

Developing Subsea Communication System Using Fiber Optics Umbilical

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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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
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APRIL - 2023



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BONAFIDE CERTIFICATE

This is to certify that this Final Year Project Report is the bonafide work of B.NAGENDRA RAVI SAI (REG NO: 39130057) AND B.NAVA KISHORE (REG NO: 3913055) who have done the project work as an individual who carried out the project entitled “**Developing Subsea Communication System Using Fiber Optics Umbilical**” under my supervision from Jan 2023 to April 2023.

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DECLARATION

We, **B.N.RAVI SAI** (REGNO: 39130057) and **B.NAVA KISHORE**(REG NO: 39130055), hereby declare that the Project Report on “**Developing subsea communication system using fiber optics umbilical**” done by us under the guidance of **Mrs. ANNIE ANGELINE PREETHI,M.E.,(Ph.D.)**, at Sathyabama Institute of Science and technology is submitted in partial fulfilment of the requirements of the award of Bachelor of Engineering degree in **Electronics and Communication Engineering**.

DATE: 26/04/2023

PLACE: Chennai

SIGNATURE OF THE CANDIDATE




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ABSTARCT

In the 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 developing a 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 it is done by hydraulics only. This report focuses on developing the speed of Communication and controlling subsea Equipment using Fiber optical as a medium, which is already present in the subsea umbilical. We have developed a device that 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 on small scale and produces 100% expected output result.

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CHAPTER 1

INTRODUCTION

This Chapter deals with the introduction of our project in a detailed manner, Future we will get into the analysis of the problem statement of our project and its objectives which will define the scope of the project.

1.1 Introduction

In the 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 developing a 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, I am using optical fiber (wired) as a medium of communication and developing the speed of Communication and controlling the subsea Equipment. 4) This project focuses on developing the speed of Communication and controlling subsea Equipment using Fiber optical as a medium, which is already present in the subsea umbilical. I have developed a device that can retrieve the message from optical Fiber and open the valve manually underneath the sea within a maximum time span of 13 second.

1.2 Problem Statement

1. Optical Cable installation costs will be highly complex.
2. 24x7 Power backup must be maintained from the substation.
3. National Firewall should be under surveillance and it must be protected against black hat hackers.
4. Optical Cable maintenance must be under care at least once in a year.
5. Additional Man-Power will create a minor impact on the existing protocol

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

1.3 Objectives

This technology is developed to overcome and avoid time delays in controlling 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 as the time of the project is reduced. To avoid long residence time in long umbilical leading to degradation of fluids (flocculation).

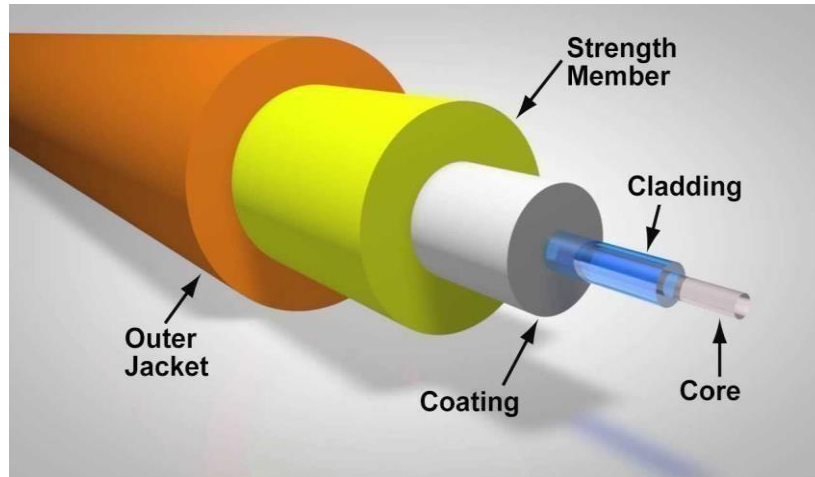


Figure 1.3.1– Fiber Optical Coaxial Cable

To develop new technology which will pave the way for wireless communication using optics in the future. To avoid issues from fluid contamination. A precise data Log can be Maintained. Hydraulics controlled through optical fiber technology will tremendously decrease the time delay when compared to existing high-pressure steam control valves. On Implementing IoT, this system can be securely handled globally from anywhere in the world. In case of a Network crash or Internet Protocol

Failure, an emergency password-protected manual control unit will do the job in the next fraction of seconds the whole system will be under systematic control and the cost of the existing mechanism will be reduced by nearly 200 percent. There is a minor chance for an error rate of nearly 5% when compared to the present traditional subsea equipment success rate. This can only be improvised based on the upcoming network technologies.

1.3.1 Scope of the Project

This project is distributed in three Phases namely Automatic, Manual, and Bridge Phase. The scope of our proposal is to reduce the buffer time in the Oil Industries. Further, we work on this project to increase the unwanted use of GDP of the nations

1.3.2 Automatic Phase

Communicating through IFTTT on ADAFRUIT and Google Assistance, Voice Recognition Engine using keywords or Phrases. Based on the encrypted trigger the valve is controlled via an optical network.

1.3.3 Manual Phase:

1. Password Synchronization
2. Toggle Switch Activation from Automatic to Manual phase
3. Button B1 to deactivate open the state of the valve and B2 - to the activate valve

1.3.4 Bridge Phase:

For the whole project, this is the main power distribution unit. Here in case of Network traffic or signal failure, we use this mode to switch the control signals between automatic and manual mode. The data will be sustained and stored in the buffered and the distribution power to the system will be shut down till the end of the retrieval of the network.

1.3.5 Snell's Law:

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

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

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

This difference in the speed of light refers to the fascinating phenomenon of refraction. This refraction technique is effectively used in optical fiber, now let us take this experiment as a hypothetical one using some dopants we were able to increase the refractive index of the glass. The light will bend more towards the surface in real-time if we increase the refractive index for a time you will see that the light can pass through the glass surface if we increase the refractive index more, the light will suddenly return to the first medium as a pure reflection, which is called 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.

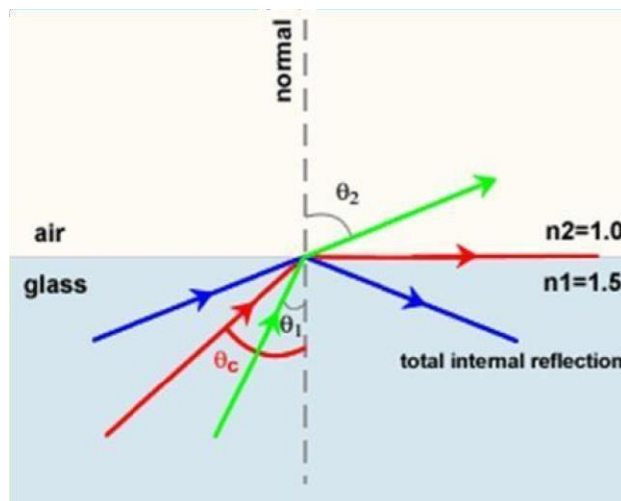


Figure 1.3.5.1 – Total Internal Reflection

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 transmits 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 of 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 these 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.



Figure 1.3.5.2 – Fiber Optics

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.

1.4 Overall Summary of the Project

1. Developing high-speed communication was achieved between 0.15 seconds - 13 seconds.
2. Reducing the overall price of the project by implementing this methodology on existing SeaUmbilical.
3. It removes the issue of hydraulic fluid discharge.
4. It avoids subsea accumulation in deep water.
5. It avoids long residence time in long umbilical leading to degradation of fluids (flocculation)
6. It avoids issues of fluid contamination.

