Development of Solar powered multipurpose marine robot model using Arduino uno board

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Abstract: Marine robotics is one of the type of robotics that focuses on the design and deployment of autonomous or remotely operated robotic systems for various applications in marine environments. These systems are designed to perform tasks, gather data, and carry out operations in oceans, seas, lakes, and other bodies of water.

This paper describes how to develop a basic model of marine robot which can identify the purity of water, temperature, humidity in marine region, and collect the garbage thrown in the water body. It is also associated with a camera which takes pictures at regular intervals to identify unwanted intruders. It helps in identifying other targets approaching the marine robot. Sensors are used to gather the information. Each sensor nodes sends the data acquired to Arduino Uno microcontroller. Wi-Fi and Bluetooth devices help in sending the collected data to cloud for further analysis. Microcontroller also analyzes the data and required actions will be carried out. Solar panel is utilized to power the system. Collected data and further action to be taken are displayed in the user mobile. Advancements in marine robotics are improving autonomy, navigation, sensing capabilities, and energy efficiency of underwater and surface vehicles. These technologies have the potential to revolutionize various industries and scientific disciplines related to marine environments, making them safer, more efficient, and more sustainable.

Key words: Robot, Micro controller, sensors, Cloud

I.INTRODUCTION

Marine robotics is a field that focuses on the design, development, and implementation of autonomous or remotely operated robotic systems for various applications in the marine environment. These robots, commonly known as marine robots or autonomous underwater vehicles (AUVs), are designed to operate on the surface of water or underwater, exploring and collecting data from the water bodies' depths and surrounding environment.

Marine robotics has gained significant attention and importance due to its ability to access remote and hazardous underwater sites that are difficult for humans to reach. These robots are furnished with an extensive range of sensors, cameras, and instruments to gather valuable data about the ocean environment, marine life, geological features, and other scientific measurements.

The applications of marine robotics are diverse and encompass several fields, including oceanography, marine biology, underwater archaeology, offshore industry, environmental monitoring, and underwater exploration.

The development of marine robotics involves interdisciplinary collaboration between engineers, oceanographers, marine biologists, and other experts. It encompasses various technological aspects, such as robotics, sensing systems, communication, navigation, and power management, to ensure reliable and efficient operation in challenging underwater conditions.

The Arduino Uno is a popular microcontroller board that can be utilized in marine robotics projects. One can interface sensors to Arduino uno board to collect various information needed, connect different communication modules, can control motors and actuators with Arduino uno board.

Advanced marine robotics systems typically incorporate higher-level control algorithms, advanced sensors, and more powerful computing platforms. However, the Arduino Uno can serve as a stepping stone or a component within a larger marine robotics system, providing an accessible and versatile starting point for experimentation and initial development**.**

LITERATURE REVIEW

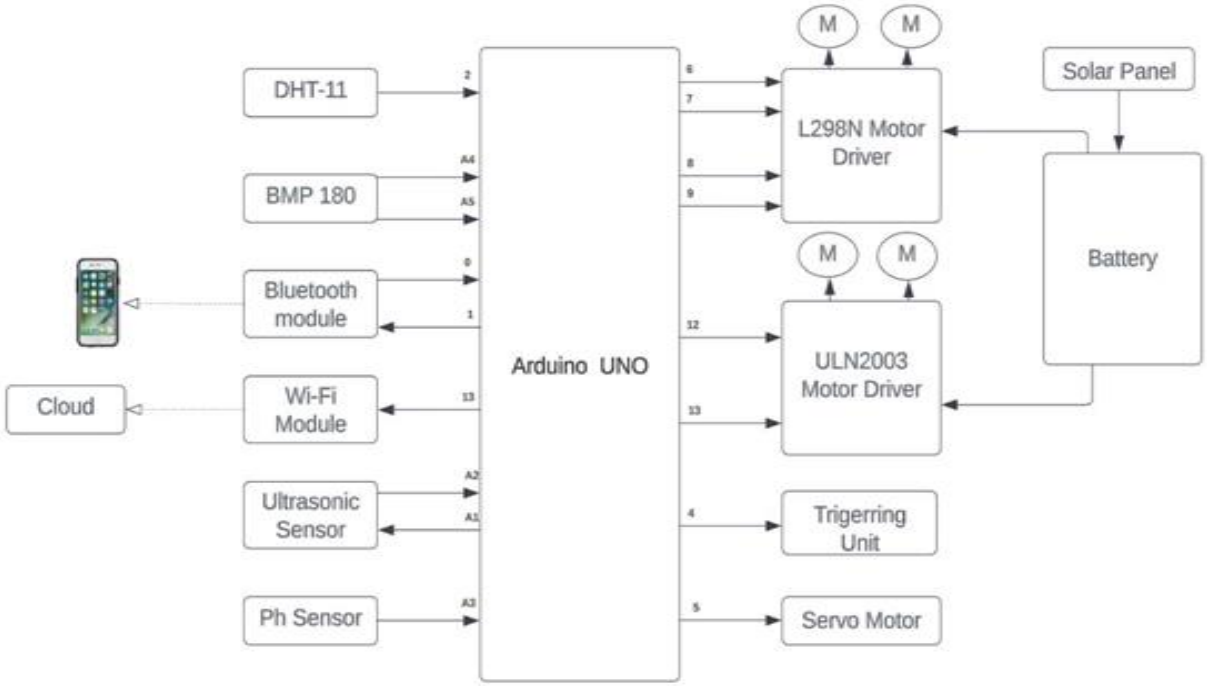
Ref paper [1] gives basic information about marine robotics and components required to develop marine robot with Arduino board. Authors of paper [2] developed a robot which can collect garbage in the internal part of the Siak tributary. A robotic ship collecting robot system is developed in this work with

