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Bio Parameters Monitoring System for Sea Researchers using LiFi

Liya George[1], K. Anusudha[2]
[1]*M.Tech Student, Department of Electronics Engineering, Pondicherry University*
[2]*Assistant Professor, Department of Electronics Engineering, Pondicherry University*

Abstract: ***Different types of health monitoring systems are now available in the market. We are using them as a part of our day-to-day life to analyze health conditions. In the case of sea researchers and scuba divers, the medium they are working is water. The health difficulties are more inside the water. So there is a need to develop a health monitoring system for sea researcher's/scuba divers to analyze their health condition frequently to ensure their safety. The proposed work uses LiFi technology as the communication method to transmit and receive corresponding bio parameter values. This work aims to provide a harmless wireless health monitoring system that will provide maximum efficiency inside the water.***
Keywords: LiFi module, Photodetector, Line of sight, LM35, heart rate sensor.

I. INTRODUCTION

The industrial standard depth unit for divers is 60 feet at sea level. We know that health difficulties inside the water are high. Breathing problems, panic attacks, etc. are the main issues they suffer. So we need health monitoring systems to measure the health parameters of such diver's/sea researchers. Some existing technologies are used to measure the health parameters of sea researchers. But most of these equipment's are not efficient enough. So there is a need to develop an efficient system that can ensure the safety of the divers. Previous technology used to communicate with the sea researcher who is working underwater uses a cable that is extended from ship to the sea. This method of using underwater wired communication has many disadvantages such as lateral drag of signal, signal degradation, and so on. Hence, to overcome these disadvantages Underwater Wireless Communication (UWC) system is introduced. RF communication causes many harmful effects on the user. This leads to the implementation of optical wireless communication. Optical communication can carry more data because it overcomes the limitation of bandwidth and it is free from harmful effects.

II. LITERATURE REVIEW

The wireless optical communication system now uses in almost all applications. It provides high-speed data transmission and efficiency. Within the last few years, optical communication increased because it provides a high data rate with low power consumption. In [1], Optical communication can achieve data rates much higher than those available through acoustic modems. The underwater environment is challenging due to variability in water quality. A rotational link may vary between 6dB and 95dB in loss depending on path length, transmission wavelength, and whether the water is turbid or clear. A wide dynamic range receiver is important for robust operation over variable link conditions. They have demonstrated the work in the laboratory and the field of a receiver combining a photomultiplier tube and linear avalanche photodiode. The photomultiplier allows high sensitivity communication and the photodetector allows high data rates when more signal power is available.

In [2], they give an overview of a method that is used to measure the bio parameters of scuba divers. In this paper, several kinds of agents were evaluated to change the coefficient of experimental water precisely. Reliability of water recreation, the frequency domain characteristics of data communication through water channel in experimental water is measured and compared. The results show that the type and particle size of agents will significantly affect water properties. The system measures the heartbeat of scuba diver. It is the heartbeat sensor that measures the heart rate and communication is achieved through a water data transceiver module.

In [3], [4], [5] explaining about LiFi (Light Fidelity) technology. It provides a detailed description of the transmission of data (text, audio) using LiFi technology. Also focuses on the study of various topologies to understand the characteristics of the LiFi system. LiFi is a visible light communication system that consists of one light source equipped with a signal processing unit and a photodiode that can receive light signals. Arduino microcontroller is used for the work. The corresponding transmitted output is displayed on the PC screen with the help of visual basic software. LiFi can be used in electromagnetic sensitive areas where electromagnetic interference is avoided like hospitals and power plants. LiFi uses direct modulation techniques that are similar to low-cost infrared devices.

In [6], they described optical communication systems for data transfer in underwater networks. They use an optical channel to facilitate the communication Link in free space and underwater. This system proves that optical communication using light can be a good solution for underwater data transmission applications that require a high data rate at moderate distances. Here introduces an underwater optical communication system that can communicate wirelessly at a transmission rate of 9600 bps over the range of 4 meters using LED as the light source.

