ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.5

Development of Underwater Monitoring Wireless Sensor Network For Disaster Management System

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Abstract:
While wireless communication technology today has become part of our daily life, the idea of wireless undersea communications may still seem far-fetched. However, research has been active for over a decade on designing the methods for wireless information transmission underwater. Human knowledge and understanding of the world's oceans, which constitute the major part of our planet, rests on our ability to collect information from remote undersea locations. Although such systems remain indispensable if high-speed communication link is to exists between the remote end and the surface, it is natural to wonder what one could accomplish without the burden (and cost) of heavy cables. White LEDs (Light Emitting Diodes) in Visible Light Communication (VLC) is an emerging technology that is being researched so it can eventually be used for common communications systems. LEDs have a number of advantages, one of which is long life expectancy. However, like many emerging technologies, VLC has many technical issues that need to be addressed. We proposed an optical indoor wireless communication system that used white LEDs like plug-in devices. We developed a practical implementation of VLC and demonstrated it experimentally. Hence the motivation and interest in wireless underwater communications. Together with sensor technology and vehicular technology, wireless communications will enable new applications ranging from environmental monitoring to gathering of oceanographic data, marine archaeology, and search and rescue missions.

Keywords: Visual Light Communication, Decision-Feedback Equalizer, Light Emitting Diode, Light fidelity, Arduino Controller.

I. INTRODUCTION

While wireless communication technology today has become part of our daily life, the idea of wireless undersea communications may still seem far-fetched. However, research has been active for over a decade on designing the methods for wireless information transmission underwater. Human knowledge and understanding of the world's oceans, which constitute the major part of our planet, rests on our ability to collect information from remote undersea locations. The major discoveries of the past decades, such as the remains of Titanic, or the hydro-thermal vents at bottom of Deep Ocean, were made using cabled submersibles. Although such systems remain indispensable if high-speed communication link is to exists between the remote end and the surface, it is natural to wonder what one could accomplish without the burden (and cost) of heavy cables. Hence the motivation and interest in wireless underwater communications.

Together with sensor technology and vehicular technology, wireless communications will enable new applications ranging from environmental monitoring to gathering of oceanographic data, marine archaeology, and search and rescue missions. Acoustic technology has advantage to transmit data over a long distance in water. However, the attenuation of the acoustic carrier and the effects of multi-path reflection will ultimately limit the data rate and bandwidth for a large amount data communication and even at the short range the bandwidth is limited to sub-Mbps. This brings a "bottleneck" problem for a large amount of data collection (such as multi-sensor data, image information, etc.). Wireless optical communication have shown promise of supporting large bandwidths, high data transfer rate, small in size, low power consumption, immune to electromagnetic interference. Thus, underwater wireless optical communication can be an alternative method for fast data transmission. The optical properties of sea water are function of water salinity, water temperature, and concentration of dissolved organic and inorganic matter, suspended particles and organisms. The attenuation of the light beam in sea water is much more serious than in the atmosphere.

Lighting power attenuated in water is mainly dominated by wavelength dependent processes: absorption and scattering. The main cause of light absorption in water is excitation of vibration state of the water molecule by photons and other dissolved particles and detritus. Scattering of light refers to processes in which the direction of the photon is changed and it can take place either on molecules or on dissolved particulate.

A) Wave Propagation

Path loss that occurs in an acoustic channel over a distance d is given as A=dka(f)d, where k is the path loss exponent whose value is usually between 1 and 2, and a(f) is the absorption factor that depends on the frequency f. The speed of sound underwater varies with depth and also depends on the environment.

Its nominal value is only 1500 m/s, and this fact has a twofold implication on the communication system design. First, it implies long signal delay, which severely reduces the efficiency of any communication protocol that is based on receiver feedback, or hand-shaking between the transmitter and receiver.

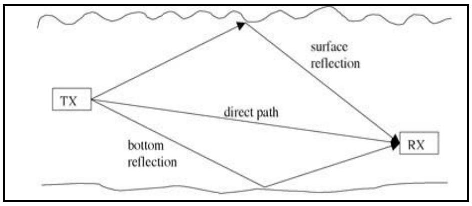

Figure.1.1: Shallow water multipath propagation

The resulting latency is similar to that of a space communication system, although there it is a consequence of long distances traveled. Secondly, low speed of sound results in severe Doppler With advances in acoustic modem technology, sensor technology and vehicular technology, ocean engineering today is moving towards integration of these components into autonomous underwater networks. While current applications include supervisory control of individual AUVs, and telemetry of oceanographic data from bottom-mounted instruments, the vision of future is that of a “digital ocean” in which integrated networks of instruments, sensors, robots and vehicles will operate together in a variety of underwater environments. Examples of emerging applications include fleets of AUVs deployed on collaborative search missions, and ad hoc deployable sensor networks for environmental monitoring.

