

SUB SEA UMBILICAL COMMUNICATION SYSTEM WITH OPTICAL FIBER FOR GAS LINE

Submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering
Degree in Electronics and Communication Engineering

by

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

**Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **T.CHANDU KIRAN KUMAR (Reg.No : 37130405)** and **VAKCHARLA SRIHARSHA (Reg.No: 37130424)**, who carried out the project entitled **“SUB SEA UMBLICAL COMMUNICATION SYSTEM WITH OPTICAL FIBER FOR GAS LINE”** under my supervision from November 2020 to March 2021.

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Submitted for Viva voce examination held on _____

Internal Examiner

External Examiner

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ABSTRACT

In oil and gas industry, though the technology has developed so much in the 21st century we are using the same old traditional way of communicating underneath the subsea using hydraulics, which takes quite a long time to communicate from topside to the subsea Equipment but produces 100% success rate. Many researchers are working on to develop the subsea communication system using Wi-Fi, but due to several factors, Wi-Fi does not travel underneath the sea. As the first step for wireless Communication, we are using optical fiber (wired) as a medium of communication and developing the speed of Communication and controlling the subsea Equipment. Currently, optical fiber cable which is already present in the umbilical collects Information and data from subsea to the topside and vice versa only, but it does not control the Equipment, e.g. opening or closing a valve in subsea is not done by Optical Fiber rather its done by hydraulics only. This report focuses on developing the speed of Communication and controlling the subsea Equipment using Fiber optical as a medium, which is already present in the subsea umbilical. We have developed a device which can retrieve the message from optical Fiber and open the valve manually underneath the sea within a maximum time span of 13 seconds and a minimum of microseconds (Millions of times per second) which is tested in small scale and produces 100% expected output result. Various communication technologies, Equipment used to construct the device, working principle with advantages, limitations and future scopes are explained in detail in this report.

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CHAPTER 1

INTRODUCTION

This chapter includes the background of the project, explaining why this project needed to be carried out. Aim and objectives, the scope of work and outline of the report are explained in detail.

This chapter includes a detailed understanding of how does wired and wireless communication works, such as fiber optics, Wi-Fi, Li-Fi and hydraulic process and choosing the suitable medium of communication to develop the subsea communication. The chosen medium of communication to develop subsea controlling is fiber optics communication.

1.1 OUTLINE OF THE REPORT

Chapter 1 (INTRODUCTION) This chapter explains the background of the development of Subsea Communication system using Fiber optics, the objectives, the statement of work, and a brief outline of the report.

Chapter 2 (LITERATURE REVIEW) This chapter explains how fiber optics, Wi-Fi, Li-Fi (Future of Wireless Communication in the sea) and traditional Communication works in subsea.

Chapter 3 (AIM AND SCOPE) This chapter explains the project final result precision and accuracy of the work done on fibre optics.

Chapter 4 (MATERIALS AND METHODS USED) understanding the equipment's used in developing the device, which helps to develop subsea communication System using fiber optics.

Chapter 5 (IMPLEMENTATION OF PROPOSED SYSTEM) Understanding how the device works, Limitations, Advantage and Applications of the device.

Chapter 6 (RESULTS AND CONCLUTION) presents the conclusion of this project and future scope of Subsea Communication system.

1.2 FIBER OPTICS COMMUNICATION

A single fiber strand is as thin as a human hair, lightweight, transparent fiber, and it also serves as a waveguide or "light pipe" to transmit light between the two ends of the fiber. The fiber-optical cables consist of thousands of fiber strands. In the early 1840s, Daniel Colladon and Jacques Babinet first demonstrated the theory of light by refraction. The evolution of Optical Fiber is enormous, and it has been an unavoidable substance in daily life. In Fiber-optic communications, optical fibers are widely used, allowing transmission over greater distances and at higher bandwidths than other modes of communication. Instead of metal cables, fibers are used because they have less signal loss and are also resistant to electromagnetic interference.

1.2.1 THE STRUCTURE OF OPTICAL FIBER COATING

Optical fiber needs a protective coating, an easy way to overcome this issue is to introduce a lower refractive index glass above the core glass known as cladding this way total internal reflection will happen and will be able to use a protective layer both the core and the cladding, silica is used as their base material. By adding various forms of dopants the variation in the refractive index can be obtained. Head optical cables are made up of a core of glass or plastic surrounded by an outer layer called cladding both the glass and the cladding have an inherent property called a refractive index which is basically a measure of how fast light can travel through something for the system to work correctly the cladding needs to have a slightly lower index of refraction than the core, This is done by using pure Silicon dioxide glass for the core, and then doping the cladding with chemicals to reduce the refractive index. The optical fiber is arranged in bundles and optical cables bundles are protected by the cables outer covering called a jacket. Optical fibers come in two types of single model fibers and multimode fibers. Cables carry information between two places using solely optical technologies.

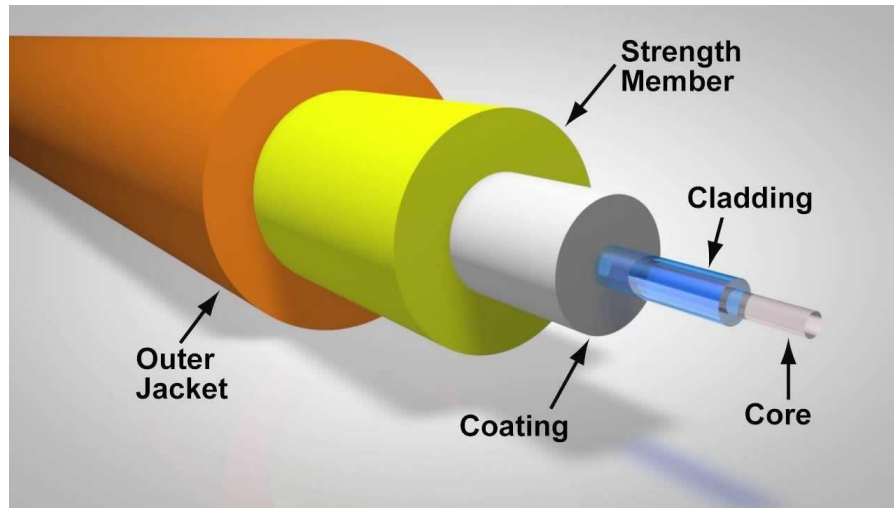


Figure 1.1 –Fiber optic coating

1.2.2 OPTICAL FIBER WORKING PRINCIPLE

light travels through a mirror, and you can see that, instead of moving straight, the light is distorted at the interface. That phenomenon is referred to as refraction.

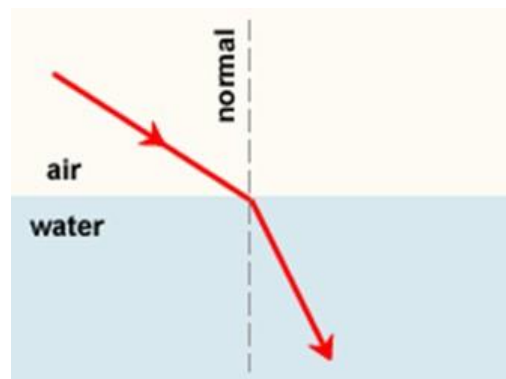


Figure 1.2 Refraction

1.2.3 SNELL'S LAW

Dutch physicist, Willebrord Snell derived the relationship between the different angles of light as it passes from one transparent medium to another in 1621

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2), \quad (1)$$

where, n_1 is the refractive index of the medium the light is leaving, θ_1 is the incident angle between the light beam and the normal, n_2 is the refractive index of the material the light is entering, θ_2 is the refractive angle between the light ray and the normal.

Refraction is the reason that a pencil appears curved in a water glass. The speed of light varies as it travels through a medium. To consider the processes of optical fibers and this change in pace is represented by the refractive index. Refractive index measures how much a material refracts light

$$n = c/v, \quad (2)$$

where, $c = 299,792.458 \text{ km/second}$, v is the speed of light in a material and n is refractive index of a material.

This difference in the speed of light refers to fascinating phenomenon refraction. This refraction technique is effectively used in optical fiber, now let us take this experiment a hypothetical one using some dopants we were able to increase the refractive index of the glass.

