A

Project Report

On

“ROBOTIC DEVICE FOR BOREWELL RESCUE OPERATION”

Submitted to

KIT’S COLLEGE OF ENGINEERING (AUTONOMOUS) KOLHAPUR,

AFFILIATED TO SHIVAJI UNIVERSITY, KOLHAPUR

IN PARTIAL FULFILMENT FOR THE REQUIREMENT FOR THE DEGREE OF

BACHLOR OF TECHNOLOGY

In

Electronics & Telecommunication Engineering

Submitted By

Mr. Nikhil Patil (2021000420)

Mr. Abhishek Rakate (2021000516)

Mr. Sourabh Yejare (2021000498)

Mr. Vivekanand Tanawade (2021000238)

Under The Guidance Of

Prof. A. A. Shinde

DEPRTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

K.I.T' s COLLEGE OF ENGINEERING (Autonomous), KOLHAPUR.

2023-2024

A

Project Report

On

"ROBOTIC DEVICE FOR BOREWELL RESCUE

OPERATION"

Submitted to

KIT'S COLLEGE OF ENGINEERING (AUTONOMOUS) KOLHAPUR,

AFFILIATED TO SHIVAJI UNIVERSITY, KOLHAPUR

IN PARTIAL FULFILMENT FOR THE REQUIREMENT FOR THE

DEGREE OF

BACHLOR OF TECHNOLOGY

In

Electronics & Telecommunication Engineering

Submitted By

Mr. Nikhil Patil (2021000420)

Mr. Abhishek Rakate (2021000516)

Mr. Sourabh Yejare (2021000498)

Mr. Vivekanand Tanawade (2021000238)

Under The Guidance Of

Prof. A. A. Shinde

DEPRTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

K.I.T' s COLLEGE OF ENGINEERING (Autonomous), KOLHAPUR.

2023-2024

DECLARATION

We hereby declare this project titled "**ROBOTIC DEVICE FOR BOREWELLRESCUE OPERATION"** TOWARDS the completion of the project in the final year of B.Tech (E&TC) in Kolhapur Institute of Technology, Kolhapur is an authentic record of our work carried out under the guidance of

PROF. A.A. Shinde
(K. I. T.'s College of Engineering, Kolhapur)

Mr. Nikhil Patil

Mr. Abhishek Rakate

Mr. Sourabh Yejare

Mr. Vivekanand Tanawade

DATE:

PLACE: KOLHAPUR

CERTIFICATE

I hereby certify that the work which is being presented in the BTech. Project Report entitled **ROBOTIC DEVICE FOR BOREWELL RESCUE OPERATION**, in partial fulfilment of the requirements for the award of the **Bachelor of Technology in Electronics and telecommunication Engineering** and submitted to the Department of Electronics and telecommunication Engineering of Kolhapur Institute of Technology's College of Engineering, Kolhapur is an authentic record of my work carried out during a period from **July 2023 to November 2024** under the guidance of **Prof. A. A. Shinde,** Assistant professor, Electronics and telecommunication Department, KITCOEK.

The matter presented in this Project report has not been submitted by me for the award of any other degree elsewhere.

Signature of Student(s)

Nikhil Patil   Abhishek Rakate   Sourabh Yejare   Vivekanand Tanawade

This is to certify that the above statement made by the student(s) is correct to the best of my knowledge.

Prof. A. A. Shinde

PROJECT GUIDE   **PROJECT CORDINATOR**

Dr. Y. M. Patil   Dr. M. B. Vanarotti

HOD (E&TC)   **DIRECTOR (KITCOEK)**

ACKNOWLEDGEMENT

We would like to express our deep gratitude to our **Project Guide** Prof. A. A. Shinde, **Project Cordinator** XYZ, **H.O.D (E&TC)** Dr. Y. M. Patil, and **Director (KITCOEK)** Dr. M. B. Vanarotti for their constant encouragement and belief in us. Their guidance and attention throughout the project work have been of immense help to us.