D) DECENTRALIZED NETWORK TOPOLOGY

Depending on the application, future underwater networks are likely to evolve in two directions: centralized and decentralized networks. In a centralized network, nodes communicate through a base station that covers one cell. Larger area is covered by more cells whose base stations are connected over a separate communications infrastructure. The base stations can be on the surface and communicate using radio links, as shown in the figure, or they can be on the bottom, connected by a cable. Alternatively, the base station can be movable as well. In a decentralized network as shown in fig.1.3 nodes communicate via peer-to-peer, multi-hop transmission of data packets. The packets must be relayed to reach the destination, and there may be a designated end node to a surface gateway. Nodes may also form clusters for a more efficient utilization of communication channel. Namely, if the relative velocity between the transmitter and receiver is ±v, then a signal of frequency fc will be observed at the receiver as having frequency fc (1±v/c). At the same time, a waveform of duration T will be observed at the receiver as having duration T (1±v/c). Hence, Doppler shifting and spreading occur. For the velocity v on the order of few m/s, the factor v/c, which determines the severity of the Doppler distortion, can be several orders of magnitude greater than the one observed in a land-mobile radio system! To avoid this distortion, a non coherent modulation/detection must be employed. Coherent modulation/detection offers a far better utilization of bandwidth, but the receiver must be designed to deal with extreme Dopplerdistortion.

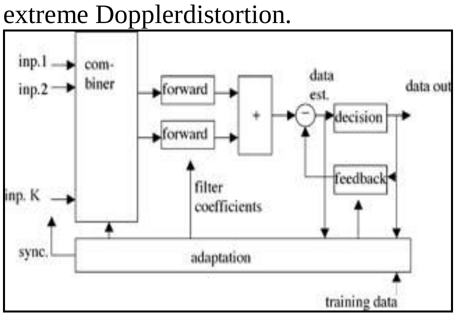

Figure1.2Multichanneladaptivedecision-feedback equalizer (DFE)

(DFE) is used for high-speed underwater acoustic communications. It supports any linear modulation format, such as M-ary PSK or M-ary QAM.

B) ACOUSTIC MODEM

Acoustic modem technology today offers two types of modulation/detection: frequency shift keying (FSK) with non coherent detection and phase-shift keying (PSK) with coherent detection. FSK has traditionally been used for robust acoustic communications at low bit rates (typically on the order of 100 bps). To achieve bandwidth efficiency, i.e. to transmit at a bit rate greater than the available bandwidth, the information must be encoded into the phase or the amplitude of the signal, as it is done in PSK or quadrature amplitude modulation (QAM). For example, in a 4-PSK system, the information bits (0 and 1) are mapped into one of four possible symbols, ±1±j. The symbol stream modulates the carrier, and the so-obtained signal is transmitted over the channel. To detect this type of signal on a multipath-distorted acoustic channel, a receiver must employ an equalizer whose task is to unravel the inter symbol interference. Since the channel response is not a-priori known (moreover, it is time-varying) the equalizer must “learn” the channel in order to invert its effect. A block diagram of an adaptive decision-feedback equalizer (DFE) is shown in Figure 1.2. In this configuration, multiple input signals, obtained from spatially diverse receiving hydrophones, can be used to enhance the system performance. The receiver parameters are optimized to minimize the mean squared error in the detected data stream.

C). UNDER WATER NETWORKS

With advances in acoustic modem technology, sensor technology and vehicular technology, ocean engineering today is moving towards integration of these components into autonomous underwater networks. While current applications include supervisory control of individual AUVs, and telemetry of oceanographic data from bottom-mounted instruments, the vision of future is that of a “digital ocean” in which integrated networks of instruments, sensors, robots and vehicles will operate together in a variety of underwater environments.

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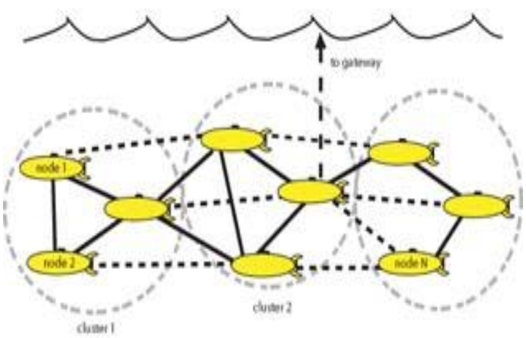

Figure .1.3 Decentralized network topology

In a decentralized network, nodes communicate via peer-to-peer, multi-hop transmission of data packets. The packets must be relayed to reach the destination, and there may be a designated end node to a surface gateway. Nodes may also form clusters for a more efficient utilization of communication channel [1]. To accommodate multiple users within a selected network topology, the communication channel must be shared, i.e. access to the channel must be regulated. Scheduling, or deterministic multiple-access, includes frequency, time and code-division multiple-access (FDMA, TDMA, CDMA) as well as a more elaborate technique of space-division multiple access (SDMA). Contention-based channel sharing does not rely on an a-priori division of channel resources; instead, all the nodes contend for the use of channel, i.e., they are allowed to transmit randomly at will, in the same frequency band and at the same time, but in doing so they must follow a protocol for medium-access control (MAC) to ensure that their information packets do not collide. All types of multiple-access are being considered for the underwater acoustic systems. Scheduling, or deterministic multiple-access, includes frequency, time and code-division multiple-access (FDMA, TDMA, CDMA) as well as a more elaborate technique of space-division multiple access (SDMA). Contention-based channel sharing does not rely on an a-priori division of channel resources; instead, all the nodes contend for the use of channel, i.e., they are allowed to transmit randomly at will, in the same frequency band and at the same time, but in doing so they must follow a protocol for medium-access control (MAC) to ensure that their information packets do not collide. All types of multiple-access are being considered for the underwater acoustic systems.

