IOT BASED SMART OIL SKIMMER ROBOT FOR THE MARINE OIL SPILL

K..MANOJ KUMAR[1], R.GOWTHAM[2], J.G.KISHORE KUMAR[3], R.PANDI PRABAKARAN[4]

[1,2,3] B.E Student Department of Electrical and Electronics Engineering, [4] Faculty of EEE,

Mangayarkarasi College of Engineering, Paravai, Madurai, Tamil Nadu,India.

Abstract - Oil Skimmer Robot is a device which can be used for ocean purification by removing the oil from water surface. The system uses a photovoltaic powered conveyor belt to propel itself and collect oil. The flexible conveyor belt softly rolls over the ocean's surface, absorbing oil while deflecting water because of its hydrophobic properties. The photovoltaic cells generate enough electricity to keep the fleet moving for several weeks and provide the energy to propel the vehicles forward. As the head moves through the water the conveyor belt constantly rotates and sucks up pollution. The belt is then compressed to remove the oil. As the clean part of the belt comes out of the head it immediately begins absorbing oil, making the collection process seamless and efficient. This process is more streamlined than current ocean-skimming technologies because the robots can operate autonomously and don't need to return to the shore for constant maintenance.

Key Words oil spill, environmental pollution, oil skimmer, Nano belt, apps and remote control,water pump motor, solenoid valve

1. INTRODUCTION

In an era of increasing environmental concern, oil pollution arising either from marine accidents or from routine ship operations (tanker loading and unloading, etc.) is a major threat for the marine environment. According to survey, Crude oil and refined fuel spills from tanker ship accidents have damaged vulnerable ecosystems in Alaska, Gulf of Mexico, Galapagos Islands, France, Sundarbans, Ogoniland, and many other places. The quantity of oil spilled during accidents has ranged from a few hundred tons to several thousand tons. Oil spills at sea are generally much more damaging than those on land, since they can spread for hundreds of nautical miles in a thin oil slick which can cover beaches with a thin coating of oil. This project helps us with the task of ocean cleanup in case of massive oil spills. Oil skimming aqua robot helps to segregate oil layer above water.

Besides corrosion of oil pipes poor maintenance of infrastructure, spills or leaks during processing at refineries, and accidental discharge from tankers or vessels and less due to sabotage, vandalisation of the oil infrastructure, and theft of oil [5]. It was reported that up to 20 miles.

2. PROPOSED SYSTEM

2.1 Node MCU ESP8266:- **Node MCU** is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

The term **"NodeMCU"** by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for **ESP8266.** It uses many open source projects, such as lua-cjson and SPIFFS.

2.2 **ESP8266 Arduino Core**

As **Arduino.cc** began developing new MCU boards based on Non- AVR processors like the **ARM/SAM MCU** and used in the Arduino Due, they needed to modify the **Arduino IDE**

So that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled for these new processors. They did this with the introduction of the Board Manager and the SAM Core.

A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an Arduino core for the ESP8266 WiFi SoC, popularly called the "ESP8266 Core for the Arduino IDE". This has become a leading software development platform for the various ESP8266-based modules and development boards, including NodeMCUs.

Features:

Finally, programable WiFi module.

- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included, plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc. all in one board.

