Under Water Health Monitoring & Tracking Device for Aquanauts

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***Abstract*—The system focuses on real-time health monitoring of Underwater Archaeologists using underwater communication technology to ensure safety during dives. This system is designed to continuously monitor vital health parameters of the diver. Through an underwater communication network, the health data is transmitted directly from the diver to a surface-level boat, enabling real-time tracking of the diver's condition. In case of any abnormal health readings, immediate alerts can be sent to the boat, allowing the crew to take quick action, ensuring the diver's safety. This system significantly improves the overall safety of Underwater Archaeologists and Scuba Drivers activities by providing a continuous link between divers and the surface, reducing risks associated with underwater health emergencies.**

I. INTRODUCTION

Underwater wireless communication is a critical aspect of ocean exploration and monitoring. Optical communication, specifically underwater optical communication (UOC), offers a promising solution for achieving high speed and long distance under water communication. As humans push the boundaries of exploration beneath the ocean's surface, the need for advanced health and safety systems for aquanauts has become more critical than ever. Aquanauts, who spend extended periods underwater for research, military, or industrial purposes, face unique physiological challenges including high-pressure environments, limited oxygen supply, temperature extremes, and the risk of decompression sickness. Ensuring their well-being in these conditions requires constant, real-time monitoring of vital signs and environmental factors. Ultimately, this technology enhances the safety, efficiency, and success of underwater missions, contributing significantly to human capability in marine research, deep-sea exploration, and underwater construction.

II. OBJECTIVE

The Underwater Health Monitoring & Tracking Device is designed to meet these needs by providing continuous surveillance of an aquanaut's physical condition and location. Using a combination of biometric sensors, environmental monitors, and underwater communication systems, this device tracks critical health indicators such as heart rate, blood oxygen levels, body temperature, hydration status, and motion. It also records environmental factors like ambient pressure, temperature, and gas composition. Data collected by the device is transmitted securely to a surface control centre or underwater habitat module, allowing medical teams to intervene quickly if any anomalies are detected. Some advanced systems may even include predictive analytics to alert aquanauts and support teams to potential risks before they become critical.

III. EXISTING SYSTEM

In current underwater Archaeologists and Scuba divers practices, divers rely primarily on manual methods and physical signals to communicate with the surface or other divers. Health monitoring is generally carried out using standalone equipment like dive computers, which measure parameters such as depth, oxygen levels, and dive time, but they do not provide real-time data transmission to the surface. This lack of real-time health monitoring increases the risks for divers, as health complications like decompression sickness or oxygen depletion may go unnoticed until it is too late.

The existing systems provide limited safety measures as they cannot offer constant supervision of the diver's health or send alerts in real-time to the boat, which could delay necessary intervention in case of emergencies.

IV. PROPOSED SYSTEM

The proposed system introduces real-time health monitoring for scuba divers, utilizing underwater communication technology to transmit vital health data directly from the diver to the surface boat. Key health parameters such as heart rate, body temperature are continuously monitored and relayed using water-based communication, ensuring uninterrupted data transmission even in deep or challenging underwater environments. This system enables the surface crew to track the diver's health in real-time, allowing them to respond quickly to any abnormalities or emergencies. In case of critical health issues, automated alerts are sent to the boat, facilitating immediate intervention and reducing the risk of health complications. Additionally, the system eliminates the need for divers to manually signal or surface for communication, providing enhanced safety and response capabilities throughout the dive. This real-time connection between diver and boat not only improves the safety of diving operations but also ensures timely action in case of emergencies, making it a vital tool for underwater health management**.**

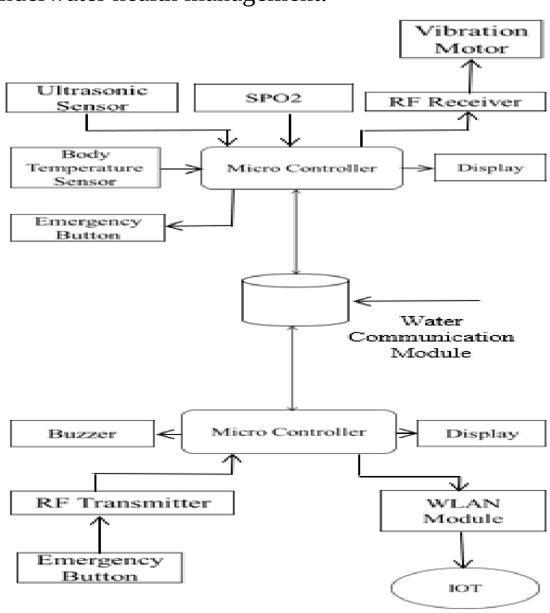

Fig:1 A Block Diagram for Underwater Health Monitoring &Tracking device for Aquanauts

The Underwater Health Monitoring and Tracking Device for Aquanauts works by continuously monitoring the vital signs and surroundings of a diver and sending this information both locally (to a nearby device) and remotely (via IoT) for real-time tracking and emergency response.

Health Monitoring

Sensors like Body Temperature Sensor and SPO2 Sensor measure the diver's health parameters. An Ultrasonic Sensor may be used to monitor distance from objects (for underwater navigation and safety).The readings are processed by the first Microcontroller. The values are displayed on an underwater Display for the diver's visibility.