E). UNDER WATER SENSOR

Generally, the natural disasters are inevitable. Among others, water based natural disasters are more dangerous and produced huge destruction to the earth. Accordingly, disaster monitoring and preventive mechanisms are very necessary. UWSN offers a wide range of applications for management and recovery of such disasters. More particularly, it relates to the monitoring of events that aggravate a disasters aftermath. Along with inadequate resources for comprehensive monitoring of the vast area of water (e.g., ocean), the task becomes even more challenging with occasionally ruthless weather. Therefore, efficient monitoring of marine and aquatic dynamics is a significant research challenge. UWSN monitoring strategies for disaster management and prevention can be formulated into a wide variety of applications such as floods, underwater volcanic eruptions, and underwater earthquakes and their resulting tsunamis, and oil spills which lead to above-the-water and underwater ecological instabilities. The repercussions of a flood and its increased frequency have pushed the researchers to find ways of timely flood alerts. The alerts need not only be placed in urban shores and hence require remote deployment. UWSN helps develop solutions of underwater sensor deployments with over-the-water relay agents to calculate aquatic vitals. These vitals are gathered at remote station and inspected for flood indications.

II. LIGHT AS COMMUNICATION MEDIUM

A) VISIBLE LIGHT COMMUNICATION (VLC)

The idea of using light as a communication medium was implemented by Alexander Graham Bell in 1880 with his invention of the photo phone, a device that transmitted a voice signal on a beam of light. Bell focused sunlight with a mirror and then talked into a mechanism that vibrated the mirror. The vibrating beam was picked up by the detector at the receiving end and decoded back into the voice signal, the same procedure as the phone did with electrical signals. But Bell could not generate a useful carrier frequency, nor was he able to transmit the light beam from point to point. Obstacles in nature such as fog and rain — which could interfere with the photo phone — made Bell stop any future. With the invention of LED (Light Emitting Diode), the idea of using light as a communication medium has started again. VLC uses white Light Emitting Diodes (LED), which send data by flashing light at speeds undetectable to the human eye. One major advantage of VLC is that we can use the infrastructure around us without having to make any changes to it. LEDs' ability to transfer information signals over light (light which is between 400THz to 800THz of frequency and whose wavelength is between 400nm to 700nm) makes it a very good communication medium [2].

1. MOTIVATION AND OBJECTIVE

A lot of research is being done to make this technology available for commercial use in various fields, including Internet access and vehicle-to-road communication using traffic signal lights. From our review of the literature, it became evident that work should be done to look into the possibility of designing a new model that could fit the present infrastructure for indoor applications. Therefore, the objectives of the research presented in this work can be summarized as follows:

- **Develop a prototype of VLC and demonstrate its efficacy by using commercial LEDs.**

Present detailed experimental work on the prototypes and discuss the performance. As the contributions of this thesis, the models proposed in this thesis were designed with RS-232 and USB. As a result, they can be easily integrated with the present infrastructure. The first prototype was integrated with the existing Terminal Emulation Program (Hyper-Terminal), which was already present in the computer. The second prototype is designed for simple connection to the computer USB comports; it needs Terminal v1.9b software, which is available for free. For better understanding of the commercial use of the white LEDs for lighting and transmission range, illumination distribution and power distribution of the white LEDs were then measured and plotted. These designs, when truncated further, can be used as plug-in devices for low-cost commercial usage.

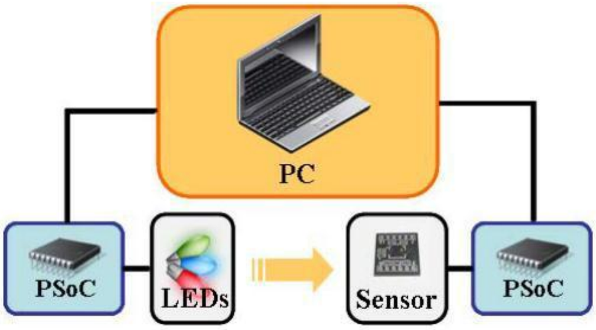

Figure 2.1: VLC Prototype Model

The above Fig. 2.1 illustrates the basic idea of the entire model design. The basic idea is to make two computers talk with each other using free space light propagation. Two models with different interfaces were proposed, namely RS-232 and USB. Prototype 1 was designed to be compatible with RS-232 interface and Prototype 2 was designed to be compatible with the USB interface.

2. LIGHT EMITTING DIODE (LED)

In this study, the work is concentrated on the semiconductors formed by P-type and N-type materials. Light emitting diode (LED) is a PN junction semiconductor that emits light when forward biased releases the energy in the form of photons. This effect is called as electroluminescence. It is the band gap of the LED which is designed for radioactive recombination. When joining the N-type and P-type materials, the Fermi levels (W_f)

will be aligned and will produce an energy barrier even when there is no external voltage applied.