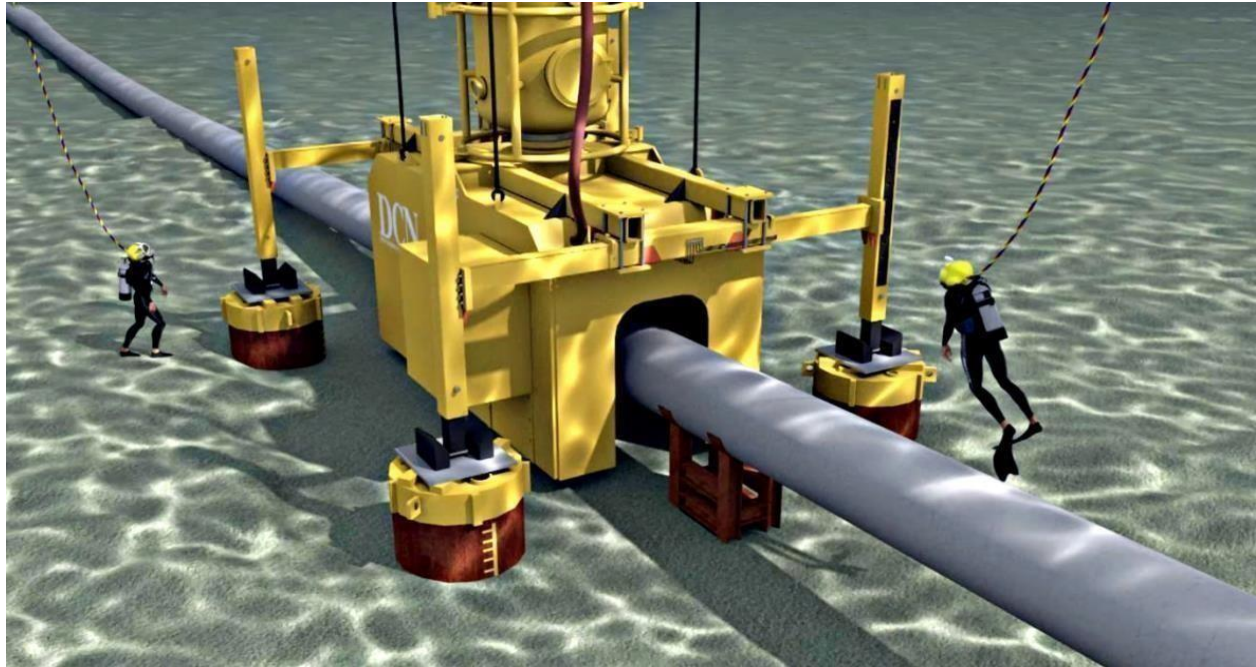


Figure 1.4.1- UnderWater Plant Management System

CHAPTER-2

LITERATURE SURVEY

2.1 Introduction

This chapter deals with the systematic study of papers and works from the older inventions and presentations of international journals and conferences and the data will be tabulated for a quick summary of revision. Through this, we have gained knowledge on correcting the mistakes and gained knowledge on factors that involved in future scopes.

2.2 Inference from literature survey

Nor Anum Zuraimi Md Noar and Mahanijah Md Kamal, ICSIMA “The Development of Smart Flood Monitoring System Using Ultrasonic Sensor with BLYNK Applications”, IEEE Transaction on Smart Instrumentation 2017.

This paper presents the development of a smart flood monitoring system using the Blynk platform as a medium of data transmission. This system is based on two NodeMCU development boards integrated using the Blynk application (IOS or android). The first NodeMCU is placed in the flood area, whilst the second NodeMCU acts as the control unit. The Transmitter unit consists of the first NodeMCU, an ultrasonic sensor that will detect the water level during flooding and display it on the LCD. Then, the data detected from the ultrasonic sensors will be sent to the Blynk application via the wireless connection. The data are instantly collected and stored in a dedicated database for recording purposes. In order to alert the person in charge of the control unit, the data then will be sent to the second NodeMCU via the Blynk bridge to trigger the buzzer and the LED. 32 Based on the findings, access to the system between the first NodeMCU and the second NodeMCU can be made within less or more than 50 meters. The findings revealed that the system works well when the data is sensed by the ultrasonic sensor display on the Blynk application and both buzzer and LED are functioning.

Pros: The data which we get from the real-world environment can be directly dropped into an excel sheet for future references

Cons: Lots of Technical inference due to the trial version of the implementation.

Chandra Afriade Siregar,Dudung Mulyadi,Agung Wahyudi Biantoro,Heri Sismoro,Yanti Irawati,IEEE “Automation and Control System on Water Level of Reservoir based on Microcontroller and Blynk”,IEEE Transactions on Cloud Computing,2020

The research aims to utilize simple technology using water level sensors, automatic switches, and the Blynk application to detect water levels automatically. The tools used are an infrared switch sensor, ultrasonic sensor, ESP 8266 module, Arduino Nano, Blynk application, and mini submersible pump machine to replace automatic water filling. The results showed that the IoT method by retrieving data sent to a smartphone, using an internet connection and the Blynk application, can display data from the sensor without being limited by the distance between the data sender and receiver. The automatic water tank filling system tool has succeeded in measuring the height of the water level in the reservoir which has been implemented properly and is sufficiently curated with an error value of about 3%.

Pros: Error value has been minimized at a huge rate. The data minimization technique has improved a lot

Cons: The design part of the system must be reconsidered for stable results in the future. Due to direct exposure chance of system failure will be huge.

Afzan A, Hari Krishnan K V, Hari Krishnan R, IEEE “River Mapping Using Ultrasonic and Flow Matching Sensor”, ICSSIT Transactions on Smart Systems, 2020

This work aims to develop a simple and low-cost method to determine the flow happening across a river which is used to determine the feasibility of a small-scale hydroelectric project. Measurement of parameters like depth of river and flow velocity of water is done with the help of a drone. A turbine flow meter is used to measure flow velocity and an ultrasonic sensor is used for depth measurement and is attached to the drone using an aluminum shaft. The instruments are carefully selected based on their capacity and output range. They are tested in artificial environments to check their reliability and effectiveness and are calibrated to work in real-world environments. The readings are transferred wirelessly to a mobile phone. Further, the calculations and analysis are performed based on river parameters. This method allows economical and eco- friendly measurement of depth and flows velocity remotely in difficult terrains and locations.

Pros: The velocity of the system is stable with the use of flow meter detection methods.

Cons: Due to instant pressure control methods, data loss of the system is huge.

Aashiq Aziz, IEEE, “Coastal alerting IoT system in response to high tides and turbulent weather”, ICCCNT Transactions on Networking, 2019

This research paper discusses the design and implementation of a coastal alerting system in response to tide levels at the shore and turbulent weather conditions based on the Internet of Things. There are two IoT platforms used in this project to showcase the results from the model namely Thing speak and the Blynk Application. The proposed model setup comprises a cylindrical structure with a water inlet, afloat, a microcontroller circuit configuration with an ultrasonic sensor as well as a large water container to simulate onshore conditions. The water level readings are measured by the ultrasonic sensor as one of the inputs for the microcontroller. This is achieved using the float placed in the cylindrical structure that is displaced by the water that flows in through the water inlet. The ultrasonic sensor which is placed above the float measures the distance between itself and the float with the change in the water level readings are measured by the ultrasonic sensor as one of the inputs for the microcontroller. This is achieved using the float placed in the cylindrical structure that is displaced by the water that flows in through the water inlet. The ultrasonic sensor which is placed above the float measures the distance between itself and the float with the change in the water level.

readings are measured by the ultrasonic sensor as one of the inputs for the microcontroller. This is achieved using the float placed in the cylindrical structure that is displaced by the water that flows in through the water inlet. The ultrasonic sensor which is placed above the float measures the distance between itself and the float with the change in the water level. The other inputs comprise the weather information from the weather API service provided by Openweathermap.org. The microcontroller makes decisions on the weather situation at the shorefront based on a set of algorithms that take all the inputs into consideration. In addition, data on nearby storms are pulled in from another API service powered by Darksky.net. This is done so as to issue appropriate responses through the IoT platforms indicating the nature of the situation on the shorefront and the possibility of storms in the vicinity.