arduino uno board with joystick controller and an android smartphone. This robot is developed to pick up trash with a river width of 10 meters and pick up trash that is on the banks of the tributary so that it can reduce waste buildup and reduce water pollution in the river. Paper[3] provides steps to create a prototype of marine robot to monitor the enemies and to collect debris from aquatic bodies. Weather report can be prepared by measuring parameters like temperature, humidity, pressure, and pH of the water. The projected system in paper [4] is a stationary autonomous surface vehicle with a surface waste collection unit, sensors to monitor the waste and performance of the whole unit. Along with the system a barrier setup is used to direct the floating waste to the system. The system is powered by solar power and furnished with wireless communication for physical time monitoring. The prototype of Robotic vehicle developed and reported in [5] has a fixed mechanical system and a modular electronic system. This paper details the design, development and qualification of the Remotely Operated Vehicle developed for carrying out the underwater marine inspections of a ship hull or marine debris etc. The initial trials of the ROV in a pool proved that the vehicle meets the primary goal of this paper and the suitability to operate in the anticipated marine environment. The article presented in [6] deals with Arduino based River Cleaning Robot. This robot floats on the water and the energy is supplied from 12V battery. The important purpose of this work is to reduce the manpower and time to take for cleaning the river.

These are just a few examples of the developments reported in recent publications on marine robotics. The field is rapidly evolving, and new developments are actuality made to address the challenges of underwater exploration, monitoring, and intervention.

II. DEVELOPMENT AND WORKING

The model developed in this work is based on Arduino Uno. The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The board has 14 digital I/O pins, 6 analog I/O pins, and is programmable with the Arduino IDE , via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. In this work Solar panel is used to generate power to run motors and to power Aurdino board.



Figure(1) Block diagram with connecting pins

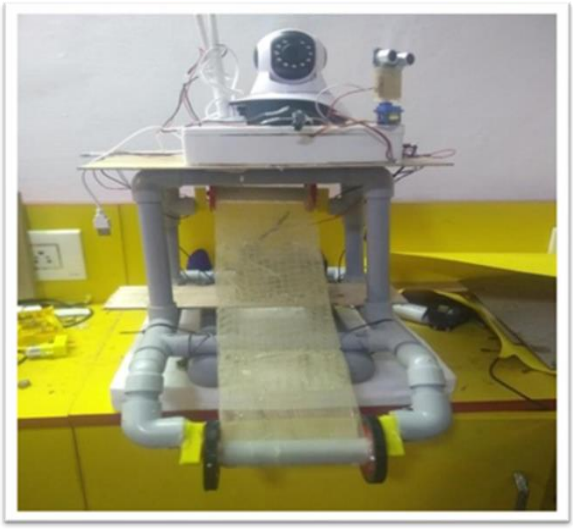
Fig (1) shows Block diagram with connecting pins used to develop the model. The system is developed with Arduino Uno 2560 processor. Sensors connected to measure environment factors are temperature sensor, humidity sensor, ultrasonic sensor, pH sensor, and pressure sensor. Communicating modules connected are Bluetooth module and Wi-Fi module ESP8266. Motor drivers, and DC motors are connected to provide movement to the robot. The model developed is shown in fig(2).

Movement of the robot in four directions is governed by DC motors through a mobile phone with the Bluetooth module. Movement of the conveyor belt is controlled by another DC motor which is used to collect waste materials from the surface of the water and is discarded into a waste bin.

Presence of obstacles around the robot is found by the ultrasonic sensor which helps in changing robot movement. Ultrasonic sensor is rotated in all directions using a servo motor. Distance of the body from the robot also can be detected with this sensor.