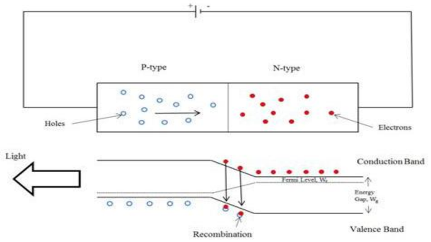

Figure 2.2 LED PN- junction biasing arrangement

There are two energy bands, namely the conduction band and valence band, which are separated by a forbidden region with the width of W_g. In the conduction band, electrons not bound to individual atoms are free to move [3]. In the valence band, unbound holes are mobile and have positive charge. The free electrons in the N region cannot go up the barrier without the external energy; that is the same for the holes that cannot surmount the barrier. By applying a sufficient energy (eV), a free electron crosses the barrier, falls into the lower energy level and recombines with the hole, releasing the energy in the form of photons.

D) WHITE LIGHT EMITTING DIODES

Although every color can be produced by LEDs within the visible region, white light is the most desirable color for general illumination. The visible radiation detectable to the human eye is between 480nm to 750nm. White light emission from an LED is by mixture of multi-color LEDs or by the combination of phosphors with blue/UV LED emission [1]. There are different types of white LEDs. Some of the important ones are:

➢ **PHOSPHOR BASED WHITE LEDS**

The InGaN blue LED is coated with phosphor. The wavelength converting phosphors is combined with a blue LED to emit white light [4], [5]. The chip inside the LED emits blue light when external voltage is applied. The emitted blue light passes through the yellow phosphor, yielding white light emission.

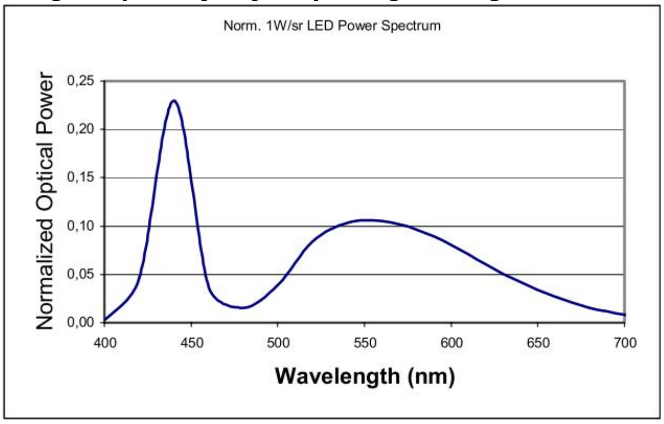

Figure 2.3: Normalized optical spectrum of a white LED

From the resulting optical spectrum in Fig.2.3, the left peak is due to the blue LED, while the wider right emission corresponds to the yellow phosphor.

➢ **ULTRAVIOLET (UV) BASED WHITE LEDS**

Ultraviolet LEDs were fabricated with pre-coating blue/green/red phosphors onto ultraviolet (UV) LED to emit white light [4], [5].

➢ **RGB (RED-GREEN-BLUE) LEDS**

An RGB (red, green, blue) 3-chip LED is a mixture combination of three colors to produce white light with little variance in the Kelvin color temperature [8]. We know that the visible spectrum of radiation that the sun emits is actually a broad range of wavelengths, ranging from red to orange, yellow, green, and blue, indigo to violet (ROYGBIV). When this broad range of colors impinges on our retina, our brain interprets it as “white”. A tri-color LED tries to mimic this effect by outputting a board range of wavelengths (red, green and blue). Note that the three dominant wavelengths of the tri-color LED are at the ends and the center of the visible spectrum, thus attempting to replicate the coverage of the range and getting close to (ROYGBIV) as possible (with minimal hardware).

III MODES OF OPERATION

1. Photovoltaic Mode

Photovoltaic mode, also called as zero bias operation, occurs when no external voltage is given to the photodiode. The photo-current generated is fixed and also linearly dependent on the incident radiation level [3].

1. PHOTOCONDUCTIVE MODE

The diode is reverse biased (cathode positive and anode negative), which increases the depletion region width, reducing the junction capacitance. This results in faster response time. However, in this mode the effects of noise and dark currents will be more [3]

1. VOLTAGE COMPARATOR

The output of the comparator depends on the differential input voltage value. If the difference of the input voltages is positive, then the output of the comparator is positive. If the difference of the voltages at the input terminals is negative, then the output is negative. The output of a comparator is a square wave [11].

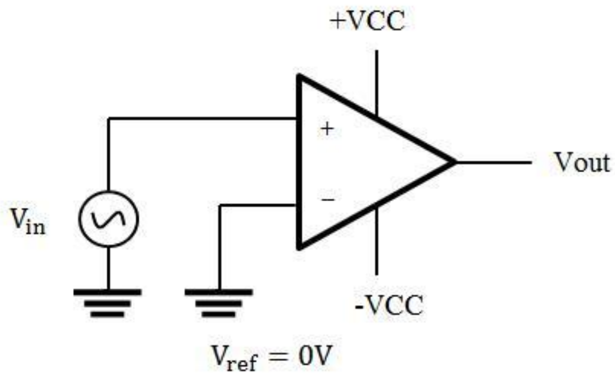

Figure 3.1: Voltage Comparator configuration

D) RS-232 Interfaces

RS-232 is a single ended electronic data communication between the DTE (data terminal equipment) and DCE (data circuit terminating equipment) in computer serial ports. It supports the bit transmission rate up to 115,200 bps in serial communications [12].