Pros: The information conveyed through the IoT domain is representative of the weather situation corresponding to the monitored location's latitude and longitude coordinates.

Cons: Results and the accuracy of the system are not up to the expected mark. It needs a lot of system calibration on the protocol designed 35

Yuliarman Saragih, Fajar Eko Kurnia Setia Aji, Agatha Elisabet, Hasna Aliya Roostiani, Abdul Aziz Hafeel, Chia Chee Ming, IEEE, "Prototype of Radio Frequency Identification Technology Utilization for Monitoring of BTS Room Using of IoT (Internet of Things) System", IEEE Transactions on System Security, 2019

The level of battery theft in the BTS room often occurs. RFID prototype is used to open the BTS room replacing the conventional key. To improve the BTS room security system, a vibrating sensor is used which is applied to the BTS room door, if anyone wants to break or damage the BTS room door by force then the alarm sounds, and use an ultrasonic sensor to detect whether there is a person or object in front of the BTS room, if a person or object is blocking in front of the BTS shelter 100 cm, the alarm will sound continuous. Also, the BTS shelter can be monitored via a smartphone as well as getting notifications both in email, smartphone and in the Blynk application.

Pros: Ultrasonic sensors are able to read objects and do not occur with an actual distance between 10 cm to 100 cm.

Cons: Positioning of both the readers create a lot of system inference and the data transmit cycles are relatively slow

Padmavathi. J, Giridharan.S, Jebastin Sonia Jas.M, IEEE, "Identification of Heavy metals in Seafood using IoT", ICSCAN Transactions on Ocean Management, 2020

In today's world, there are many contaminations of heavy metals in the foods during export. Due to many industrial pollutions, water is contaminated with industrial waste and it is mixed with the rivers and seawater. Industrial waste is mixed with the water bodies and causes health in the issues to both the human being causing many health effects.

being causing many health effects. A recent issue occurred in Japan in May 1956, four patients from the city of Mina Mata on the east coast of the southern Japanese island of Kyushu were admitted to the hospital with severe baffling symptoms. Mina Mata Disease is the methyl mercury poisoning that occurred in humans who ingested fish and shellfish contaminated by MeHg (Heavy Metal) discharged in wastewater from a chemical plant (Chisso. Co. Ltd). As of March 2001, 2,265 victims had been officially recognized (1,784 of whom had died). A second outbreak of Mina Mata disease occurred in Niigata Prefecture in 1965.

Pros: The heavy metals present in the seafood using the infrared thermal sensor. Many metals can be analyzed and can be identified.

Cons: A lot of Flaws in the existing prediction algorithm. A thermal imaging camera can be used to locate the presence of heavy metals in seafood with accurate contamination.

Haonan Liang, Hao Wei, Tian Zhang, Jida Huang, IEEE, “The Simulation of Marine Plastic Debris Distribution Based on Cellular Automata”, INCCASM Transactions on Environmental Science 2020

Marine plastic debris is becoming an increasingly serious marine pollutant. Based on the comparative positions of marine plastic debris and marine current movement and in order to describe and comprehend the extent, density, and distribution of the plastic debris in the gyre, the cellular automata model was introduced to analyze the marine plastic debris distribution. Through simulating, the cellular automata model perfectly and truly presented the moving process and the final distribution of plastic debris in the North Pacific Ocean. At the same time, the influence of dumping quantity and dumping place of the plastic debris on the final distribution is presented.

Pros: Only a few notable parameters throughout the project slightly reduce the system efficiency

Cons: The rate of prediction is proportionally less when compared to real-world predictions

Claire Dufau, Marion Sutton, Brice Robert, Solene Routaboul, Marc Lucas, Nicolas Longepe, Nicolas Granier, IEEE, “Satellite Solutions for Tracking Litter Plastic Pollution in the Ocean”, IEEE Transaction on Satellite Communication, 2019

Ocean plastic pollution is the accumulation of plastic products in the environment that adversely affects wildlife, its habitat, and humans. It causes a lot of ecological and human health impacts. Marine debris management is a major challenge for coastal countries which are both a source of debris and the most affected areas. A large part of plastic in the ocean comes from rivers. Once reaching the sea, ocean surface currents and winds play a primary role in the transport and dispersal of floating marine debris, which often move quite predictably along well-traveled paths in the oceans. CLS has been developing applications for the marine domain using satellite technologies since 1986: wildlife tracking with the Argos satellite system, managing marine resources and fisheries, detecting oil spills, identifying polluters for maritime surveillance, marine traffic monitoring, illegal fishing, and ocean state monitoring. Thanks to its expertise in both oceanography from space and satellite-based data collection and positioning systems, CLS proposes to improve the litter and plastic pollution tracking in Ocean 38 through a combined solution that includes tracking from space and a drift modeling service based on surface currents derived from Earth Observations satellites. Tracking litter-like transmitters at sea help in improving our understanding and in identifying the main marine debris hotspots by providing a realistic idea of how debris travel on currents. This approach proposes additional in situ tracked buoys deployment to better describe the chaotic movement of marine debris. The second approach involves long-term surface drift modeling based on Copernicus Ocean monitoring and forecasting products. It stimulates the marine debris pathways from littering sources and maps macro plastic hotspots. The marine litter tracking buoys positions and the long-term drift modeling study results can be displayed through a web interface that is also part of the proposed solution. It provides the following displaying functionalities: location of each tracked buoy, long-term drift modeling trajectories, probability grid, and heatmap (“hotspots”) for each littering source.

Pros: Information dissemination and awareness will be managed thanks to a dynamic user-friendly web-based interface. **Cons:** Slight Connectivity issues will cause data loss

Ron Bentley, Vickie Edgar, IEEE, "KEEPING THE NAVY'S PLASTIC WASTE OUT OF THE WORLD'S OCEANS - A REPORT ON THE NAVY'S PRIME PROGRAM" IEEE Transactions on Navy, 2020

Pollution of the seas of the world is a serious environmental concern. Although pollution originates from land-based as well as atmospheric sources, it is the sea-borne sources that have been targeted as the main culprits for this particular pollution problem. Recently, Congress extended the Navy's deadline until 31 December 1998 for bringing itself into compliance with Annex V of the International Convention for the Prevention 39 of Pollution from Ships. Annex V contains a number of pollution control measures with the most restrictive being an absolute ban on the dumping of any plastic wastes into the world's oceans. In the remaining time available, the Navy, which disposes of its solid waste products largely by dumping them into the oceans, must devise ways of coping with this particular aspect of its solid waste stream aboard ships. Although a number of approaches are being pursued, most acknowledge that pollution prevention is the preferred alternative. It makes good sense that by controlling the nature of the items that go aboard ships, the Navy will be able to directly influence the composition of the waste stream that will ultimately be produced during operations. In pursuing this strategy, not only must items themselves be examined, but also their packaging, because the latter enters the waste stream almost immediately after it has served its function. This paper reports on ongoing activities under the Navy's Plastic Removal in the Marine Environment (PRIME) Program. Under the PRIME Program, every item that the Navy uses aboard ships Vickie Edgar Navy Ship Parts Control Center

P.O. Box 2020 Mechanicsburg, Pennsylvania 17055 (717) 790-5623 is subjected to an evaluation concerning environmental acceptability at the point of disposal. By carefully selecting the items that go aboard the ship and by specifying the types of allowable packaging, the Naval Supply Systems Command (NAVSUP) can influence the amount and composition of the waste stream that will require processing.

