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Marine Metal Detection Technology Using Raspberry Pi

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Abstract: ***In this paper we focus on detecting the missing parts of ships, submarines and aircrafts. The world of automation does not prefer time consuming processes in detection of missing parts. Hence, this marine metal detector is proposed. Raspberry pi acts as the core of the device. This device is activated when water sensor detects water. The device runs on renewable energy. The device submerges and moves in the form of a sine wave. When any metal part is detected, the device goes to off state and comes to the surface of the water. When the device starts floating, GSM module that is bridged to the device sends a message to the user through satellite. With GSM signal as reference, the location will be tracked. This enables users to detect the missing parts within short range. The device is conceptualized such that it is fully automated, eliminates man power, reduces time, utilizes renewable source, is compact in size and requires very little or no maintenance.***

Keywords: Raspberry pi, Water sensor, Metal Sensor, GSM

1. Introduction

The distributed sensor network for submarine detection in places where the parts of submarines are missed are not easily tracked by the sonar system. [1] The precise location of underwater metal parts remains an active research in the underwater community. The device is a self-powered, self-propelled, self controlled and submersible having applications in marine habitat monitoring, resource exploration and detection of missing parts of aircrafts and submarines. It is small, reusable, automated device designed to glide from the ocean surface to a programmed depth. [3] The device uses renewable energy (solar energy). When the device is left in the ocean, the sensor detects the water. Only if the water is detected the device will be in on state (DC motors will be turned on such that it is submerged inside the water) else will be in off state(floating). Now the Raspberry pi gets activated. From Raspberry pi, the control signal will be sent to 5 DC motors. The programming is done such that one DC motor is in continuous rotation while the other motors are oscillating between on and off states alternatively. This makes the device move in the form of a sine wave. When the device is in motion, if the sensor detects the metal parts the command will be sent to the Raspberry pi and all the DC motors go to the off state and so the device comes to the surface of the water (starts floating). From Raspberry pi the signal will be send through GSM module to the receiver (cellular phones) via satellite. Using this signal the location can be tracked within the short range. Thus the precise location of the metal can be detected easily.

Initially the device is provided with the power source from the Lithium battery. Once the power goes down (DC motors are in off state), the device comes to the surface of the water and gets charged via sun rays. When the device is fully charged, it moves inside the water and resumes its defined programming mission.

2. Literature Background

In recent days, the Ministry of Marine is heading towards great difficulties in finding the missing parts of aircrafts, ships or submarines. These difficulties require the development of an appropriate model to detect the missing parts. But it has been observed that the number of detailed, well documented experimental models available in the literature is limited. SONAR technology was used in earlier days to detect the submerged ships and submarines but that was not much efficient. The Raspberry pi used in the device is more compact than employed in the previous models. The GSM module which is bridged to the device does not function (does not send signals) inside the water because of high attenuation and low data rates. An analysis of the current developments of facilities and systems for remote detection and ranging demonstrates that I Russia and especially in foreign countries there has been an intensive development of multifunctional electromagnetic technical means for detection of metal bearing objects,explosive objects among them,in different host media.A special attention is given to the development of pulse-induction probing methods and versatile portable devices on their basis for the solution of humanitarian tasks of both land and underwater engineer reconnaissance.It should be recalled that this metal detector combines the functional capacities of land and underwater engineer reconnaissance in a single device.The physical principle of operation of the detector relies on the method of transient processes.Its essence consists in the pulse-induced excitation of eddy currents in the objects and in the measurement of amplitude temporal characteristics of the transient attenuation of the secondary electromagnetic field in the gap between the probing pulses. Excitation of the primary and conversion of the secondary electromagnetic fields into an electrical signal is performed by a sensor-converter consisting of induction and receiving coils. The submerging depth varies between 3-65m.The conceptualization remains the same with this paper.