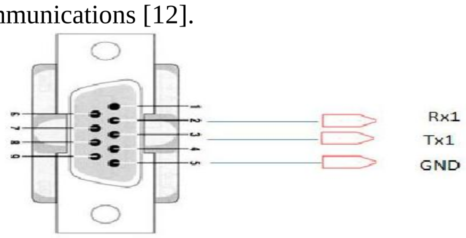

Figure 3.2: DB-9 female connector

E) UNIVERSAL SERIAL BUS (USB)

It is the replacement of serial and parallel port communications with more efficiency and ease of use that supports a data rate of 12Mbps (USB 1.0), 480Mbps (USB 2.0). The new version of USB 3.0 can run up to 5Gps. USB was designed in such a way that it can connect easily to all the computer peripheral devices. It is a hot plug and play with +5v at the source [9], [10].

IV. INTEGRATED SYSTEM

This topic discusses the integrated system of White LED Visible Light Communication, Power Line Communication. An easy wiring system for optical communication using the existing power-line is proposed. This system is emitted as visible-light from LED lighting according to the transmitted signal waveform without demodulating the signal from the power-line. This system is expected to be applicable from the existing illuminant easily like exchanging electric bulbs [3].

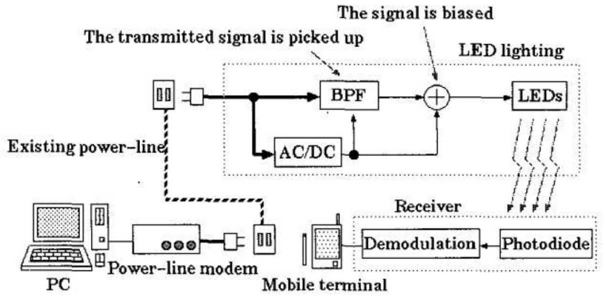

Figure 4.1 System model

As in optical intensity modulation, the transmitted signals are added to the cyclic waveform of the alternating current (AC). The transmitter signal from the PC is picked by BPF through the power-line, and biased before sending to the LED lights. The electrical signal is then converted into an optical signal by LEDs and sends it to the photodiode, where it converts the captured optical signal to an electrical signal. The signal is demodulated according to the received level of light and then is passed to the mobile terminal.

1. ADVANCED DRIVER ASSISTANT SYSTEMS

Optical communications for outdoor communication has been discussed and elaborated upon. Devices such as laptops and mobile phones can be used for transmitting and receiving information, using transceivers, as shown in Fig. 4.2.

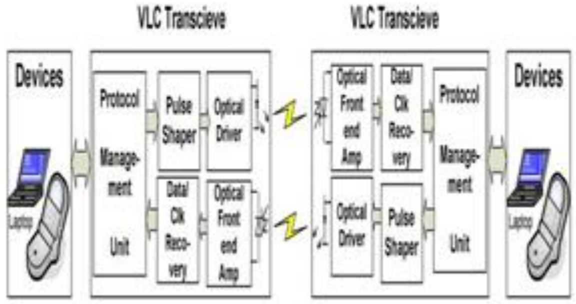

Figure 4.2: General architecture for a full duplex VLC system

Transceiver systems use both LEDs and photodiodes. Intensity modulation was implemented to reach the most viable modulation. Transceiver systems use both LEDs and photodiodes. Intensity modulation was implemented to reach the most viable modulation. Various important design parameters were optimized by using intensive investigation based on gain variation over 100m of transmission range [13].

2. INTEGRATED COMMUNICATION AND LOCALIZATION OF UNDERWATER ROBOTS

An optical wireless link has been established between the Remotely Operated Vehicles (ROV) and gateway station using LEDs and Photodiodes on both sides. Underwater ROV was used to communicate with the gateway station over water to transmit control signals. Both the gateway station and ROV are capable of directing a light beam in the three-dimensional space [4], 14].

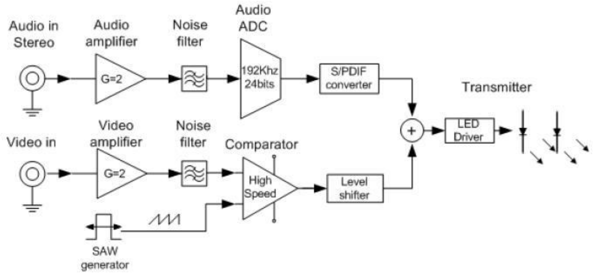

Figure 4.3 Architecture of the dual-use optical communication

1. RGB LED LIGHTS

A prototype was designed to demonstrate wireless VLC using RGB LEDs and sensors. On the left are the RGB LEDs used as signal transmitters. The right side is the RGB sensor, which is used as a receiver.

