Proceedings of the Fifth International Conference on Intelligent Computing and Control Systems (ICICCS 2021)
IEEE Xplore Part Number: CFP21K74-ART; ISBN: 978-0-7381-1327-2

# *Microcontroller based Smart Marine Saver*

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***Abstract*—** Water bodies are a significant element of the Earth's landscape. The issue of water contamination is taking a chance with our lives. This paper addresses the issue and depicts the plan and testing of a proposed framework of a Smart Marine Saver using ARM7 LPC2148, the framework comprises of a central body, a solar panel, oil skimming and garbage gatherer or trash collector arrangement. This can play out the function of expelling marine oil spills incorporated with sensors – such as pH sensor, Ultrasonic sensors and MQ3 sensor. It can likewise play out the function of Scooping Trash or garbage from the water surface alongside extra applications to shield the boat from adverse environment condition automatically. The real-time location of the boat tracking facility using GPS locator is also installed in the system

Keywords— Water Contamination, Marine, Construction, Oil spill, Floating garbage, Smart, Solar, Cleaning

## I. INTRODUCTION

The water bodies (oceans, seas, rivers, lakes, ponds etc.) are perhaps the best blessing to Mankind. Water bodies are turning out to be over saturated with a wide assortment of plastics and marine creatures because of synthetic compounds and harmful gases that are discharged because of oil slicks that poison the water bodies such as lakes, rivers oceans. Water contamination is a broad issue that is risking our wellbeing. Large numbers of individuals are killed every year than war and any other type of violence.

The framework proposed has been carried out looking into the current situation of the water bodies which are dumped with garbage, hazardous pollutants, toxic materials, and debris etc. With the increasing water pollution, it is hampering the life of aquatic animals. The proposed system will collect the waste from the surface of the water bodies. This will reduce the water pollution and death of the aquatic life. The fundamental use of the proposed system is to decrease the labor and time utilized to clean the water bodies.

There are several attempts and research works on mechanical patterns over the years and framework for cleaning the surface of water bodies [1-4]. In [1] the analysis for cleaning the machine is proposed that uses the generated electric power from the alternator coupled to the turbine. In [5-8] the system that uses the multi-robot system for cleaning the surface of water bodies is proposed where the Global asymptotic stabilization and hydrodynamic parameters are considered that monitors the oil spill marine radar. These works are limited only for cleaning the surface of water, whereas the proposed smart marine saver is a wireless technology with Autonomous Control using Smartphone through Bluetooth, incorporated with the solar panels as well as the battery to increase the working duration of the system. The proposed system is featured with a real-time location of the boat tracking facility using a GPS locator. In [9-12] the work has been carried out on collecting trash and detecting oil spills, the proposed system has additional features of detecting harmful gases present in the water bodies. It also helps us in tracking the water level in water bodies.

The organization of the paper is as follows: In Section II, the Block Diagram, the Circuit Description and the Hardware components of the Smart Marine Saver that is proposed in this work are described. Next, section III discusses the design Methodology of Smart Marine Saver. Followed by Section IV where the results of the system that is prototyped and tested are presented. Finally, in section V the conclusion is given.

## II. CIRCUIT AND HARDWARE DESCRIPTION

This section discusses the block diagram and the circuit diagram proposed for the Smart Mariner Saver system as shown in Figure 1 and Figure 2 respectively. It incorporates a micro controller, sensors, motors, GPS, solar panel, H Bridge Motor and Bluetooth interface. The framework has 3 engines/motors to be specific M1 motor for oil skimming, M2 motor for forward-reverse movement of the boat and M3 motor for right-left heading movement of the boat.

