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UNDERWATER POSITIONING NAVIGATION BASED ON METAL DETECTOR

A.MOUNIKA
Student of M.TECH (ES)
SR Engineering College
Warangal, INDIA
Mounika.alupula447@gmail.com

Mr.K.RAJKUMAR
Associate Professor in ECE
SR Engineering College
Warangal, INDIA
rajkumar_k@srec.ac.in

Abstract— 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 nodes or beacons, 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, based on trilateration and iterative procedures. The results show how the different phenomena affect the vehicle estimated position errors for the different positioning algorithms. In addition, 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: GPS, MEMS, RF

Introduction:

The precise location of underwater nodes remains an active research topic in the underwater 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). Whereas obtaining the location of a vehicle at the sea surface can be achieved by means of the GPS [1], this technology cannot be used underwater due to the 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 [2], [3]. 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. [6] presented a brief outline on Electronic Devices and Circuits which forms the basis of the Clampers and Diodes. 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

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(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.

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 LBL systems, the acoustic beacons are commonly separated between several hundred meters and a few kilometers. 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 [7]; alternatively, they can measure the time difference of arrival (TDoA) from the different beacons in the Unsynchronized systems [8]. This last scheme is also known as silent positioning, since the node to be located does not need to send any acoustic signal through the underwater channel, which allows to save energy in the vehicle. However, 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 [9]. 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 [10]. 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 [11]. These systems are easy to mount, since they can be placed in the hull of a ship or in the vehicle [12], but the ship and the vehicle need to be close to avoid geometric configuration problems related to the dilution of precision (DOP), so they are not suited for long-range missions [13]. In addition, they need external sensors, such as a vertical reference unit and a heading reference unit to obtain the absolute position.

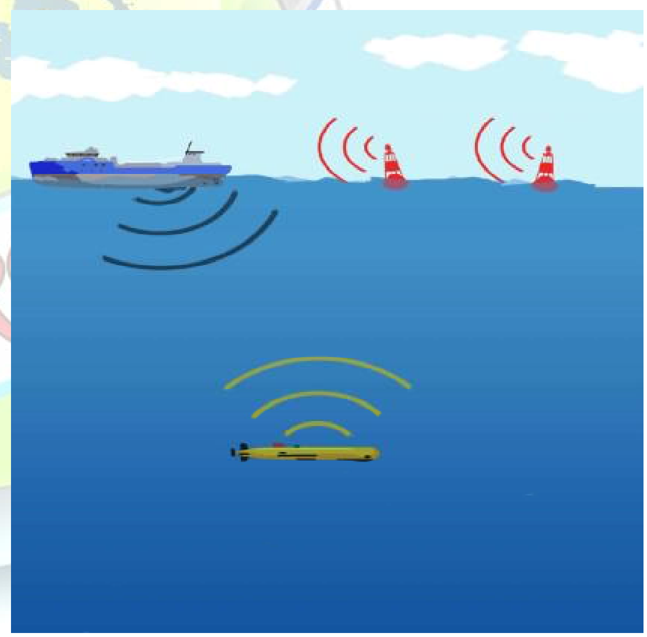

Fig. 1. Positioning system based on GPS and acoustic signals.

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PROPOSED SYSTEM

TRANSMITTER SECTION:

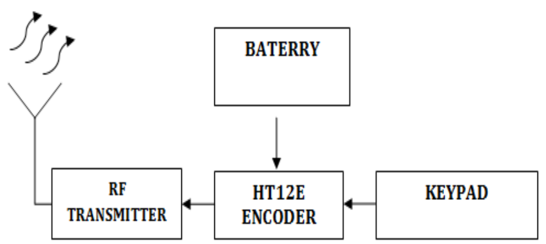

Fig:2 Block diagram

RECEIVER SECTION:

