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Dive Guard IOT Based Health Monitoring System for scuba Divers

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Abstract: Dive Guard is an IoT-based real-time health and safety monitoring system designed to enhance the security of scuba divers during underwater activities. Traditional diving practices rely heavily on manual monitoring and diver experience, which can lead to delayed detection of critical physiological or environmental risks. The proposed system integrates wearable waterproof sensors to continuously track key biometric parameters—such as heart rate, oxygen saturation, and body temperature—along with environmental variables including depth, water temperature, and remaining tank pressure. Sensor data is transmitted wirelessly to a surface-level monitoring station using low-frequency acoustic communication or optimized RF technologies suitable for underwater transmission. The collected data is processed and analyzed to identify early signs of distress, enabling timely alerts to dive supervisors or rescue teams. The system also logs dive profiles for post-dive evaluation and safety compliance. By combining IoT connectivity, real-time analytics, and ergonomic design, Dive Guard improves situational awareness, reduces accident risk, and supports safer, more data-driven diving operations for both recreational and professional.

I. INTRODUCTION

Dive Guard is an innovative IoT-based health and safety monitoring system designed to enhance underwater protection for scuba divers. Diving is an activity that exposes individuals to a variety of risks, including pressure-related injuries, oxygen depletion, hypothermia, panic episodes, and unpredictable marine conditions. Traditional diving equipment provides depth gauges, tank pressure readings, and timers, but these tools do not offer real-time information about a diver's physiological status. Dive Guard addresses this challenge by integrating advanced sensor technologies, underwater communication methods, and intelligent data analytics into a compact, rugged, and diver-friendly device.The system incorporates multiple waterproof biometric sensors to continuously monitor vital signs such as heart rate, oxygen saturation, respiratory patterns, and body temperature. These sensors are embedded into a wearable module that attaches comfortably to a diver's suit or wrist. Along with physiological monitoring, the system measures environmental factors including depth, surrounding water temperature, ambient pressure, and remaining air in the scuba tank. By combining internal body indicators with external environmental data, Dive Guard generates a complete safety profile for each diver diver, allowing early detection of dangerous conditions before they escalte.A key aspect of Dive Guard is its effective underwater communication capability. Since traditional wireless transmission such as Bluetooth or Wi-Fi cannot penetrate water efficiently, the system employs acoustic or low-frequency communication methods that work reliably under varying underwater conditions. Data collected from the diver is periodically transmitted to a surface-level unit or a companion device, enabling supervisors or teammates to monitor the diver's condition in real time. The system uses intelligent, fault-tolerant algorithms to ensure that signals are clear, synchronized, and secure. In situations where communication is temporarily disrupted, the wearable device performs edge processing—analyzing data onboard—to detect anomalies and alert the diver immediately through visual or vibration-based notifications. The internal processing core of Dive Guard is built around a low-power microcontroller optimized for marine environments. The device is encased in a pressure-tolerant, corrosion-resistant housing to withstand extended exposure to saltwater. Low-power operation is achieved through efficient power management techniques, which allow the device to function throughout long diving sessions without interruption. Data storage modules record dive profiles, biometric variations, environmental patterns, and any triggered alerts. After the dive, all stored data can be uploaded to a cloud system or local computer for post-

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analysis, allowing divers and instructors to assess performance, identify health trends, and improve future training or diving strategies. One of the most important features of Dive Guard is its intelligent alert mechanism. The system continuously compares real-time readings with established safety thresholds based on diving physiology guidelines. If parameters such as heart rate, SpO_2, or depth show rapid or abnormal fluctuations, the device immediately issues alerts. These alerts may appear as warning lights, vibration patterns, or audio tones depending on the severity. Severe cases, such as sudden oxygen drops, irregular breathing.

