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Underwater Communication using Wireless Sensor Networks

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Abstract: *Underwater data communication using water as a medium shows potential as a technology, but laboratory experiments have limitations due to physical scale and the difficulty in replicating natural water conditions. Although artificial scattering agents are used to simulate water conditions, the similarity between experimental and natural water can be unreliable, especially in frequency domain characteristics. Therefore, it is essential to consider the limitations of laboratory experiments and validate the results in real-world scenarios. While laboratory experiments can provide insights, they cannot replace real-world testing to evaluate the performance of underwater data communication technologies.*

Keywords: Microcontroller, Water communication module, Temperature, Heartbeat, Underwater Communication

I. INTRODUCTION

Underwater wireless information transmission is essential for various applications such as military, industry, and scientific research. Optical wireless communication has gained attention for its ability to provide high data rates with low power and mass requirement, but it is relatively less explored for underwater links due to the wide range of physical processes in different types of underwater environments. Although artificial scattering agents are used to recreate underwater optical communication channels, the similarity between experimental water and natural water is not reliable. The underwater acoustic communication has been developed for the underwater wireless sensor network, but the bandwidth is limited and the delay is considerable. A new approach that is in the most rising area of research is the underwater wireless optical communication, which has begun to establish a direct communication link between the satellite or aircraft and the underwater vehicle. Light-emitting diodes and laser diodes are utilized as light sources in these systems, and the LD outperforms the LED in terms of data rate. While long-distance transmission is difficult, a point-to-point method that exploits the laser's strong directivity at a short distance can solve the interference and security problems. The blue-green laser has the lowest energy fading in seawater and is estimated to play an important role in offering secure, efficient, and high data rate communication within short distances.

II. LITERATURE SURVEY

[1] UNDERWATER ACOUSTIC NETWORKS

Underwater communication networks (UWCNs), including underwater acoustic networks (UANs), have been gaining increasing attention due to their important military, scientific, and commercial applications. These networks consist of sensors and autonomous underwater vehicles (AUVs) that work together to carry out various tasks, such as environmental monitoring, underwater surveillance, and oil and gas exploration. However, UWCNs face several challenges in the harsh underwater environment, such as signal interference, multipath fading, and high attenuation. Therefore, developing reliable communication protocols, efficient network topologies, and effective signal processing techniques are crucial to ensure reliable and efficient communication Despite these challenges, UWCNs have the potential to revolutionize various aspects of underwater operations, such as oceanographic research, infrastructure maintenance, and underwater exploration. These networks enable real-time communication, data sharing, and coordinated operations among different devices and can greatly improve our understanding of the ocean and its ecosystems.

[2] UNDERWATER COMMUNICATION USING LIFI TECHNOLOGY

In most cases, a network is used to transmit data. Due to issues with installation and upkeep of the conventional cable network, wireless communication is required in many applications, including underwater communication, environmental monitoring, etc. The use of LI-FI technology for underwater communication has been suggested by authors. This article presents the suggested system design. The electromagnetic, acoustic, and optical signals constitute the foundation of the current underwater communication systems. The authors suggest a LI-FI based communication system for underwater communication to address the drawbacks of these systems.

[3] UNDERWATER COMMUNICATION USING OPTICAL COMMUNICATION

Understanding the frequency domain properties of seawater is crucial for developing efficient and reliable underwater optical communication systems. Seawater exhibits unique frequency-dependent properties due to its complex composition and the presence of impurities such as dissolved organic matter and planktonTo recreate the frequency domain properties of seawater channels, researchers have conducted various experiments. One such approach involves measuring the attenuation and dispersion of light at different wavelengths using spectrometers and other optical instruments. These measurements can then be used to determine the frequency response of the seawater channel, which provides insights into the performance of optical communication systems.In addition to experimental methods, researchers also use analytical models and numerical simulations based on the optical properties of seawater to predict the behavior of optical signals in different underwater environments. This can help optimize the design of underwater optical communication systems and ensure reliable performance.Overall, a deeper understanding of the frequency domain properties of seawater channels is essential for the development of efficient and reliable underwater optical communication systems that can operate effectively in different underwater environments.

III. EXISTING SYSTEM

Acoustic communication systems are the most commonly used underwater communication systems due to their ability to transmit signals over long distances. However, they are limited by low data rates and high latency. Optical communication systems offer higher data rates and lower latency but are limited by their dependence on line-of-sight transmission and sensitivity to water turbidity.

Electromagnetic communication systems, such as radio frequency and magnetic induction systems, offer another option for underwater communication. They are less affected by water turbidity and have the potential for higher data rates, but they are limited by their shorter range and susceptibility to interference.