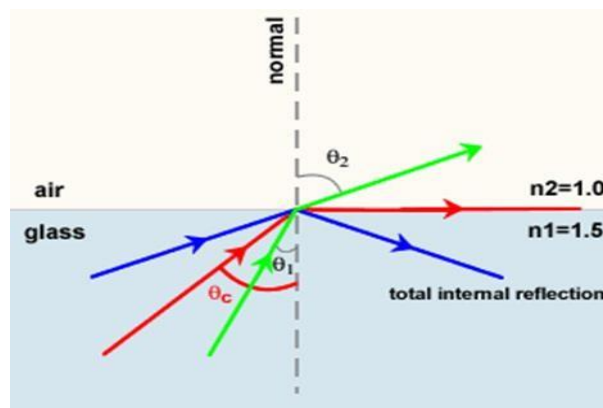


Figure 1.3 Total internal reflection

Total internal reflection is possible if in this case, we raise the angle of incidence rather than the refractive index at a certain angle, called the critical angle. Total internal reflection takes place between high refractive index glass and low refractive index; in theory, the optical signal should keep going all the way until it reaches the other end of the Fiber.



Figure 1.4 – Fiber optics

Amplitude is modified into a series of ones and zeros , i.e. the first bar of value is encoded 1010 it can be done for each section of the curve, instead of looking at the waveform, one can think of the signal as a time-organized set of ones and zeros, and it is that sequence that transmit through a flash fiber optic cable for a one and nothing for zero, at the receiving end the precise form of encoding is understood, so it is a trivial matter to decode the packet.

Due to absorption different losses in the wire takes place commonly referred to as attenuation, and scattering is the primary cause for signal attenuation. This is why amplifiers in cables improve the signal intensity after a certain distance and allow signals to be transmitted over a long distance from close sources to draw the power needed for the amplifier, No matter how high end and pure an optical cable is there will always be some imperfections even if they are so small that you could only see them at the molecular level and these will cause some of that light to scatter weakening the signal over distance until eventually it can't be understood by the equipment at the other end so

to combat this long distance fiber runs are assisted by repeaters or amplifiers are a repeater gets placed at a point down the fiber where the signal will have weakened significantly but it's still strong enough to be read once the light hits the repeat and turned into the corresponding electronic signal which is then turned back into light much as it was at the origination point and then sent along on its merry way. Repeaters come with the latency and complexity cost though so many modern long distance systems now use amplifiers instead these gadgets have optical fibers which are doped with chemicals that directly amplify light when the weekend signal hits them so the ions in the fibers themselves will reemit the same signal but much more strongly than what came in and it continues down the cable in this way optical fiber runs can be designed to be really long making them a more viable choice for long distance communication than copper. Optical fiber is not only more cost effective than copper wiring it's more power efficient and it even goes farther without requiring a boost also because it's thinner and doesn't cause electromagnetic interference to the cables around it. It is common to bundle a bunch of optical fibers each of which can carry multiple wavelengths of light into one large cable making it possible to transmit enormous amounts of data without taking up too much space.

Some of the advantages of optical fiber are its wavelength, frequency, windows, attenuation, and dispersion. Some of the disadvantages are high cost of investment, need for more expensive optical transmitters and receivers, more complicated and costly splicing, price, fragility, chemicals affected and opaqueness.

1.3 WIFI COMMUNICATION

In the 1980s, personal computers started to join our lives for good, but they were connected to the Internet by the infamous Ethernet cables at the time. However, those early attempts were unsuccessful since waves bounced back on walls furniture in pretty much anything that stood in a computers way, Dr. John O'Sullivan and his colleagues tried to detect radio signals from space, he was also known as the father of Wi-Fi, and they came up with fast Fourier transforms, but they could not detect further. Surprisingly 20

years later he and his Co-workers restarted the project, after many failures, they formed the basis for the Wi-Fi and finally cracked the code and came up with the first version of the 802 protocol in 1997. A message, which may be a human voice, a television image or records, originates from the source. The source is transformed by an input transducer into an electric waveform referred to as the baseband signal or message signal. The transmitter usually consists of one or more of the following subsystems: a pre-emphasizer, sampler, a quantizer, a coder and a modulator. The transmitter adjusts the baseband signal. The channel is a medium by which the signal of the transmitter is transmitted, through a wire, a coaxial cable, an optical fiber, or a radio link. Modern communication systems are classified into two types depending on the channel type: wireline communication systems and wireless communication systems. The transmission system is intended to effectively and reliably transmit data (power and spectrum). Through undoing the signal changes made to the transmitter and the radio, the receiver reprocessed the signal obtained from the antenna. The receiver's job is to retrieve the message at the source of the channel from the blurred and noisy signal. The receiver consists of a demodulator, a decoder, a filter, and a de-emphasizer. The receiver output is fed to the output transducer, which converts the electrical signal to its original form. Transmitters and receivers are carefully designed to overcome the distortion and noise.

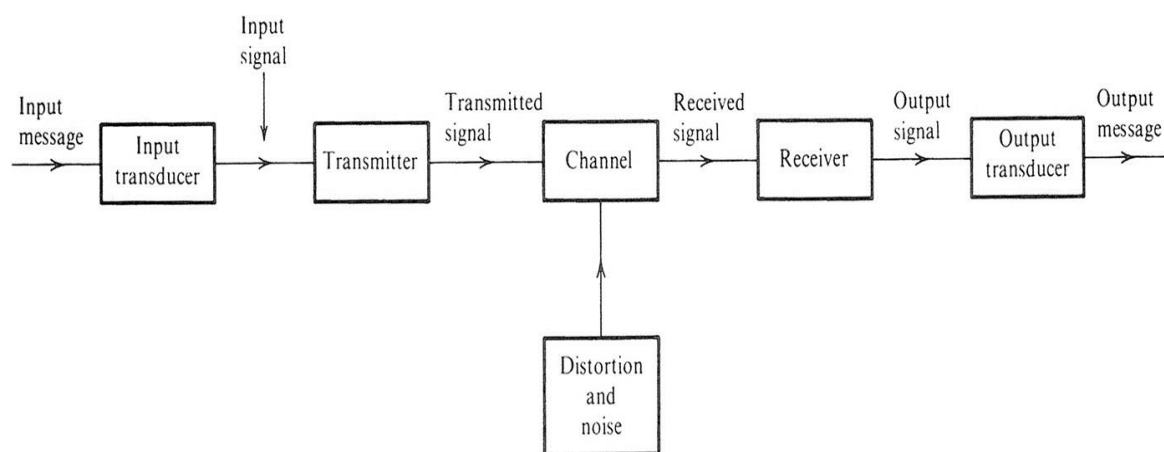


Figure 1.5 – Components of Wi-Fi systems

Wi-Fi is a technology that helps you access the Internet on your handheld device

it does it over the air, or wirelessly. IEEE or the Institute of electrical and electronics engineers defines the Wi-Fi standard under the family of 802. Wi-Fi networking standards are defined under 802.11, and there are many sub-standards which defines the frequency bandwidth. Several hardware components like wireless access points or routers which are equipped with Wi-Fi adapter, on the other hand the wireless router is connected to the Internet via a physical connection with a fiber cable or with an analogue line which uses a telephone and a modem which is then connected to the wireless router or modulator.

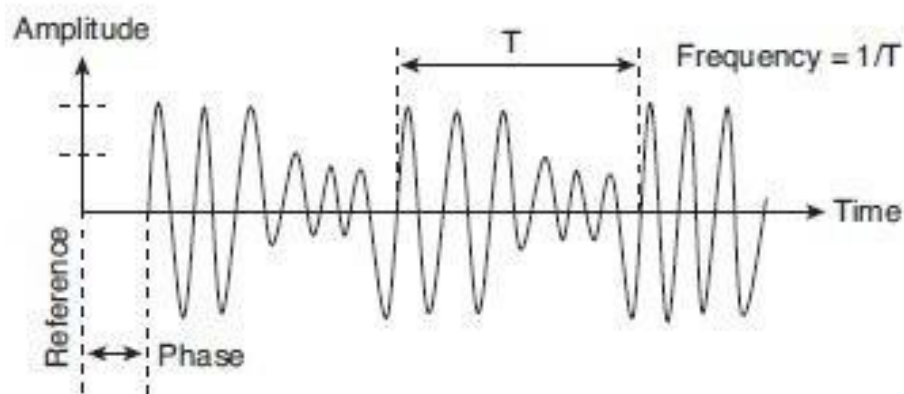


Figure 1.6 – Amplitude, frequency and phase modulation

The modulator is needed for analogue to digital and digital to analogue signal conversion the Wi-Fi router that connects to the end devices via radio waves to establish an end to an end Internet connection, The wireless router collects the data from the Internet here and converts it into the radio signals and transfers it to the connected devices over the wireless network, the same mechanism also occurs in reverse. Let us say a Lake, and when a rock is thrown, it is going to cause ripples. The critical point about these ripples would make waves is that they propagate because they can carry information out about the initial disturbance, the same concept is used in wireless communication, let us understand about electromagnetic or EM waves, i.e. X Rays, waves that form that image are X Rays, and radio waves are another particular types of electromagnetic waves. The data are transferred into zeros and ones, so the frequency

is modulated, this idea is the basis of how digital communication takes place called something more complex frequency shift key, these concepts Frequency modulation and Amplitude modulation and phase modulation constitute the majority of how electromagnetic waves travels between wireless devices.