3. System Description

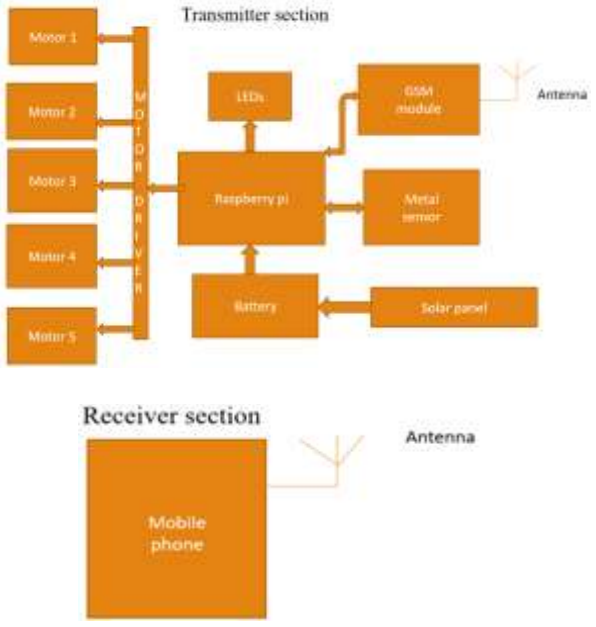
The device is fabricated such that water does not affect the other components (water resistant). It is simply like a closed box such that it floats initially. When the Raspberry pi is activated the DC motors are in on state. When the propellers rotate it pulls the device inside the water. It starts searching for metal parts by moving in the form of a sine wave. Once the metal is detected by the metal sensor, it goes to off state and sends the message to the receiver via satellite through GSM. At least 24 GPS satellites orbit the earth twice a day. They travel at 7,000 miles per hour(approx) about 12,000 miles above the surface of the earth. These satellites are positioned so that a GPS receiver present anywhere in the world can receive signals from any satellites (a minimum of four satellites).The signal which is received is fed to a clipper-limiter diode, a wideband amplifier and to a threshold discriminator, where a data signal about the metal detected is formed. In order to determine the presence of metal, the signal to noise ratios in the signal samples are measured at different instants of time and compared with the measured samples and with the threshold value, and based on the observations, a conclusion is made. From the relationship between the amplitudes and delay times of the signals the presence of the metal in under water is determined.

3.1 Components Used

1) Raspberry pi
2) 5 DC motors
3) Metal Sensor
4) Lithium Battery
5) Solar Panel
6) GSM module
7) Light Emitting Diode

3.2 Block Diagram

The underwater metal detector block diagram consists of two sections:
1) Transmitter section
2) Receiver Section

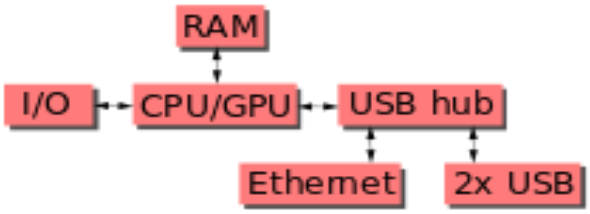


3.3 Component Description

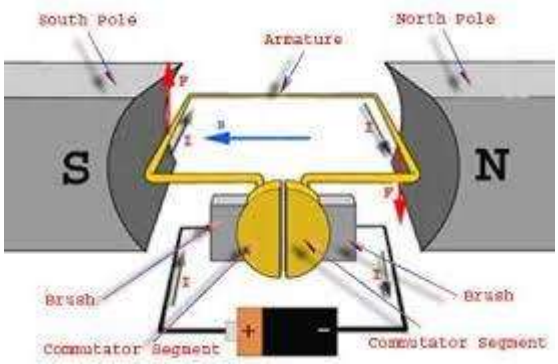
3.3.1 Raspberry Pi

The Raspberry Pi is the heart of the marine metal detector.It acts as a small computer which can perform basic operations. it is of low cost and it is commercially available. The CPU is of 1.4GHz with 64 or 32 bit Quad core ARM cortex-A53.It facilitates micro slot storage. The number of USB ports varies from 1 to 4.It also consists of General Purpose Input/Output pins, Ethernet and Bluetooth facilities.

HARDWARE OF RASPBERRY PI:



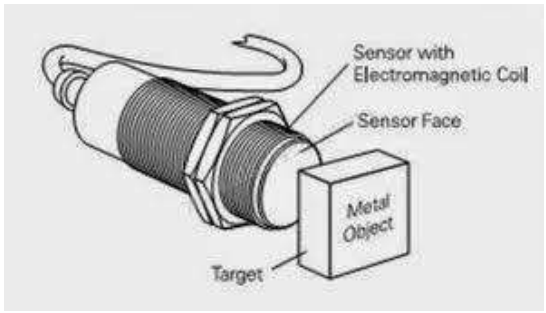
3.3.2 DC motors



DC motor is an electrical machine that converts electrical energy into mechanical energy(Transducer). It operates at 12V.It consists of Rotor and a Stator. The working principle of DC motor is that “Whenever a current carrying wire or a conductor is placed in the magnetic field, it experiences a mechanical force”. A DC motor’s speed is controlled over a huge range, using a variable supply voltage or by changing strength of the current in its electric field windings.

3.3.3 Metal Sensor

The metallic sensor which is attached to the device is used to sense the metal present in the underwater. The metal includes missing parts of ships, submarines and aircrafts. The sensor face of the metal detector consists of a sensor which detects the metal parts under water. The sensor is of proximity type.



