pipelines, ROVs are also utilised for a wide variety of other purposes, many of them scientific. They have proven to be of great utility in ocean research and are also employed in aquarium instructional programmes and live online connections to scientific excursions.

III. METHODOLOGY CARRIED OUT

- The conceptual design with a 3D model of the overall frame is created through CAD software.
- Required raw materials of the ROV is purchased which includes CPVC pipes, PVC pipes, Bilge Pumps, Arduino circuit board, Li-ion Battery, several joints (T joints, L joints etc), Propeller, Waterproof Camera, Acrylic tubes, LED Lights, wire connections and other accessories such as glue, glue stick hacksaw, hot glue gun mountings, nut and bolt etc.
- The frame is fabricated thoroughly from the conceptual 3D model that has been made through CAD software.
- Here the CPVC pipes are used for the outer frame of the ROV model and PVC pipes are used to act as a floater

- Three Bilge Pumps of two are of 1100 GPH and another one of 2000 GPH are used
- The ROV will act on 3 degrees of freedom(DOF) in which the two 1100 GPH Bilge pumps will be operating in the right and left direction and the other 2000 GPH Bilge Pump will be operating in the upward and downward direction.
- After the frame is fabricated the programming for the Arduino circuit is done.
- The ROV is then allowed to test underwater for detection.

IV. TECHNICAL DETAILS, SPECIFICATIONS AND CALCULATIONS

This vehicle works on Archimedes Principle. In order to reduce the overall weight of the ROV the outer frame is fabricated by using CPVC pipes and elbows.

The Floater is designed with the help of PVC pipes with both ends closed with end caps. The camera is installed in one of the PVC pipes which is installed in front of the ROV with one end closed and the other end fixed with a transparent convex lens in order to detect the foreign bodies in the water.

The ROV is equipped with three Bilge Pumps with modified propellers installed on the shaft for Six-degrees of Freedom for movement i.e, Forward and Backward, Right and Left and Upward and Downward movement and it is controlled by the NodeMCU circuit Board.

A. Calculations

- Total Weight Estimated = 8kg
- Floater Volume =(π x d^2 x L)/4
- d = Diameter of Floater (15cm) ; L = 20cm (Length of Floater)
- Total Volume of Floater = 7.068 x 10^-3 m^3
- Total Volume of Frame = 2.985 x 10^-3 m^3
- Total Volume of ROV = 10.053 x 10^-3 m^3
- Density = Mass/Volume = 795.782 kg/m^3
- Buoyancy Force = -DgV = (Appr) 80 N
- Where (-ve) sign indicates Upthrust on the body(ROV)

B. Specifications, Lengths and Others

SL No	Components	Lengths and others
1	CPVC Pipes,PVC Pipes	1 feet*10,1.5 feet*2
2	Propellers	Bore Dia mm*3
3	NodeMCU	49mm x 26mm
4	Li-Ion Battery	12V 7AH
5	Low Lux Camera	4K Resolution
6	Acrylic Tubes	5 feet
7	LED Lights	4 inch
8	Bilge Pumps(*3)	1100 GPH*2 and 2000GPH
9	C-Clamp Mountings	4inch*2 & 6inch*1
10	Waterproof Casing	1.2 feet length, 10 inch height, 8 inch breadth
11	PVC End caps	75mm*4
12	Relays	7 Amp, 12V DC, 250V AC

Fig. 1. Table of Specification, Cost, Length and Others

V. IMPLEMENTATION AND FINAL OUTCOME

A. Source Code for NodeMCU

```
#include "config.h"
// digital pin 5
#define LED_PIN 5
#define LED_PIN1 4
#define LED_PIN2 12
// set up the 'digital' feed
AdafruitIO_Feed *MOTOR1 = io.feed("MOTOR1");
AdafruitIO_Feed *MOTOR2 = io.feed("MOTOR2");
AdafruitIO_Feed *MOTOR3 = io.feed("MOTOR3");
void setup() {
  // set led pin as a digital output
  pinMode(LED_PIN, OUTPUT);
  pinMode(LED_PIN1, OUTPUT);
 pinMode(LED_PIN2, OUTPUT);
  // start the serial connection
  Serial.begin(115200);
  // wait for serial monitor to open
  while(! Serial);
  // connect to io.adafruit.com
  Serial.print("Connecting to Adafruit IO");
  io.connect();
  // set up a message handler for the 'digital' feed.
  // the handleMessage function (defined below)
  // will be called whenever a message is
  // received from adafruit io.
  MOTOR1->onMessage(handleMessage);
   MOTOR2->onMessage(handleMessage1);
   MOTOR3->onMessage(handleMessage2);
  // wait for a connection
  while(io.status() < AIO_CONNECTED) {
    Serial.print(".");
    delay(500);
  }
  // we are connected
  Serial.println();
  Serial.println(io.statusText());
//digitalWrite(LED_PIN,HIGH);
//digitalWrite(LED_PIN1,HIGH);
}
void loop() {
  // io.run(); is required for all sketches.
  // it should always be present at the top of your loop
  // function. it keeps the client connected to
  // io.adafruit.com, and processes any incoming data.
  io.run();
}
// this function is called whenever an 'digital' feed message
// is received from Adafruit IO. it was attached to
// the 'digital' feed in the setup() function above.
void handleMessage(AdafruitIO_Data *data) {
  Serial.print("received <- ");
  if(data->toPinLevel() == HIGH)
    Serial.println("HIGH");
  else
    Serial.println("LOW");
  // write the current state to the led
```

```
  digitalWrite(LED_PIN, data->toPinLevel());
}
void handleMessage1(AdafruitIO_Data *data) {
  Serial.print("received <- ");
  if(data->toPinLevel() == HIGH)
    Serial.println("HIGH");
  else
    Serial.println("LOW");
  // write the current state to the led
  digitalWrite(LED_PIN1, data->toPinLevel());
}
void handleMessage2(AdafruitIO_Data *data) {
  Serial.print("received <- ");
  if(data->toPinLevel() == HIGH)
    Serial.println("HIGH");
  else
    Serial.println("LOW");
  // write the current state to the led
  digitalWrite(LED_PIN2, data->toPinLevel());
```