1.4 LIFI COMMUNICATION

Li-Fi stands for Light Fidelity. The technology is very new and was proposed by the German physicist Harald Haas in 2011. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses light as medium to deliver high-speed communication in a manner similar to Wi-Fi and complies with the IEEE standard IEEE 802.15.7. The IEEE 802.15.7 is a high-speed, bidirectional and fully networked wireless communication technology based standard similar to Wi-Fi's IEEE 802.11. Light Fidelity (Li-Fi) technology is a wireless communication system based on the use of visible light between the violet (800 THz) and red (400 THz). Unlike Wi-Fi which uses the radio part of the electromagnetic spectrum, Li-Fi uses the optical spectrum i.e. Visible light part of the electromagnetic spectrum.

The principle of Li-Fi is based on sending data by amplitude modulation of the light source in a well-defined and standardized way. LEDs can be switched on and off faster than the human eyes can detect since the operating speed of LEDs is less than 1 microsecond. This invisible on-off activity enables data transmission using binary codes. If the LED is on, a digital '1' is transmitted and if the LED is off, a digital '0' is transmitted. Also these LEDs can be switched on and off very quickly which gives us a very nice opportunity for transmitting data through LED lights, because there are no interfering light frequencies like that of the radio frequencies in Wi-Fi. Li-Fi is thought to be 80% more efficient, which means it can reach speeds of up to 1Gbps and even beyond. Li-Fi differs from fiber optic because the Li-Fi protocol layers are suitable for wireless communication over short distances (up to 10 meters).

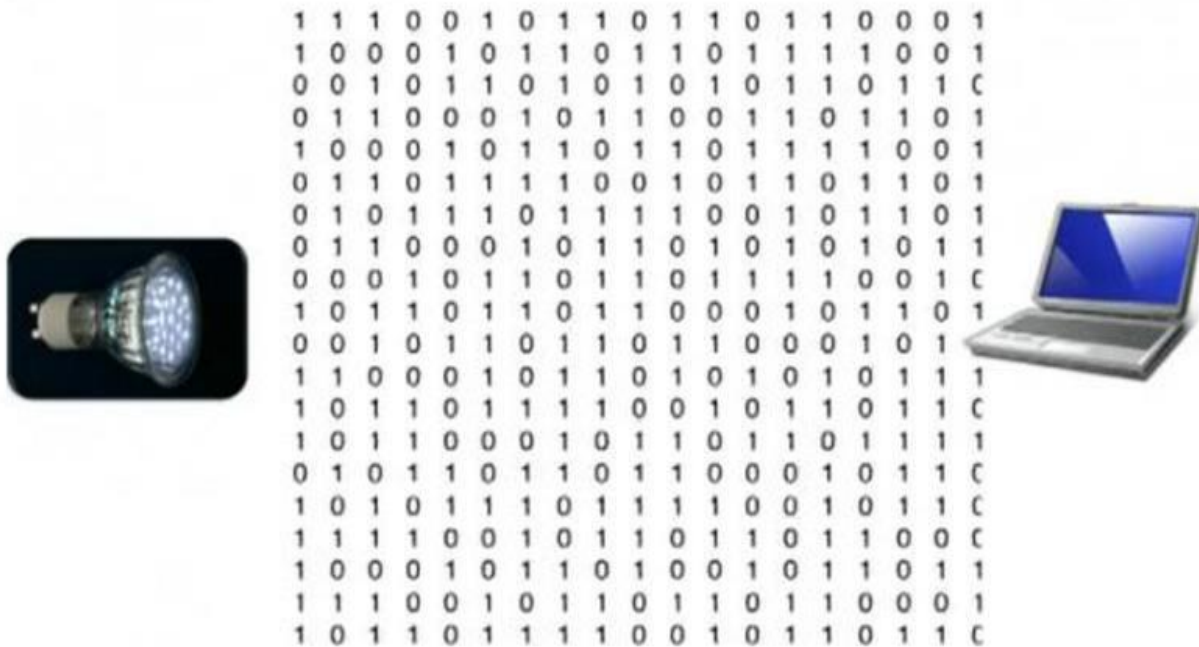


Figure 1.7 – Working principle of LiFi

This puts Li-Fi in a unique position of extremely fast wireless communication over short distances.



Figure 1.8 – LiFi bulb

Li-Fi provides better bandwidth, efficiency, connectivity and security than Wi-Fi and has already achieved high speeds larger than 1 Gbps under the laboratory conditions. By leveraging the low-cost nature of LEDs and lighting units, there are lots of opportunities to exploit this medium. Li-Fi is the transfer of data through light by taking fiber out of fiber optics and sending data through LED light bulb.

1.5 HYDRAULIC COMMUNICATION

This is the medium of communication used currently in oil and gas industry. A key function of a subsea control system is the operation of subsea valves, using the hydraulic and electrical power in the control system. Valve is a device to control or isolate flow of material through a pipeline or other equipment.

1.5.1 TO OPEN AN ACTUATED SUBSEA VALVE

The operator uses the control system interface to request the required valve movement. The Master control system sends a coded message to the relevant SEM. The SEM interprets the message and energizes the appropriate solenoid operated pilot valve. Multiplexed electro-hydraulic system energizing the pilot valve allows hydraulic fluid to flow into the valve actuator function line. Pressure in function line to the valve actuator rises quickly to a value which allows the valve to latch open hydraulically. The valve will remain open as long as the hydraulic supply pressure remains above the spring return pressure.

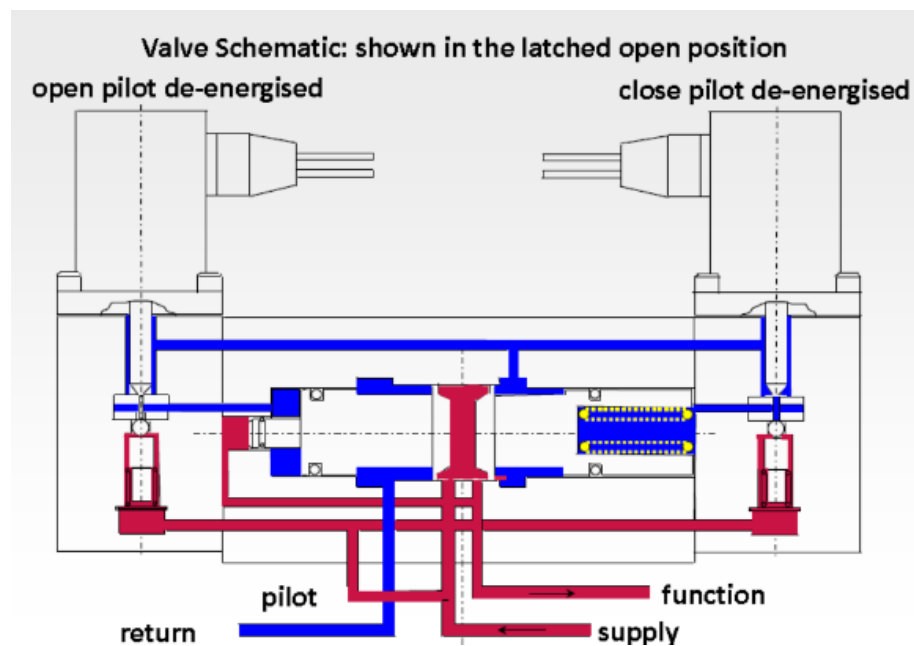


Figure 1.9 – Open position valve

1.5.2 TO CLOSE A VALVE

Similarly, the close solenoid is energized. The spool in the pilot valve moves, venting the hydraulic fluid from the valve actuator. For an open loop system, used fluid is vented to sea via a non-return valve and thus a valve is closed in subsea using hydraulics.