Emergency Handling

If the diver presses the Emergency Button or abnormal health readings are detected. A Vibration Motor alerts the diver immediately. Data is sent to the surface through a Water Communication Module to another Microcontroller.

Surface Communication

The second Microcontroller receives the data. It updates a Display and sounds a Buzzer if an emergency is detected. It can also activate an RF Transmitter to send quick emergency alerts locally.

Remote Monitoring via IoT

Data is sent to the cloud using ESP8266 Node MCU. Supervisors or medical teams can monitor the aquanaut's health status in real-time via an IoT platform (like a web or mobile app).

Sensors Block

Body Temperature Sensor → Measures body temperature.

SPO2 Sensor → Measures blood oxygen saturation level.

Ultrasonic Sensor → Measures surrounding distance underwater.

Emergency Button → Manual trigger in case of diver distress.

First Microcontroller Block (Underwater Unit)

Collects sensor data. Displays health information on an underwater Display. Receives emergency signals via RF Receiver. Controls Vibration Motor to give feedback to the diver. Sends all collected data through Water Communication Module.

Water Communication Module

Special communication system for transmitting data underwater to the surface.

Second Microcontroller Block (Surface Unit)
Receives underwater data. Displays data on a Display for surface monitoring. Sounds a Buzzer in case of emergency. Sends emergency alerts via RF Transmitter. Interfaces with ESP8266 Node MCU for IoT connectivity.
IoT Block
ESP8266 Node MCU uploads data to the internet.
Health and tracking data are visible on a remote web dashboard or mobile app. Enables real-time monitoring by doctors or supervisors.

V. SYSTEM ARCHITECTURE

ATMEGA328p (ARDUINO) The Arduino microcontroller was a wise choice for the system that was put into place. The micro-controller should use less power because our suggested system is a low power option. The fact that Arduino has an 8-channel Analog to Digital converter makes it much easier for this microcontroller to collect data from the analogue sensors that are linked to it. It has a huge number of functionalities on the chip.
WLAN Module We utilized the ESP8266 Wi-Fi module, which has the TCP/IP protocol stack on the chip, to connect any micro controller to a Wi-Fi network. To connect with the pre-configured SOC ESP8266, all microcontrollers must use the UART interface. The module is set up using AT instructions and requires 3.3 volts of supply voltage to function. For the module to be configured in client mode, the microcontroller must be designed to provide AT instructions in the precise sequence required. The ESP8266 may be used in client and server modes.
Sensors Spo2, temperature, and SOS button make up the system. These three sensors will each measure temperature and heart rate. Each of these sensors will deliver an analogue voltage that corresponds to a certain weather component. These analogue voltages will be transformed into digital data by the ESP8266.
IOT (Internet of Things)
Data Collection (Underwater Sensors + Arduino UNO) Various health monitoring sensors (such as heart rate, body temperature, oxygen level sensors) are connected to the Arduino UNO (ATmega328 microcontroller). The Arduino continuously reads and processes the sensor data.
Data Transmission (Arduino UNO → ESP8266 Node MCU) The Arduino sends the processed data to the ESP8266 Node MCU through serial communication (usually UART). The Node MCU acts as a bridge between the Arduino and the internet.

Wireless Communication (ESP8266 Wi-Fi Module) The ESP8266 connects to a Wi-Fi network and uploads the received sensor data to the cloud. It uses the Blynk platform to send this data securely over the internet.
Remote Monitoring (Blynk App on Smartphone)
The Blynk app, installed on the monitoring team's smartphone,fetches the real-time data from the cloud. It displays the aquanaut's health information in an easy-to-read format (graphs, gauges, notifications). Thus, the system enables live health tracking of underwater divers, ensuring their safety by continuously monitoring their vital signs remotely.

Device testing the software implementation of the suggested system is crucial for retrieving sensor data and updating it on the server. Here, we mainly employed two software programmers. The ARDUINO IDE is an embedded programming platform that supports a range of microcontrollers and gives them access to a full programming environment. The system's full programming can be done in the C programming language. The SCUBA Diver Health Monitoring System using IoT has the potential to revolutionize the way scuba divers are monitored, providing a comprehensive and reliable system for monitoring their health and ensuring their safety during dives.

Water Communication Module
A water communication module is a device that facilitates the transmission of data related to water consumption and other water-related information, such as alarms and tamper detection, from a water meter to a central system for monitoring and management. These modules can use various technologies, including NB-IoT, LoRa WAN, and WM-BUS, to establish communication.
- Data Transmission
- Remote Configuration and Monitoring
- Various Communication Technologies
- IP68 Protection

Modulation Technique & Principle
- Acoustic Communication Modulation
- Orthogonal Frequency Division Multiplexing

(OFDM)
- Spread Spectrum Techniques (DSSS, FHSS)
- Optical Communication Modulation
- Pulse Position Modulation (PPM)
- Electromagnetic Communication Modulation

VI. ADVANTAGES

Underwater health monitoring and tracking of aquanauts offer several significant advantages, both in terms of safety and mission success. These systems provide real-time data and insights into the aquanauts' physiological and environmental conditions, improving decision-making and reducing risks.