In underwater industrial technologies, the most trending issues are the sensors that needed for underwater task. [2] The sensors that are utilized are quite expensive. Most of the sensors are not waterproof and there are numbers of obstacles underwater for a sensor to detect an object or to obtain an accurate measurement. Meanwhile, the waterproof sensor has a small number of production when compared to the normal sensor[2]. Thus, the integrated sensor is introduced which facilitates underwater operations such as searching objects submerged in the sea or underwater search and rescue procedurals [2]. Even though the detection range is relatively small, this detector has the following advantages:

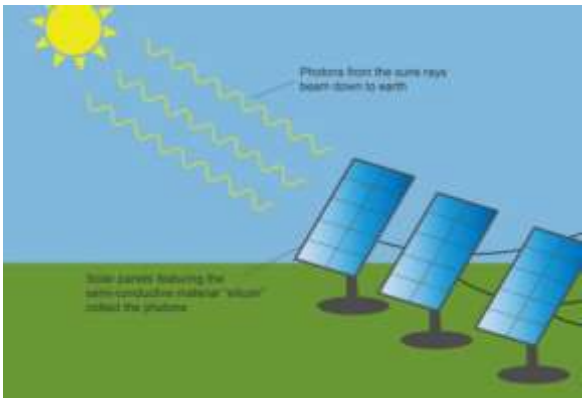
1) The device does not require any power supply for its operation.
2) It is useful in muddy or turbid waters where the television camera is useless. [9]

3.3.4 Lithium Battery

These are primary batteries that have lithium as anode. It is a 12V battery acting as the source for the device. These types of batteries are also referred to as lithium-metal batteries. The application of Lithium batteries includes portable consumer electronic devices and electric vehicles ranging from full sized vehicles to radio controlled toys. [13]

3.3.5 Solar panel

Solar panels absorb sunlight, which is the major source of energy that generate electricity or heat. A photovoltaic system includes an array of photovoltaic modules, a battery pack for storage, an inverter, interconnection wiring, and a solar tracking mechanism. It also acts as a transducer. All the cells in the panel should be connected in a series manner . It delivers 12V. A photovoltaic panel is used to convert solar power into electrical energy and a DC converter is used to control the output power of the photovoltaic panel and the charging current which is required for the battery [8]. Most parts of the solar panel are recycled including 95% of certain semiconductor materials or the glasses as well as large amount of ferrous and non-ferrous metals.



Limitations in battery life have limited underwater device usefulness in few applications. The concept of a device that would allow on-station recharging of batteries, using solar cells, has been presented as a means to significantly enhance the effectiveness of under water device platforms where long-term or ongoing deployment is required. The device is designed to be placed on the surface while recharging batteries and then to execute its programmed mission. [4]

3.3.6 GSM Module

GSM (Global System for Mobile Communications) to describe the protocols for second-generation digital cellular networks used by mobile devices such as tablets. It operates at 8V. It consists of GND/5V/TX/RX/PWR/Restrict also consists of SMA antenna and reset button. It is compact in size. It consists of three segments namely space segment, control segment and user segment.

Receiver collects and processes signals from the GPS satellites and then uses that information to determine and display your location, speed, time, and so on. PS receiver does not transmit any information back to the satellites. [5] Whereas obtaining the location of a vehicle at the sea surface can be achieved by Global Positioning System. This technology cannot be used underwater due to the high attenuation of the electromagnetic waves in this aquatic medium [6]. Radio frequency (RF) communications are not effective (very high level of attenuation) in underwater communication due to medium effect on communication. Water absorbs more RF energy and only very short range communication is allowable using RF communication [7].

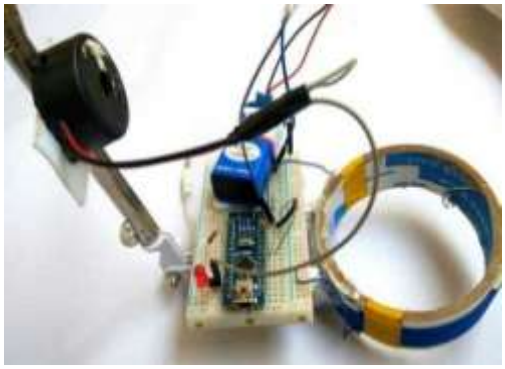
3.4 Light Emitting Diode

The Light Emitting Diode is a PN junction device which emits light when forward biased. The working principle is electroluminescence. When it is activated by 5V,some of the energy is radiated in the form of heat and some in the form of light. The charge carrier recombination takes place and as a result, the electrons lying in the conduction bands of N-region fall into the holes lying in the valence band of the P-region. Light is generated by recombination whereby excess energy is transferred to an emitted photon. The brightness of the light is directly proportional to the forward bias current.