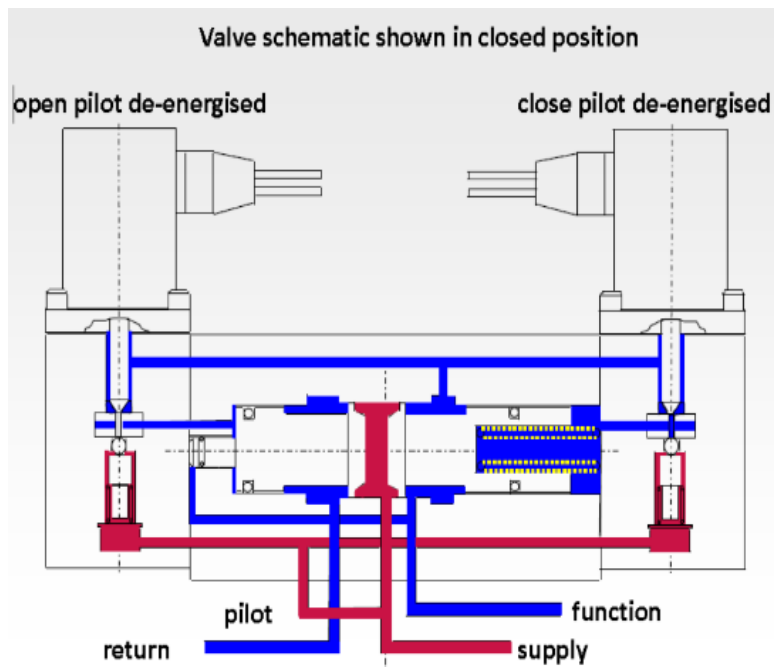


Figure 1.10 – Close position valve

CHAPTER 2

LITERATURE SURVEY

This chapter provides detailed literature survey related to the project, literature summary, problem definition.

The electrical power for the subsea industry is generated in two different ways, one being the offshore power generation and other is onshore generating station. As the subsea loads such as ESPs and compressors are located very far from the on-shore generating stations, it requires a long tieback power transmission system. Subsea industry has already started using high power high voltage AC transmission systems in order to minimize the power losses, and the reactive power due to the large capacitance of the power umbilical [16], [17]. The high voltage direct current (HVDC) transmission system in the subsea industry is being considered as an efficient power transmission solution for the long tieback subsea power systems as the number of power conductors and the reactive power consumption are minimal [18]. The transmission distance for a typical long tieback system spans from 100 km to 150 km and the distribution line distance is about 3000 m. The transmission voltages are typically kept at higher values, of the order 36 kV - 100 kV to compensate for the transmission power losses and also to reduce the reactive power consumption. However, the distribution line voltages are in general kept low of the order 3.3 kV to 6.6 kV, to supply the individual electrical loads.

2.1 LITERATURE SUMMARY

Based on the survey that we have mentioned above, The HVAC systems employ line frequency bulk transformers at the sending and receiving ends of the transmission line as well as in the distribution systems. This results in a large footprint and low power density system.

2.2 PROBLEM DEFINITION

Optical Cable installation cost will be highly complex. 24x7 Power backup must be maintained from substation. National Firewall should be under surveillance and it must be protected against black hat hackers. Optical Cable maintenance must be under care at least once in a year. Additional Man-Power will create minor impact to the

existing protocol since persons are required to support over all power backup and system maintenance but, when compared to the profit ratio this factor is purely negligible.

CHAPTER 3

AIM AND OBJECTIVE OF THE PRESENT INVESTIGATION

3.1 AIM

The aim of project is to reduce the time in subsea Communication by using fiber optics as a medium for Communication. Due to several factors affecting the frequency travel of wireless network underneath sea with great depth, temperature, pressure, and presence of saltiness makes wireless Communication in subsea impossible and many researchers are working on to develop the subsea communication system using Wi-Fi technology.

This technology is developed to overcome and avoid time delay in controlling the subsea equipment, to remove the issue of hydraulic fluid discharge, to avoid subsea accumulation in deep water, to reduce the overall cost of the project by reducing the overall time of the project, to avoid Long residence time in long umbilical leading to degradation of fluids (flocculation) , to develop new technology which will pave a way to wireless Communication using optics in future and to avoid issues from fluid contamination.

3.2 OBJECTIVE

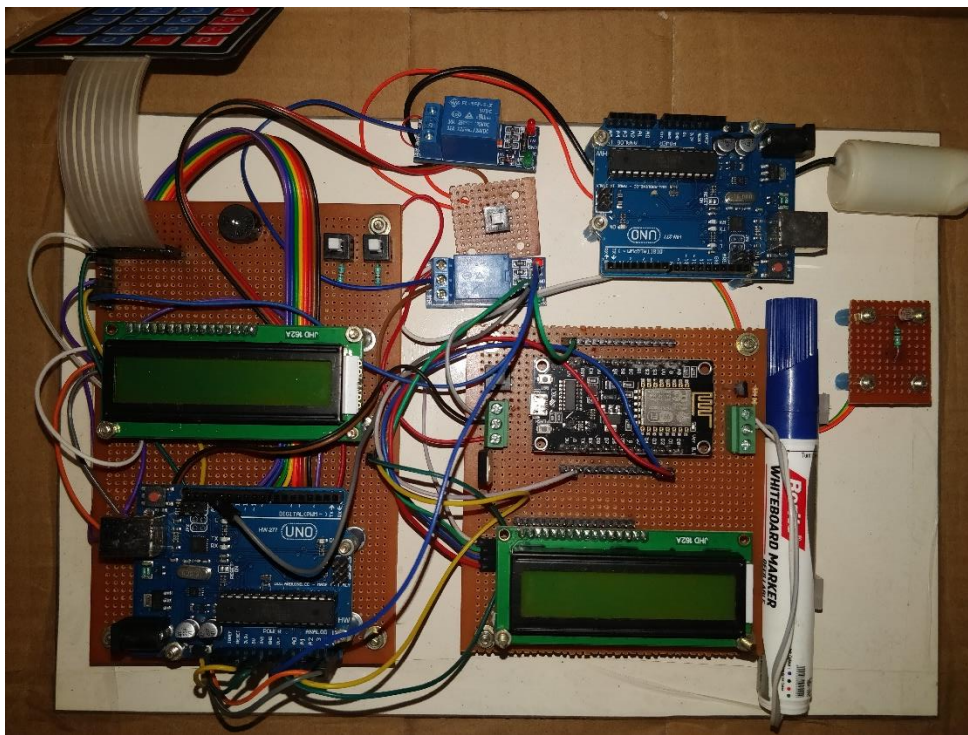
- To analyze the existing methodology of - to design and develop Sub Sea Umbilical Communication System with optical fiber for gasline.
- To develop the Subsea Communication system by using Fiber optics as a medium of communication and controlling the valves in subsea system. The aim is achieved by using the existing Fiber Optical cable in umbilical and Separate product.

CHAPTER 4

MATERIALS AND METHODS USED

4.1 COMPONENTS

This chapter explains about the equipment used in developing the device which helps to control the subsea equipment's using optical fibre, such as At mega 328P, Node MCU, LDR, LCD, keypad module, light-emitting diode, relay switch, push-button, diode, buzzer, transistor and jumper wire and their pinouts are explained in detail.



Figure(4.1) – Components configuration

4.2 BLOCK DIAGRAM OF PROPOSED SYSTEM

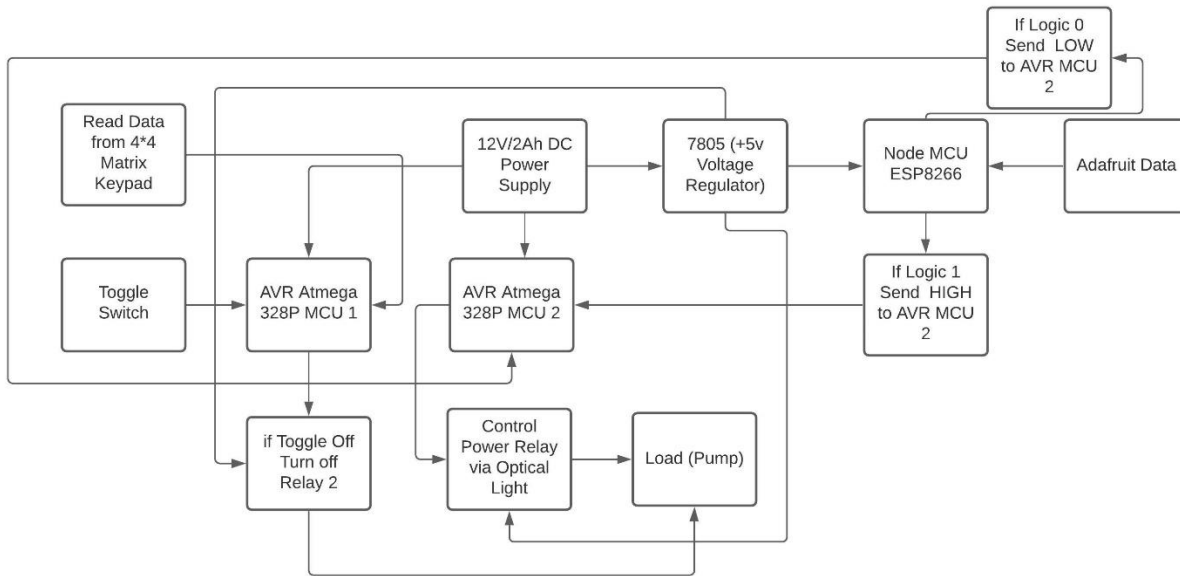


Figure (4.2)-Block Diagram

Proposed system consist of the devices which gives the control of equipments using -

4.3 ATMEGA 328P

ATMEGA328P is a very advance and feature-rich microcontroller. It is one of a favorite microcontroller because of its use in Arduino UNO board. In our device, we have two ATMEGA328P with Arduino, one for Automation and other for Manual phase.