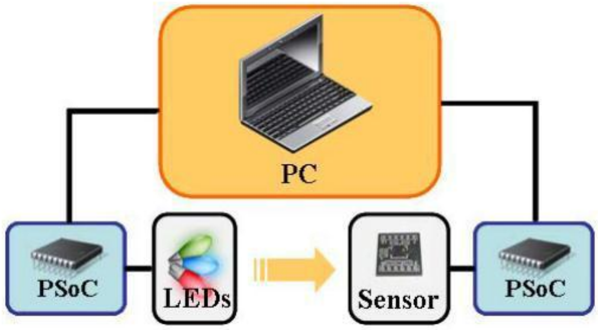

Figure 4.4: Outline of the system

The RGB LEDs enable parallel signal communication, and a PSoC microcontroller is used to control them, thus significantly reducing the need for extra circuits. Pulse Width Modulation was used to switch RGB LEDs at high speeds. The characteristics of both the variation in color and change in intensity of each RGB LED and RGB sensor were analyzed to realize multiple-value signals communication by using RGB color [15].

D) VISIBLE LIGHT COMMUNICATION LINK FOR AUDIO AND VIDEO TRANSMISSION

A VLC system to transmit high quality video and audio signal was proposed and demonstrated by using illumination LEDs. The analog video signal was modulated by using an ultra high speed comparator in the transmitter. The analog signal was converted from analog to digital. Both the video and analog signals were transmitted using the illumination LEDs in the transmitter. The photodiode at the receiver senses the optical signals from the LEDs and is converted into electrical signals. The electrical signal is then amplified to recover the digital signal and converted back to an analog signal to video/ audio out [16].

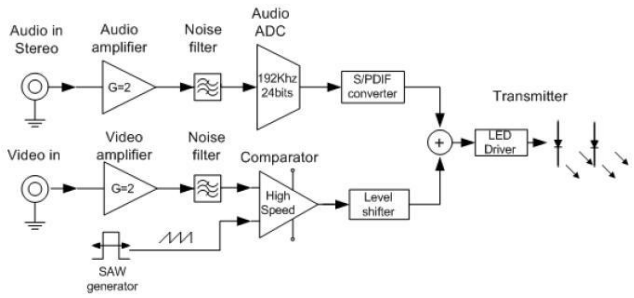

Figure .4.5. Block diagram of receiver module

V. ARDUINO MICROCONTROLLER

The popularity of Arduino is steadily increasing and it is fast becoming the microcontroller of choice for students, hobbyists and smaller companies. Many different electronics PCB manufacturing companies are jumping on the bandwagon and producing their own variations of the boards, as well as "shields" (additional circuits that fit directly on top of many Arduino boards to increase their functionality) and accessories. The Arduino website offers free resources and tutorials as well as a language reference to help you understand the code and syntax. In order to get started, you will at the very minimum need an Arduino board. Note that all the Arduino (and most of the clone boards) can use the Arduino software. If you are unsure what hardware to get, the Arduino USB is currently the most popular model, and these 5 minute tutorials are based around it.

1. "Newest: Arduino Interface

When the software is loaded, the first screen you will see is a white window (shown below) with several different shades of blue and blue-green as border. Arduino projects are called "sketches", several additional files can be created. The main headings are "File" "Edit" "Sketch" "Tools" "Help" and several shortcut icons beneath "Verify", "Upload", "New", "Open", "Save", and at the far right, the "Serial Monitor". Note that all these icons are also available from the main menus.

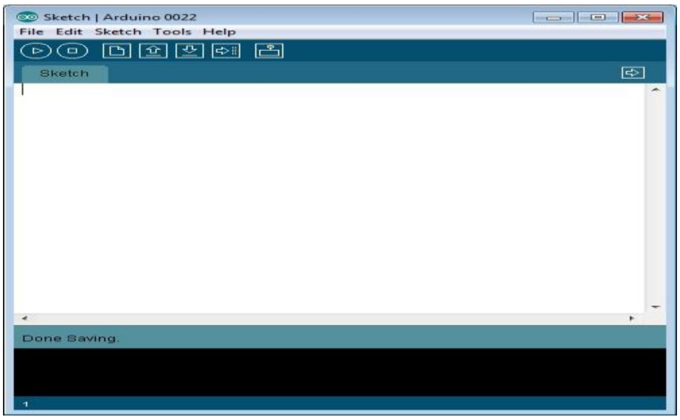

Figure 5.1 Newest: Arduino Interface

The Arduino language is CASE SENSITIVE: a capital letter is not the same as a lower case letter. The following code represents the minimum in order for a program to compile: The "**void setup()**" section is widely used to initialize variables, pin modes, set the serial baud rate and related. The software only goes though the section once. The "**void loop ()**" section is the part of the code that loops back onto itself and is the main part of the code. In the Arduino examples, this is called "Bare Minimum" under File-> Examples -> Basics. To add subroutines using the same syntax:

void subroutine name() {}

Almost every line of code needs to end with a semicolon ';' To write single line comments in the code, type two back slashes followed by the text://comments are overlooked when compiling your program To write multi-line comments, start the comment with /* and end with */ /* This is a multi-line comment and saves you having to always use double slashes at the beginning of every line.