### *A. Block Diagram & Circuit Diagram*

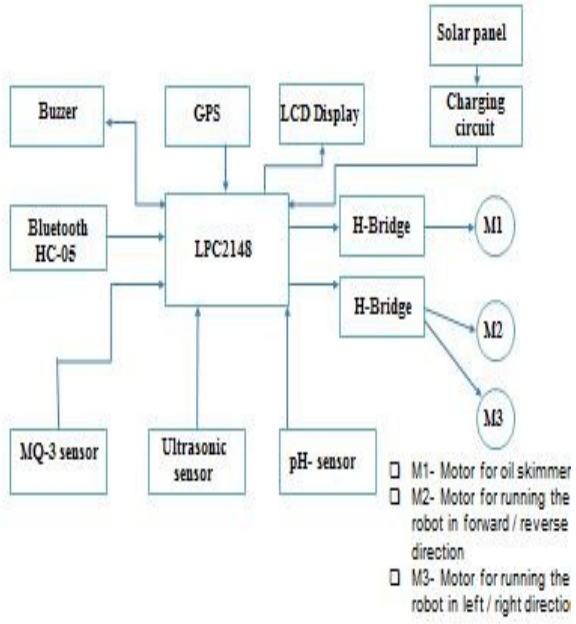


**Figure 1:** Block diagram for Smart Marine Saver.

2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS) | 978-1-6654-1272-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICICCS51141.2021.9432231

According to the block diagram as indicated in Figure 1 the circuit diagram is built as shown in Figure 2. The connections in the circuit are designed and planned in such a way that the system performance is at the maximum level. Table 1 lists the: Hardware Description of the components used in the proposed work.

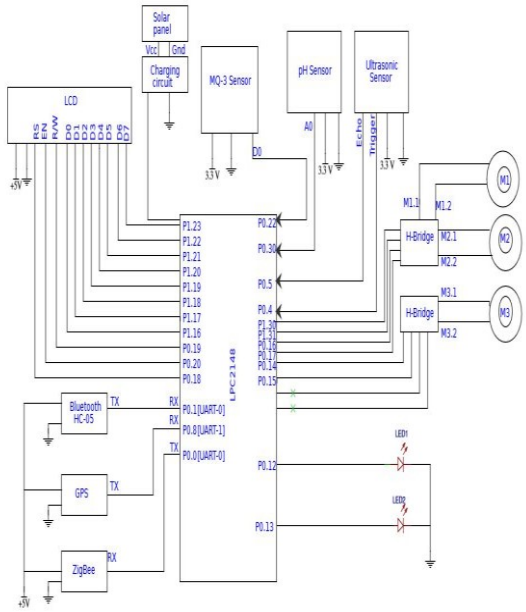


**Figure 2:** The circuit connections for Smart Marine Saver Hardware Description

***Table 1****: Hardware Description of the components used in the proposed work.*

| Sl.no | Component | Description |
|---|---|---|
| 1 | ARM-7 Microcontroller | LPC2148 32kB on chip SRAM, 512kB on chip FLASH memory |
| 2 | Bluetooth HC-05 | HC-05 MASTER/SLAVE module, V2.0+EDR, 3Mbps Modulation, 2.4GHz radio transceiver and baseband. |
| 3 | H Bridge Motor Drive | Polarity of a voltage applied to load is switched. |
| 4 | MQ3-Sensor | Operating voltage 2.5V to 5.0V. Interface Type: Analog & Digital, On board Power indication. |
| 5 | Solar panel | Poly-crystalline cells connected in series, robustness and high-performance and Insulation Resistance |
| 6 | Liquid crystal display | 16×2 display, 5×7-pixel matrix |
| 7 | Global positioning system | estimate the actual position, velocity and time |
| 8 | pH sensor | Measures the hydrogen-ion activity, difference in electrical potential between a pH electrode and a reference electrode. |
| 9 | Ultrasonic sensor | Voltage: 5VDC, Static current: < 2mA, Level output: high-5V |

## III. WORKING PROCEDURE

The Methodology carried for implementing this work is to design and develop the Smart Marine Saver, based on ARM, Bluetooth and Embedded C and its functional efficacy. The validity of the concept is required to be demonstrated by using hardware components, developing software – Keil has been used for the system and integrating it all to fabricate a functioning prototype model. The sensors are used to detect and measure the parameters and the processed data is stored in the memory of the ARM board. These parameters are transmitted over Bluetooth and their processed values are displayed by the Embedded C based APK. The values of the technical parameters are displayed on the screen and machine functions are activated by received signals.

The construction and working principle of the proposed framework consist of a central body, a solar panel, and oil skimming and trash collector. LPC2148 ARM 7 Microcontroller is used as the heart of the system which operates at 3.3V.