In [7], the system presents the design and implementation of underwater communication through LiFi. The data is sent from the transmitted submarine to the receiver submarine. The system develops voice, signal, text, and image which transmit using light waves of low noise. The data is converted to digital values and those digital data is transmitted as light. Photodetector at the receiver side receives the light and gives output.

III. EXISTING WORK

There are two types of communication systems. Wired communication system and wireless communication system. The disadvantages of wired communication system can be overcome by wireless communication system. In the case of bio parameter monitoring systems for sea researchers also used cables for data transmission in the early period. The cable is connected to the ship and researcher. The disadvantage of this system leads to the development of a wireless health monitoring system [8]. The wireless methods are mainly based on RF waves [9]. But this causes many harmful effects on humans. The recent method that was published related to the monitoring health parameter of sea researcher is based on the water data transceiver module [10]. This work measures the bio parameters of sea researchers using sensors. The sensor output will give to the PIC microcontroller. The output of the controller is given to the water data transmitter module. The data signals are converted into electrical pulses and will transmit through water. The water data receiver module receives the transmitted data and is given to the microcontroller on the receiver side. The result will obtain in LCD. But this work cannot be practically possible because the data communication range is short. Moreover, there is no connection with the PC. Therefore, the data cannot properly use for safety purpose.

A. Disadvantages Of The Existing Methods

1) Long distance communication cannot be possible for wired systems.
2) RF communication causes health related issues.
3) Limited band width therefore it cannot carry a large amount of data.

IV. PROPOSED WORK

The proposed system measures two bio parameters. Sea researcher's body temperature, and heartbeat. It also consists of an emergency switch. The emergency switch output value goes high if there is an emergency. The temperature sensor and heartbeat sensor measures the corresponding temperature and heart rate values and gives their output to the PIC microcontroller. The microcontroller gives this value to the transmitter module. The transmitter module converts it in the form of light. The photodetector at the receiver side receives the corresponding light and converted it to corresponding values. The output values can be monitored in the PC which is connected to the output of the photodetector. The main hardware requirements of the proposed work are PIC16F877A Microcontroller, Power Supply, Heartbeat Sensor, Temperature Sensor, LiFi module, photodetector, Switch, LCD and the software part consists of MPLAB IDE.

A. LIFI Data Transmission

LiFi (Light fidelity) is a visible light communication method that can bring not only light but also wireless connection. LiFi transmits data in the form of light waves so it is not harmful like radio waves. Energy efficiency, high data rate, secure communication are the key features of LiFi communication. The working of LiFi is based on switching of LED ON and OFF. Binary data is transmitting in the form of light. Binary 1 means LED ON and 0 means LED OFF, it cannot recognize by the human eye. Photodetectors are used at the receiver side. Photodetector collects the light and converts it into original data.

1) Features of LiFi

a) LiFi transmit data using bits in the form of light.
b) There is no interference issue as in the case of radio waves.
c) The spectrum range is more than Wi-Fi.
d) High data rate of transmission.
e) Security of the transmitted data is more than other communication methods.

B. Working

Block diagram of the proposed system is given below. It consists of two sensors and one emergency switch. Temperature sensor LM35 is used for temperature measurement and a heartbeat sensor for heartrate measurement. Emergency switch value becomes high when there is an emergency. The sensors attached to the body measures the readings. As shown in the block diagram output of the sensors is given to the microcontroller. An LCD connected to the microcontroller shows the corresponding sensor output.

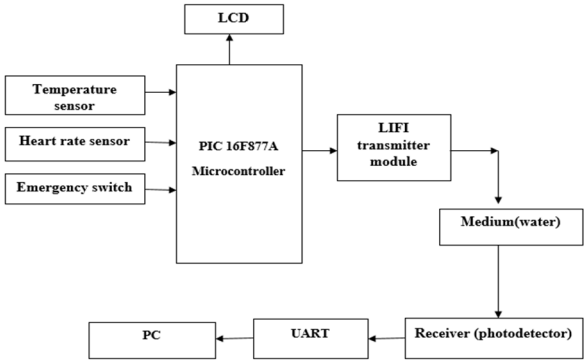

Fig1: Block diagram of the proposed system

The microcontroller gives the value to the transmitter module. The transmitter module consists of a LiFi circuit. In LiFi, the transmission of data occurs in the form of light. Here the data from the microcontroller is given to the LiFi module and converted to light. Then the light is transmitted through water. The receiver side includes a photodetector and PC. The photodetector is a device that receives light information and converts it into original data. The photodetector is placed at the bottom side of the ship according to the line of sight. To achieve proper data communication, the transmitter and receiver should be in the line of sight. The photodetector output is connected to the PC through UART. So the output can be monitor on the PC.