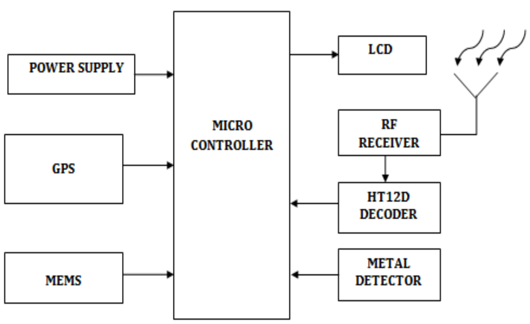

Fig: 3 Block diagram

METHODOLOGY

Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

Raspberry Pi : The Raspberry Pi delivers 6 times the processing capacity of previous models. This second generation Raspberry Pi has an upgraded Broadcom BCM2836 processor, which is a powerful ARM Cortex-A7 based quad-core processor that runs at 900MHz. The board also features an increase in memory capacity to 1Gbyte.

Liquid-crystal display (**LCD**) is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock.

GPS:

Global Positioning System (GPS) technology is changing the way we work and play. You can use GPS technology when you are driving, flying, fishing, sailing, hiking, running, biking, working, or exploring. With a GPS receiver, you have an amazing amount of information at your fingertips. Here are just a few examples of how you can use GPS technology.GPS technology requires the following three segments.

- Space segment.
- Control segment.
- User segment

Space Segment:

At least 24 GPS satellites orbit the earth twice a day in a specific pattern. They travel at approximately 7,000 miles per hour about 12,000 miles above the

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earth's surface. These satellites are spaced so that a GPS receiver anywhere in the world can receive signals from at least four of them.

Control Segment:

The control segment is responsible for constantly monitoring satellite health, signal integrity, and orbital configuration from the ground control segment includes the following sections: Master control station, Monitor stations, and Ground antennas.

User Segment

The GPS user segment consists of your GPS receiver. Your receiver collects and processes signals from the GPS satellites that are in view and then uses that information to determine and display your location, speed, time, and so forth. Your GPS receiver does not transmit any information back to the satellites.The following points provide a summary of the technology at work: Your GPS receiver collects information from the GPS satellites that are in view.

Your GPS receiver accounts for errors. For more information, refer to the Sources of Errors.

Your GPS receiver determines your current location, velocity, and time.

Your GPS receiver can calculate other information, such as bearing, track, trip distance, and distance to destination, sunrise and sunset time so forth.

Your GPS receiver displays the applicable information on the screen.

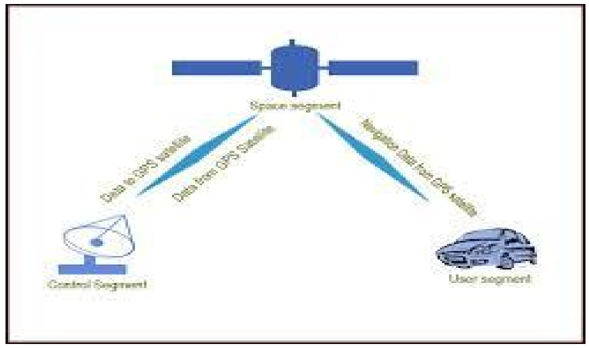

Fig: 4 GPS Working

MEMS:

Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. While the electronics are fabricated using integrated circuit (IC) process sequences (e.g., CMOS, Bipolar, or BICMOS processes), the micromechanical components are fabricated using compatible "micromachining" processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices. MEMS promises to revolutionize nearly every product category by bringing together silicon-based microelectronics with micromachining technology, making possible the realization of complete systems-on-a-chip. MEMS is an enabling technology allowing the development of smart products, augmenting the computational ability of microelectronics with the perception and control capabilities of micro sensors and micro actuators and expanding the space of possible designs and applications. Microelectronic integrated circuits can be thought of as the "brains" of a system and MEMS augments this decision-making capability with "eyes" and "arms", to allow

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micro systems to sense and control the environment. Sensors gather information from the environment through measuring mechanical, thermal, biological, chemical, optical, and magnetic phenomena. The electronics then process the information derived from the sensors and through some decision making capability direct the actuators to respond by moving, positioning, regulating, pumping, and filtering, thereby controlling the environment for some desired outcome or purpose. Because MEMS devices are manufactured using batch fabrication techniques similar to those used for integrated circuits, unprecedented levels of functionality, reliability, and sophistication can be placed on a small silicon chip at a relatively low cost.