VII. DEVICE AND IT’S USE

Scuba Diving Safety
The system can be used by recreational and professional divers to ensure real-time health monitoring during dives, enhancing safety and reducing the risk of accidents.
Underwater Exploration
In marine research and underwater archaeology, the system ensures the safety of divers exploring challenging environments by providing continuous health data to surface teams.
Rescue and Recovery Operations
In search and rescue missions, the system allows monitoring of rescue divers' health while they work in hazardous underwater conditions, ensuring immediate response if any health issues arise.
Commercial Diving
The system is ideal for commercial divers working in underwater construction, oil rigs, or maintenance, where long-duration dives are common, providing real-time monitoring to prevent health-related incidents.
Military and Defense
Used in navy and military operations, this system enhances diver safety in underwater missions by maintaining constant communication and monitoring, allowing quick response during emergencies.

VIII. SAFETY INCIDENT ANALYSIS REPORT

The risk levels that scuba divers encountered and saw between 2010 and 2025 are summarized in this study. The information displays the total number of dangers encountered, the number of risks the diver personally experienced, and the number of risks a dive companion or other observer personally witnessed. The data from 2010 to 2025 reveals an overall rise in the risks that scuba divers encounter, with 122 risks in total in 2010 and 168 risks in 2025. Additionally, the data reveals a steady rise in the number of risks faced by divers, from 34 in 2010 to 61 in 2025.

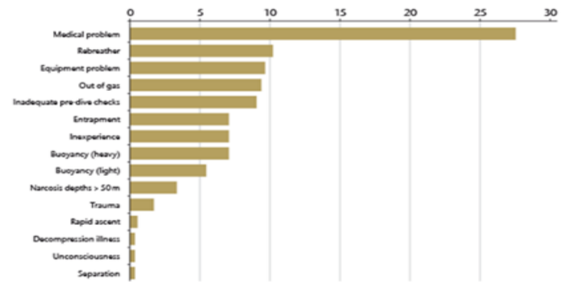

Fig:2 The risk analysis data for scuba divers from 2010 to 2025

However, the number of risks witnessed by dive partners or observers has decreased over the same period, with a total of 88 risks witnessed in 2010 and 107 risks witnessed in 2025. This suggests that dive partners may be less vigilant in monitoring the safety of divers, or that divers are less likely to report risks to their partners. The risk analysis data for scuba divers from 2010 to 2025 are shown in Figure.

IX. EXPERIMENTAL ANALYSIS

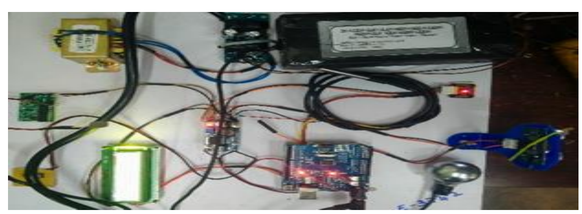

Fig:3 A Experimental setup for transmitter for Underwater Health Monitoring &Tracking device for Aquanauts

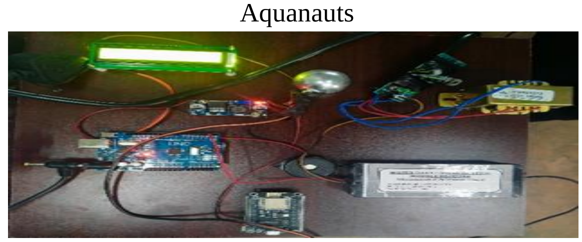

Fig:4 A Experimental setup for Receiver for Underwater Health Monitoring &Tracking device for Aquanauts

Fig:5 IOT BLYNK APPLICATION RESULT for Underwater Health Monitoring &Tracking device for Aquanauts

X. CONCLUSION

This project successfully demonstrates an effective underwater health monitoring and tracking system tailored for aquanauts. By integrating sensors like SpO_2 monitors, emergency buttons, RF communication, and a real-time cloud interface using the ESP8266 and Blynk platform, the system ensures continuous tracking of vital parameters and emergency alerts even under challenging underwater conditions. The Arduino UNO acts as the central controller, efficiently managing sensor data acquisition, local display updates, and communication with the cloud, providing immediate feedback through visual and audible indicators like displays and buzzers. This enhances both the safety and operational efficiency of underwater missions. The system for tracking the health parameters of scuba divers utilizing an IoT and UWC scenario has been developed, and it is now operational. The system offers a low power option for setting up a ship station. This model addressing the need for continuous monitoring of divers' health as Underwater Health Monitoring &Tracking device for Aquanauts. The device offers a dependable and effective way to monitor vital indications including heart rate, oxygen levels, and other important markers of diver health by utilizing water data communication technology. Assuring the safety and wellbeing of scuba divers, the system's IoT-based design enables wireless data transmission and offers real-time monitoring and analysis capabilities. Based to the use of low power wireless sensors, a SoC with a built-in Wi-Fi module, and UWC, the system has successfully updated the Scuba diver while being tested in environment.

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