C. Components

There are software and hardware components are required for this work. The main hardware components are PIC microcontroller, Temperature sensor, Heartbeat sensor, Switch, LiFi transmitter module, Photodetector, UART, LCD and PC. Software requirements are MPLAB IDE and Microsoft Visual Basic 6.0.

1) Hardware requirements

a) PIC Microcontroller: PIC16F877A is the microcontroller used for this work. It has 40 pins. Among 40 pins 33 pins can be used for input and output. PIC microcontroller uses flash memory technology. Flash memory technology means we can write and erase the program according to our requirement. Using MPLAB IDE coding part is done and using pic kit, code will dump into the controller. For the proposed work three input connections are given to the controller. They are a temperature sensor, heart beat sensor and emergency switch. The output port is connected to the LiFi transmitter module.

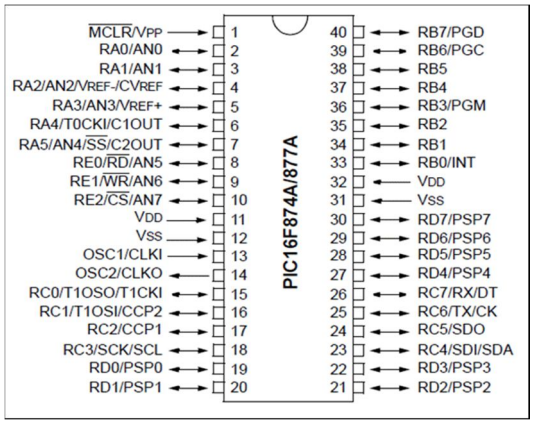

Fig2: Pinout diagram of PIC controller.

b) Temperature sensor: LM35 is the temperature sensor used for the proposed work. The output voltage of the sensor will vary according to the variation in temperature. It can measure temperature from -55 degrees Celsius to 150 degrees Celsius. There will be a rise of 0.01v for every degree Celsius rise in temperature. LM35 consists of three pins as shown in figure 3. Input, output and ground pin.

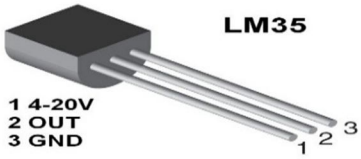

Fig 3: Pinout diagram of LM35

c) *Heartbeat Sensor:* The heartbeat sensor measures the heart rate of the sea researcher. The sensor consists of an optical LED light source and LED light sensor. The light shines through our skin then the light sensor measures the corresponding light reflection amount. The figure 4 shows the working principle of the heartbeat sensor.

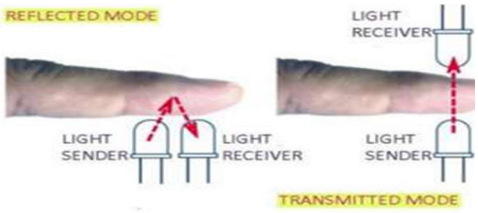

Fig 4: Heart rate sensor

d) *LCD:* LCD is an electronically modulated optical device that uses the modulating properties of liquid crystals combined with polarizers. Here 16×2 display is used for displaying the result.

Fig 5: LCD display

e) *LiFi Transmitter and Receiver Module:* LiFi uses for high-speed wireless communication. In the LiFi module, the data will transmit in the form of light. The working of LiFi is based on switching of LED ON and OFF. The receiver is a photodetector. A photodetector is a device that receives light and converts it into the original data.