Pros: Accuracy has reached 97% with a simple algorithm

Cons: 97% precise and accurate but depends purely on real-time saturation and hue point.

Robert W. Zelle, T.A. Warstler, IEEE, “Ocean Disposal Monitoring System”, IEEE Transaction on Satellite Communication, 2019

EPA is responsible under the Clean Water Act (a, PL 95-217) and the Marine Protection, Research, and Sanctuaries Act (MPRSA, PL 92-532) for ensuring for ensuring that man's 40 activities, specifically Ocean disposal, do not unreasonably degrade coastal or open ocean waters. This responsibility includes monitoring the environmental and human health effects of Ocean discharges, Ocean dumping of municipal and industrial (M&I) wastes, Ocean dumping of dredged material, and Ocean incineration. The purpose of this paper is to describe EPA's strategy for developing and implementing cost-effective ocean disposal monitoring plans. issuance and standards - for Ocean deposite management which allow only limited environmental effects during individual operations as well as limited accumulative effects from multiple or continuing dumping activities. For example, EPA's Ocean dumping regulations and permits require that limiting permissible concentrations (LPC) of toxic constituents must be met at ocean dumpsite boundaries at all times, also, that the LPCs must be met everywhere for four hours after ocean dumping (40 CFR 227.29). In addition, EPA's regulations (40 CFR 228.10) list several Ocean dumping effects (standards) which must be considered when determining whether a designated dumpsite is being unreasonably degraded. EPA presumes that compliance with these kinds of permit requirements and dumpsite management standards will protect the marine environment from unreasonable degradation as mandated by the MPFSA. The goal of EPA's Ocean monitoring program is to provide program managers with reliable information, in a cost- effective manner, on Ocean disposal effects on the marine environment. Such information is needed for decisions on permit issuance and dumpsite designation modifications, also, in response to public concerns about human health and environmental protection. Consistent with this goal, the Agency's first monitoring priority is to provide reliable, low- cost information on compliance with permit requirements and dumpsite management standards. Our second priority is to verify the above- stated presumption that compliance with permit requirements and dumpsite management standards does, in fact, protect the marine environment from unreasonable degradation 41

Pros: Less Complexity throughout the paper

Cons: Not much notable content when compared to recent trends

CHAPTER 3

REQUIREMENTS ANALYSIS

3.1 INTRODUCTION

This chapter explains about the equipment used in developing the device which helps to control the subsea equipment's using optical fibre, such as Atmega 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.

3.2 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.

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 as shown in the figure

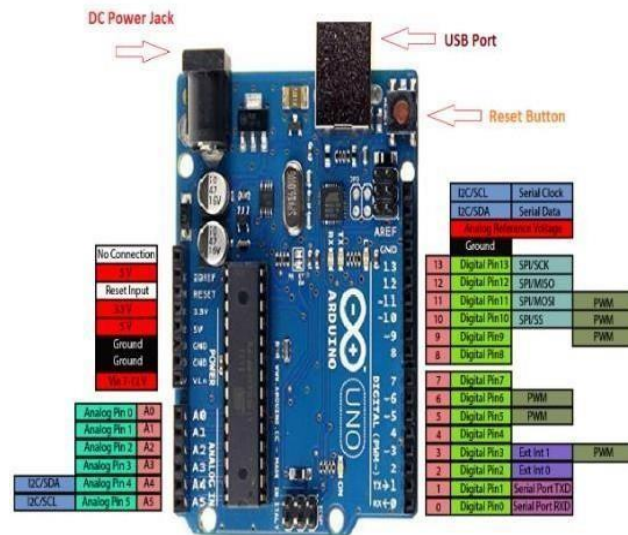


Figure 3.2.1: Arduino board

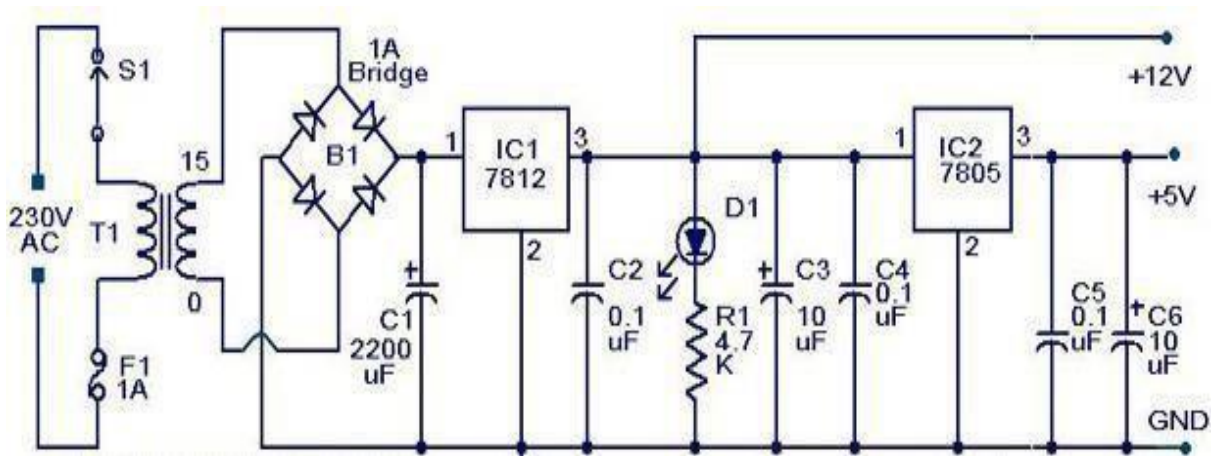


Figure 3.2.2 - 12v,5v power supply diagram.

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.

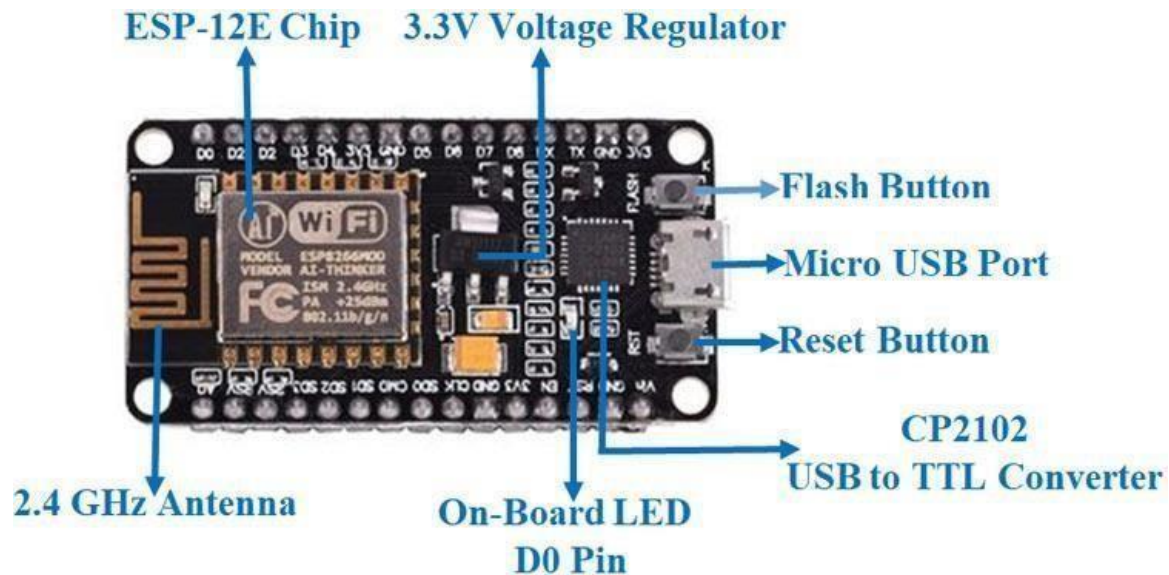


Figure3.3.1 –NodeMCU

3.4 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 conductorshave 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.