4. Result and Future Work

Using this device, one can easily detect the missing parts of aircrafts, ships or submarines. The device can also be modified such that it detects the buried treasures. To reduce the size of the device and bring it to a perfect compact model the Raspberry pi can be replaced by Arduino-Nano. The technology can also be developed by fixing a camera in addition to the sensor which helps in under water surveying because habitat monitoring in under water is the challenging task in this complex real time system. In future, the device can also be used to find the depth of the well. Further enhancements can be made to the device to find the PH value

of the water (checking the salinity level) and accordingly desalination techniques can be employed.



5. Conclusion

The main advantage of the device is: it is fully automated, reduces man power, utilizes minimum amount of time, compact in size and requires very little or no maintenance. The signal from the GSM can be tracked easily. The components used in the device is cheap and efficient. Hence, in our paper, we have implemented the idea of marine metal detection technology using Raspberry pi zero, DC motors, Lithium battery, Solar panel, GSM module and LED.

References

[1] Zhou, S., Willett, P., "Submarine location estimation via a network of detection-only sensors" IEEE Transactions 20075563104311510.1109/tsp.2007.893970MR2512431 2-s2.0-34249804492
[2] Mohd Shahrieel Mohd Aras ; Muhammad Nizam Kamarudin ; Iktisyam Zainal ; Hasif Aziri ; Mohd Khairi Mohd Zambri ; Mohammad 'Afif Kasno ; Mohd Zamzuri Ab Rashid ; Hairol Nizam Md Shah ., "Analysis of integrated sensors for unmanned underwater vehicle application"by IEEE in 2016
[3] Wang.W.H, Chen. X. Q, and Marbug. A, (2013) "Design of Autonomous Under Water Vehicle", Japan Agency for Marine-Earth Science and Technology, vol. 13, No.2
[4] J. Jalbert; J. Baker; J. Duchesney; P. Pietryka; W. Dalton; D.R. Blidberg; S. Chappell; R. Nitzel; K. Holappa, OCEANS 2003. Proceedings, IEEE, 22-26 Sept. 2003
[5] Sai Jagan. A, Dr. R. Prakash Rao., Mrs. B. Kanaga Durga, "Underwater Positioning Navigation Based on Metal Detector" Volume 9/Issue 1/ AUG 2017
[6] H.-C. Lee, C.-Y. Lin, C.-H. Lin, S.-W. Hsu, and C.-T. King, "A low-cost method for measuring surface currents and modeling drifting objects," IEEE Trans. Instrum.Meas., vol. 60, no. 3, pp. 980–989, Mar. 2011.
[7] Felemban, Advanced border intrusion detection and surveillance using wireless sensor network technology International Journal of Communications, Network and System Sciences 2013060525125910.4236/ijcns.2013.65028
[8] Ke Liu,Fanshawe College, London, Ontario, Canada John Makaran,Applied Science and Technology at Fanshawe College, London, Ontario, Canada "Design of a solar powered battery charger", IEEE,Oct-2009
[9] Kenichi Asakawa, Yuichi Shirasaki, Member, IEEE, and Yoshinao Iwamoto, "Metal Detector for Tracing Submarine Telecommunication Cables", IEEE transactions on instrumentation and measurement,Vol.IM-32, no.4, Dec 1983
[10] H-C.Lee,C-Y.Lin,C-H lin,S-W Hsu,and C-T. king,"A low-cost method for measuring surface currents and modeling drifting objects, "IEEE Trans.Instrum.Meas.,vol 60,no.3,pp.980-989,Mar 20ll.
[11] A.Munafo et al., "Enhancing AUV localization using underwater acoustic sensor networks:Results in long baseline navigation from the COLLAB13 sea trial." In proc.IEEE OCEANS conf., St.John's, NL, Canada, Sep.2014,pp 1-7.
[12] D.Heckman and R.Abbott,"An acoustic navigation technique,"in proc.IEEE Int.Conf.Eng.Ocean Environ.(Ocean),Seattle,WA,USA,Sep.1973,pp-591-595.
[13] M.Uliana,F.Andreucci,and B.Papalia,"The navigation system of an autonomous underwater vehicle for Antarctic exploration," in proc.IEEE OCEANS conf.,vol.1 Halifax,NS,Canada,Oct.1997,pp.403-408.
[14] D.A.Janeera, Dr.S.Sheeba et al., Design of Programmable Marine Metal Detector Using UniFi Controller Jour of Adv Research in Dynamical & Control Systems, Vol. 10, 05-Special Issue, 2018

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