We express our sincere thanks to all the teaching and non-teaching staff and all those who have directly or indirectly helped in making project a success.

Yours Sincerely,

Mr. Nikhil Anand Patil

Mr. Abhishek Dipak Rakate

Mr. Sourabh Suresh Yejare

Mr. Vivekanand Vishwanth Tanawade

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

This project is based on the device which is used for providing assistance to NDRF (National Disaster Response Force) team in the rescue operations to rescue victims fallen into the borewell. These days NDRF team dig a pit parallel to borewell for rescuing the child but, this method takes much time & lacks humanitarian expertise due to which many times the victim is found dead. The NDRF does not have any real time information inside borewells. Here this system which consist of various sensors, will provides temperature, moisture, oxygen percentage and also visual information about Victim inside borewell. The system is using microcontroller PIC18F4550 and ESP8266 WIFI module.

Chapter 1: INTRODUCTION

1.1 INTRODUCITON TO BOREWELLS

Borewells are crucial for drawing groundwater in India, it exceed 27 million in number, with a significant portion becoming non-functional. When left unused, these borewells marked only by open holes, cause an extreme risk, especially to children. The present rescue method, which is the parallel pit approach, has proven ineffective due lack of information inside the borewell during rescue operation, leading to a considerable number of unsuccessful attempts, as reported by the National Disaster Response Force (NDRF). Sadly, more than 40 children have lost their lives in accidental borewell falls since 2009.

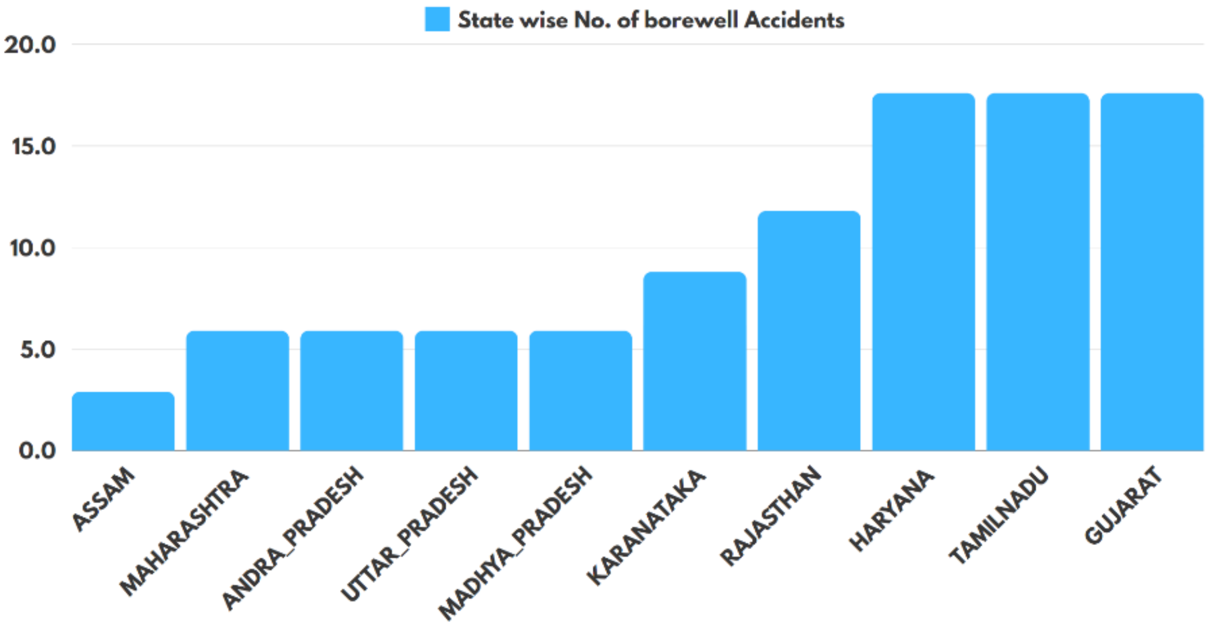


Fig 1.1 No of Borewell Accidents: State-wise.