Some of the Chip implementations are as follows Industrial machinery operating devices, solar-driven machinery and technologies, IoT-based technologies, power supply, charger-based applications, weather systems, wireless networking applications, security-based applications, medical & health-related ventures & systems, automobile-related applications, and many more.

It has 6 ADC channels that can be used to convert the analogue signal to digital, In Manual phase, A0 is connected to the light-dependent resistor (LDR), whereas in Automatic phase A0, A2 is connected to +12V Relays, A3 and A4 are connected to 16*2

LCD. The analogue converter needs to be activated first by its power pin and Reset is to restart the microcontroller in error conditions.

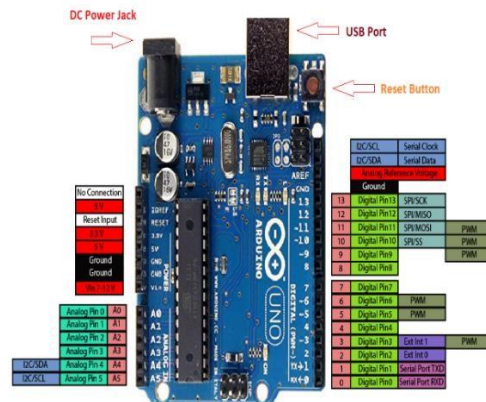


Figure 4.3: Arduino board

Any controller needs the power to work, and the power input pin is present on the board. In ATmega328P, the number of power pins is three. One pin is for voltage, and the other two are for a neutral ground. Both of those ground pins are internally connected, and it does not matter which one is used, In Automation phase, the 5V pin is connected to LDR and further linked to 16*2LCD and Node MCU thus, activating these components. In Manual phase, the power pin is connected to 16*2LCD.

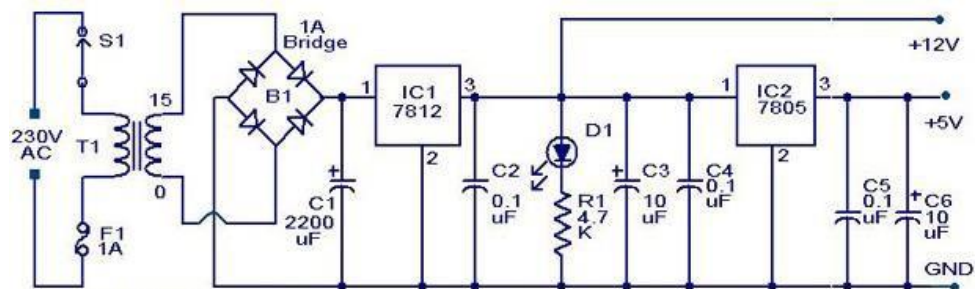


Figure 4.4 - 12v,5v power supply diagram.

There are 13 Digital pins which are connected to sensors and peripherals, In Automation phase, the output of the main gate valve motor is connected to pin 7, whereas in the manual phase pin 4 to pin 11 is connected to 4*4 keypad and pin three is connected to a buzzer.

4.4 NODEMCU

NodeMCU is a development board specially targeted for IoT based applications. Prototyping of IoT devices, Low power battery-operated applications, Network projects, Projects requiring multiple interfaces with Wi-Fi and Bluetooth functionalities are some of the leading applications of Node MCU. In the device the pins are connected as follows, Power Pins there are four power pins. VIN pin and three 3.3V pins. VIN can be used to supply the NodeMCU and its peripherals directly. This pin is connected to LDR viz Arduino through which power delivered through the onboard regulator. NodeMCU I2C Pins are used to connect I2C sensors and peripherals, two GND pins are connected to 16*2LCD and Arduino, respectively. Control Pins are used to controlling the NodeMCU, NodeMCU has 16 GPIO pins, each digital-enabled GPIO can be configured to internal pull-up or pull-down or set to high impedance.

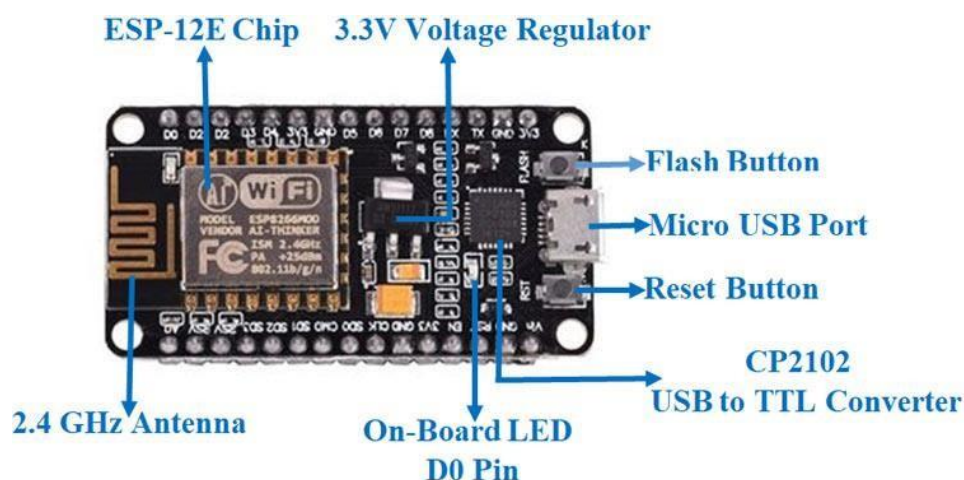


Figure4.5 –NodeMCU

4.5 LIGHT DEPENDENT RESISTOR

Often known as the photo resistor, photocell, the photoconductor is an LDR (light- dependent resistor). It is a type of resistor, which is based on how much light falls on its surface. When the light falls on the capacitor, the resistance decreases, these resistors are used in many circuits, where detecting the presence of light is necessary. These resistors have several diverse roles. i.e., the LDR is in darkness; it is used to turn ON light or while it is in the sun used to switch off the light. A standard light-dependent resistor has a resistance of 1M Ω in the darkness and resistance of some K Ω in the daylight. Light-dependent resistors are low-cost and are simple. Frequently these resistors are used as light sensors. The principle of Photo resistors is photoconductivity. Healthy conductors have a host of free electrons which, under the action of a potential difference, can drift in a given direction high resistance. Insulators have very few free electrons, and thus it is impossible to allow them travel and hence a current flows, which gives some of them enough ability to break away from the crystal lattice and be able to conduct electricity, this results in a decrease of the semiconductor resistance and thus the total resistance of the LDR. The method is revolutionary because as the LDR semiconductor reflects on light, more electrons are released for transmitting-electricity.

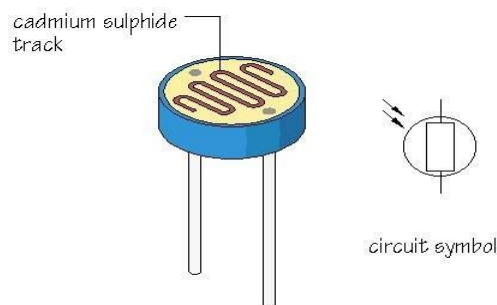


Figure 4.6 - LDR (Light dependent resistor) & circuit symbol

4.6 16x2 LCD

It has sixteen columns and two rows, hence it is called as 16*2 LCD. There are lots of variations available, including 8 *1, 8 *2, 10*2, 16*1, etc., but the most commonly used one is the 16*2 LCD. So, it will have a total of 32 characters ($16*2=32$), and each character will consist of 5 premature Pixel Dots. Now, we know that each character has 40 pixels ($5*8=40$) and we'll have 1280 pixels for 32 characters. In addition, the LCD should also be advised about the Pixel Location. Therefore, doing anything with the aid of MCU would be a hectic task; therefore, an interface IC like HD44780 is used, mounted on the back of the LCD module itself.