B. *Final Outcome*

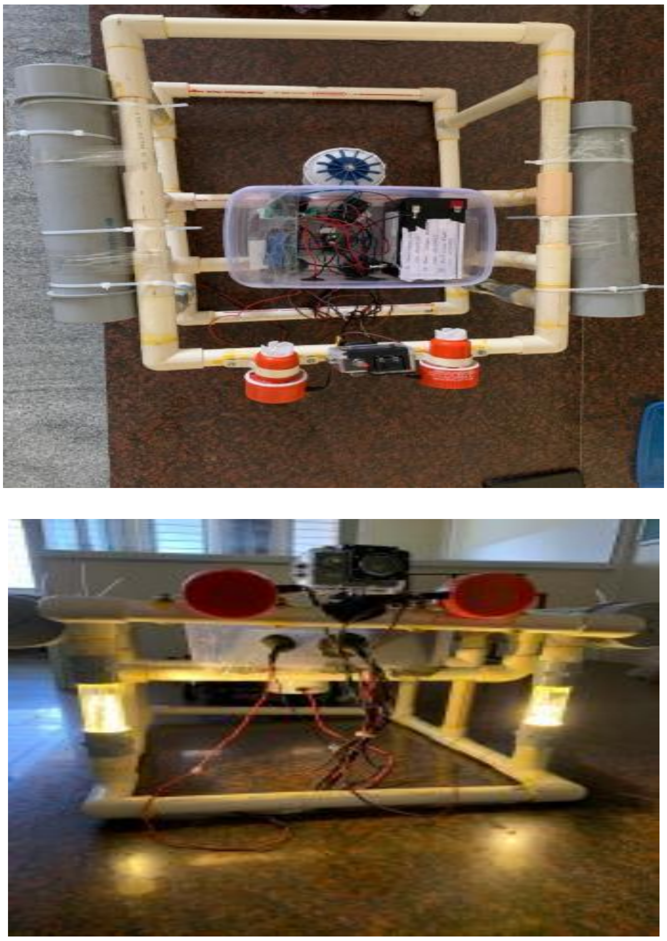

Fig. 2. Front View and Top View of the ROV Model

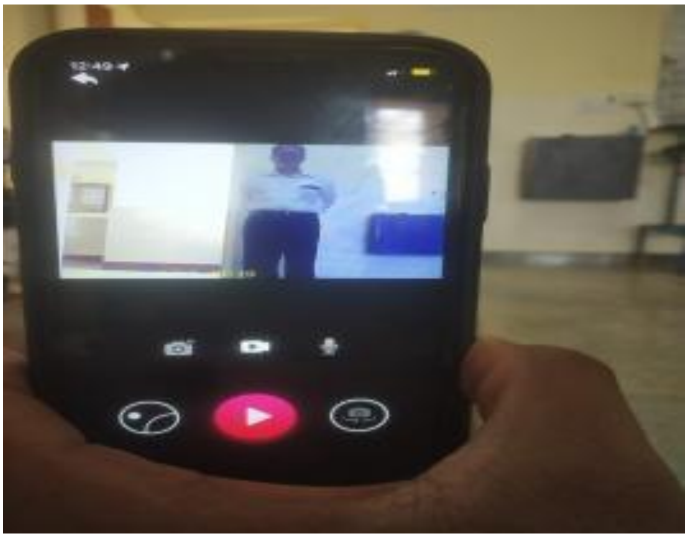

Fig. 3. Wi-Fi Port Camera Visual

VI. WORKING OF THE ROV MODEL

This vehicle employs the Archimedes Principle, as is well known. The model uses three degrees of freedom to operate. The NodeMCU circuit board has been inserted in the model underwater so that it can be controlled via an interface made with the Adafruit IO app. The Arduino IDE app was used to create the algorithms and code. Three ON/OFF switches have been made in order to operate the three motors.Two switches that were programmed and connected to the two 1100GPH Bilge Pumps through NodeMCU will be turned on if we wish to advance the ROV model, which will then cause it to do so. The ROV model can rotate in the right direction by turning off the 1100GPH bilge pump that is positioned on the right side of the frame in addition to the two 1100GPH bilge pumps that will be in the ON position if we wish to move the model in that direction. In a similar manner, we will disconnect the left pump attached to the frame before sliding the model to the left. The interface designed by Adafruit IO app turns ON the 2000GPH pump to move it in an upward manner.

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