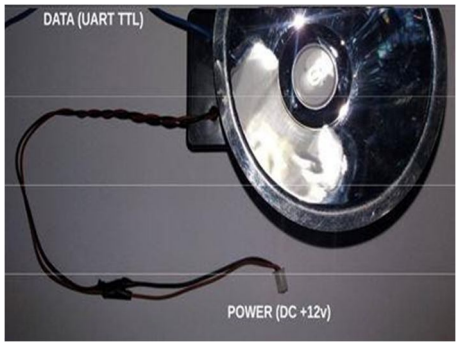

Fig 6: LiFi transmitter module

The output data from the microcontroller gets modulated and converted into the form of light. The photodetector receives the light. After demodulation, the light will convert to original data.

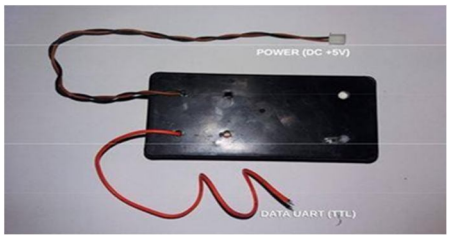

Fig 7: Receiver module

f) Power Supply: Separate power supply modules are used for the transmitter and receiver sections. Power supply units consist of a stepdown transformer, rectifier unit, input and output filters.

g) UART: UART stands for universal asynchronous Receiver and transmitter. UART is used for asynchronous serial communication with configurable speed.

Fig 8: UART module

2) Software Requirements

a) MPLAB IDE: MPLAB IDE is used for writing code for the PIC microcontroller. Embedded c is the language used to write code in this software. Using PIC Kit, the code is dump into the PIC controller.

b) Visual Basic 6.0: Microsoft Visual Basic 6.0 is used for making the output window in the PC. Using this software, we can build the output screen requirements.

The prototype of the proposed work is shown in the figure below. It consists of the transmitter section and receiver section.

Fig 9: Prototype of the proposed work

Here the components are not placed inside the water because they need waterproof covering. So a small water tank is placed between transmitter and receiver section. The sensor output is given to the microcontroller. The output of the microcontroller is given to the LiFi transmitter. LiFi transmits the information in the form of light. This light passes through water and will reach the receiver. The receiver is a photodetector. The transmitter and receiver should be in the line of sight so that proper communication will occur.

V. RESULT AND DISCUSSION

The result obtained from the proposed work is the body temperature, heartbeat rate, and the emergency switch value on our PC and LCD.Reflection of light inside water and water flow can also affect the accuracy of the result. But those factors are not considered for this work.

Fig 10: Output obtained in LCD

Only a prototype model simulated for the proposed concept. The maximum range of communication is 4feet. It can increase by increasing the intensity of light. The figure below shows the output screen of the PC.

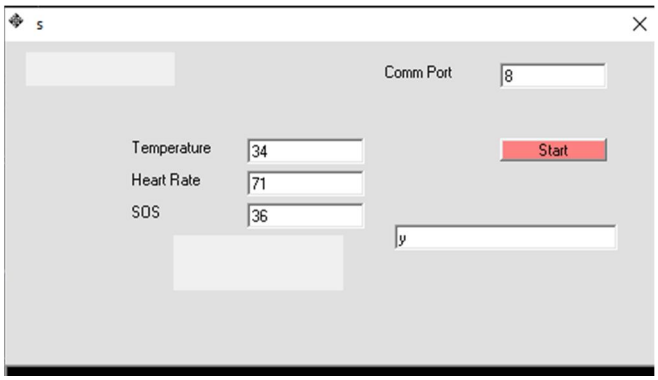

Fig 11: Output screen obtained in PC

The screen consists of temperature value, heart rate value and emergency switch output value.

No	Heart Rate Value (bpm)	Temperature Value (°C)
1	71	34
2	70	37
3	72	36
4	80	36
5	82	36

Table 1: Output of different observations

The table above shows the temperature and heartrate values of different observations.

VI.CONCLUSION

The result obtained from the proposed system is temperature and heart rate. The observed result is accurate and easy to access by the people who were on the ship and they can monitor continuously. The line of sight is a factor that will affect communication. Therefore, it is required to fix photodetector at the base portion of the ship at a particular location.

