Monitor The Diver's Biomedical Condition from The Navigator Through Underwater Wireless Communications

Said Al Siyabi[1] and Shaik Mazhar Hussain[1#]

[1]Middle East College, Muscat, Oman
[#]Advisor

ABSTRACT

Underwater wireless communication is one of the wireless communications whose medium is water. At the present time, there are audio, radio frequency, and optical wireless communications. With the advanced development of underwater wireless communications, however, it suffers from the transmission of data to the surface of the water and may be very expensive. The ship's personnel suffer from knowledge of the diver's biomedicine, which makes the diver more vulnerable. This project focuses on underwater communications to transmit biomedicine to the diver from underwater. Data will be transmitted from underwater to the surface of the water using Li-Fi technology to transfer vital medicine to the diver during his diving period and to the main station, which puts the diver in a safe state. This project will be important to raise the efficiency and maintain the safety of divers and scientific researchers for marine companies that include diving courses and fishermen. The project follows the V model methodology in implementing all steps.

Introduction

Nowadays, it has become important for underwater wireless information transmission in various fields, such as the military, industry, and the scientific community. At the beginning there are high increasing in large numbers of unmanned cars and devices inside the water that need a large speaker and a high frequency to transmit data inside the water. Over the past two years, interest has increased in the field of optical wireless communications for terrestrial, space, and in-water links that have the potential to provide high data rates with low power and mass requirements. In addition, many researchers contributed through their studies by discovering that optical wireless links inside water are more difficult to implement than aerial wireless links. Through the results of scientific research on visual communication underwater, we find that there is a difference between the scientific experiment and the real reality in terms of multiple characteristics, including:

First, the frequency domain properties of the problems facing the transmitter and receiver are to work poorly within the aqueous environment to form mechanical stability. Secondly, the transmission characteristics of the submerged optical communication signals. We find that despite the development of the acoustic communication of the underwater wireless sensor network, it is weak because of its dispersion inside the water. In addition to that, sound or sonar frequencies face a huge delay inside the water until they reach the receiver. Where when the devices send sound frequencies, they are reflected on the surface without penetrating them, and this causes practical inefficiency in discovering oceans and seas.

There are many solutions that the researchers worked on, the most prominent of which are:

Discover optical communication without wires as these signals have linked with satellites, aircraft, and submarines inside the water. Also, other solutions that have been developed are optical wireless underwater communications, which work using light-emitting diodes and laser diodes. The effectiveness of underwater laser wireless communication has been measured as playing an important role in providing safe, efficient, and high-data-rate communication over short distances.

Moreover, with the progress and development in the field of communication and modern technology, navigators, marines, divers and others who practice their profession at sea need to provide them with additional support in unexpected situations that bring them risks. Therefore, it is necessary for researchers and scientists to search and monitor the predictions of people inside the sea to reveal the health status of divers and navigators. The work of a water data communication system is to convey messages to marine navigators or fishermen and also can monitor their health conditions. Where the water communication unit uses data to obtain text and sensor readings on the ground from the navigator and avoid person death. Also, within this system there are sensors to measure the temperature of the navigator under water and the navigator's blood pressure. If the reading of the device is detected that the navigator's temperature and pressure are not stable, the crew on the ground must intervene quickly to assist him. (Rajan et al., n.d.)

