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UNDERWATER POSITIONING AND NAVIGATION BASED ON RF COMMUNICATION

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Abstract— Underwater positioning systems are used in an extensive variety of underwater work, including oil and natural gas exploration, oceanography, marine archaeology and naval operations**.** It is known that we know more about the moon and other celestial bodies than the secrets of an ocean. The main reason is that the lack of proper vehicular system and underwater communication. This paper presents a characterization of an underwater positioning system based on surface nodes equipped with GPS and acoustic transducers. The positioning system calculates the coordinates of an underwater vehicle in one of the surface beacons or nodes, by the emission, detection, and reply of acoustic encoded signals. The characterization of the system has been performed by means of a statistical study, considering different numbers of beacons, beacons' position and physical phenomena, such as noise, multipath, and Doppler spread. The error propagation caused by these phenomena and the geometrical configuration of the system has been quantitatively assessed in different positioning algorithms which based on trilateration and iterative procedures. This results show how the different phenomena affect the vehicle estimated position errors for the different positioning algorithms. In addition to the obtained errors inside the projected area of the beacons are 1 m or lower, rising to a few meters for the worst case scenario, showing the feasibility of the acoustic positioning system.

Keywords: *Global positioning systems, Micro-Electro-Mechanical Systems, Radio frequency.*

I. INTRODUCTION

Underwater communication remains an active research topic in the present community. To obtain the position of a submerged node is crucial in different applications, such as underwater sensor networks, where the recorded data must be attached to a specific location, and the navigation of autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs. With the help of GPS we can obtain the location of the vehicle. This technology cannot be used underwater due to high attenuation of the electromagnetic waves in this medium. Close to the sea bottom, localization can be achieved by using different alternatives, such as Doppler velocity log (DVL) or simultaneous localization and mapping [1], [2]. Apart from deploying artificial landmarks, these systems usually do not need any external sensors in the environment to operate, what makes them more convenient than other systems that need certain infrastructure deployed in the ocean. On the other hand, the vehicle needs to be close to the bottom to locate itself, and this imposes an important restriction. This way, localization in the middle of the water column remains a challenging issue. A common approach is to use dead-reckoning systems to navigate below the sea surface, using a DVL as an acoustic Doppler current profiler or other inertial navigation sensors (INSs) to obtain the vehicle speed. These systems can easily obtain their measures in the environment, but their errors are unbounded, unless some corrections are performed regularly.

II. LITERATURE SURVEY

Acoustic positioning systems are a practical solution to obtain the location in the middle of the water column, being an important part of most underwater navigation systems. They are traditionally classified in long baseline (LBL), short baseline (SBL), and ultra-SBL (USBL), depending on the distance between the different acoustic beacons. In Long base line system, the acoustic beacons are commonly separated between several hundred meters and a few kilometers. In long base line systems they measure the times of-flight (TOFs) between the beacons and the submerged vehicle by means of sharing a common clock or by time stamps using underwater acoustic modems [4], [5]; alternatively, they can measure the time difference of arrival (TDoA) from the different beacons in the Unsynchronized systems [6].

This last scheme is called as silent positioning. In this it has to locate the node it doesn't require to send a acoustic wave under the water medium, which is very much helpful in the saving the electrical energy. The location of the vehicle remains unknown for the crew. LBL systems provide good accuracy, but their deployment is costly, since the beacons need an absolute position, which was commonly obtained by anchoring the beacons to the sea bottom, and a calibration stage [7]. A more recent alternative to this configuration is the use of buoys equipped with GPS and acoustic transducers, which allows an easier deployment of the positioning system [8]. With regard to SBL and USBL systems, the distance between the acoustic beacons in SBL is usually around tens of meters, whereas in USBL systems is around tens of centimeters [9]. These systems are easy to handle, since they are handy can be stored in the cabin of ship or in the underwater vehicle, but the ship and the vehicle need to be close to avoid geometric configuration problems related to the dilution of precision (DOP) where the exact location cannot be found due to the multiplicative of navigational satellite, so they are not preferable for long distance communication. In addition, they need external sensors, such as a vertical reference unit and a heading reference unit to obtain the absolute position.

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III. PROPOSED SYSTEM

- **TRANSMITTER SECTION:**

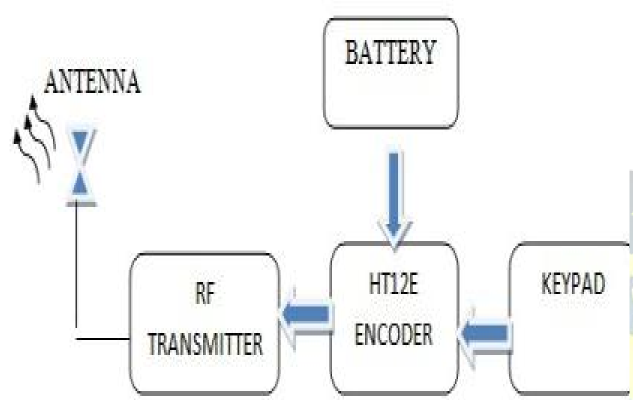

Figure.3.1 Block diagram.

Here in the transmitter section we select the range by pressing the 4 keys on the keypad. Four keys have the different range selection. The HT12E encodes the data from the keypad and transmits the signal from Radio frequency transmitter via antenna.