VII. FUTURE SCOPE

The proposed work mainly focused on the prototype model. A real-time model of the proposed work can do as a future scope. Adding more sensors to determine more bio parameters, increase the range of communication by increasing intensity can be included in the future work.

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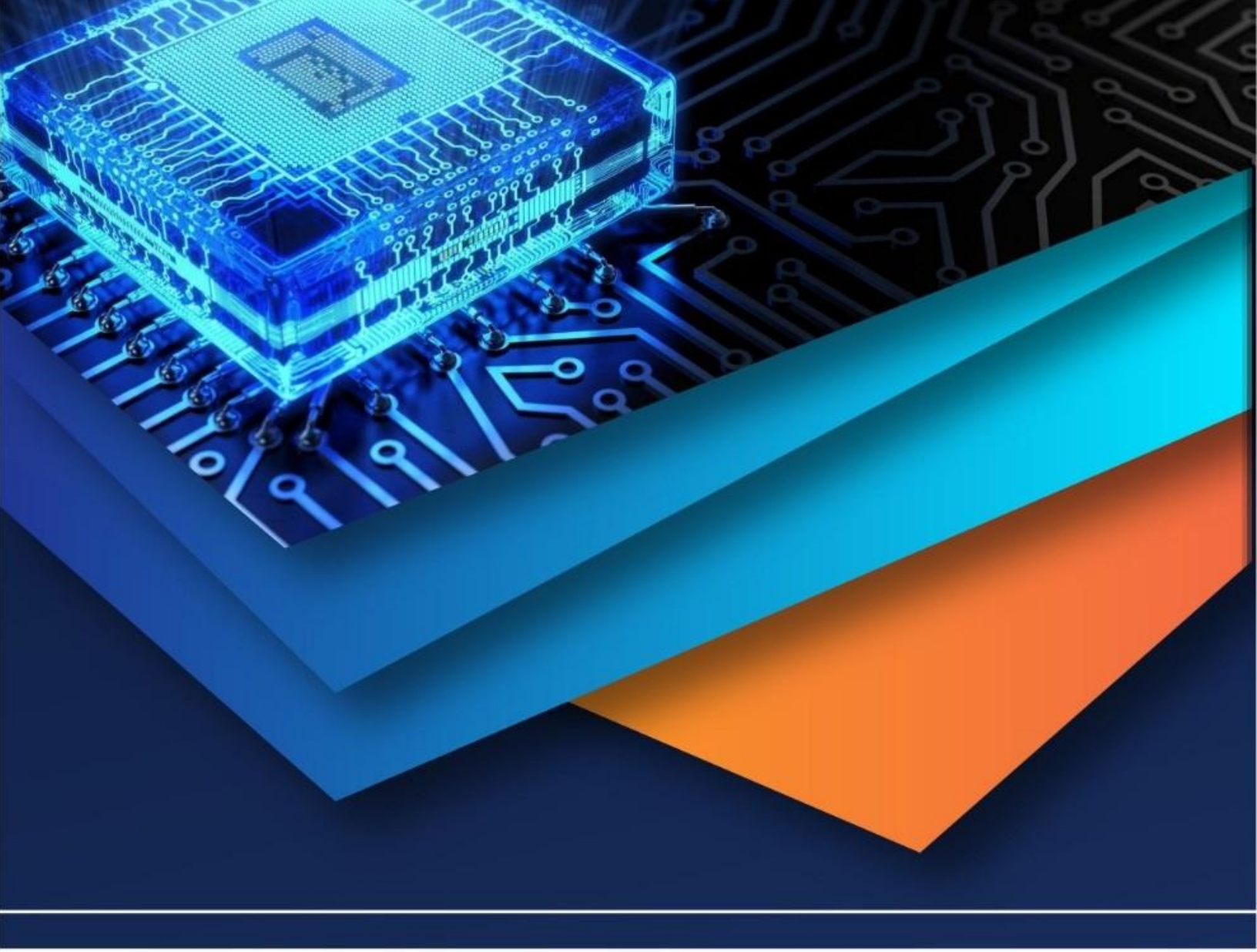

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