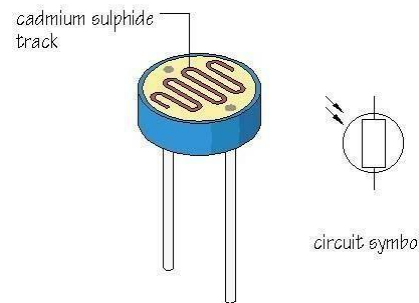


Figure 3.4.1 - LDR (Light dependent resistor) & circuit symbol

3.5 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 ($16 \times 2 = 32$), and each character will consist of 5 premature Pixel Dots. Now, we know that each character has 40 pixels ($5 \times 8 = 40$) and we'll have 1280 pixels for 32 characters. In addition, the LCD should also be advised about the Pixel Location.



Figure 3.5.1 - 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. Vdd (+5 Volt) LCD is powered by +5V (4.7V-5.3V), Power received from LDR through ATMEGA328P Arduino board in both the phases.VE (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.

3.6 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.

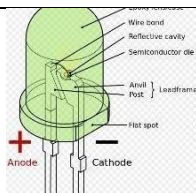


Figure 3.6.1 - 4x4 keypad

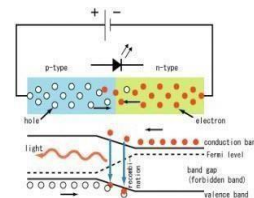
In the device the pin output is as follows, pin1, pin2, pin3 and pin4 are 1st, 2nd, third and 4th row respectively, pin5, pin6, pin7 and pin8 are 1st, 2nd, third and 4th column respectively. All the pins from 1 to 8 is connected to Arduino board pins 4 to 11. Now consider a button is pressed on the keypad 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.

3.7 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.



**Figure 3.7.1 -
Light Emitting
Diode**



**Figure 3.7.2 -
Working Principle
of LED**

3.8 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.

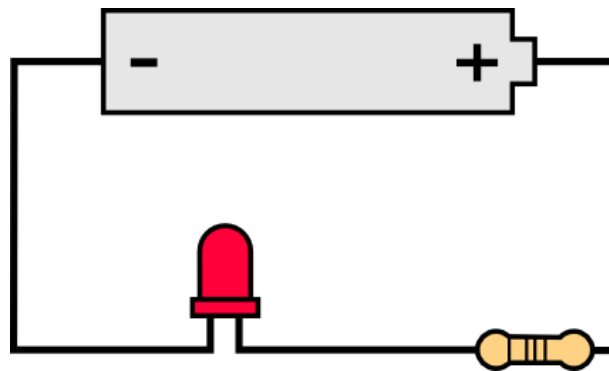


Figure 3.8.1 - Resistor

3.9 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.

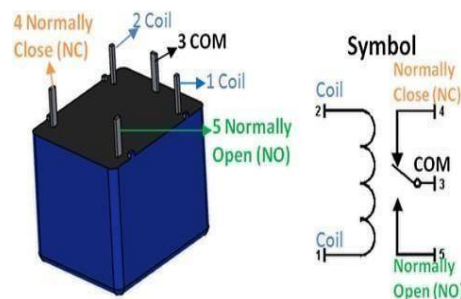


Figure 3.9.1 - Relay

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.

3.10 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 3.10.1 - (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.

3.11 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."

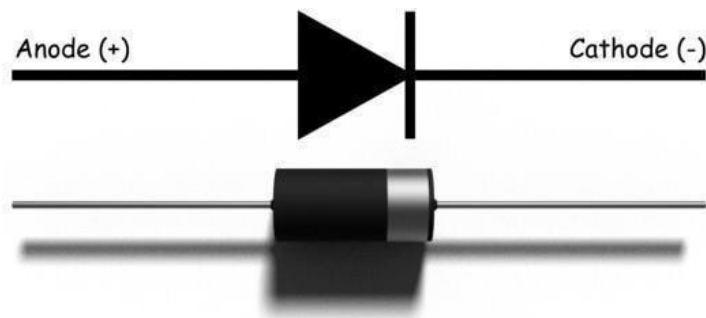


Figure3.11.1 – Diode

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.

3.12 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



Figure3.12.1 – Buzzer

. In this device, the buzzer is connected to indicate the success and failure of keypad entries. It's 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.

3.13 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.

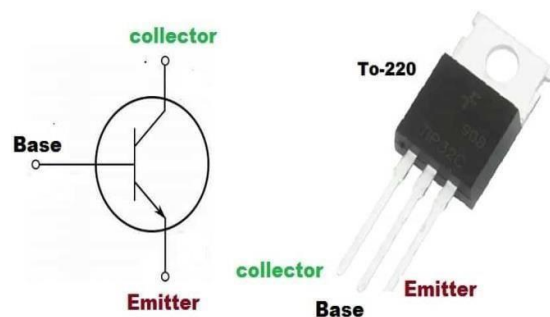


Figure3.13.1 –Transistor

3.14 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.



Figure3.14.1 - Jumper wire

CHAPTER-4

DESCRIPTION OF EXISTING AND PROPOSED SYSTEM

4.1 Introduction

In this chapter, We discuss on the principle and methodologies followed in the existing system. Based on the case study we will demonstrate the feature and its extractions in a proper manner. Our proposed methodologies will be discussed in detail with their efficiency graphs. Based on the advantages of the proposed system efficiency of the project will be determined.

4.2 Existing system

Existing ONGC stations involved hydraulics and Steam generation process which would nearly take a couple of twenty mins cycles for gate valve control operation which is nearly forty mins of duration to control the valve in an open and closed state. A huge amount of hot air vaporization is required for every single operation of hydraulics. This method produces a 100% success rate but, the resource management failure rate is very high. When compared to the recent innovations and existing technologies this traditional method of existence could be improvised through optical fiber communication on the existing sea umbilical. Since resource management is the key for the next generation this old traditional methodology must be replaced with the latest innovations.