ARM7 LPC2148 is chosen in the proposed work as it has sufficient memory of 32kB on chip SRAM. It also has a FLASH memory of 512kB and end point USB RAM up to 2kB. In-System/In-Application programming (ISP/IAP) is also incorporated with on-chip boot-loader software. It also has a single flash sector or full chip erase in 400ms and programming of 256 bytes in 1ms which are applicable to real time that offers with high-speed tracing of instruction execution by Embedded ICE RT and Embedded Trace interfaces.

The proposed system uses solar panels with a remote or independent power system without connecting to the grid. There is a requirement for batteries to store power in the off-grid system during night times. When enough light energy from the sun is not captured by the modules.

In the proposed frame there is a solar panel which charges up to a maximum capacity of 22V. A lithium polymer battery of 14V is interfaced with a solar panel which in turn is connected to the LPC2148. The body will consist of three motors for driving the robot in forward-reverse, left-right directions and for oil skimming, and a dry box that will house the LPC2148, battery, and sensors.

### A. Boat movement

An H bridge is proposed in this work. Usually An H- Bridge is a device that is used to switch the polarity of voltage applied to the DC load. These allow the DC motors to run forward or backward and are also incorporated in other applications such as robotics etc.

The H-Bridge used in this work is for the purpose of acting as a bridge which converts 3.3V of the ARM LPC2148 supply to 12V motors supply. In this system the single H-Bridge drives two DC motors. The proposed system needs three motors to be connected; henceforth we have proposed the use of two H- Bridge. In the proposed system we make

use of a bipolar stepper motor which is driven by a motor controller which contains Two H Bridges. Forward and Reverse direction control motor in the ARM LPC2148 is connected to P1.30 and P1.31. The left and right direction control motor is connected to P0.16 and P0.17. The oil spill motor is connected to P0.14 and P0.15, to remove the oil spills in the water surface.

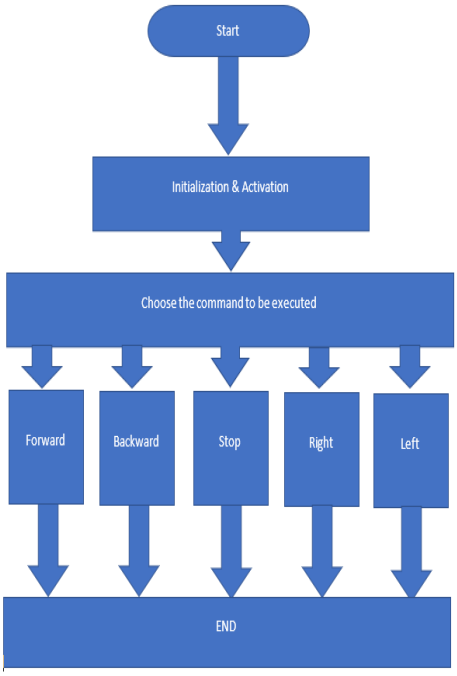


**Figure 3:** Flowchart of Boat movement using bluetooth.

### B. Sensors

In the proposed work three main sensors are used such as pH sensor, Ultrasonic sensors and MQ3 sensor. The system continuously monitors the oil spills using a pH sensor connected to P0.30. The pH sensor produces an analog output which is converted to digital output through an ADC converter and displays the output in the range of 0 to 5V. When the robot detects an oil spill (3.5 to 5V) it automatically operates the oil spill motor and starts skimming it, this will remove the oil spill at the initial stage.

Ultrasonic sensors detects the tide level of the water bodies, it is connected to P0.4 and P0.5 of LPC2148. When the tide level is more than 9cm, the condition for abnormality is detected and sends the information to the main controller PC in the shore. MQ3 sensor detects the toxic gases released from the oil spills and sends the information to the main controller PC on the shore. It is connected to P0.22 of LPC2148.

### C. Location tracking

The work includes a real-time location of the boat tracking facility using a GPS locator installed in the system. The Latitude and Longitude value for the current location of the robot is displayed in LCD and transmits the details to the operator to track the system.