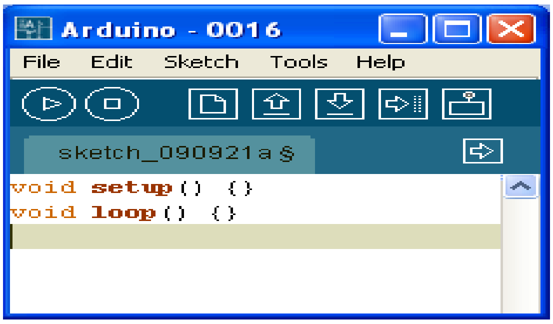

Figure 5.2 Arduino code

B) SERIAL COMMUNICATION

The Arduino board can communicate at various baud ("baud rates"). A baud is a measure of how many times the hardware can send 0s and 1s in a second. The baud rate must be set properly for the board to convert incoming and outgoing information to useful data. If your receiver is expecting to communicate at a baud rate of 2400, but your transmitter is transmitting at a different rate (for example 9600), the data you get will not make sense. To set the baud rate, use the following code:

```
void setup() {
Serial.begin(9600);
}
```

9600 is a good baud rate to start with. Other standard baud rates available on most Arduino modules include: 300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, or 115200 and you are free to specify other baud rates.

1. BLINK LED PROGRAM

Connect the board to the computer if it is not already connected. In the Arduino software go to File -> Examples -> Basics -> Blink LED. The code will automatically load in the window, ready to be transferred to the Arduino. Ensure you have the right board chosen in Tools -> Board, and have the right COM port as well under Tools -> Serial Port. If you are not sure which COM port is connected to the Arduino, (on a Windows machine) go to Device Manager under COM & Ports.

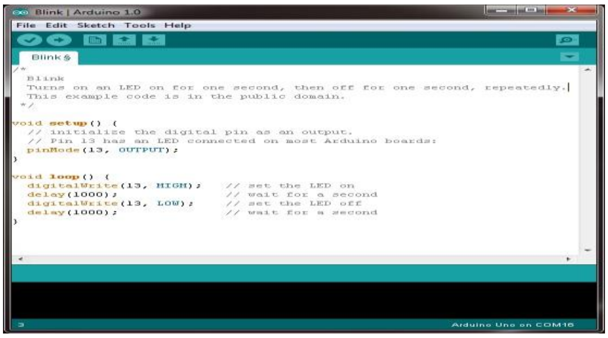

Figure 5.3 Blink LED Code

The three new lines of code you have not seen before are:
pinMode(13, OUTPUT);This sets pin 13 as an output pin. The opposite, being INPUT, would have the pin wait to read a 5V signal. Note that the 'M' is capitalized. A lower case 'm' would cause the word "pinmode" to not be recognized.
digitalWrite(13, HIGH); and digitalWrite(13, LOW);
The line digitalWrite(pin, HIGH);
puts a specified pin high to +5V. In this case we chose pin 13 since on the Uno, the LED is connected to pin 13. Replacing HIGH with LOW, the pin is set to 0V. You can attach your

own LED using a digital output and the GND pin. Note that the ‘W’ is capitalized.
Delay (1000);
The delay (1000); line causes the program to wait for 1000 milliseconds before proceeding (where 1000 is just a convenient example to get a 1 second delay).

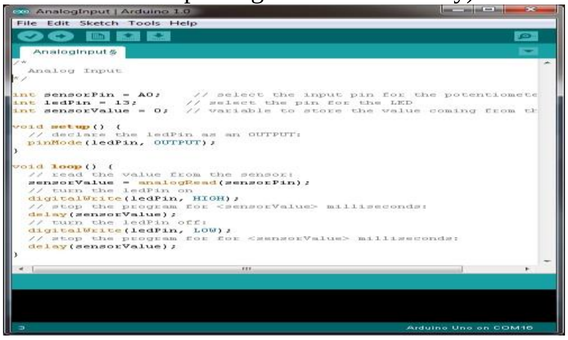

Figure 5.4 Analog Input

Open the sample sketch “Analog Input” under File -> Examples -> Analog. The comments section has been reduced below to make the code clearly visible. We see several new lines of code here:
int sensorPin = A0;
The “int” is short for “integer”. The name “sensorPin” was chosen only to describe what the variable represents; “sensor pin”. The fact that the ‘P’ is capitalized makes it easier to see that it is actually two words, since spaces cannot be used. The integer “sensor pin” is equal to A0, where “A0″ is Analog pin 0 on the Arduino. On its own, “A0″ is not a reserved term. However, when used in context, the system recognizes it as analog pin 0. The line must be ended with a semicolon. By declaring a variable in the setup, you can use the term, which in this case is “sensor Pin”, throughout the code instead of “A0″. Therefore a voltage of 0V corresponds to a numeric value of 0. A voltage of 5V corresponds to a numeric value of 1024. Therefore a value of 3V would correspond to a numeric value of:
3/5 =x/1024, x = 3*1024/5 = ~614
Alternatively you could have written: sensorValue = analogRead(A0);
int ledPin = 13;
Once again, the term “ledPin” is not a reserved word in Arduino, it was chosen to describe which pin was connected to the LED. The value “13″ is a normal value, but just like “A0″, when used in context represents pin 13.
Int sensorValue = 0;
The term “sensorValue” is not a reserved term either. Connect the potentiometer to pins A0, 5V and GND. The middle (wiper) lead is the one to connect to the analog pin and the voltage varies on this pin. The orientation of the other two pins does not matter. The other option is to connect the potentiometer to pins A0, A1 and A2. However, you will need to add the following code under void setup():

digitalWrite (A1, LOW);
digitalWrite (A2, HIGH);

This sets the corresponding pins to 0V (GND) and 5V (PWR). Once the potentiometer is connected, upload this sketch to the board and change to the Serial monitor. As the knob gets rotated (or slide the slider), the values should change between 0 to 1023. Correspondingly, the LED will blink with a faster or shorter delay. You can now read values and use them within your code. The new function used here is “analogRead();” where the pin selected is pin #2. If you used analog pin #5, you would change the code to read:
int sensorpin = 5;
If the system does not work, check the syntax and ensure the code uploads correctly. Next, check the connections to the potentiometer ensuring that the middle lead goes to the correct pin, and the other pins are powered at 0V and 5V.