Literature Review/Theory

The underwater communication method uses infrared, which is also utilized for wireless communication. The system is divided into two circuits, each of which has an 8051 microcontroller, an IR LED transmitter sensor, a TSOP 1738 infrared receiver, and a message display, in addition to a keyboard for typing messages. A clear water container was put between the two circles so that infrared rays convey data through the water and are received by the infrared sensor, essentially allowing wireless communication between the two circles. The results demonstrated effectiveness in transmitting and receiving data underwater through infrared radiation, and it might be an alternate solution for underwater cables, which are costly. The domain of underwater wireless communications is in great progress with current technology to overcome the existing limits in sending and transferring data such as sound and images from under water, and to keep pace with environmental consequences and oceanographic research. (Chaithanya Vardhan et al., 2021). The system recognizes the marine navigator's health and locates it using GPS, following which the microcontroller activates the Wi-Fi sensor and sends the data to the cloud. The ground station (a person on Earth) receives data from the Internet of Things cloud and records the navigator's position. The findings showed that the Internet of Things website received accurate data on the marine navigator's health status, such as temperature and oxygen level in the blood, in addition to the navigator's position. In addition to the speed of transmission and data transmission from the ground station to the marine navigator. The idea may be improved by increasing the transmission range and adding sensors, such as a water quality sensor that detects the quantity of pH, dissolved oxygen, and salt in the sea and sends the data to the Internet of Things cloud. (Sahu & Pawar, 2021). The underwater communication system operates through a deck connection process and is linked to a 5 GHz (10 km) wireless Wi-Fi network, making wireless communication possible. Over these channels, the vehicle will get the compressed photos, the input from the sensors, as well as the control commands. The system will integrate a unique communications protocol that will adapt the compression ratio in real time based on the bandwidth that is available at any given time. This will be done in response to changes in bandwidth. This will guarantee that the system maintains a minimal degree of quality, which is required for an experienced operator to conduct accurate monitoring of the intervention. When a user requires a higher image quality in a specific location, it is also considered a reason to improve the compression system so that the scene's quality can be varied on a regional basis. This makes it possible to change the quality of the scene on a per-region basis. (Centelles et al., n.d.). In this paper, Li-Fi technology was used to transmit data from under water. There are many underwater communications such as electromagnetic waves, sound waves, and light signals, but these examples have their own disadvantages, such as the fact that electromagnetic waves depend on short-range communications and light waves exist. has line-of-sight problems. In this paper, more efficient and cheaper LED lighting methods were used to transmit data on which Li-Fi technology relies, as well as Bluetooth and GPS that are linked to the Internet of Things. The system consists of two systems, the transmitting system, and the receiving system. Show below. (Krishnamoorthy et al., 2021)

System Design

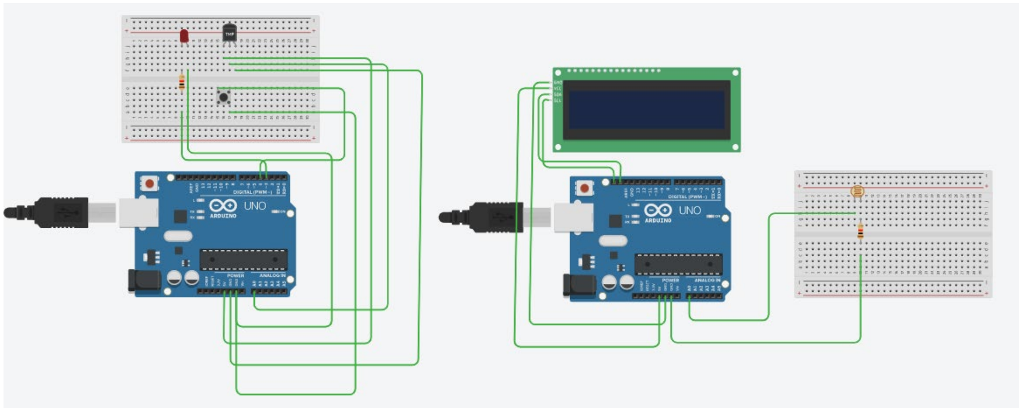

Figure 1. System Design

How to connect MLX sensor to Arduino UNO:

1) Connect pin VCC to from MLX sensor to 5 volts in Arduino pin.
2) Connect pin (- negative) to GND pin in Arduino.
3) Connect the S pin to Arduino to in pin A0.

How to connect Heartbeat sensor to Arduino UNO:

1) Connect pin VCC to Arduino uno in pin 5 volts.
2) Connect pin (- negative) to pin GND in Arduino.
3) Connect pin S pin to pin A0 in Arduino.