### D. Boat control

The boat movement and scanning mode functions are controlled using Bluetooth HC-05 via Bluetooth controller application in android. The Bluetooth is connected to P0.1 [UART-0] of LPC2148. Bluetooth HC-05 is utilized in the proposed framework. The Bluetooth SPP (Serial Port Protocol) module is easy to use. It is designed for transparent wireless serial connection setup. The HC-05 is used for replacement of serial port for establishing the connection between MCU and GPS and other embedded systems and its components.

## IV. RESULTS

In this section we discuss the results of the system prototyped and tested. The system or the boat was first tested for collecting the floating trash on the surface of a water body. Secondly, the oil spills were detected and were skimmed off using the oil skimmer module. Finally, the sensors and GPS module showed the desired results with proper functioning as well.

### A. Real time set-up

The prototype was setup in a real-time environment as shown in the figure 3. The challenges faced during the process and solutions for overcoming those are explained in the following sections.

#### *1) Intermediate and final prototype model:*

**Figure 4:** Intermediate Prototype model and Final Prototype model

The above figures (figure 4) show the prototype models of the proposed framework, i.e., Smart Marine Saver. Due to the weight of the motors, the small propeller was not able to turn left or right. But it was able to move forward and backwards efficiently. Replacement of the propeller resulted in overcoming the disadvantage. That is, it was able to move in the left and right direction. And was also able to move forward and backward.

The propeller is used for forward and backward movement and left-right direction. By this setup, movement of the boat is controlled efficiently.

**2) Trash collector module:**

**Figure 5:** Trash collector module

Figure 5 shows the trash collector module for collecting the Floating garbage on the surface of water, for instance, plastic containers, food waste and so on and Table 2 shows the result of Garbage Collected and the time consumed.

***Table 2**: Results of the Trash collector module used in Smart Marine Saver.*

| Sl.no | Time consumed to collect Garbage (min) | Weight of Garbage collected (kg) |
|---|---|---|
| 1. | 4 | 0.66 |
| 2. | 3 | 0.71 |
| 3. | 5 | 0.85 |
| 4. | 6 | 1.01 |

***3) Oil skimmer module:***

**Figure 6:**Oil skimmer module

Oil spills are skimmed utilizing the oil skimmer module as shown in Figure 6 using a skimming technique. When the belt rotates, the oil spills on the surface of the water are skimmed off and the results are tabulated in Table 3.

***Table 3**: Results of Oil skimmer module utilized in Smart Marine Saver.*

| Sl.no | Thicknessof the Oil(cm) | Time consumed (sec) |
|---|---|---|
| 1. | 0.5 | 30 |
| 2. | 1.0 | 40 |
| 3. | 2.0 | 45 |
| 4. | 3.0 | 55 |

**4) BLUETOOTH CONTROLLER APPLICATION:**

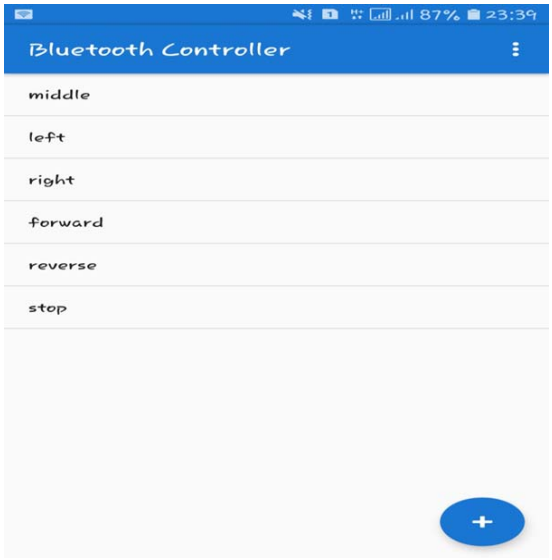


**Figure 7:** Bluetooth Controller Application

A Bluetooth application is utilized to control the movement of the smart marine saver as indicated in Figure 7. The administrator/operator provides orders from the mobile phone to the system through Bluetooth interface and the boat moves in a like manner to the headings or order given by the operator.Range covered by the bluetooth is 10mts. The above figure shows the Bluetooth mobile application utilized for the boat movement control.