I. PROPOSED METHODOLOGY

Underwater Pathway to the Proposed Methodology

The image presents a calm and visually engaging underwater scene that uses scuba divers as a metaphor for a structured and thoughtful methodology. At the top, the title stands out clearly, signaling that the illustration is meant to support an academic, research, or project-based explanation of how a process will unfold. Beneath this title, the underwater world is illustrated with smooth layers of blue that deepen in color as they descend, giving a sense of depth, clarity, and gradual exploration. Within the center of the scene, two scuba divers are shown rising toward the lighter part of the water, their movements suggesting progress, intention, and direction. They wear wetsuits, fins, masks, and bright yellow air tanks that create a vivid contrast against the blue tones of the ocean. Between them runs a vertical dashed line with an arrow at the top, and this line acts as a visual representation of structure, order, and sequential steps. The divers move alongside it as though following a planned path upward, symbolizing the logical progression found in a methodology section—moving from initial exploration into deeper understanding and finally toward clarity and completion.

The curves of the water, the gentle bubbles rising upward, and the presence of soft, stylized sea plants at the bottom further enhance the atmosphere of exploration and discovery. These plants, situated near darker shades of blue, represent the deeper, more foundational stages of a process, while the lighter tones at the top convey clarity, surface, and goals reached. The symmetry of the divers on either side of the dashed line adds balance and subtly conveys teamwork, collaboration, and shared movement toward an objective. Even their posture and orientation suggest focus and commitment, as though they are not merely drifting through the water but following an intentional course. The upward arrow reinforces the idea of improvement, advancement, and rising toward an outcome, providing a simple yet powerful metaphor for methodological steps. The entire composition combines minimalistic shapes, clean edges, and soft gradients, making the visual message easy to understand and aesthetically calm. This artistic approach emphasizes that a methodology is not just a list of steps—it is a journey of moving from complexity toward clarity, from depth toward understanding, and from exploration toward structured achievement. The underwater theme suggests that research or project work involves entering new territory, navigating unknown elements, and steadily progressing in a guided, well-organized manner. Through its soothing colors, orderly layout, and upward flow, the image communicates that methodology involves both discovery and discipline. It suggests that success comes from following a structured path with awareness, analysis, and collaboration. Ultimately, the illustration conveys a thoughtful message about progress, learning, and the movement through stages, making it an effective visual representation for any presentation or report discussing the proposed methodology of a study, project, or investigation.

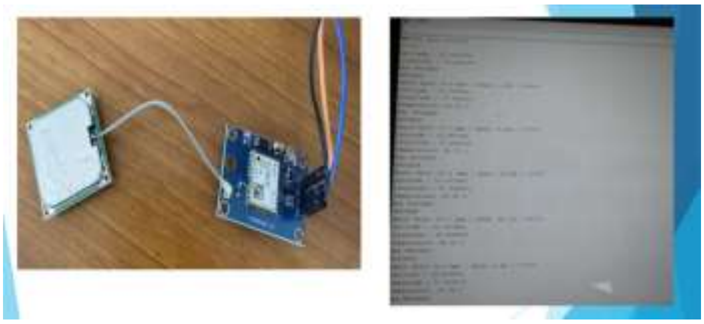
II. IMPLEMENTATION

Scuba Diving Process with System Deployment Overview

The image combines two types of instructional visuals: a step-by-step scuba diving sequence and a simplified system deployment architecture diagram. The upper section shows four illustrated panels of a diver preparing for a dive, adjusting his mask, performing final checks, stepping into the water, and finally swimming while using his breathing apparatus. The artwork is clean, minimalistic, and uses consistent colors such as blue, yellow, and black to depict the complete transition from land to underwater activity.Below the diving sequence is a deployment architecture diagram that represents a standard web