How to connect LDR sensor to Arduino:

1) Connect the pin small in GND in Arduino pin.
2) Connect the big pin in any digital pins in Arduino.

How to connect LDR sensor to Arduino:

1) Connect the VCC to 5v pin in Arduino.
2) Connect the GND to GND pin in Arduino.

3) Connect the SDA-to-SDA pin in Arduino uno.
4) Connect the SCL to SCL pin in Arduino uno.

Methods

In this project will choose The V model methodology is like the classic waterfall methodology that compensates for the shortcoming of the test. The reason for choosing this methodology is the project's compatibility with this methodology, the project works on the C++ programming language using the Arduino microcontroller, in addition to conducting testing at each stage of its stages, which facilitates the development of the project and early detection of errors. V model methodology will show below in details.

V Model Methodology

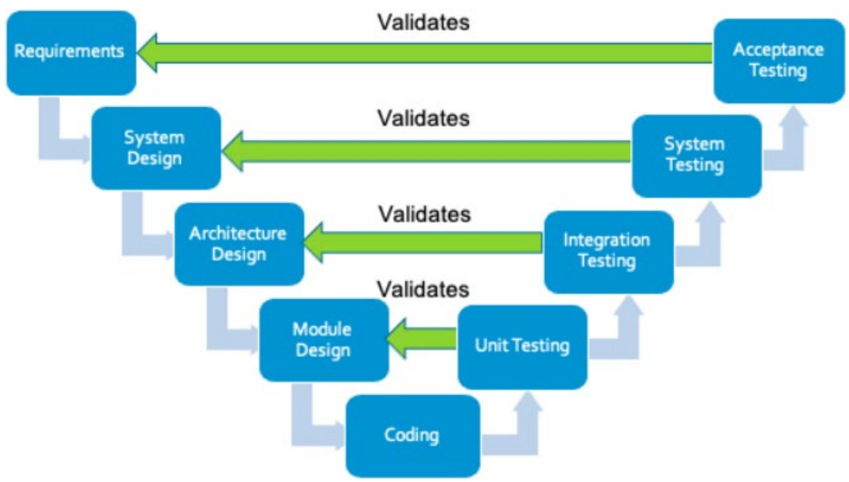

Figure 2. V-Methodology

Requirements: Here the requirements needed by the project such as body temperature sensor, heart rate and LED will be collected.

Design system: All the details of the software and hardware used will be taken in the block diagram and the flowchart, through which it explains the working method, after that the test details will be prepared.

Architectural design: In this step, data and communication processes are transferred between systems and internal units.

Module design: In this step, the interior design is selected and all components and sensors are understood through the data sheet.

coding This step contains the development of the program through Arduino, which contains the code.

Unit testing: At this stage, a test is prepared on the code that helps in detecting errors by connecting the body temperature sensor to the Arduino and seeing the response of the code.

Integration testing: In this step, all components are tested and biomedical data from underwater to the main station are received from the diver and the extent of Li-Fi technology is verified.

System testing: In this step, the entire project is tested to take notes on the system and detect errors to modify them.

Acceptance testing: In this step, the defects and performance of the system and the problems that occur to the sensors are analyzed.

Conclusion

In conclusion, wireless communications under water have become more interesting to scientific researchers as discoveries under the depths of the sea become more developed. Therefore, Li-Fi-related biomedicine is an advanced technology in underwater wireless communication that is useful for divers. In this project, a diver's biomedical monitoring system was made under water, and the body temperature sensor, the heart rate sensor, and the emergency switch were connected to Arduino. PESETL risk management was discussed, and it was found that it is possible to carry out this project with some observations in the environmental field that were justified. The second chapter includes the methodologies, and the V-model methodology was used during the project plan. In the third chapter, the literature was reviewed, and four articles were selected that revolved around the focus of my project. In the fourth chapter, he talks about the project budget and project time planning. The fifth chapter talked about project design and analytics. The underwater wireless communications are explained in an easy and concise way for the reader. Although there was a delay during the first weeks, I managed to finish it in time. Some features will be included to develop the idea of the project, such as the Internet of Things.