This urgent situation calls for an innovative solution. The "Robotic Device for Borewell Rescue Operation" project addresses this challenge by creating a robotic device capable of descending into borewells, monitoring crucial conditions, and providing real-time data during rescue operations.

Borewell accidents can be worrying, and traditional rescue methods often face difficulties due to insufficient monitoring of critical conditions underground. The need for a reliable system that can provide real-time information about temperature, moisture levels, oxygen percentage, and visual data inside the borewell is the need for a reliable system that can provide real-time information about temperature, moisture levels, oxygen percentage, and visual data inside the borewell is noticeable.

1.2 PROJECT OBJECTIVE

The "Robotic Device for Borewell Rescue Operation" project seeks to create an innovative device designed to descend into borewells to monitor conditions and provide real-time data during rescue operations. The primary goal is to improve rescue success rates by offering rescue teams accurate and timely information from inside the borewell.

1.3 THE PROBLEM WITH BOREWELL RESCUES

Many borewells are abandoned without proper sealing, creating a safety hazard. Traditional rescue techniques are often ineffective due to:

- Limited access to critical information inside the borewell.
- Challenges in locating the exact position of the person needing rescue.
- Lack of visibility and awareness of environmental conditions, such as temperature, moisture, and oxygen levels.

These factors contribute to delays in rescue operations, reducing the chances of successful outcomes.

1.4 SOLUTION OVERVIEW

The proposed robotic device will provide a safer and more efficient way to conduct borewell rescues by:

- Descending into the borewell to gather data.
- Using sensors to measure temperature, moisture levels, oxygen percentage, and other critical factors.
- Offering real-time video footage to guide rescue teams during operations.

This comprehensive approach allows rescue teams to make informed decisions quickly and safely, improving rescue success rates.

1.5 DESIGN AND FEATURES OF THE DEVICE

The robotic device is designed with the following key features:

- Sensors: Equipped with sensors to monitor temperature, moisture, and oxygen levels.

- Camera: Provides real-time video footage of the borewell's interior.
- Communication System: Allows the device to transmit data to rescue teams above ground.
- Mobility: The device can navigate within the borewell to reach specific locations.

These features ensure that rescue teams have the necessary information to conduct operations effectively.

Chapter 2: LITERATURE SURVEY

2.1 LITERATURE SURVEY

In study [1] Nish Kurukuti, Somasekhar Dantla, Tanjeri Purushotham and Mallikarjuna Korrapati aimed at rescuing victims of bore well accidents, addressing a critical need in rural areas where such incidents occur frequently. Various sensors like ultrasonic sensor, cameras, and servo motors on adjustable arms for a highly effective operation are added in the system. The model they've designed is an 3D model which has provided optimum solutions for rescue operations in real world applications.

In study [2] Preedipat Sattayasoonthorn and Jackrit Suthakorn had provided a through roughf study on battery managementsystemsfor rescue robotswhich offers detailed strategies and insights, which are crucial for performance and reliability. Analysis of power consumption and selection of appropriate battery types, the study also aims to mitigate potential failures. Also implementation on a tele-operative robot provides real world insights, with future plans to extend findings to autonomous systems,whichpromises enhanced operational efficiency and effectiveness.

In study [3] Nitin Agarwal, Hitesh Singhal, Shobhit Yadav, Shubham Tyagi and Vishaldeep Pathak had made a manual control system with two plates, cameras, and pneumatic arms for borewell rescue, offering a safer and efficient method. The intergration of audio, video and light in the sytem made it an objective driven research. The model had used servo motors which reduces the overall weight of the system, making a significant advancement in the industry.

In study [4] M R Chaitra, Monika P, Sanjana M, Shibha Sindhe S R and Manjula G had suggested an innovative robotic solution for borewell rescue operations, integrating features like real-time tracking, emergency alerts, and live video streaming to enhance effectiveness and safety. Critical challenges were addressed in the research which aligns with most with the current objectives of this research. In contest there's a need for further research in mapping, teleoperation, and manipulation systems to improve rescue capabilities.