The image presents a combined instructional and technical infographic. The top half focuses on the practical process of scuba diving, using four sequential panels to show the diver's preparation and entry into the water. The diver is fully equipped with a wetsuit, oxygen tank, mask, snorkel, and fins. The first frame highlights initial gear adjustment, the second shows readiness and posture, the third captures the step-off technique used to safely enter the water, and the fourth illustrates the diver beginning to swim and breathe underwater. The visuals depict a smooth transition from land-based preparation to underwater activity, helping viewers understand the fundamental stages of a scuba dive.The lower portion of the image shifts from physical activity to digital architecture. It illustrates a simplified deployment model commonly used in web applications. A user device sends an HTTP request to a server, which then interacts with a backend database to process data. After completing the operation, the server returns an HTTP response to the user. The components—user, server, and database—are connected through arrows that represent data flow. This architecture diagram emphasizes how information is exchanged in a basic client–server system.Overall, the image blends two different types of workflows: a real-world action sequence and a technical system diagram. It visually demonstrates how step-by-step processes can be communicated clearly whether in physical tasks like diving or in software deployment. The image is a hybrid infographic that merges a practical, real-world training sequence with a simplified representation of software deployment architecture. In the upper half, the focus is entirely on scuba diving preparation. Four cleanly illustrated panels guide the viewer through the essential stages of beginning a dive. The diver is shown adjusting equipment, such as the mask and breathing apparatus, which is critical for ensuring safety and visibility underwater. The artwork emphasizes proper posture, readiness, and technique, particularly in the moment when the diver steps off into the water. The final frame situates the diver completely submerged, swimming confidently with clear streams of bubbles showing oxygen circulation. These panels visually narrate the progression from preparation to action, highlighting the importance of sequential steps in any physical procedure. In contrast, the lower half of the image transitions into a conceptual technical diagram. This part portrays a standard deployment architecture .

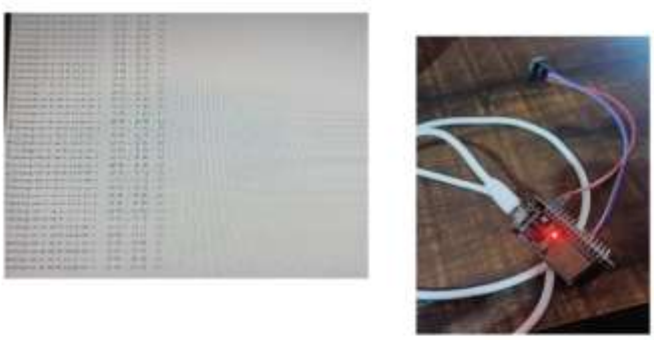
RESULT AND DISCUSSION



NEO -6M GPS MODULE (LOCATION)

The NEO-6M GPS module is a compact, low-power satellite-based positioning receiver widely used in embedded systems, navigation devices, and hobbyist electronics. It operates using the u-blox NEO-6 series chipset, which is known for its stable performance, efficient signal processing, and fast acquisition times.

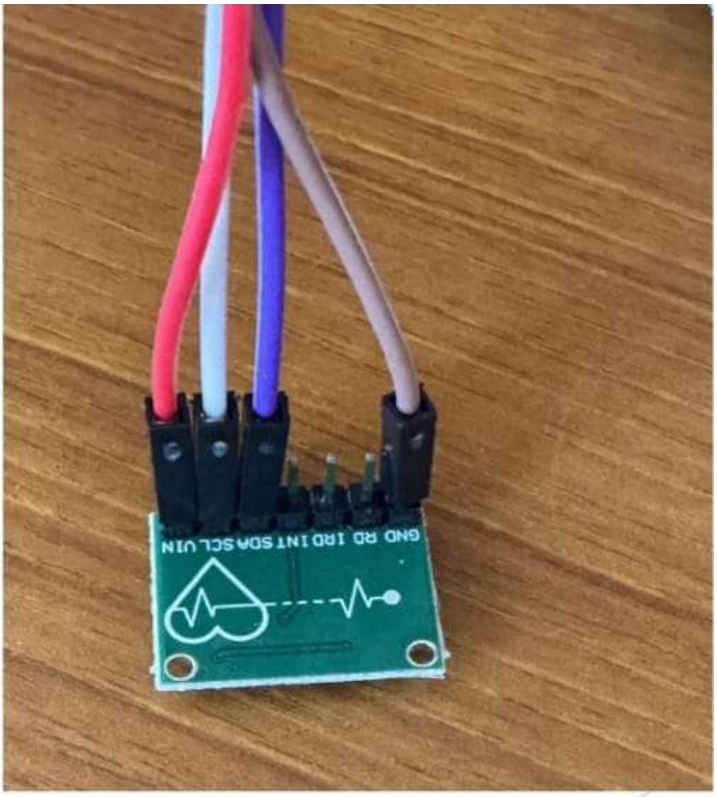
The module calculates its location by receiving radio signals continuously transmitted from a network of GPS satellites orbiting Earth. Each satellite broadcasts extremely precise timing information, and by measuring how long these signals take to arrive, the NEO-6M can compute its distance from each satellite in view. When distances to at least four satellites are known, the module uses trilateration to determine its exact latitude, longitude, and altitude, forming a complete 3D position fix.Once it has locked onto satellites, the module outputs its location in NMEA-0183 sentences, a widely accepted text-based protocol used by navigation systems. Sentences such as GGA, RMC, GSA, and GSV carry details including coordinates, fix status, visible satellites, speed over ground, heading, and precise UTC time derived from atomic clocks. These NMEA messages are transmitted through a UART serial interface, typically at a default baud rate of 9600 bps, though this can be changed using configuration tools. The data is easy for microcontrollers such as Arduino, ESP32, STM32, or Raspberry Pi to parse and use for navigation or tracking applications.The NEO-6M usually includes a small ceramic patch antenna, although many modules support or include an active antenna that provides additional gain for improved reception. Because GPS signals are extremely weak by the time they reach the Earth's surface, a clear line-of-sight to the sky is crucial for a strong and stable fix. Indoors or in urban environments surrounded by tall buildings, satellite visibility may be reduced, increasing the time required to obtain a fix or lowering accuracy. Under open-sky conditions, the module can typically achieve around 2.5 meters positional accuracy, which is sufficient The NEO-6M supports update rates up to 5 Hz, allowing it to output new position data several times .