Limitations

- Satisfaction of companies and divers of the project.
- availability of modern underwater wireless communication technologies that are more efficient, such as radio frequencies, so the project relies on Li-Fi technology, which is considered competitive.
- The nature of the climate and water is it possible to apply this project under changing climatic conditions and the different type of water easily to give all its specifications and advantages.
- Being able to obtain accurate data of the health of the diver underwater to the main station.

Acknowledgments

I thank my supervisor for his unlimited support, his words of encouragement that made me complete the project planning without any difficulties, and his words of encouragement that provided me with help and support. I would also like to thank the Head of the Department of Engineering and the Middle East College for their support. Further, the content of this paper is completely related to my project.

References

16x2 LCD module | Joy-IT. (n.d.). Joy-It.net. https://joy-it.net/en/products/SBC-LCD16x2

16x2 LCD module | Joy-IT. (n.d.). Joy-It.net. Retrieved January 5, 2023, from https://joy-it.net/en/products/SBC-LCD16x2

admin. (2020, February 14). *How to Compute Resistor Value for LED*. CyberBlogSpot. https://cyberblogspot.com/how-to-compute-resistor-value-for-led/

Akademi, T. (n.d.). *Arduino Uno Datasheet : Tesla Akademi Elektrik Elektronik Sistemleri Eğitim Merkezi.* Teslaakademi.com. https://teslaakademi.com/arduino-uno-datasheet

ATMega328P Microcontroller Pinout, Pin Configuration, Features & Datasheet. (2018). Components101.com. https://components101.com/microcontrollers/atmega328p-pinout-features-datasheet

Breadboards for Beginners. (n.d.). Adafruit Learning System. https://learn.adafruit.com/breadboards-for-beginners/breadboards

Breadboards for Beginners. (n.d.). Adafruit Learning System. Retrieved January 5, 2023, from https://learn.adafruit.com/breadboards-for-beginners/breadboards

Centelles, D., Rubino, E., Sales, J., Martí, J., Marín, R., & Sanz, P. (n.d.). *Wireless RF Camera Monitoring for Underwater Cooperative Robotic Archaeological Applications*. Retrieved January 4, 2023, from https://upcommons.upc.edu/bitstream/handle/2117/77631/33.pdf

Chek, W., & Khusairi, W. A. (2014). *PI voltage control technique for 3 phase induction motor using Simulink and Arduino*. Www.semanticscholar.org. https://www.semanticscholar.org/paper/PI-voltage-control-technique-for-3-phase-induction-Chek-Khusairi/5bdcc4c2a125fea9528a120641aae37c8792b78a

Daimiwal, N., Sundhararajan, M., & Shriram, R. (2014). Comparative analysis of LDR and OPT 101 detectors in reflectance type PPG sensor. *2014 International Conference on Communication and Signal Processing*. https://www.semanticscholar.org/paper/Comparative-analysis-of-LDR-and-OPT-101-detectors-Daimiwal-Sundhararajan/49f1a5527aed4829cbd611e1ac66d3ae17ad43d2

de Bruin, L. (2016, September 18). *PESTEL Analysis (PEST Analysis) EXPLAINED with EXAMPLES | B2U*. B2U - Business-To-You.com. https://www.business-to-you.com/scanning-the-environment-pestel-analysis/

Digital plug & play infrared thermometer in a TO-can. (2019). Melexis. https://www.melexis.com/en/product/mlx90614/digital-plug-play-infrared-thermometer-to-can

Digital plug & play infrared thermometer in a TO-can. (n.d.). Melexis. https://www.melexis.com/en/product/MLX90614/Digital-Plug-Play-Infrared-Thermometer-TO-Can#