In study [5] B. Bharathi, B. Suchitha Samuel had proposed alternative solution suggests the development of a robot equipped with Zigbee technology for efficient rescue operations, offering real-time monitoring and control capabilities. Movements thorough confined spaces can be made with the integration of camera and wireless communication system. More sensors have been added which improves its versatility for different applications, with promising advancements in safety and efficiency in hazardous environments.

2.2 PRESENT THEORIES AND PRACTICES

2.2.1 Rescue Techniques for Borewell Accidents

1. Makeshift Local Arrangements

When an accident involving a borewell occurs, local authorities and bystanders often attempt makeshift rescue techniques to extract the trapped victim. These methods vary greatly and often rely on improvised tools or materials found on-site. Some common practices include:

- **Ropes and Hooks:** Locally sourced ropes and hooks are used to reach into the borewell and attempt to grab the victim's clothing or limbs. This approach has significant risks, including causing injury or further distress to the victim due to the rough nature of the tools used. Additionally, it is not always successful, as it requires precision and can worsen the situation if not done carefully.
- **Heavy Machinery**: In some cases, local authorities bring in heavy machinery to dig around the borewell. This approach can be dangerous if not executed with proper planning and expertise. The use of such machinery requires expertise and can potentially cause further destabilization of the borewell structure.

2. Vertical and Horizontal Drilling

One of the more formal techniques involves drilling a parallel hole next to the borewell and then creating a horizontal passage to reach the trapped victim. This method is typically employed by specialized rescue teams and involves several key steps:

- **Vertical Drilling**: A drill is used to create a parallel shaft next to the borewell. The depth of this shaft should be sufficient to reach the level where the victim is trapped. It is often advisable to angle the drilling toward the borewell to reduce the distance and time required for horizontal drilling.
- **Horizontal Drilling:** Once the vertical hole is complete, a horizontal tunnel is drilled to connect to the borewell. This requires careful calculation to ensure accuracy and safety. Horizontal drilling is often more challenging, as it must avoid further collapse of the borewell and reach the exact location of the victim.

This technique is generally safer than makeshift local arrangements but requires significant time, expertise, and equipment.

3. Techniques Adopted by NDRF

The National Disaster Response Force (NDRF) employs a variety of specialized techniques to rescue victims from borewell accidents. These techniques are designed to be safer and more effective than makeshift local methods. Some common approaches include:

- **Rope Rescue:** A more refined version of the local rope method, this technique uses specialized ropes designed for rescue operations. It involves skilled personnel lowering ropes into the borewell to securely lift the victim without causing additional injury.
- **Magic Ball:** A unique approach where a ball-like device is lowered into the borewell. It expands to create a secure grip, allowing the rescue team to lift the victim safely.
- **Umbrella Tool:** This device opens like an umbrella once inside the borewell, providing a stable platform for securing the victim and lifting them out. The tool is designed to minimize further injury or distress.
- **Cloth Bucket:** A flexible cloth-based container that can be lowered into the borewell to gently secure the victim and lift them out. This approach is designed to be soft and minimize injury.
- **Iron Rods in "L/J/U" Shapes**: These rods are used to reach into the borewell and secure the victim in various ways. The different shapes allow for flexibility in approach, depending on the situation's specifics.
- **Aluminium Wire with Hooks:** These wires are used to create a secure grip on the victim's clothing or body. The use of aluminium reduces the risk of heavy metal injury, and the hooks are designed to minimize tearing or damage to clothing.
- **Life Jackets Made of Plastic Sheets with Wires:** This technique involves creating a makeshift life jacket from plastic sheets and wires, providing additional safety and buoyancy when lifting the victim from the borewell.

These techniques demonstrate the variety and complexity of rescue operations in borewell accidents. While each method has its advantages and limitations, the key to successful rescues lies in proper planning, expertise, and the use of specialized tools designed to minimize further injury to the victim.