***B. Testing Results***

This section discusses on the testing results of the prototype

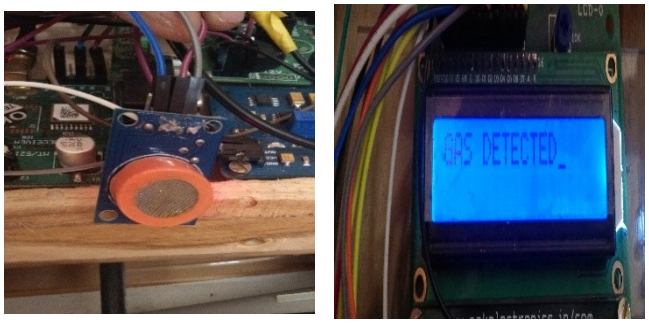


**Figure 8:** MQ3Sensor Result

As shown in the Figure 8, the MQ3 sensor detects the toxic gases released from the oil spill. It informs the operator about the toxic gases which are released and contaminate the water bodies, which helps the operator to take the required action to remove the oil spills and the toxic gases.


**Figure 9**:pH Sensor Result

The pH sensor detects oil spill when voltage is in the range of 5-10V. When there is a change in the pH of the water, it is detected by the sensor. If the pH value detected is similar to oil or any other greasy substances, oil skimming will be performed as indicated in the Figure 9 and the results are as tabulated in Table 4.

***Table 4**: Results of pH sensor utilized in Smart Marine Saver.*

| Sl.no | pH value | pH sensor status(V) |
|---|---|---|
| 1. | 8.5 | 10.1 |
| 2. | 9.0 | 9 |
| 3. | 9.0 | 10.19 |
| 4. | 8.5 | 10.16 |


**Figure 9:** Latitude and Longitude values from GPS

The specific location of the boat is obtained by making use of the GPS module as indicated in Figure 10. These values also help the operator to track the system even in a larger water surface. Furthermore, with the knowledge of these values, we can drive the system to the desired location in the water.

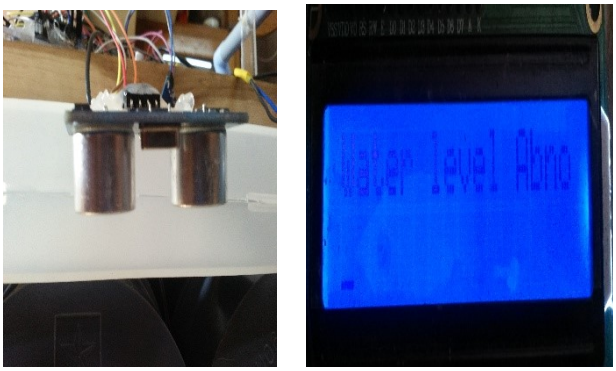


**Figure 11:** Ultrasonic Sensor Result

Figure 11 shows the results of the ultrasonic sensor. The sensor detects the water level in the water bodies. Also, help in detecting the depth of the water bodies.

## V. CONCLUSION

This paper presents the prototype model of The Smart marine saver which is developed with oil spill and trash collector module. The model/prototype was tested in a real-time environment and oil spill, trash was gathered/collected successfully. The developed system is light in weight in this way it builds the probability/convenience of the system. In comparison to the previous works carried out the present proposed framework is more efficient as it can perform collecting the surface waste and skimming of oil spills simultaneously, where in the previous works could only perform one particular function at a time. And it also helps us in detecting harmful gases and the water level in the water bodies by enabling us to take the required actions to protect the water bodies.

| Sl.no | Functions performed | Previous works | Proposed systems |
|---|---|---|---|
| 1. | Collecting trash | Yes | Yes |
| 2. | Skimmimg of oil spills | Yes | Yes |
| 3. | Detection of harmful gases | -- | Yes |
| 4. | Water level detection | -- | Yes |

The present system developed can further be improvised according to the future trends. The system can be upgraded to quad copter technology wherein we can land the system directly where the oil spills are present. And also, a pair of systems together with coordination can perform fishing while fishing nets attached to them. The smart marine saver built in this work is a prototype model it can be further enhanced for larger and commercial requirements.

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