- **RECEIVER SECTION:**

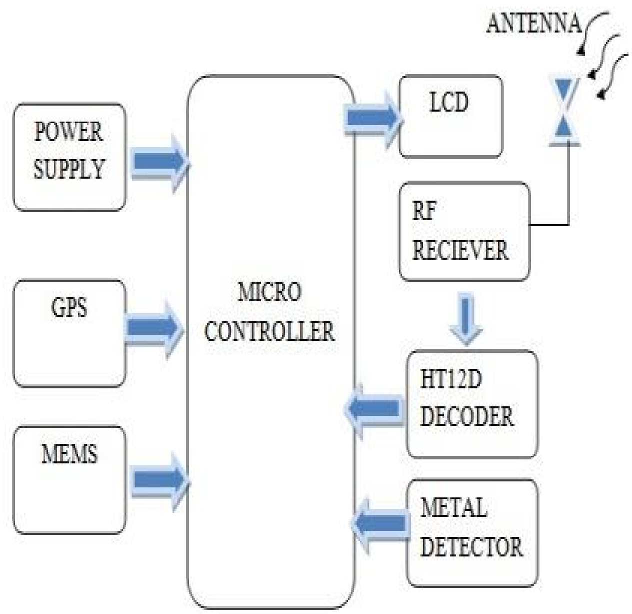

Figure.3.2: Block diagram

At the receiver section it is equipped with GPS, MEMS, RF receiver, Metal detector, LCD and HT12D Decoder.

IV. METHODOLOGY

ARM7TDMI: It is the heart of the proposed system which computes all the data from GPS, MEMS, HT12D decoder and gives out the result.

Liquid-crystal display (**LCD**) is a flat panel display in which the project related data is displayed like Initialization of MEMS, Depth (in meters), GPS Location in the longitude and latitude format.

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KEYPAD: It consists of 4 keys for the different depths of water. So by the selection of the range we can detect the vehicle.

GPS:

Global Positioning System (GPS) technology is used in this project to track the location of metal. At initial position it LCD shows GPS initializing. After getting the longitude and latitude values from the satellite it displays the values like LN:YYYYY.yyyy ; LT:XXXX.xxxx.

MEMS: Micro-Electro-Mechanical Systems (MEMS) is used to monitor the condition of vehicle like If strong waves occurred in sea. Then it shows on displays on LCD. Bending back, bending front bending right, bending left are the conditions of vehicle when it is travelling along the sea. These conditions will be taken into consideration by the vibration of MEMS attached to the vehicle. This gives the physical conditions of the vehicle. And this data will be useful for the future vehicle design and marine studies. Christo Ananth et al.[3] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.

RF transmitter and Receiver:

RF transmitters are used to measure depth with particular levels provided by RF Transmitter. RF Transmitter has 4 functional keys used to detect the metal from 4 levels. By pressing the key1, it depth within 100meters has been activated. Then location is detected by GPS. For the key2, key3, key4 the depth is within the range of 500meters, 1000meters, 1500meters has been applied. In this particular ranges the searching for metal will starts. RF Receiver receives the commands from transmitter. This data is essential for the oceanographic study and safety of the vehicle.

METAL DETECTOR:

It is a system of radio direction-finding, which was to be used for accurate navigation. If a radio beam could be distorted by metal, then it should be possible to design a machine which would detect metal using a search coil resonating at a radio frequency.

V. RESULTS

On switching on the system first the GPS gets initialized, gets connected and gives the location in the Longitude (LN) and Latitude (LT) form for navigational usage. The keypad is pressed accordingly until the underwater vehicle is located. So the depth positioning is derived from it. Then the MEMS get initialized. The MEMS gives out the physical characteristics of the underwater vehicle, whether it is overthrown by the strong waves or the vehicle is bending right or left back or front. This data can be used for the early detection of Tsunami waves and Physical, Biological, Chemical oceanography. And it can also be used for the monitoring the marine borders of country.

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Figure.5.1: GPS initialization.

Figure.5.2: Longitude and Latitude values.

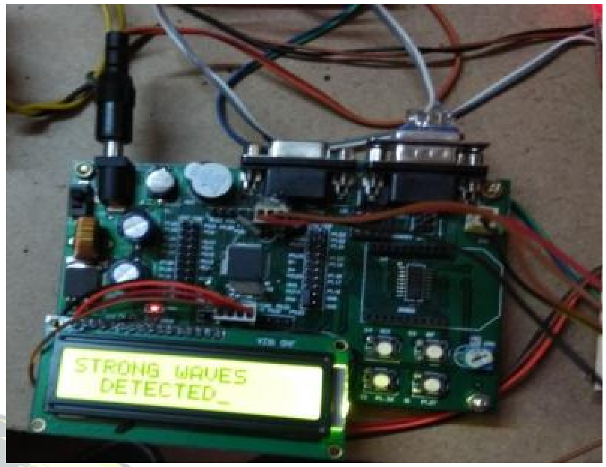

Figure.5.3: Strong wave indication

Figure.5.4: Positioning of vehicle in depth 500 meters

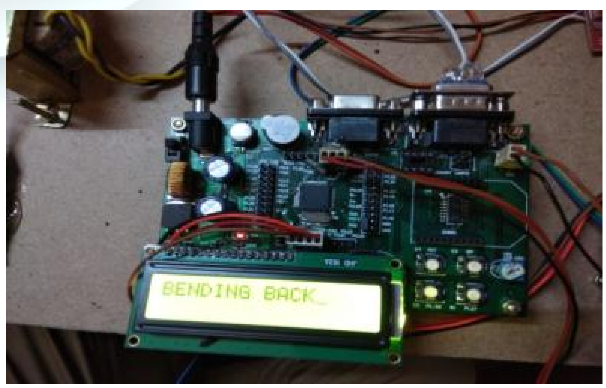

Figure.5.5: Vehicle bending back

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CONCLUSION

An underwater positioning and navigation system equipped with RF and GPS communication system the accurate position and location of underwater vehicle is known by deriving the depth (mts) and coordinates of the vehicle.

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