- **Serial**.println(sensorValue);

This sends the value contained in the variable “sensorValue” serially via the USB plug and digital pin 1. Verify, then upload this sketch to your Arduino. Once it is done, press on the “magnifying glass” located towards the top right of the window. This is the “Serial monitor” and monitors communications being sent and received by the Arduino.

- **Serial**.print(sensorValue);

Infrared distance sensors are useful for measuring distances without actually touching a surface. The three wires protruding from a distance sensor represent +5V (in most cases), Gnd (Ground) and signal. These are almost always color coded with black as ground, red as +V and white or yellow as the signal.

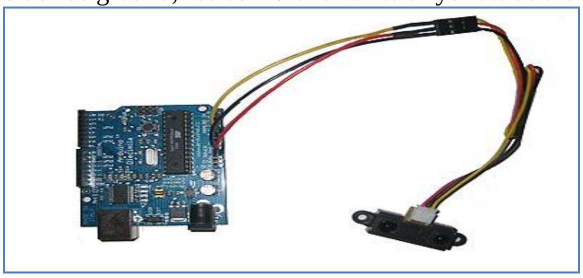

Figure 5.5 Arduino controller kit

Infrared distance sensors are useful for measuring distances without actually touching a surface. The three wires protruding from a distance sensor represent +5V (in most cases), Gnd (Ground) and signal. These are almost always color coded with black as ground, red as +V and white or yellow as the signal.

D) ARDUINO AND PUSH BUTTONS

Connecting toggle switches, push buttons and momentary contact switches to the Arduino is straightforward. A push button is a simple device that completes a circuit. One end of the button is connected to source, usually a low voltage (5V on the Arduino is ideal) and the other connected to the digital pin. When the switch is flipped, pressed or toggled, the circuit is either opened or closed. The digital pin simply returns if there is 5V or 0V.
The code associated with this is:
digitalRead(pin);
In the following simple program, a push button is used to turn on the LED connected to pin 13. The line
digitalWrite(ledPin, status);
turns the ledPin (in this case assigned to digital pin 13) HIGH (1) or LOW (0) depending on the status variable. We initially set the status to be low (0).

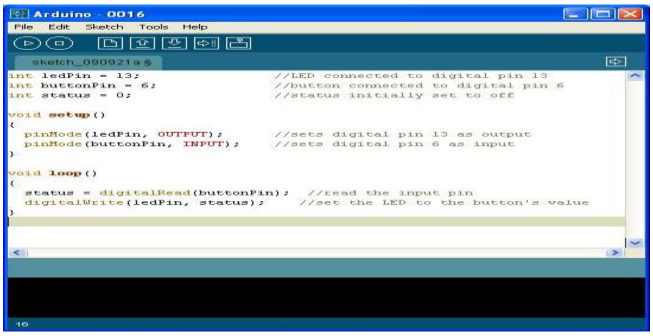

Figure 5.7 Arduino Code using push button is used to turn on the LED

VI. LI-FI

LiFi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. “At the heart of this technology is a new generation of high brightness light-emitting diodes”, says Harald Haas from the University of Edinburgh, UK,”Very simply, if the LED is on, you transmit a digital 1, if it’s off you transmit a 0,”Haas says, “They can be switched on and off very quickly or simply by changing the light color, which gives nice opportunities for transmitted data.” It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rate. Wi-Fi is basically, light fedility“ which uses visible light communication instead of radio wave communication as in WI-FI. As speed of light is way faster than radio waves hence it can be used with a speed of around 250 times more than any high speed broadband. Day by day use of internet is increasing and hence traffic is increasing.

The limitations are overcome by LI-FI which can be used for:

1. Large coverage of area
2. Traffic handling capacity
3. Cheaper

Li-Fi has the advantage of being able to be used in sensitive areas such as in aircraft without causing interference. However, the light waves used cannot penetrate walls. Moreover Li-Fi makes possible to have a wireless Internet in specific environments (hospitals, Airplanes etc.) where Wi-Fi is not allowed due to interferences or security considerations. Light Fidelity is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term some have used to label the fast and cheap wireless Communication system, which is the optical version of WiFi.

VII. CONCLUSION

In this topic the main challenges for efficient communication are overviewed in under water acoustic sensor networks. The eculiarities of the underwater channel with particular reference is outlined to networking solutions. The ultimate objective of this topic is to encourage research efforts to lay down fundamental basics for the development of new advanced communication techniques for efficient under water communication and networking for enhanced ocean monitoring and exploration applications.

- The aim of this is to build an acoustic communication
- This is not only the way for underwater communication
- By using optical waves which offers higher throughput (Mbps) over short distances (up to about 100 m).

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