Wi-Fi module helps in sending live video footage or pictures to the control station.

The pH value, and other weather parameters are uploaded to the cloud where further analysis will be done. The entire robot is powered using solar panel and battery.



Fig(2) Marine robot model

III. SOFTWARE FOR CONTROLLING ROBOT

Sensors, motors, WiFi module and Bluetooth modules connected to arduino uno board are controlled by writing embedded C program. Writing a program for an Arduino board to control motors and sensors empowers us to interact with the physical world, customize functionality, automate tasks, integrate with other devices, prototype ideas, and gain valuable educational insights into embedded systems and programming. Arduino programming provides the flexibility to customize the behavior of motors and sensors according to specific requirements. We can define how they should respond to input signals, adjust their speed, direction, and perform complex operations based on sensor readings. By writing a program, one can establish communication protocols and exchange data between these devices, allowing for integration with larger systems or enabling remote control.

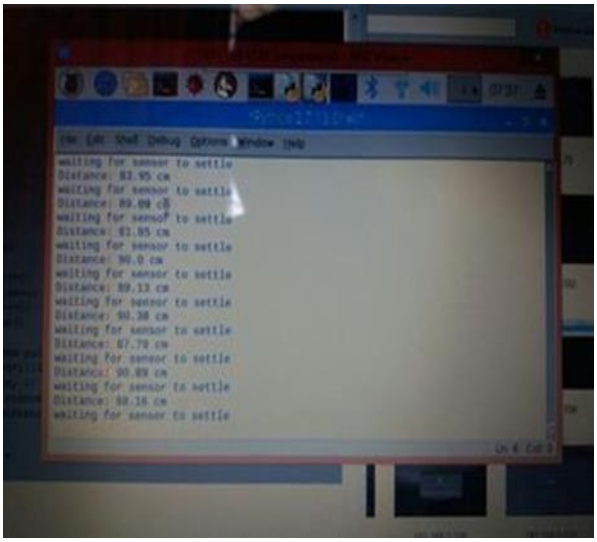
To program an Arduino for interfacing sensors, following steps are followed:

- ✓ Setting up the hardware: Connect the sensor to the appropriate pins on the Arduino board. This typically involves connecting power (VCC and GND) and data lines (analog or digital pins) between the sensor and the Arduino. Sensor's datasheet or documentation should be referred for specific wiring instructions.
- ✓ Installing the Arduino IDE: Download and install the Arduino Integrated Development Environment (IDE) from the official Arduino website. The IDE is a software tool used to write, compile, and upload programs to the Arduino board.
- ✓ Writing the program: Open the Arduino IDE and start a new sketch. A basic Arduino program consists of two main functions: setup() and loop().
  - ➢ The setup() function runs once when the Arduino board is powered on or reset. In this function, we can initialize the sensor, set pin modes, and configure any necessary settings.
  - ➢ The loop() function runs repeatedly after the setup() function completes. Here, we can read data from the sensor, process it, and perform any desired actions based on the sensor readings.
- ✓ Reading sensor data: Appropriate functions and libraries provided by Arduino should be used to read data from the sensor. Arduino supports various sensors such as temperature sensors, light sensors, proximity sensors (e.g., ultrasonic sensor), and more. Arduino reference guides can be referred to find the relevant functions and libraries.

- ✓ Processing sensor data: Depending on the sensor and the project requirements, we need to process the raw sensor data. This can involve scaling or converting the data, applying filters or algorithms, and extracting meaningful information.
- ✓ Taking actions based on sensor data: Based on the sensor readings and any processing done, implement logic and decision-making in the program. This can include controlling other components such as motors, LEDs, or actuators based on the sensor data.
- ✓ Compiling and uploading: Once the program is written, verification is done in the Arduino IDE. If there are no errors, Arduino board is connected to the computer via USB. Appropriate board and port from the Arduino IDE's "Tools" menu should be selected and by clicking on the "Upload" button, the code can be compiled and uploaded to the Arduino board.
- ✓ Observing the sensor output: Open the Arduino Serial Monitor from the IDE's "Tools" menu to observe the output of the program. One can use this to debug the code, display sensor readings, or log data for further analysis.

Figure(3) Arduino IDE

Fig(3) shows Arduino IDE where program is written for collecting distance information through ultrasonic sensor. Fig(4) shows Data received from ultrasonic sensor displayed.