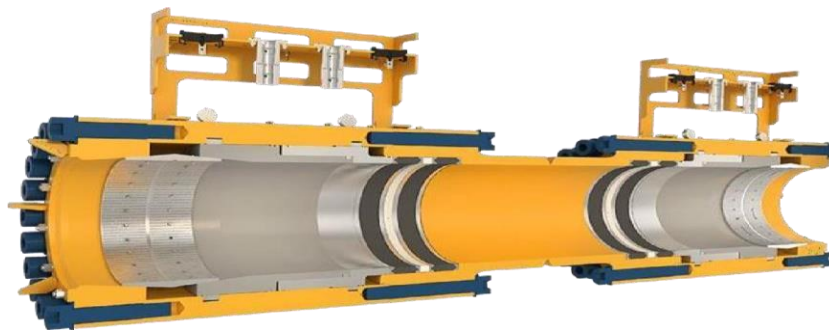


Figure 4.2.1 – Existing Pressure control Solenoid valve

4.3 Proposed Methodology:

Instead of using the traditional gate-valve control mechanism on compressed steam pumping, in this project as proposed solenoid valves can be replaced which will be a unique choice for communicating under sea against underwater pressure. These kinds of solenoidal valves can be controlled via microcontrollers based on logical triggering voltage. In this proposal we put forward two divisions: phase - I automatic Mode and phase - II on Manual Mode. Both modes are secured via digital passwords to ensure the Firewall safety system of the nation. Through the Google Assistant voice engine, trigger phrases are created to control the gate mechanism of valves from any part of the world. On the other hand, this system can be manually operated through the resource person from the sub-station against emergency activation and de-activation of the entire system.

4.3.1 Advantages of Proposed System:

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

4.3.2 Proposed System Block Diagram:

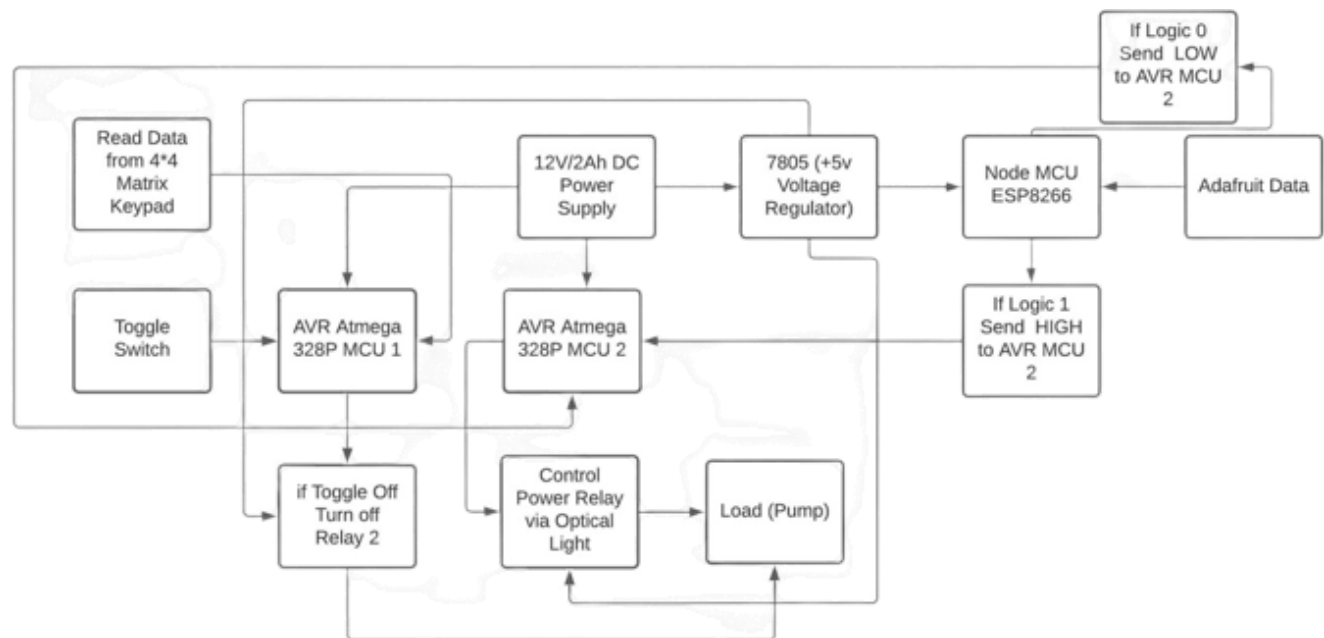


Figure 4.3.2 – Proposed Block Diagram

CHAPTER 5

WORKING PRINCIPLE

5.1 INTRODUCTION

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 METHODOLOGY

Table 1: Methodology

Sl.No	Tasks	Description of work
1	Define problem	Study of how wireless/wired communication works.
		Choose the medium of communication to develop Subsea Technology.
		Identify and study about required technologies and equipment needed.
2	Adopt the technique	Planning of equipment arrangements and pinouts.
		Programming Arduino coding accordingly.
3	Monitoring the success and failure results	To determine the success of valve opening. In event of failure, reprogramming and equipment changing is done.

4	Evaluate the results	Comparing the traditional method and the optical method of controlling the subsea equipment.
5	Achieve project aim	To develop a device which improves subsea controlling system using optical fibre.

5.3 THE ARCHITECTURE OF THE DEVICE

The device which I have invented includes two phases, namely manual and automatic. Manual phase to operate from topside, e.g. engineers or supervisors can control the subsea equipment's by directly giving a command to open or close the valve in subsea, and the command is travelled through fibre optics and the device which placed in the subsea acts as a receiver and decoded the digital message and manually open or close the valve. On the other hand, automatic mode is made easy for engineers in any part of the world to control the subsea equipment using IoT. E.g. an engineer in India can control the subsea equipment in United Kingdom by commanding through Google assistant, and the command is received to the particular IP address only as programmed so when the command is received the same process is carried out to open or close the valve in subsea using fibre optics as a medium.

Fibre optics communication can be the future of subsea Communication which appears to be the fast and cheap optical version of Wi-Fi. The main components of my device are as follows:

1. Optical fibre cable (which is already present in subsea Umbilical)
2. Receiving and decoding element such as light-dependent resistors with good response to optical lights.

Switching on manually or generating the command from elsewhere, makes the optical light to generate digital strings as 0's, in this way optical fibre cable acts as a sender by modulating the optical lights. Similarly, to off the valve the optical light generate digital strings such as 1's. To make the process simple and easy, I have programmed as when the digital message is not received, or no light message to receiving end, then it is

understood that 1's, which means a command to close the valve. The communicationspeed is said to be maximum of 13 seconds irrespective of the distance and minimum of microseconds (millions of times per second). It is impossible for human eyes to detect the speed or frequency of Communication.

My complete system consists of three primary subassemblies:

1. Manual and automatic phase with security layer (for not to overlap commands in the same Cable)
2. Optical fibre cable in subsea umbilical

Receiving device which decodes the digital message and manually opens and closes the valve with the help of electrical cables.

5.3.1 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 is 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.

By using:

1. MQTT broker (Message Queuing Telemetry Transport) it is a network protocol which transfers information between devices, the protocol usually runs by receiving all the messages from the client and then routing the message to the appropriate IP address only.
2. IFTTT (If this then that) it is an Applet, web-based service which creates chains of a simple conditional statement.
3. (Adafruit cloud) It is a cloud service which is primarily used for storing and retrieving appropriate messages and instructions.
4. Node MCU is a Wi-Fi module specially targeted for IoT based applications.

5.3.2 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.