Figure 4.7 - 16x2 LCD (Liquid crystal display)

The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen. The pin configuration for this device is as follows, Ground pin connected to system ground, it is connected to Node MCU System in automation phase and in Manual phase, the ground pin is connected to ATMEGA 328P Arduino board. V_{dd} (+5 Volt) LCD is powered by +5V (4.7V-5.3V), Power received from LDR through ATMEGA328P Arduino board in both the phases. V_E (Contrast V) Limits the display level. It is grounded to get maximum contrast. Enable Microcontroller Pin Linked and toggled between 1 and 0 for data acknowledgement. Data Pin 0 to 7 is connected to Node MCU D1 to D7 respectively in automatic mode, and in Manual mode, it is connected with the Arduino board's analogue to digital pins such as A4 and A5.

4.7 4X4 KEYPAD MODULE

A 4x4 keypad will have eight terminals. In them, four are rows of the matrix, and four are columns of the matrix. These eight pins are driven out from 16 buttons present in the module. Those 16 alphanumeric digits on the module surface are the 16 buttons arranged in a matrix formation. Some of the application is security systems, vending machines, industrial machines, engineering systems, measuring instruments, data entry for embedded systems, hobby projects, basically anywhere input device is needed.



Figure 4.8 - 4x4 keypad

In the device the pin output is as follows, pin1, pin2, pin3 and pin4 are 1st, 2nd, third and 4th row respectively, pin5, pin6, pin7 and pin8 are 1st, 2nd, third and 4th column respectively. All the pins from 1 to 8 are connected to Arduino board pins 4 to 11. Now consider a button is pressed on the keypad the current flows in the respective direction, i.e., the high current flow in column and row is identified and the controller is programmed to remember, c2 going high and the button pressed is in c2 column; thus, identifying the match and accessing what key is pressed in 4x4 keypad module.

4.8 LIGHT EMITTING DIODE

The diode emitting the light is a p-n junction diode. It is a specially doped diode and is composed of a particular form of the semiconductor. If the light is forward biased,

then it is considered a diode emitting light. The Light-emitting diode's operating philosophy is based upon the quantum theory. There are several LED uses, and some of them are explained below, LED is used as a lamp in homes and factories, light-emitting diodes are used in bikes, vehicles, cell phone display and also used in the traffic light. Some of the advantages of Led are, cost of LED's is cheap, and they are tiny, By using the LED the electricity is controlled, the intensity of the LED differs with the help of the microcontroller. In our device, we are using Led to signal us about the functions happening inside the circuit in various places.

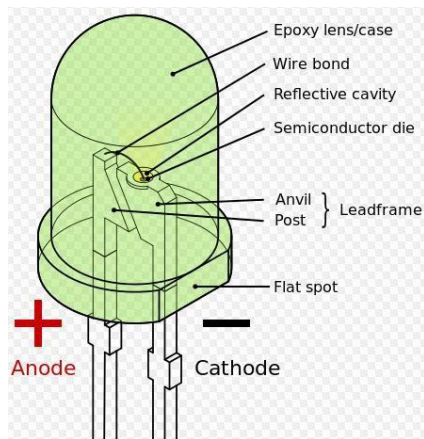


Figure4.9 - Light Emitting Diode

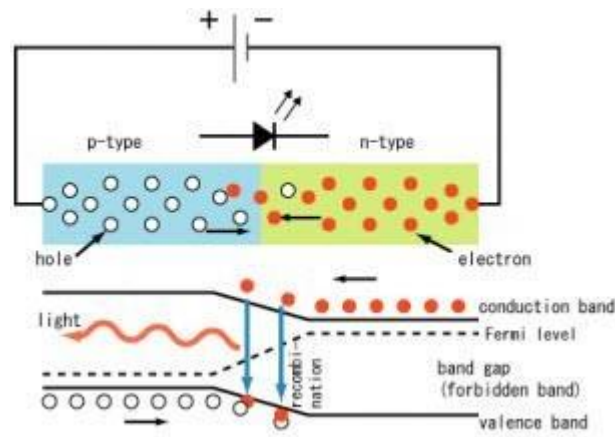


Figure 4.10 - Working Principle of LED

4.9 RESISTORS

If you link an LED directly to a current source, it will attempt to dissipate as much power as it is permitted to obtain, and it will kill itself, that is why restricting the amount of current flowing through the LED is necessary. We use resistors for this. Resistors restrict electrical flow in the circuit and prevent the LED from attempting to draw too much current. The basic template for an LED circuit is pretty simple, connect your battery, resistor and LED in series.

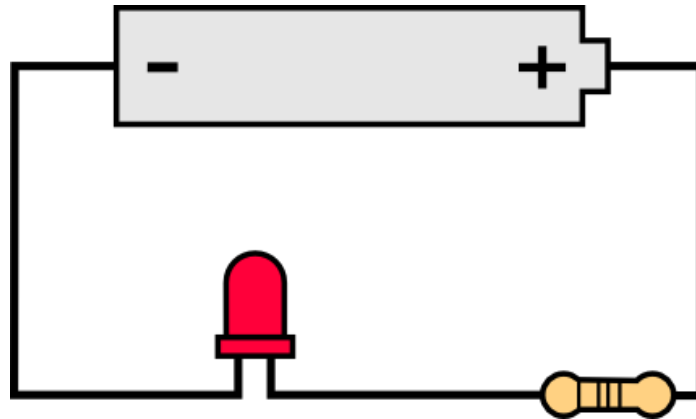


Figure 4.11 - Resistor

4.10 12V RELAY SWITCH

The 12v Relay is an electromechanical switching system that controls the AC devices through DC. Commonly used in switching circuits, For Home Automation programmers to turn AC loads, To Monitor (On / Off) Heavy loads at a predetermined time/condition, used in safety circuits to detach the load from the supply in case of malfunction, Used in Cars electronics to monitor indications of glass motors.

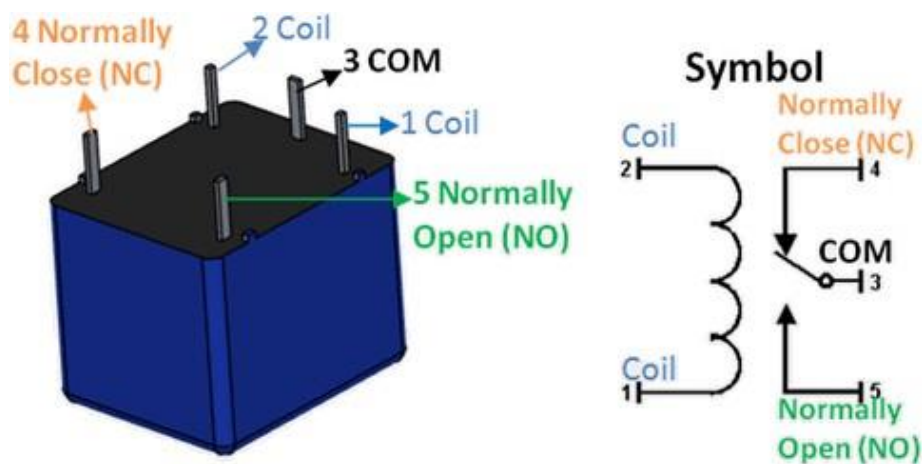


Figure 4.12 - Relay

The pinout configuration is as follows, Coil End 1 and Coil End 2 is used to triggering (On/Off) the Relay, one end is connected to 12V and the other end to ground.

Popular (COM) Common is attached to one End of the Load to be operated, Usually Closed (NC), is either attached to NO or NC, If connected to NC the load stays attached until triggered, Usually Open (NO), the other end of the load is connected to NO or NC. The load remains disconnected until trigger while attached to NO.

4.11 PUSHBUTTON SWITCHES

Pushbutton Switches, also known as Push Buttons, are hand-operated electro-mechanical mechanisms that are found in buttons and switching circuits. Pushbuttons are tactile switches which usually move. Push buttons allow us to control the circuit, or to attach only when we click the button. Simply, when pushed, it keeps the circuit connected, and splits when removed.



Figure 4.13 - (ON)-OFF, Push button

These are the essential buttons that we use in the computer devices of our everyday lives. Pushbutton is used in calculators, pushbutton computers, kitchen appliances, magnetic locks, many other mechanical and electrical gadgets, home appliances, and commercials. In this device, there are two pushbuttons, namely B1 and B2, when B1 is pressed, it is programmed to open the gate valve, and when B2 is pressed, it is programmed to close the gate valve. These are connected to Arduino boards Analog pins A1 and A2 respectively, and the power is extracted from the same board for operation.