Figure(4) Data received from ultrasonic sensor displayed

Programming steps followed to get the data from different sensors and communicating devices and controlling their functionalities are given below:

Steps used to connect DHT-11 (Temperature and Humidity Sensor)

- ✓ Include the dht.h library
- ✓ Connect the data pin to pin no.2
- ✓ Initialize dht object: DHT
- ✓ Read the temperature and humidity values

Steps used to connect BMP180 (Air Pressure Sensor)

- ✓ Include the Adafruit_BMP085.h
- ✓ initialize Adafruit_BMP085 object
- ✓ Connect the SCL to A4 and SDA to A5
- ✓ Initialize BMP085 Sensor: BMP.begin()
- ✓ Read Pressure from BMP085 Sensor
- ✓ Print the Pressure Values

Steps used to connect Bluetooth HC-05

- ✓ Include library software Serial.h
- ✓ Initialize software Serial object: My Serial (with Rx pin0 &Tx pin1)
- ✓ Begin Serial communication at 9600 baud rate : Serial.begin(9600)
- ✓ Check z=1, if true execute the ultrasonic
- ✓ Read incoming characters from Serial
- ✓ Perform corresponding action based on received character
- ✓ F=Forward, B=Backward, R=Right, L=Left, S=Stop, Y=Conveyor On, Z=Conveyor Off, U=Upload, t=Trigger

Through Bluetooth module, we are connecting to our smart phone, and controlling different motors through the Blynk app installed in it. Blynk is a popular Internet of Things (IoT) platform that provides a smartphone app to control and monitor Arduino projects. It supports Bluetooth connectivity along with Wi-Fi and Ethernet. With Blynk, one can create a custom smartphone interface to interact with the Arduino board.

Steps for Servo Motor connection

- ✓ Include the servo library
- ✓ Create servo object to control a servo
- ✓ Create variable to store the servo position
- ✓ Set the threshold distance for to determine left or right Position
- ✓ If distance < threshold, object position is on left side
- ✓ If distance > threshold, object Position is on right side.

Steps for pH Sensor connection

- ✓ Declare variable pH
- ✓ Connect the sensor to the Pin A3
- ✓ Read analog value from pH sensor
- ✓ Set the threshold value60 from the sensor
- ✓ If the threshold measured value is less then threshold value than the output will be Acidic
- ✓ If the threshold measured value is more than the threshold value then output will be Basic (alkaline)

Steps to connect Wi-Fi module:

- ✓ Begin serial communication for my serial object at 115200 baud rate: my serial.begin (115200)
- ✓ Call wifi-init () function
- ✓ Initialize wi-fi using AT commands
- ✓ Connect to the wi-fi module by entering username & the Password
- ✓ Create the thing speak account & generate the API
- ✓ Enter the API key to the Program
- ✓ create 4 field in thing speak account
- ✓ Press the upload button in the mobile application

A wireless camera is used to send images continuously to the authority through WiFi module to monitor the ocean surroundings. It works as a surveillance camera.
Garbage Collection:

To collect garbage, the marine bot chassis is constructed using PVC pipes, which are widely utilized in various piping applications. A conveyor belt, often referred to as a belt conveyor, is a mechanism used to transport materials within a conveyor system. It utilizes an endless loop of a conveyor belt that rotates around two or more pulleys, also known as drums. These pulleys can be either powered or unpowered. The powered pulley, called the drive pulley, is responsible for moving the belt and the materials on it forward, while the unpowered pulley, known as the idler pulley, supports the belt's movement.

IOT and Cloud:
An embedded operating system serves as the foundation for an Internet of Things (IoT) system, enabling devices to communicate with the internet and other interconnected objects. In an IoT system, the IoT service acts as a crucial component that bridges the gap between various "things" or devices.

Things Speak is a cloud based online platform and service that can greatly benefit Arduino projects in several ways. We can enhance data logging, visualization, remote monitoring, control, data analysis, and integration capabilities. It simplifies the process of storing, analyzing, and interacting with data from Arduino-based sensors and devices, expanding the possibilities of what we can achieve with the projects.

To begin using ThingSpeak, we need to click on "Get Started Now" button at the center of the webpage which will redirect us to the sign-up page. On the sign-up page, after providing the necessary details to create the account, "Create Account" button should be clicked on to proceed further.

Fig(5) shows graph of different parameters measured. Variations in temperature, humidity, pH value and wind pressure is shown in these figures which are obtained from ThingSpeak.

Figure(5) Graphs showing variations in temperature, humidity, pH value and wind pressure

IV CONCLUSION

This work develops a prototype of marine robot which can collect few environmental data and helps in removing the floating garbage. Surveillance is possible as a camera unceasingly observers the nearby area to find out enemy approaching. Overall, marine robotics helps in progressing one's understanding of the ocean, enhancing environmental monitoring, and facilitating human activities in the marine realm. As technology continues to advance, we can presume even more state-of-the-art applications and advancements in the field of marine robotics.

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