5.3.3 OPTICAL FIBRE CABLE IN SUBSEA UMBILICAL

We are not using any external devices which cost so much to implement additionally in the sea to develop the speed of Communication, but instead, we are using optical fibre cables which is already present in the umbilical as a medium of communication. Subsea Umbilical is a group of optical cables, electrical Cable, plastic hoses and steel tubes combined or individually with protected layers. The subsea Umbilical's Function in the control system is to link between the master control system such as topside host, platforms, vessels or land-based structures and the subsea equipment such as control systems, Christmas trees, manifolds, pumps and valves. Umbilical are power cable, fibre optical cable, chemical lines (such as scale inhibitor injection, corrosion inhibitor injection, asphalt inhibitor injection, methanol injection, gas injections), hydraulic lines and weight elements. The optical fibre cables functions are to determine the pressure, temperature and strain data, one up to 96 fibres are present in a single fibre cable, and the Cable is protected with several materials such as stainless steel, hydrogen scavenging gel, polyethene inner sheath, galvanized steel wire armor and polyethene outer sheath. The collected energy from the electrical Cable is used to open the valves in subsea as soon as the digital messages received. When the optical light strikes on the light detecting resistor, the values change to be less than 100 as programmed then, it sends a trigger message to the relay to open the valve. Similarly, when the optical fibre is off the light detecting resistance value will increase more than 100, the digital value is directed to Atmega Arduino, and it automatically sends the trigger message to relay to close the valve.

5.3.4 RECEIVING DEVICE

Receiving end is the central part of the entire device which consist of LDR, Atmega Arduino board and a relay which converts the digital message to electrical which in turn mechanical open or close a valve. The collected energy from the electrical Cable is used to open the valves in subsea as soon as the digital messages received. When the optical light strikes on the light detecting resistor, the values change to be less than 100 as programed then, it sends a trigger message to the relay to open the valve. Similarly, when the optical fibre is off the light detecting resistance value will increase more than 100, the digital value is directed to Atmega Arduino, and it automatically sends the trigger message to relay to close the valve.

5.4 WORKING OF THE DEVICE

This project works on based on three phases (Automatic, Manual and Bridge). Each phase is monitored entirely throughout the system which is been imposed to protection layers and communication layers.

5.4.1 HOW IT WORKS

Optical fibre technology is a wired communication system based on optical lights travelling through glass fibres. 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.

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.

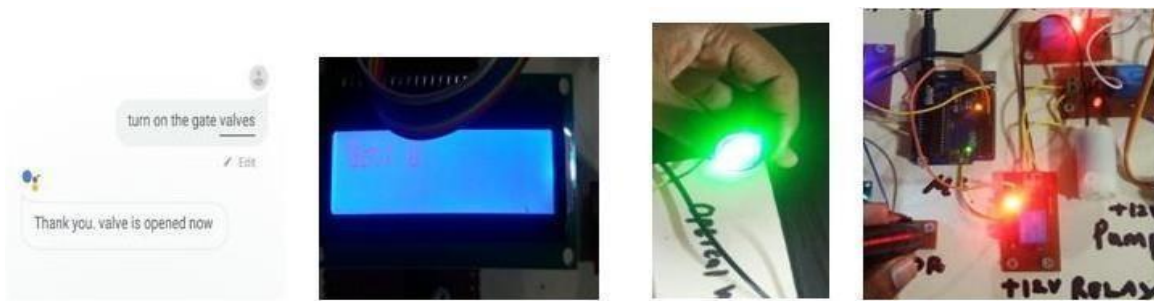


Figure – 5.4.1 Automatic phase on

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-5.4.2 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.

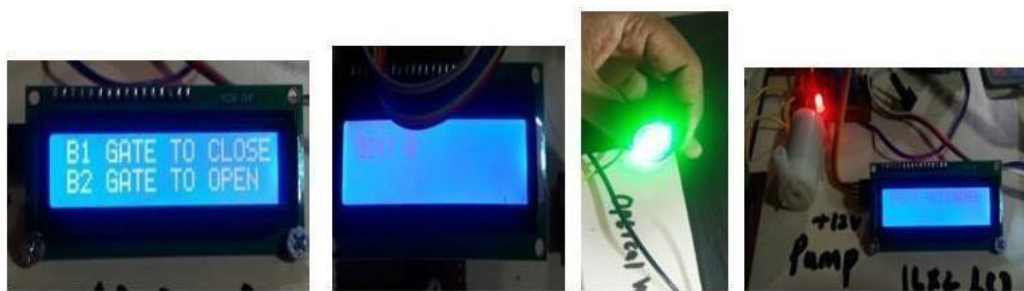


Figure -5.4.3 Manual phase on

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 – 5.4.4 Manual phase on

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.

5.4.2 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.

5.5 WHY 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.

5.6 ADVANTAGES OF OPTICAL FIBRE COMMUNICATION IN SUBSEA

- i. Efficiency: Using efficiently all existing substance to improve subsea communication with little alterations in subsea equipment.
- ii. High speed: Subsea equipment is controlled within a microsecond and a maximum of 13 seconds irrespective of the depth.
- iii. Availability: Availability is not an issue as optical fibre cable is already present in the sea.
- iv. 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.
- v. 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.

- vi. Underwater applications: It can be used for Communication in the sea with astonishing speed.
- vii. Optical fibre communication underneath the sea has a great scope in future.

5.7 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.

CHAPTER-6

CONCLUSION AND FUTURE SCOPE

6.1 INTRODUCTION

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.

6.2 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. Fibre communication in subsea is that the forthcoming and growing technology is acting as a catalyst for numerous alternatives developing new inventions/technologies. Therefore, there is a certainty of the event of future applications of the fibre communication in subsea, which might be extended to totally different platforms within the oil and gas industry. As mentioned at the start of the report, the project objective is to Develop Subsea Communication using Fiber Optics and therefore the same is developed and produces 100

per cent outcome as expected, If enforced it will manage the Subsea equipment's using Fiber Optics within few seconds. So, developing the time of Communication in subsea indirectly reduce the overall price concerned within the project. Furthermore, the Study on the ways of using this technique in current Subsea Equipment are to be analyzed and tested real-time within the field.

6.3 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.

The device developed is controlling the subsea equipment within microseconds with the help of optic fiber(wired) as a medium, in future wireless Communication in Subsea can be developed using Li-Fi as a medium of communication.

CHAPTER 7

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CHAPTER 8

APPENDIX

SOURCE CODE

8.1 AUTOMATIC PHASE ARDUINO CODING

```
#include <ESP8266WiFi.h>

#include <LiquidCrystal.h>

#include "Adafruit_MQTT.h"

#include "Adafruit_MQTT_Client.h"

#define WLAN_SSID          "MSJ"

#define WLAN_PASS          "7373771991"

#define AIO_SERVER         "io.adafruit.com"

#define AIO_SERVERPORT     1883

#define AIO_USERNAME       "MSJRW"

#define AIO_KEY             "aio_dgzx29nR4KlwBfyLAHxVePmohZLn"

const int rs = D1, en = D2, d4 = D4, d5 = D5, d6 = D6, d7 = D7;

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

#define Optic D0

WiFiClient client;

Adafruit_MQTT_Client mqtt(&client, AIO_SERVER, AIO_SERVERPORT,

AIO_USERNAME, AIO_KEY);

Adafruit_MQTT_Subscribe onoffbutton =

Adafruit_MQTT_Subscribe(&mqtt, AIO_USERNAME "/feeds/sample");

void MQTT_connect();

void setup()

{
```

```

lcd.begin(16, 2);

lcd.setCursor(5,0);

lcd.print("Subsea");

lcd.setCursor(2,1);

lcd.print("Comm. System");

delay(3000);

lcd.clear();

lcd.setCursor(3,0);

lcd.print("Using Fiber");

lcd.setCursor(0,1);

lcd.print("Optics Umbilical");

delay(3000);

lcd.clear();

pinMode(Optic,OUTPUT);

Serial.begin(9600);

delay(10);

Serial.println(F("Adafruit MQTT demo"));

Serial.println();

Serial.println();

Serial.print("Connecting to ");

lcd.print("Connecting to ");

Serial.println(WLAN_SSID);

lcd.setCursor(0,1);

lcd.print(WLAN_SSID);

WiFi.begin(WLAN_SSID, WLAN_PASS);