4.12 DIODE

Diodes are one of the simplest of all semiconductor devices and also most useful device. A diode is known as an electronic two-terminal component that conducts current in one direction only. An ideal diode in one direction would have zero resistance and infinite resistance in a reverse way. At the same time, diodes cannot reach zero or infinite resistance in the real world. Instead, in one direction, a diode would have negligible

resistance (to allow current flow) and very high resistance in the reverse direction (to avoid current flow). A diode is essentially like an electronic circuit switch. The Diode is known to be "forward biased" when current is performed in this direction. The reverse barrier breaks down over this level. The voltage at which this separation occurs is termed the "reverse voltage breakdown."

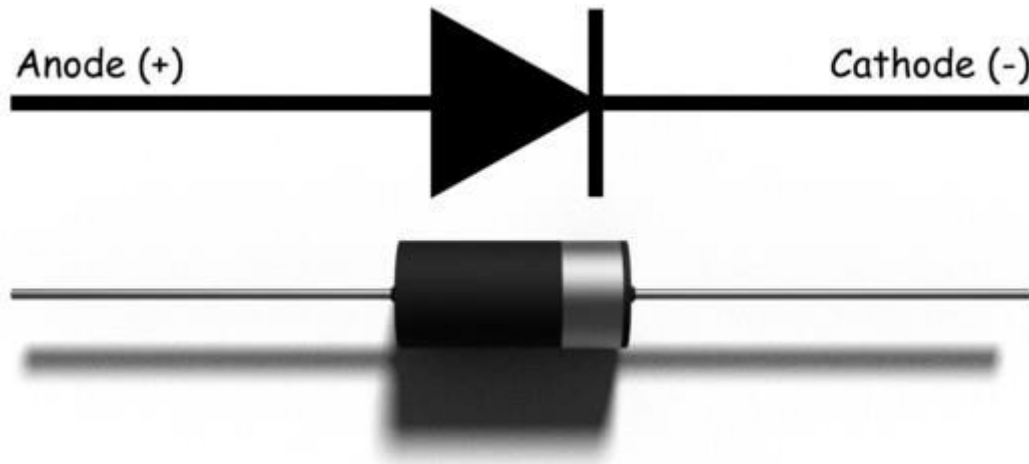


Figure4.14 - Diode

No majority carriers across the junction at that point, and instead they travel away from the junction. Moreover, a diode blocks the current flow as it is distorted in reverse. Consequently, there is a tiny current running from positive to negative side through the Diode. The amplitude of this current is marginal because the number of carriers with minority charges in the Diode is minimal. When attached in the reverse direction (i.e. the "high resistance" direction) inside a circuit, the Diode is said to be "reverse biased." This current is termed the current of reverse saturation. If the reverse voltage across a diode increases above a secure value, several covalent bonds get broken to contribute a considerable number of free electron-hole pairs in the Diode, and the process is cumulative. The considerable number of such charging carriers generated in the Diode would contribute a substantial reverse current. If this current is not controlled by an external resistance connected to the diode circuit, the Diode can be permanently destroyed. So, Diode is added in many places in this device to prevent above-mentioned conditions.

4.13 ACTIVE PASSIVE BUZZER

It is typically used for identification and alarm purposes across many major industries. The primary application categories that utilize buzzers for indication or alert purposes include home appliances, automotive electronics, medical, safety and security, industrial, and office automation. Positive identified by (+) symbol or longer terminal lead. Can be powered by Arduino board in the manual device, Negative Identified by (-) short terminal lead and typically connected to the ground of the circuit. In this device, the buzzer is connected to indicate the success and failure of keypad entries. Its programmed that when all the character entered is correct the buzzer indicates with expected frequency whereas, the wrong character entered, different frequency buzzer is indicated as output.

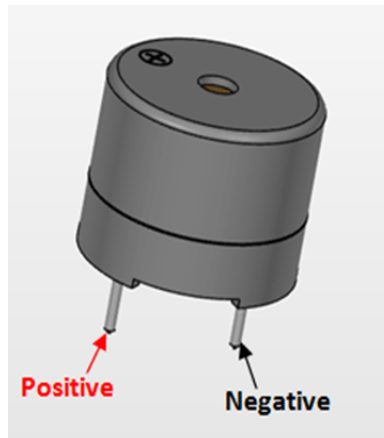


Figure4.15 - Buzzer

4.14 TRANSISTOR

The transistor is a semiconductor system that passes a weak signal from low to high resistance circuit. The words trans mean transition property and is to mean resistance property offered to the junctions. In other words, it is a switching system that controls the voltage or current of the electrical signal and amplifies it. Transistors are widely used as electrical switches in digital circuits, for high-power applications such as switched-mode power supplies and logic gates for low-power applications, which can be either in on or off state. In our device transistor is used in many places.

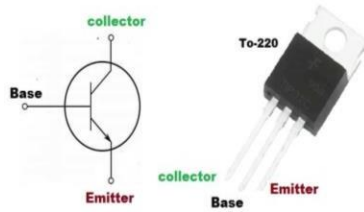


Figure4.16 –Transistor

4.15 JUMPER WIRE

The term "jump wire"(also known as jumper wire, or jumper) refers to a conducting wire or set of wire, with a connector or pin at either end in a cable (or sometimes without them – simply "tinned"). It provides an electrical connection between two points in a circuit, typically used to connect, without soldering, the components of a breadboard or other prototype or test circuit, internally or with other equipment or components.

Individual jump wires are fitted by inserting with their "end connectors" into the slots provided in a circuit board, the header connector of a circuit board, or a piece of test equipment. In our device, we have used jumper wires to connect between points.

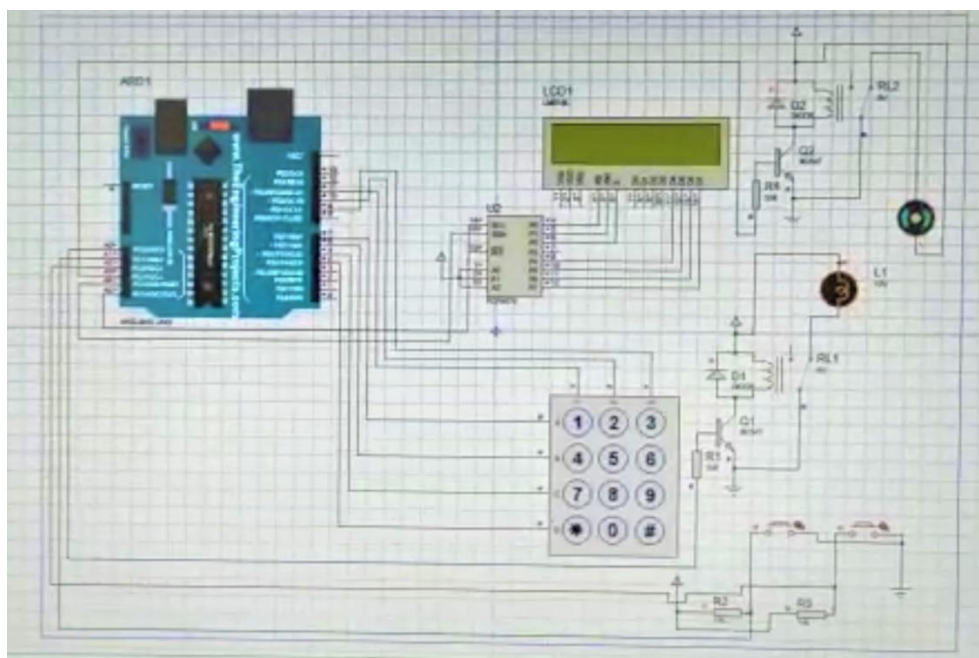


Figure4.17 - Jumper wire

CHAPTER 5

IMPLEMENTATION OF PROPOSED SYSTEM

5.1 CIRCUIT DIAGRAM FOR THE PROPOSED SYSTEM



Figure(5.1): circuit diagram for the proposed system

This chapter explains about the detail working principle of the device such as the methodology, architecture of the device, working of the device, basic concepts, why optical fibre communications specifically, advantages of optical fibre communication with its limitations are explained in detail.

5.2 AUTOMATIC MODE

This process is newly introduced according to the latest technology as everything is under our palms. These IoT technologies are developed over recent years. However, the equipment inside the subsea are quite old from 18th centuries, and it can be only controlled from the top side using hydraulics as a medium of communication, so I have added the automatic phase to make the process little more comfortable to communicate to subsea equipment from any part of the world.