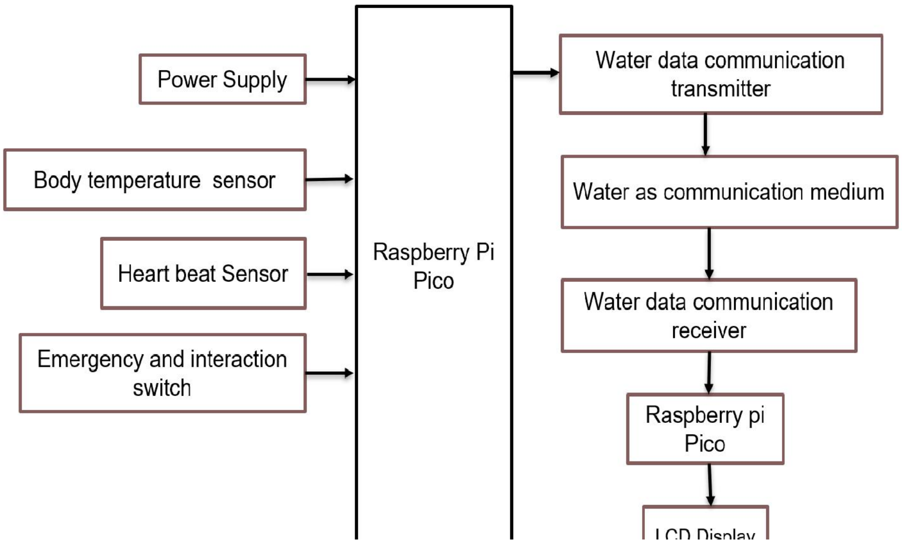
Overall, underwater communication systems face significant challenges due to the harsh underwater environment, such as high attenuation, multipath fading, and signal interference. Developing reliable and efficient communication protocols and optimizing network topologies are crucial to ensure effective communication in underwater environments.

Disadvantages:

The person cannot interact with the ground, and his health cannot be checked in the sea, which is a drawback of the current technology. The individuals buried beneath the earth will not be able to know if he passes away. Additionally, he would be unable to learn about any underground activities.

IV. PROPOSED SYSTEM

Underwater communication faces a significant challenge due to the different wireless signals used by sensors and devices ashore, which work only in their corresponding mediums. Radio signals that travel through air die quickly in water, while acoustic signals, or sonar, often reflect off the surface without penetrating it. To address this challenge, two types of underwater communication exist: hardwired and wireless. Divers prefer wireless communication as it allows them to communicate freely with their dive partners and those on the surface without being constrained by cable length. Wireless underwater communication offers many advantages, such as the ability to monitor the health conditions of navigators from the ground, communicate with fishermen, and monitor health conditions from anywhere, as well as ease of deployment, data aptness, and reliability.



BLOCK DIAGRAM OF PROPOSED SYSTEM

V. HARDWARE REQUIREMENTS

Raspberry pi pico

The Raspberry Pi Pico has become extremely popular among hobbyists and professionals alike as a powerful and versatile microcontroller. This low-cost board provides an easy and flexible way to interface with various sensors, devices, and peripherals.At the heart of the Raspberry Pi Pico lies the RP2040 microcontroller, which is designed in-house by the Raspberry Pi team. The RP2040 features a dual-core Arm Cortex-M0+ processor that runs at 133 MHz and provides ample processing power for a wide range of tasks. Additionally, the microcontroller boasts 264KB of RAM and 2MB of onboard flash memory, which provides plenty of space for storing programs and data.One of the main benefits of the Raspberry Pi Pico is its flexibility. It can be programmed using a variety of programming languages, including C, Python, and MicroPython, giving developers the freedom to choose the language that best suits their needs. Furthermore, the board features a range of input and output pins, such as SPI, I2C, and UART, which can be used to connect to different sensors, displays, and other devices.Thanks to its low cost and large community of supporters, the Raspberry Pi Pico is highly accessible. There are numerous online resources available, such as tutorials, forums, and libraries, that make it easy for developers to get started and build projects with the board. In conclusion, the Raspberry Pi Pico is a versatile and powerful microcontroller that provides excellent value for its price, making it an ideal choice for hobbyists and professionals alike.

Fig 5.1: Raspberry Pi Pico

Power Supply

To function properly, the Raspberry Pi Pico microcontroller board requires a stable and dependable power supply. The board can be powered using a USB cable connected to a computer or power adapter, or via an external power source such as a battery or power supply module connected to its Vin and GND pins. It is critical to ensure that the power supply meets the recommended specifications to avoid problems such as voltage drops, which may cause the board to reset or malfunction. Furthermore, the power supply must be capable of providing adequate current to support the peripherals and sensors attached to the board. Appropriate power supply management is essential for achieving optimal performance from the Raspberry Pi Pico.