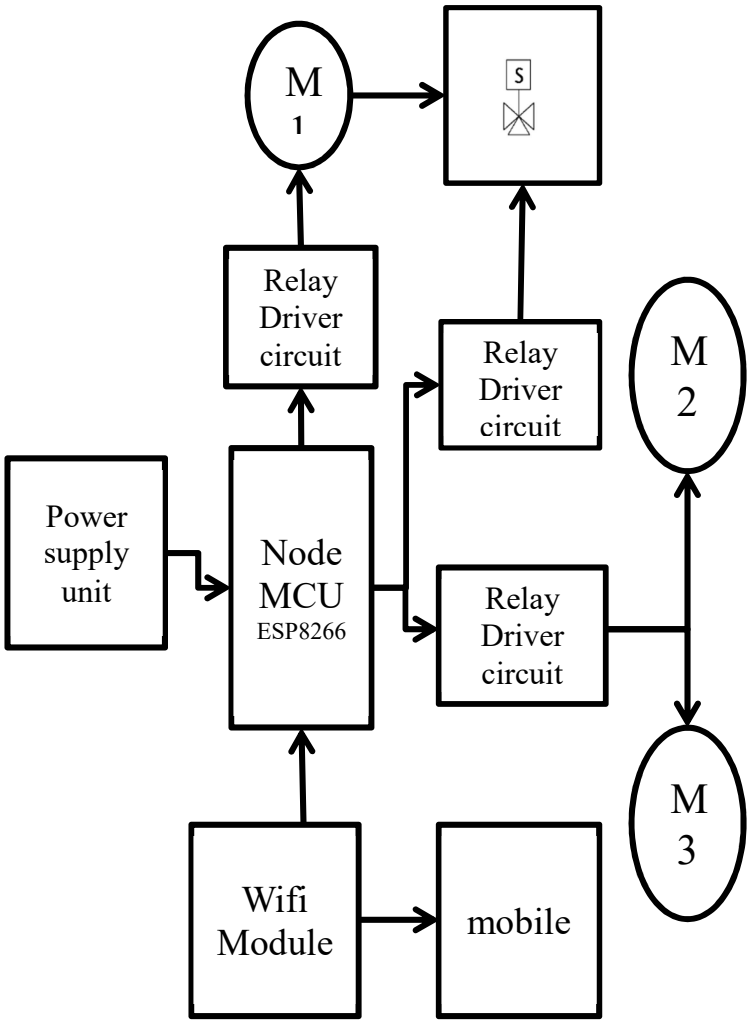

Fig -1: Block diagram of the system

2.3 Water Pump Motor

Compact, submersible water pumps are mostly used on air coolers, aquariums, and fountains. If the pump runs out of water and continues to operate — an issue known as dry running — it can become damaged. This circuit protects submersible water pumps from dry running with the help of associated level electrodes. The circuit detects the absence of water and monitors the water level to prevent dry running from occurring. The water pump guard electronics consist of two level electrodes, a water level detector, an electromagnetic relay, and the relay driver circuitry. Supporting components are necessary to prevent restarting if the pump guard is used in turbulent water. The recommended supply voltage is 5 V. While it is possible to run the unit off of a higher voltage, minor modification is required. The finished electronics can be housed into a minuscule case (the level electrodes, formed from two short-length rigid copper wires, pass out through the case). Don't forget to waterproof the case (and joints) using any suited epoxy adhesive.

2.4 DC MOTOR

A DC motor in simple words is a device that converts electrical energy (direct current system) into mechanical energy. The very basic construction of a DC motor contains a current carrying armature which is connected to the supply end through commutator segments and brushes.

The armature is placed in between north south poles of a permanent or an electromagnet as shown in the diagram above. As soon as we supply direct current in the armature, a mechanical force acts on it due to the electromagnetic effect of the magnet.

A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field winding.

2.5 Relay Module

A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5 V provided by the Node Mcu ESP8266 pins. Controlling a relay module with the Arduino is as simple as controlling any other output as we'll see later on. This relay module has two channels (those blue cubes). There are other models with one, four and eight channels. This module should be powered with 5V, which is appropriate to use with an Arduino. There are other relay modules that are powered using 3.3V, which is ideal for ESP32, ESP8266, and other microcontrollers.

2.6 Oil Skimmer

Skimmers are often used in conjunction with booms. A skimmer is a device that collects and removes oil from the surface of the water. Skimmers can be towed, self-propelled in river currents, or even used from shore. Many types of skimmers are available for use, depending on the kind of oil spilled and the weather conditions. Disc skimmers are floating skimmers with a series of rotating discs that remove floating oil and fuel from the water. Disc skimmers are available in a variety of sizes and are suitable to use on ponds, or in the ocean, sumps, pits, dams, rivers, harbour and marinas.

2.7 solenoid valve

A **solenoid valve** is an electromechanical device in which the solenoid uses an electric current to generate a magnetic field and thereby operate a mechanism which regulates the opening of fluid flow in a valve.

Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. The mechanism varies from linear action, plunger-type actuators to pivoted-armature actuators and rocker actuators. The valve can use a two-port design to regulate a flow or use a three or more port design to switch flows between ports. Multiple solenoid valves can be placed together on a manifold.

Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

2.8 Android Application:- Blynk for NodeMCU

Blynk is a Platform with IOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. Join the most popular IoT Platform to connect your devices to the cloud, design apps to control them, and manage your deployed products at scale. After downloading the app, create an account and log in. (If possible than log in with tour real mail id for better connectivity later.)

You'll also need to install the **Blynk Arduino Library**, which helps generate the firmware running on your ESP8266. Download the latest release from https://github.com/blynkkk/blynk-library/releases , and follow along with the directions there to install the required libraries.