BMP 180 SENSOR(TEMPERTURE)

The BMP180 is a compact digital barometric pressure and temperature sensor designed by Bosch Sensortec, widely recognized for its precision and stability in atmospheric measurements. It plays an important role in weather-monitoring systems, altimeters, GPS enhancement modules, drones, and environmental data loggers because it can sense very small changes in air pressure and convert those readings into accurate altitude or weather-related information. The sensor uses a piezo-resistive sensing element that reacts to pressure changes by altering its electrical resistance, and this response is measured and processed to produce calibrated digital readings. Bosch preloads the sensor with unique factory calibration coefficients stored in internal memory, allowing the device to automatically compensate raw data and deliver more precise results without requiring manual tuning from the user.Because atmospheric pressure decreases as altitude increases, the BMP180 can estimate elevation using standard barometric formulas, making it extremely valuable for navigation and flight-related applications. While the altitude reading is an estimate rather than an absolute measurement, it is usually stable enough for general-purpose altimetry and is often integrated into drones to maintain steady flight levels. The sensor communicates using the I²C protocol, which makes it simple to interface with microcontrollers like Arduino, ESP32, Raspberry Pi, STM32, and many other embedded platforms. It sends temperature and pressure readings digitally, eliminating the need for analog-to-digital converters and improving measurement reliability. Its operating pressure range spans from about 300 hPa to 1100 hPa, covering altitudes from mountain peaks to sea-level environments, while the supported temperature range from around –40°C to +85°C ensures versatility in outdoor condition.

The data analysis interface further supported system validation by displaying efficiency distribution, demand prediction, and detailed sensor telemetry. Efficiency distribution charts revealed that the majority of nodes operated within medium to high efficiency ranges, confirming balanced load distribution. The demand prediction module identified high-demand nodes accurately, assisting in proactive routing and congestion avoidance. The tabular sensor data provided granular insights into node behavior, showing temperature values, pressure, efficiency, and demand levels aligned with real-time simulation output.



MAX30100 SENSOR(HEART RATE AND OXYGEN SENSOR)
The MAX30100 is an integrated sensor designed for simultaneously measuring heart rate and blood oxygen saturation using optical technology. It combines red and infrared LEDs with a sensitive photodiode, allowing it to analyze how blood absorbs and reflects light as it flows through capillaries. By detecting periodic changes in infrared absorption, the sensor extracts heart-rate information, while the ratio between red and infrared light absorption is used to calculate SpO_2, or blood-oxygen saturation. The device communicates through the I^2C protocol and typically uses the addresss.

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