```

```

while (WiFi.status() != WL_CONNECTED)
{
    delay(500);
    Serial.print(".");
    lcd.print(".");
}

Serial.println();
lcd.clear();

Serial.println("WiFi connected");
lcd.setCursor(0,0);
lcd.print("WiFi connected");
delay(1000);
lcd.clear();

Serial.println("IP address: ");
Serial.println(WiFi.localIP());
mqtt.subscribe(&onoffbutton);
}

uint32_t x=0;

void loop()
{
    MQTT_connect();

    Adafruit_MQTT_Subscribe *subscription;
    while ((subscription = mqtt.readSubscription(5000)))
    {
        if (subscription == &onoffbutton)

```

```

    {
        lcd.clear();

        Serial.print(F("Got: "));

        lcd.print(F("Got: "));

        Serial.println((char *)onoffbutton.lastread);

        lcd.setCursor(5,0);

        lcd.print((char *)onoffbutton.lastread);

        uint16_t state = atoi((char *)onoffbutton.lastread);

        digitalWrite(Optic,state);

    }

}

void MQTT_connect()
{
    int8_t ret;

    if (mqtt.connected())
    {
        return;
    }

    Serial.print("Connecting to MQTT... ");

    uint8_t retries = 3;

    while ((ret = mqtt.connect()) != 0)
    {

        Serial.println(mqtt.connectErrorString(ret));

        Serial.println("Retrying MQTT connection in 5 seconds...");
    }
}

```

```

    mqtt.disconnect();

    delay(5000);

    retries--;

    if (retries == 0)
    {
        while (1);
    }
}

Serial.println("MQTT Connected!");
}

```

8.2 ARDUINO CODING

```

#define LDR 14

#define Relay 7

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

    pinMode(LDR, INPUT);

    pinMode(Relay, OUTPUT);
}

void loop()
{
    int value = analogRead(LDR);

    Serial.println(value);
}

```

```

if(value <= 200)
{
    Serial.println("Pump is On");
    digitalWrite(Relay,HIGH);
}
else
{
    digitalWrite(Relay,LOW);
}
}

```

8.3 MANUAL MODE ARDUINO CODING

```

#include <Wire.h>

#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,16,2);

#include <Keypad.h>

#define Relay 14

#define B1 15

#define B2 16

#define T 17

int character = 0;

int activated =0;

char Str[16] = {' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' '};

```

```

int buzzer=3;

const byte ROWS = 4;

const byte COLS = 4;

char hexaKeys[ROWS][COLS] =
{
    {'1','4','7','*'},
    {'2','5','8','0'},
    {'3','6','9','#'},
    {'A','B','C','D'}
};

byte rowPins[COLS] = {7, 6, 5, 4};

byte colPins[ROWS] = {11, 10, 9, 8};

Keypad customKeypad = Keypad( makeKeymap(hexaKeys), rowPins,
colPins, ROWS, COLS);

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

    pinMode(buzzer,OUTPUT);

    pinMode(Relay,OUTPUT);

    pinMode(B1,INPUT);

    pinMode(B2,INPUT);

    pinMode(T,OUTPUT);

    lcd.begin();

    lcd.backlight();

    lcd.clear();

```

```

    lcd.print("    PASSWORD");

    lcd.setCursor(0,1);

    lcd.print("    -***    ");

    digitalWrite(Relay,HIGH);

    digitalWrite(T,LOW);

}

void loop()

{

    char customKey = customKeypad.getKey();


    if (customKey)

    {

        if (character == 0)

        {

            Serial.println(customKey);

            Str[6]= customKey;

            lcd.clear();

            lcd.setCursor(0,0);

            lcd.print("    PASSWORD");

            lcd.setCursor(0,1);

            lcd.print(Str);

        }

        if (character ==1)

        {

            Serial.println(customKey);

```

```

Str[7]= customKey;

lcd.clear();

lcd.setCursor(0,0);

lcd.print("    PASSWORD");

lcd.setCursor(0,1);

lcd.print(Str);

}

if (character ==2)

{

Serial.println(customKey);

Str[8]= customKey;

lcd.clear();

lcd.setCursor(0,0);

lcd.print("    PASSWORD");

lcd.setCursor(0,1);

lcd.print(Str);

}

if (character ==3)

{

Serial.println(customKey);

Str[9]= customKey;

lcd.clear();

lcd.setCursor(0,0);

lcd.print("    PASSWORD");

lcd.setCursor(0,1);

```

```

    lcd.print(Str);
}

if (character ==4)
{
    Serial.println(customKey);
    Str[10]= customKey;
    activated=1;
}

character=character+1;
}

if (activated == 1)
{
    if(Str[10]='A' && character==5 && Str[6]=='1' && Str[7]=='9' &&
Str[8]=='9' && Str[9]=='1' )
    {
        lcd.clear();

        lcd.setCursor(4,0);

        lcd.print("ACCEPTED");

        activated = 2;

        analogWrite(buzzer,240);

        delay(250);

        analogWrite(buzzer,200);

        delay(250);

        analogWrite(buzzer,180);

        delay(250);
    }
}

```

```

analogWrite(buzzer,250);

delay(250);

analogWrite(buzzer,LOW);

delay(1000);

lcd.clear();

lcd.setCursor(4,0);

lcd.print("WELLCOME");

lcd.setCursor(1,1);

lcd.print("MODE MANUAL ON");

delay(2000);

digitalWrite(Relay,LOW);

Serial.println("Automatic Mode Shutdown");

delay(2000);

lcd.setCursor(0,0);

lcd.print("B1 GATE TO CLOSE");

lcd.setCursor(0,1);

lcd.print("B2 GATE TO OPEN");

while(1)

{

int value1 = analogRead(B1);

int value2 = analogRead(B2);

Serial.print("value1: ");

Serial.println(value1);

Serial.print("value2: ");

Serial.println(value2);

```

```

if(value1 <= 100)
{
    lcd.clear();

    lcd.print("VALVE ACTIVATED");

    lcd.noDisplay();

    delay(500);

    lcd.display();

    delay(500);

    digitalWrite(T,HIGH);

    Serial.println("Manual Mode Gate Valve Activated");
}

else if(value2 <= 100)
{
    lcd.clear();

    lcd.print("DEACTIVATED");

    lcd.noDisplay();

    delay(500);

    lcd.display();

    delay(500);

    digitalWrite(T,LOW);

    Serial.println("Manual Mode Gate Valve De-activated");
}

else
{
    lcd.setCursor(0,0);

```

```

        lcd.print("B1 GATE TO CLOSE");

        lcd.setCursor(0,1);

        lcd.print("B2 GATE TO OPEN");

        digitalWrite(T,LOW);

    }

}

}

else

{

    digitalWrite(T,LOW);

    digitalWrite(Relay,HIGH);

    lcd.clear();

    lcd.setCursor(1,0);

    lcd.print("PASSWORD ERROR");

    lcd.setCursor(3,1);

    lcd.print("TRY AGAIN");

    analogWrite(buzzer,150);

    delay(3000);

    analogWrite(buzzer,LOW);

    character=0;

    Str[6]= '-';

    Str[7]= '*';

    Str[8]= '*';

    Str[9]= '*';

    Str[10]= ' ';

```

```
    activated = 0;

    lcd.clear();

    lcd.setCursor(4,0);

    lcd.print("PASSWORD");

    lcd.setCursor(0,1);

    lcd.print(Str);

}

}

}
```