Temperature Sensor

Temperature sensors are electronic devices that detect and measure the temperature of their surrounding environment, converting the measurement into an electrical signal. There are several types of temperature sensors, including thermistors, thermocouples, resistance temperature detectors (RTDs), and integrated circuit (IC) temperature sensors. Thermistors operate by sensing changes in electrical resistance that occur in materials with changes in temperature. Thermocouples generate a voltage that is proportional to the temperature difference between two junctions using the Seebeck effect. RTDs detect temperature by measuring changes in the electrical resistance of a material as temperature changes. IC temperature sensors are integrated circuits that detect temperature by measuring changes in the output voltage of a temperature-dependent circuit. These sensors are used in many applications such as consumer electronics, medical devices, automotive systems, and industrial processes. Temperature sensing is essential to ensure that systems and devices function correctly and safely.

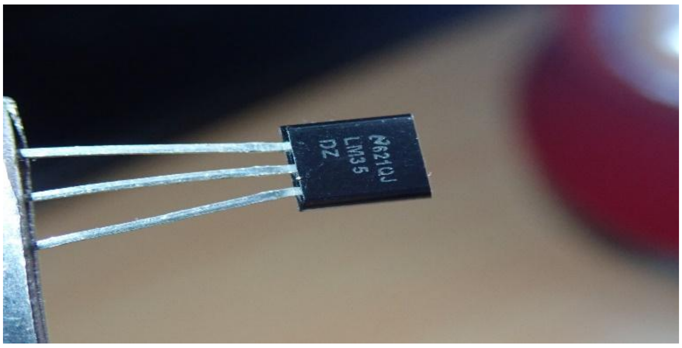


Fig 5.2: Temperature Sensor

Heartbeat Sensor:

A heartbeat sensor is a device used to monitor the heartbeat of an individual. It can be used for medical purposes or for fitness tracking. The sensor works by detecting the electrical signals that are generated by the heart as it beats. These signals are then processed to calculate the heart rate, which is displayed on the device. There are various types of heartbeat sensors, such as chest straps, wristbands, and fingertip sensors. Chest strap sensors work by detecting the electrical signals of the heart through electrodes that are attached to the chest. Wristband sensors use optical sensors to detect changes in blood volume in the wrist, which is then used to calculate the heart rate. Fingertip sensors work by detecting the pulse of the fingertip using infrared light. Heartbeat sensors are widely used in sports and fitness applications, as they help users monitor their heart rate during exercise and ensure that they are staying within a safe and effective heart rate range. Additionally, doctors and medical professionals use heartbeat sensors to monitor patients during medical procedures and to diagnose various heart conditions. Overall, heartbeat sensors are an important tool for monitoring and maintaining heart health

Fig 5.3: Heartbeat Sensor

Water communication module

A water communication module is a device designed to facilitate communication underwater. It uses acoustic signals, or sonar, to transmit and receive data between underwater devices or between underwater devices and those on land. These modules are typically used in underwater applications such as oil-rig maintenance, environmental research, coastal surveillance systems, autonomous underwater vehicle (AUV) operations, and submarine-to-land communication. The water communication module can operate in a range of frequencies, and its range depends on the frequency used and the conditions of the water. These modules typically have built-in error correction algorithms to account for signal degradation and other distortions that may occur in underwater environments. The water communication module is an essential component of underwater communication networks (UWCNs) and enables devices to interact, coordinate, and share information with each other to carry out sensing and monitoring functions. With advances in technology, the development of water communication modules has greatly enhanced underwater communication and made it possible to carry out complex underwater operations that were previously impossible.

Fig 5.4: Water Communication Module

Switch:

A switch is an electronic component that can be used to control the flow of electricity in a circuit. When a switch is turned on, it allows electricity to flow through the circuit, and when it is turned off, the flow of electricity is stopped. In the case of the Raspberry Pi Pico, switches can be used to control various functions of the device, such as turning on and off the power supply or controlling the flow of data through different pins.

LCD:

LCD displays can be connected to microcontrollers to provide visual feedback or to display information to the user. To connect an LCD to a microcontroller, the first step is to identify the pins required for communication. These pins typically include a data bus, a control line, and power and ground pins. Once the required pins are identified, the LCD can be connected to the microcontroller by wiring the data bus and control line to the appropriate GPIO pins on the microcontroller. It is also important to ensure that the power and ground pins are connected to the correct voltage and ground pins on the microcontroller. After the hardware connections are made, the microcontroller must be programmed to communicate with the LCD. This is typically done using a library or driver that provides functions for initializing the display, writing text or graphics to the display, and controlling the display's settings such as backlight brightness and contrast. The programming language used to control the LCD display can vary depending on the microcontroller and the library being used. For example, in Arduino, the Liquid Crystal library can be used to communicate with an LCD display. Overall, connecting an LCD display to a microcontroller can be a great way to provide visual feedback or display information to the user. With the appropriate connections and programming, an LCD display can be a powerful tool for creating interactive and engaging projects.