Chapter 3: PRESENT WORK

3.1 PRESENT WORK

The current rescue method, the parallel pit approach, has demonstrated limitations, with a significant number of unsuccessful attempts and tragic consequences. To address these challenges, the proposed robotic device places a primary emphasis on real-time monitoring parameters, incorporating video surveillance to track the victim's condition. Additionally, the device aims to monitor vital environmental factors, including temperature, atmospheric pressure, humidity, oxygen levels, and the detection of hazardous gases. The integration of these features seeks to provide rescue teams with immediate and broad insights, enabling predetermined decision-making and enhancing the efficiency and safety of borewell rescue operations. This project aims to develop a reliable and technologically advanced solution to reduce the risks associated with borewell accidents and ultimately save lives.

3.2 BLOCK DIAGRAM

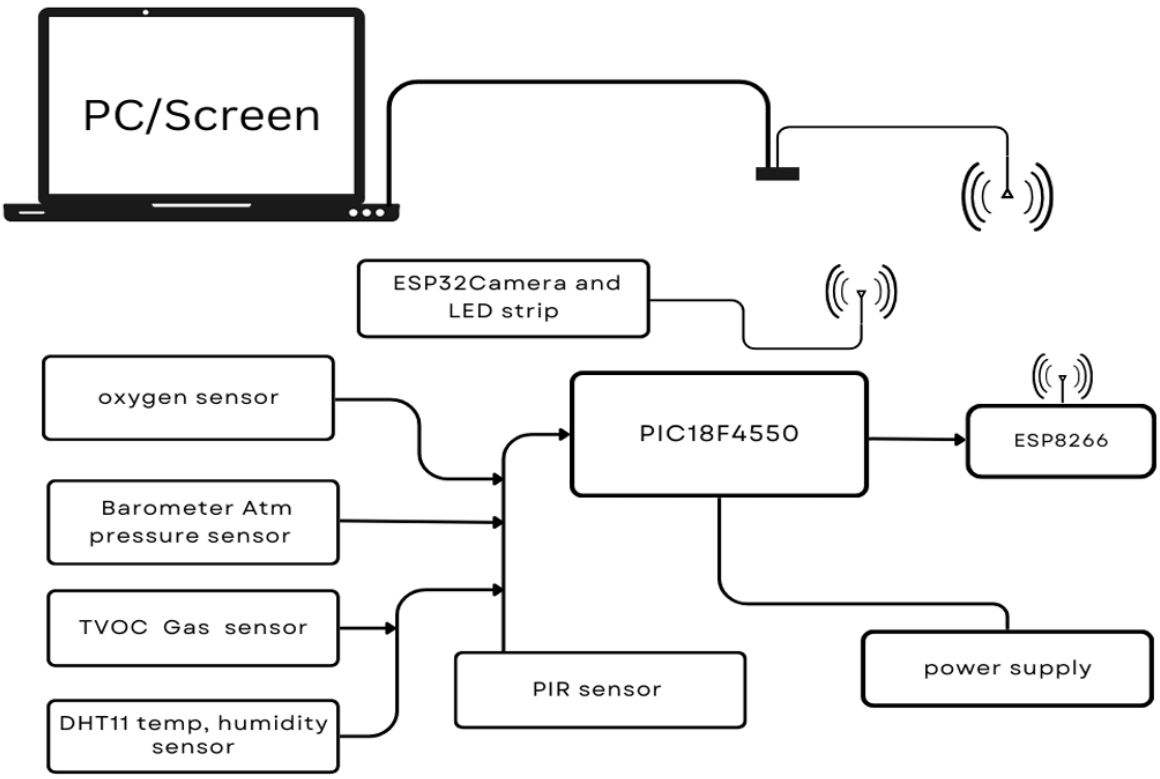


Fig 3.2. Structured Block Diagram.