Electronics, E., Electronics, P., Electronics, A., Things, I. of, Electronics, A., Vehicles, E., Events, Robotics, Circuits, 555, Projects, A., Projects, R. P., News, E., Forum, E., & Calculators. (2015, October 24). *16x2 LCD Display Module*. Circuit Digest. https://circuitdigest.com/article/16x2-lcd-display-module-pinout-datasheet

How to connect a push ... | Creative Technology Lab Wiki. (n.d.). Lab.arts.ac.uk. https://lab.arts.ac.uk/books/physical-computing/page/how-to-connect-a-push-button-or-switch

How To Install the Arduino IDE. (n.d.). Nonscio. Retrieved January 2, 2023, from https://www.nonscio.com/blog/how-to-install-the-arduino-ide

IR LED (Infrared LED). (n.d.). Components101. https://components101.com/diodes/ir-led-pinout-datasheet

Jumper Wires. (2013, May 19). Exploring Arduino. https://www.exploringarduino.com/parts/jumper-wires/

Jumper Wires. (2013, May 19). Exploring Arduino. https://www.exploringarduino.com/parts/jumper-wires/

Krishnamoorthy, N. R., Gerald, A., Rajalakshmi, G., Marshiana, D., & Thaj Mary Delsy, T. (2021). An Automated Underwater Wireless Communication System Using Li-Fi with IOT Support and GPS Positioning. *Journal of Physics: Conference Series*, *1770*(1), 012030. https://doi.org/10.1088/1742-6596/1770/1/012030

KS, A. (2020, November 3). Basics of IR Sensor | IR LED Pin Diagram & Working. Electronics for You. https://www.electronicsforu.com/technology-trends/learn-electronics/ir-led-infrared-sensor-basics

New Product News SMD Tactile Switch B3FS-4 Surface-mounting Switches with 12 x 12 mm size • Surface-mounting device of B3F-4 series. • Distinctive snapping action and extended mechanical/electrical durability. • Available in embossed taping packages for automatic mounting. (n.d.). Retrieved January 2, 2023, from https://docs.rs-online.com/1b59/0900766b81126ccb.pdf

Sahu, G., & Pawar, S. S. (2021). IOT-Based Underwater Wireless Communication. *Innovations in Computer Science and Engineering*, 33–41. https://doi.org/10.1007/978-981-33-4543-0_5

Scratch. (2018). *Scratch - Imagine, Program, Share*. Mit.edu. https://scratch.mit.edu/

*SMD Mini Push Button Switch 4 Pin 4*4*1.5MM*. (n.d.). Micro Ohm Electronics. Retrieved January 5, 2023, from https://microohm-eg.com/product/smd-mini-push-button-switch-4-pin/

*SMD Mini Push Button Switch 4 Pin 4*4*1.5MM*. (n.d.). Micro Ohm Electronics. https://microohm-eg.com/product/smd-mini-push-button-switch-4-pin/

What is Scratch. (2017). *What is Scratch?* Computerhope.com. https://www.computerhope.com/jargon/s/scratch.htm

www.NEWPAGES.com.my. (n.d.). *LDR Sensor Module (Light Dependent Resistor), LDR-MOD Sensor Modules Hobby / Education Development Kits Development Boards & Evaluation Kits Melaka, Malaysia, Batu Berendam Supplier, Suppliers, Supply, Supplies | Jit Sen Electronics Sdn Bhd*. M.jselectronics.com.my. http://m.jselectronics.com.my/index.php?ws=showproducts&products_id=1963634

ZorinkMore. (n.d.). *LEDs As Light Sensors*. Instructables. Retrieved January 2, 2023, from https://www.instructables.com/LEDs-as-light-sensors/#:~:text=LED%20as%20light%20sensor%3A

6 Basic SDLC Methodologies: Which One is Best? (2021, October 28). Www.roberthalf.com. https://www.roberthalf.com/blog/salaries-and-skills/6-basic-sdlc-methodologies-which-one-is-best#One