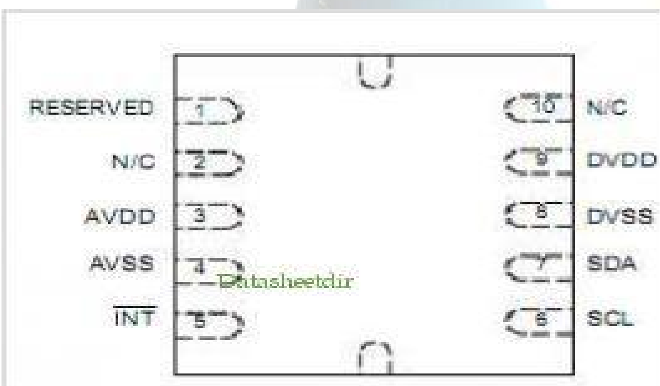

Fig: 5: MEMS IC

RF transmitter and Receiver:

RF transmitters are electronic devices that create continuously varying electric current, encode sine waves, and broadcast radio waves. RF transmitters use oscillators to create sine waves, the simplest and smoothest form of continuously varying waves, which contain information such as audio and video. Modulators encode these sign wives and antennas broadcast them as radio signals. There are several ways to encode or modulate this information, including amplitude modulation (AM) and frequency modulation (FM). The ST-TX01-ASK is an ASK Hybrid transmitter module. The ST-TX01-ASK is designed by the Saw Resonator, with an effective low cost, small size, and simple-to-use for designing.

- Frequency Range: 315 / 433.92 MHZ.
- Supply Voltage: 3~12V.
- Output Power: 4~16dBm
- Circuit Shape: Saw

RF receivers are electronic devices that separate radio signals from one another and convert specific signals into audio, video, or data formats. RF receivers use an antenna to receive transmitted radio signals and a tuner to separate a specific signal from all of the other signals that the antenna receives. Detectors or demodulators then extract information that was encoded before transmission. There are several ways to decode or modulate this information, including amplitude modulation (AM) and frequency modulation (FM)

METAL DETECTOR

The modern development of the metal detector began in the 1930s. [[Gerhard Fisher]] had developed a system of radio direction-finding, which was to be used for accurate navigation. The system worked extremely well, but Fisher noticed that there were anomalies in areas where the terrain contained ore-bearing rocks. He reasoned that 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. In 1937 he applied for, and was granted, the first patent for a metal detector. However, it was one [[Lieutenant]] [[Józef Kosacki|Jozef Stanislaw Kosacki]], a Polish officer attached to a unit stationed in [[St Andrews]], [[Fife]], [[Scotland]] during the early years of [[World War II]], that refined the design into a practical [[Polish mine detector]].<ref>"The Polish Contribution to The Ultimate Allied Victory in The Second World War" Tadeusz Modelski, Worthing, England 1986, Page 221</ref> They were heavy, ran on vacuum tubes, and needed separate battery packs.

DESCRIPTION:

The RX04 is low powers ASK receiver IC which is fully compatible with the MitelKESRX01 IC and is suitable for use in a variety of low power radio applications including remote keyless entry. The RX04 is based on a single-Conversion, super-heterodyne receiver architecture and incorporates an entire phase-locked loop (PLL) for precise local oscillator generation.

CONCLUSION:

In this paper, an underwater positioning system based on beacons equipped with GPS and acoustic transducers has been characterized for different measurement errors related to environmental conditions and geometrical configurations.

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