3.3 SYSTEM STRUCTURE

The system has two main sections:

- Transmitter Section: Located inside the borewell, responsible for collecting sensor data and transmitting it wirelessly.
- Receiver Section: Operated by the National Disaster Response Force (NDRF) team, this section receives the data and displays it on a laptop or other device for analysis.

Transmitter Section

The transmitter section is installed in the borewell and includes the following components:

- Sensors: These sensors monitor various environmental conditions inside the borewell. Key sensors include:
- Temperature Sensor: Measures the temperature inside the borewell.
- Humidity Sensor: Tracks the level of moisture or humidity.
- Hazardous Gas Sensors: Detects harmful gases like methane or carbon dioxide.
- Camera: Provides real-time visual monitoring of the borewell's interior.
- Microcontroller: Controls the sensors, collects data, and manages wireless transmission.
- Wireless Transmitter: Transmits sensor data wirelessly to the receiver section.
- Power Supply: Provides energy to the transmitter section. This can be a battery pack or other portable power sources.

Receiver Section

The receiver section is operated by the NDRF team and includes the following components:

- Wireless Receiver: Receives data packets from the transmitter section. This component should match the transmission protocol used by the transmitter (Wi-Fi).
- Laptop or Tablet: Displays the incoming data in real-time. Software applications designed for this purpose allow for visual representation of sensor data and camera feeds.
- Data Analysis: Processes and interprets sensor data, providing insights into the borewell's condition. This software can alert the team to critical changes, like rising temperatures or hazardous gas levels.

System Operation

The system operates as follows:

- Data Collection: Sensors in the transmitter section collect real-time data on temperature, humidity, hazardous gases, and other conditions. The camera captures visual information.
- Data Transmission: The microcontroller in the transmitter section packages the collected data into wireless data packets and transmits them to the receiver section.
- Data Reception: The receiver section captures the transmitted data packets and displays the information on a laptop or tablet screen.
- Data Analysis: The NDRF team uses the data analysis software to monitor the borewell's condition and assess rescue strategies. If hazardous conditions are detected, appropriate safety measures are taken.