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Fig 5.5: LCD Display

VI. SOFTWARE REQUIREMENTS

Thonny software

Thonny is an IDE that is commonly used for programming the Raspberry Pi Pico. This software is designed to be user-friendly and simplifies the process of writing, testing, and debugging Python code for the Pico microcontroller board.One of the key advantages of Thonny is that it allows for direct interaction with the Pico board. Users can upload their code, run it, and monitor output in real-time, making the process of programming much more efficient.Thonny also has several helpful debugging features, including breakpoints, step-by-step execution, and variable inspection, that make it easier to identify and fix errors in your code.In conclusion, Thonny is an excellent choice for programming the Raspberry Pi Pico. Its intuitive interface and powerful debugging tools make it suitable for programmers of all levels of experience.

Micro Python

MicroPython is a popular implementation of the Python programming language optimized for microcontrollers and embedded systems. It is a compact, efficient and flexible language that can be used to control a wide range of hardware devices, including sensors, motors, and other peripherals.

One of the popular microcontrollers that can be used with MicroPython is the Raspberry Pi Pico, a low-cost development board designed by the Raspberry Pi Foundation. The Raspberry Pi Pico is powered by a Microchip RP2040 microcontroller and features a range of input/output pins that can be used to connect to various devices.UsingMicroPython with the Raspberry Pi Pico is straightforward, and there is a wealth of resources available online to help users get started. To begin with, one needs to install the MicroPython firmware on the Pico, which can be done easily using a tool like Thonny or Mu. Once thefirmware is installed, the Pico can be connected to a computer using a micro USB cable, and the user can start writing and running MicroPythonscripts.One of the significant advantages of using MicroPython with the Raspberry Pi Pico is the ease of accessing the board's input/output pins. The MicroPython firmware comes with a range of libraries that can be used to control various hardware devices, including GPIO pins, SPI and I2C buses, and UART communication. These libraries provide a high-level interface to the underlying hardware, allowing users to write simple and efficient code to control their devices.In summary, MicroPython is an excellent choice for controlling hardware devices with the Raspberry Pi Pico. Its compact size, efficiency and flexibility make it an ideal language for embedded systems, and the wealth of resources available online make it easy for users to get started. With MicroPython and the Raspberry Pi Pico, users can build a wide range of projects, from simple LED blinkers to complex robotic systems, all with ease and efficiency.

VII. RESULTS

The Underwater Communication Using WSN’s is designed as per block diagram given in the developed version of Kit is given below.

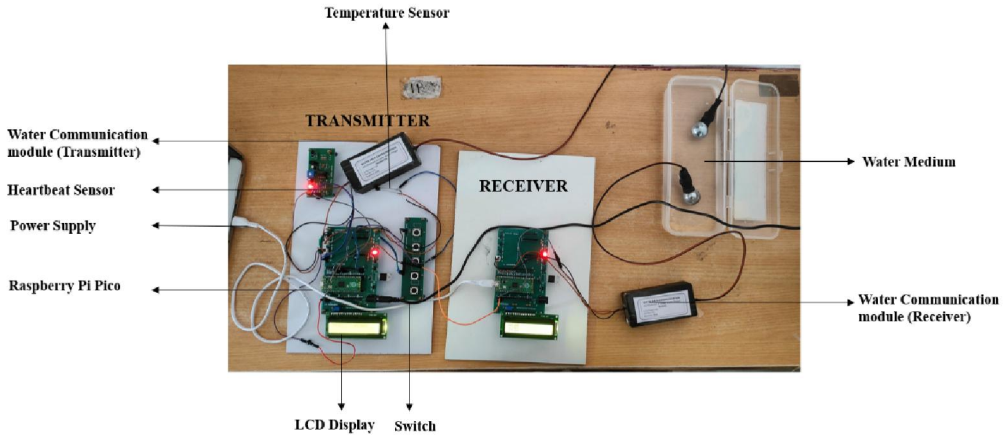

Fig. Underwater Communication using Wireless Sensor Networks.

However when a diver sends a message from his transmitter it will be displayed on the receiver present on the ship or land with health Conditions also monitored like as shown in below figure.

Fig. Receiver side display.

The Information regarding health conditions of the diver will be displayed on the LCD on the receiver side**.**

IX. CONCLUSION

The drawback of the existing system is scuba divers present in underwater cannot move freely. It can be overcome by this paper and we have used wireless sensor networks like hearbeat sensor, temperature sensor and water communication module.

X. FUTURE SCOPE

This paper only presents the underwater communication using wireless sensor networks and it is applicable to specific range only.In future it may be possible to increase the range of communication

XI. ACKNOWLEDGEMENT

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