3.0 Calculations:-

T = total oil collected by skimmer in one rotation

R= radius of disc of oil skimmer(cm)

t = thickness of oil film(mm)

R = 6cm

t= 1mm

$T = \Pi \times R2 \times t \quad = \Pi \times (6)2 \times 0.001 \quad = 0.113$ ml

R= rate of oil collected

$R = T \times RPM \quad = 0.113 \times 50 \quad = 5.65$ ml/min

4.0 Test Result

SR. NO	OIL And Water SPILLED (ml)	COLLECTED OIL (ml)	TIME (min	RATE OF OIL COLLECTED
1	239	180	3.2 min	3800ml/ h
2	475	360	7.5 min	3800ml/h
3	950	842	15 min	3800ml/h

5.0 CONCLUSION

A swarm of sea robots can be used in collecting an oil spill in the sea more successfully and efficiently than most of the other methods and save the environment from a real threat. This way it will be possible to reduce human intervention and enhance accuracy even in the most hostile environmental conditions. Using swarm of sea robots instead of using barges specially in collecting small oil spills will save money and time.
As future extension of work, design of chassis of the robot with most of the components considered for integration on a single PCB, dispatching algorithm and partition algorithm could be implemented.

5.0 References

[1] Emmad Mohammed H. Zahugi, Mohamed M Shanta, T.V. Prasad, "Design of Multi-Robot System For Cleaning Up Marine Oil Spill", IJAIT ,Vol. 2, no.4, August 2012.
[2] Isamu Fujita, Muneo Yoshie ," An Onboard Air Conveyer Oil Skimmer", IEEE Ocean Conference,1-4244-0115-1/06 ,Boston 18 Sept 2006.

[3] Prof.P.A.Patil , Mr.Pratik Shinde , Mr.Ashish Shetty , Mr.Siddarth Lodha , Mr.Nikhil Vaidya , "Design And

Fabrication of Oil Skimmer" , International Research journal of engineering and technology ,Vol. 4,May-2017.
[4] Subrajit Bhattacharya, Hordur Heidarsson, Gaurav Sukhatme, Vijay Kumar, "Cooperative Control of Autonomous Surface Vehicles For Oil Skimming And Cleanup", IEEE International Conference on Robotics and Automation,2011.
[5] Suraj Nair, Kajol Kamble, Sayali Shewale, Sanjay Lohar, "Design And Fabrication of Disc Type Oil Skimmer", IJSART International Journal for Science and Advance Research in Technology, Vol.3, April 2017.
[6] Song-ping Zhu, Dmitry Strunin. "A numerical model for the confinement of oil spill with floating booms," Spill Science &Technology Bulletin, vol. 7, no. 5–6, pp. 249–255, 2002.
[7] Ming Xiao, Qingjun Gao, Jianguo Lin, Wei Li, Xiao Liang. "Simulation of submarine pipeline oil spill based on wave motion " 2nd conference on computer modeling and simulation, 2010
[8] S.D. Wanga, Y.M. Shena, Y.H. Zheng. "Two-dimensional numerical simulation for transport and fate of oil spills in seas," Ocean Engineering, vol. 32, pp. 1556–1571, 2005.
[9] Wikipedia available at http://en.wikipedia.org/wiki/Oil_spill"
[10] Mazmdouh T. Ghannam and Omar Chaalal, "Oil spill cleanup using vacuum technique ," Fuel, vol. 82, pp. 789-797, May 2003.
[11] N. E. Leonard and J. G. Graver, "Model-based feedback control of autonomous underwater gliders," IEEE Journal of Oceanic Engineering, vol. 26, no. 4, pp. 633–645, 2001
[12] P. R. Bandyopadhyay, "Trends in biorobotic autonomous undersea vehicles," IEEE Journal of Oceanic Engineering, vol. 30, no. 1, pp. 109–139, 2005
[13] T. Fukuda, A. Kawamoto, F. Arai, and H. Matsuura, "Steering mechanism of underwater micro mobile robot," in Proceedings of the IEEE Conference on Robotics and Automation, 1995, pp. 363– 368.
[14] P. E. Hagen, N. Storkersen, K. Vestgard, and P. Kartvedt, "The HUGIN 1000 autonomous underwater vehicle for military applications," OCEANS 2003. Proceedings, vol. 2 pp. 1141 - 1145, 2003.
[15] Xiaobo Tan, Kim, D. Usher, N. Laboy, D. Jackson, J; Kapetanovic, A. Rapai, J. Sabadus, B. Xin Zhou, "An Autonomous Robotic Fish for Mobile Sensing", Intelligent Robots and Systems, pp 5424– 5429, 2006.
[16] Pascoal, A., Silvestre, C., Oliveira, P. (2006) Advances in unmanned marine vehicles. IEE Control Series, ch. Vehicle and mission control of single and multiple autonomous marine robots, pp. 353 386.
[17] Joordens, M.A." Design of a low cost underwater robotic research platform", System of Systems Engineering, SoSE IEEE International Conference, pp 1-6, 2008.