3.4 IMPLEMENTATION

- **PCB DESIGNING:**

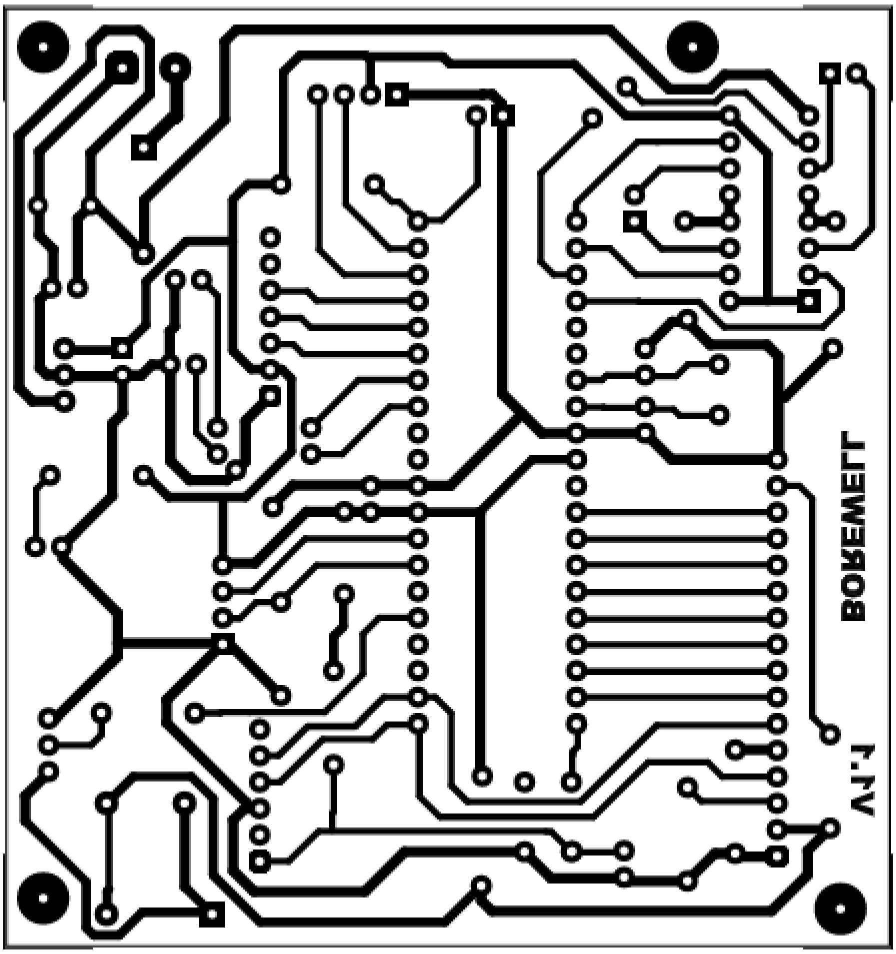


Fig 3.4 PCB Layout

3.4.1 MATERIALS AND EQUIPMENT NEEDED

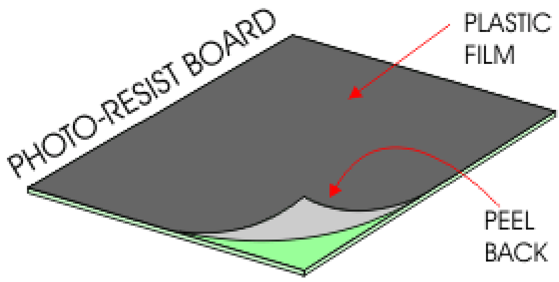
To manufacture PCBs at home, you'll need the following materials and equipment:

- Copper-Clad Board: A board coated with a thin layer of copper.
- PCB Design Software: Software for creating PCB layouts (like KiCad, Eagle, or Fritzing).
- Laser Printer: For printing the PCB design onto transfer paper.
- Toner Transfer Paper: Special paper used for transferring the printed design onto the copper-clad board.
- Etching Solution: Ferric chloride or ammonium persulfate for etching away excess copper.
- Plastic Containers: For holding the etching solution.

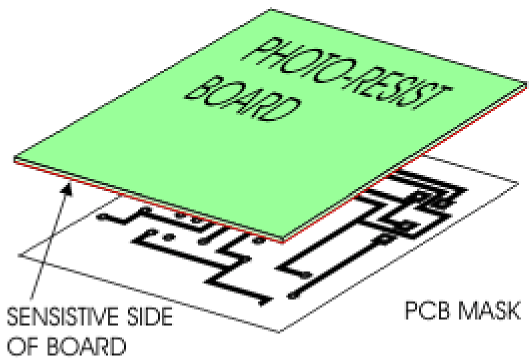
- Drill and Drill Bits: For making holes for components.
- UV-Resistant Marker: For making additional markings on the board.
- Safety Gear: Gloves, goggles, and a respirator for safety during the etching process.

3.4.2 DESIGN PROCESS

1. Design your circuit board. Use PCB computer-aided design (CAD) software to draw your circuit board. You can also use a perforated board that has pre-drilled holes in it to help you see how your circuit board's components would be placed and work in reality.

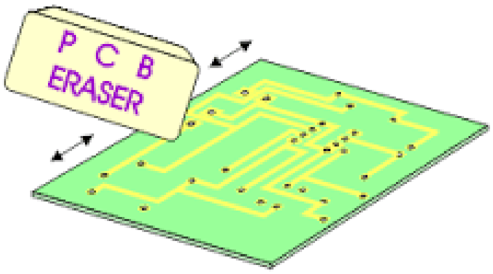


2. Buy a plain board that is coated with a fine layer of copper on one side from a retailer.
3. Scrub the board with a scouring pad and water to make sure the copper is clean. Let the board dry.
4. Print your circuit board's design onto the dull side of a sheet of blue transfer paper. Make sure the design is oriented correctly for transfer.