8 Basic Software Development Models and Methodologies You Should Know. (n.d.). Saigon Technology - 8 Basic Software Development Models and Methodologies You Should Know. Retrieved January 3, 2023, from https://saigontechnology.com/blog/8-basic-software-development-models-and-methodologies-you-should-know

Camacho, R. (2020, October 22). Verification vs Validation in Embedded Software. Parasoft. https://www.parasoft.com/blog/verification-vs-validation-in-embedded-software/

CIT Relay and Switch - Surface%20Mount switches. (n.d.). Citrelay.com. Retrieved January 3, 2023, from https://citrelay.com/category.php?category=Surface%20Mount&type=switches

Heartbeat Sensor - How to Measure Heartbeat: Working and Application. (2013, October 26). ElProCus - Electronic Projects for Engineering Students. https://www.elprocus.com/heartbeat-sensor-working-application/#:~:text=The%20heartbeat%20sensor%20is%20based

I2C - DUO Control System. (2023). Revrobotics.com. https://docs.revrobotics.com/duo-control/sensors/i2c

In-Depth: Detect, Measure & Plot Heart Rate using Pulse Sensor & Arduino. (2021, January 16). Last Minute Engineers. https://lastminuteengineers.com/pulse-sensor-arduino-tutorial/

Jayathilaka, C. (2020, July 30). *Agile Methodology*. Medium. https://medium.com/@chathmini96/agile-methodology-30ec4cdf3fc

Jayathilaka, C. (2020, July 30). *Waterfall vs. Agile Methodology*. Medium. https://medium.com/@chathmini96/waterfall-vs-agile-methodology-28001a9ca487

LCD 16x2 Display Module | Sensors & Modules. (n.d.). Www.electronicwings.com. https://www.electronicwings.com/sensors-modules/lcd-16x2-display-module

Light dependent resistor (LDR). (n.d.). LEDnique. http://lednique.com/opto-isolators-2/light-dependent-resistor-ldr/

Melexis MLX90614ESF-AAA Infrared Temperature Sensor. (n.d.). Génération Robots. Retrieved January 7, 2023, from https://www.generationrobots.com/en/402119-infrared-temperature-sensor.html

Rajan, R., Amala, M., Roy, S., Elizabeth, M., Aiswarya, M., & Bousally, M. (n.d.). *Underwater Wireless Communication System*. Retrieved January 11, 2023, from https://www.ijert.org/research/underwater-wireless-communication-system-IJERTV9IS090387.pdf

Rathore, A. (2020, October 15). *What Is Light Dependent Resistors (LDR)? | Basics*. Electronics for You. https://www.electronicsforu.com/technology-trends/learn-electronics/ldr-light-dependent-resistors-basics

Sonary. (n.d.). Sonary. Retrieved January 5, 2023, from https://sonary.com/b/autodesk/tinkercad+cad/

Trunkett, O. (2020, August 27). *SDLC Methodologies: From Waterfall to Agile | Virtasant*. Virtasant.com. https://www.virtasant.com/blog/sdlc-methodologies

What is LDR? (Photoresistor) - Types, Working, Application, Diagram & Symbol [Complete Details]. (2021, December 8). Engineering Learn. https://engineeringlearn.com/what-is-ldr-photoresistor-types-working-application-diagram-symbol-complete-details/

What is V-model- advantages, disadvantages and when to use it? (n.d.). Tryqa.com. https://tryqa.com/what-is-v-model-advantages-disadvantages-and-when-to-use-it/

Al Balushi, I., & Hussain, S. M. (2021). IoT BASED AIR QUALITY MONITORING AND CONTROLLING IN UNDERGROUND MINES. *Journal of Student Research.*

Hussain, S. M., & AL HABSI, N. S. N. S. (2021). Protection of foodstuffs in storage warehouses system. *Journal of Student Research.*

Hussain, S. M., & Al Saadi, E. A. S. N. (2021). Voice enabled Elevator system. *Journal of Student Research.*