5.3 MANUAL MODE

This process is the same old traditional way of commanding from topside and controlling the subsea equipment. In my case I have used switches such as B1 and B2 and linked to Atmega Arduino which converts the analogue message to digital message and the same is travelled through the optical fibre and reaches the receiving end in this subsea. To avoid overlapping of Communication automatic mode and manual mode at the same time, I have added a security layer, In my device, I have used four by four matrix keypad with the secure password entered correctly it switch off's the automatic mode, and only manual mode can be operated by which overlapping is avoided.

5.4. WORKING

Optical fibre technology is a wired communication system based on optical lights travelling through glass fibers. Unlike Wi-Fi which uses radio waves as a medium whereas, Optical fibre uses the optical spectrum. The principle of optical fibre is based on sending data using an optical light source in a well-defined and standardized way.

In automatic face I am using MQTT broker in storing the commands in Adafruit cloud and whenever the command is said through Google Assistant from any part of the world the messages are retrieved from Adafruit cloud respectively to the IP address particularly. In my case, the IP address is "192.168.043.202," i.e., whenever I say open the gate valve command the IFTT applet which is linked to my Gmail account recognizes the command and particular response messages return to the IP address as programmed so when the message zero is received, the router sends a signal to on optical light, and the optic message travels from the top side to bottom when it is received in the receiving end its decoded using LDR light detecting resistor, and when the digital value is less than 100, Atmega Arduino board sends a signal to the relay to on the gate valve thus automatic face is operated. Considering the manual face instead of using the Internet of things, we give a command from the top side to open the valve. When the command is given the optical signal travels through an optical fibre cable, and it is received in the receiving end, and the LDR signal again reduces below 100, Atmega board indicates really to open the gate valve.

In automatic mode we are giving the command "turn off the gate valve" through Google Assistant and the same whole process of retrieving the message from cloud to particular Ip address and indicates to turn off the optical fibre signal so, values will be more than 100 which indicates the Arduino board to send a signal to relay to close the valve. In manual mode to close the gate valve, switches B1 is pressed or commanded from the top side is given so, the fibre optic signals stop passing through the fibre optic cable, and when the light is not received at the receiving end, the LDR values will be more than 100. Arduino board sends a signal to the relay to close the valve and thus the basic concepts of how the device works. To avoid signal clashes between automatic phase and manual phase and to develop security, I have used a security layer for single communication.

5.5 BASIC CONCEPT

The working of the device is straightforward. There is a Optical emitter on one end, i.e. an Optical transmitter, and a Light dependent resistor (light sensor). The data input to the Optic fiber cable transmitter is encoded into the light 'on' and 'off' to generate strings of 1s and 0s. The resistor works on the principle of photoconductivity.

The devices depend on the light, when light falls on the LDR, then the resistance decreases below 100 at the receiving end, and the data is received as light signal and decodes the information, so as soon as the decreased value below 100 is received, the valve is opened. Similarly, as soon as the Optical light stops falling on LDR the value increases above 100 then, it is programmed accordingly to close the valve. The receiver (LDR) registers a binary '0' when the transmitter is ON and a binary '1' when the transmitter is OFF. In simple terms, when optic message is received then the valve will be opened and when the optical light is not received the valve will be closed. Thus the basic concepts of opening and closing of valves in subsea using optical fibre.

Hence all that is required is the device attached to the subsea equipment connected with the fibre optic cables and electrical cables so whenever transmitter sends an optical signal the device will open the valve and whenever the transmitter stops sending the optical signal, the device will close the valve. The device is producing 100% outcome as expected, further development of the device is to make it into a smaller printed circuit board so that it can easily be installed in real-time and tested.

5.6 OPTICAL FIBRE COMMUNICATION

The frequency of Wi-Fi operates at 2.4 & 5.8 GHz. These frequencies are way too high for underwater propagation, preferred underwater frequencies are 10 kilohertz to 1 kilohertz. Theoretically it works underwater but would face significant attenuation issues such as the saltiness in sediments, mass of water itself and it experiences too much signal loss underwater preventing it from being used as a medium of communication in subsea.

As mentioned earlier hydraulic is the traditional way of communicating underneath the subsea which takes quite a lot of time to communicate so, to improve the speed and to reduce the cost we are choosing optical fibre as a medium of communication and also it is readily and already available in subsea with no harmful effects. While the other wave regions have disadvantages, radio waves are expensive (because of spectrum charges) and less secure, gamma rays are harmful because it could be dangerous for living beings to deal with because of their proven toxic effects. X-rays have health problems similar to gamma rays, infrared rays due to high safety regulations can be used only with low pressure, Hence the Optical fibre does not cause any harm to any living organism in subsea. The optical fibre is safe to use, provides larger bandwidth and also has a promising future in the Subsea communication field.

5.7 ADVANTAGES OF OPTICAL FIBRE COMMUNICATION IN SUBSEA

- *Efficiency*: Using efficiently all existence substance to improve subsea Communication with little alterations in subsea equipment.
- *High speed*: Subsea equipment is controlled within a microsecond and a maximum of 13 seconds irrespective of the depth.
- *Availability*: Availability is not an issue as Optical fibre cable is already present in the sea.
- *Cheaper*: Optical fibre not only requires fewer components for its working, it also reduces the overall cost of the entire project by developing the speed of Communication.
- *Security*: One main advantage of optical fibre communication is security. Even though IoT is linked with the device, I have used the security layer to avoid overlapping of Commands from automatic phase and manual phase.
- *Underwater applications*: It can be used for Communication in the sea with astonishing speed.
- Optical fibre communication underneath the sea has a great scope in future.

5.8 LIMITATIONS OF OPTICAL FIBRE COMMUNICATION IN SUBSEA

Some of the significant limitations of Optical fibre communication in subsea are:

- Information cannot be accessed without an optical fibre cable
- Only gate valve is used, but this technology is applicable for all types of valves.
- Real-time testing should in large scale is not yet carried out.
- Minor losses while communicating between topside and subsea.
- However, it is yet to be developed for mass-scale adoption.

CHAPTER 6

RESULT AND CONCLUSION

This chapter explains about the conclusion of the comprehensive report with its results concerning the aim and objective of the project stated at the beginning with its future scope and future invention which can pave the way for wireless communication in future subsea Industry.



Figure - 6.1 Automatic phase on

So, the above diagram clearly explains how the device works in automatic phase .when the command is given to “turn on the gate valve” Message ‘0’ is received from the Adafruit cloud to the particular IP address, when zero is received the optical fiber is transmitted as programmed and when received in the LDR the valve is activated.



Figure - 6.2 Automatic phase off

similarly to close the valve the command “turn off the gate valve” is given and the message ‘1’ is received from the Adafruit cloud to the particular IP address and fiber optic is turned off and hence the valve is deactivated.



Figure - 6.3 Manual phase on

For manual operations, the command to open or close the gate valve is given by using a push button. In this case button B2 is used to open the gate valve, when pressed message ‘0’ is received and the fiber optic is transmitted, and hence the valve is activated.



Figure - 6.4 Manual phase off

Similarly, to manually close the valve, button B1 is pressed and the message '1' is received which indicates the optical fiber to switch off and when the signal is not received in the LDR the valve is deactivated.

6.1 CONCLUSION

Development of this technology as commercial success is very near, and it guarantees excellent potential within the field of Subsea communication system. A significant range of researchers and corporations are presently engaged in this idea of wired and wireless Communication in subsea, that guarantees to resolve the problem of Subsea communication speed. By implementing this technology, we will migrate to a greener, cleaner, safer communication networks. The thought of fibre communication guarantees to resolve problems like underwater Communication, developing high-speed Communication in subsea, reducing the overall price of the project, it removes the issue of hydraulic fluid discharge, it avoids subsea accumulation in deep water, it avoids Long residence time in long umbilical leading to degradation of fluids (flocculation) and it avoids issues of fluid contamination.

6.2 FUTURE SCOPE

As already there is fibre cable present in subsea umbilical, there is an excellent scope for the utilization and evolution of fibre communication technology in subsea. If this technology becomes mature, controlling the majority of Subsea equipment become possible. As the Optical Communication in subsea becomes widespread, it will result in a cleaner, greener, safer communications and have a bright future and environment. The thought of fibre communication is deriving several because it is accessible and quicker means of transferring information. The optical communication system in subsea may become another resolution to ancient hydraulic Communication. The long-run appearance appears to be excellent for the Oil and gas industry as the downfall is about to complete. The Statista report identified 91 new projects within the year 2019 and many additional to come. Continuing advancements in fibre optic technology with a spotlight on capability and affordability is anticipated to play a significant role within the future growth of the industry.

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