5. Place the blue transfer paper on the board with the circuit board's printed design against the copper.

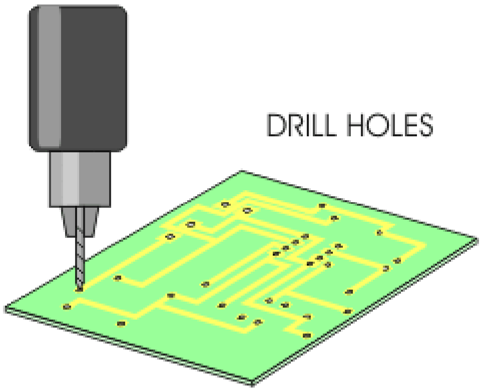
6. Lay a sheet of ordinary white paper over the blue paper. Following the transfer paper's instructions, iron over the white and blue paper to transfer the design onto the copper board.
7. Iron every design detail that appears near an edge or corner of the board with the tip of the iron.
8. Let the board and blue paper cool. Peel the blue paper slowly away from the board to see the transferred design.



9. Examine the transfer paper to check for any black toner from the printed design that failed to transfer to the copper board. Make sure the board's design is oriented correctly.
10. Replace any missing toner on the board with ink from a black permanent marker. Allow the ink to dry for a few hours.
11. Remove exposed parts of the copper from the board using ferric chloride in a process called etching.
12. Put on old clothes, gloves and safety goggles.
13. Warm the ferric chloride stored in a non-corrosive jar and sealed with a non-corrosive lid, in a bucket of warm water. Do not heat it above 115 F (46 C) to prevent toxic fumes from being released.
14. Pour only enough ferric chloride to fill a plastic tray that has plastic risers in it to rest the circuit board on. Be sure to do this in a well-ventilated space.

15. Use plastic tongs to lay the circuit board face down on the risers in the tray. Allow 5 to 20 minutes, depending on the size of your circuit board, for the exposed copper to drop off the board as it etches away. Use the plastic tongs to agitate the board and tray to allow for faster etching if necessary.
16. Wash all the etching equipment and the circuit board thoroughly with plenty of running water.

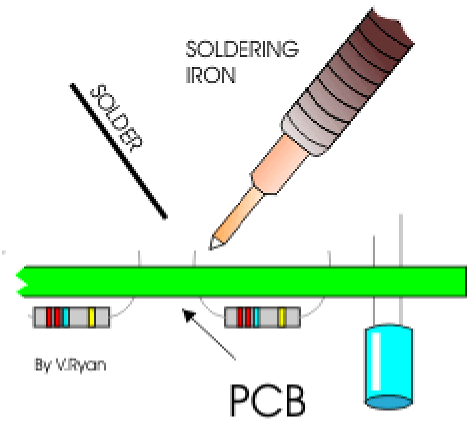
17. Drill 0.03-inch (0.8 mm) lead component holes into your circuit board with high-speed steel or carbide drill bits. Wear safety goggles and a protective mask to protect your eyes and lungs while you drill.



18. Scrub the board clean with a scouring pad and running water. Add your board's electrical components and solder them into place.

3.4.3 SOLDERING TECHNIQUES

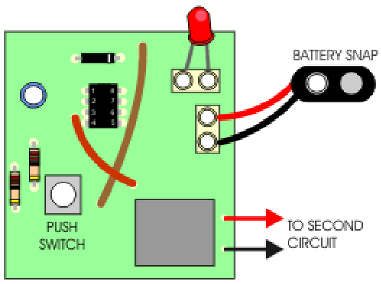
Soldering is the only permanent way to 'fix' components to a circuit. However, soldering requires a lot of practice as it is easy to 'destroy' many hours preparation and design work by poor soldering. If you follow the guidelines below you have a good chance of success 46 Use a soldering iron in good condition. Inspect the tip to make sure that it is not past good operation. If it looks in bad condition it will not help you solder a good joint. The shape of the tip may vary from one soldering iron to the next but generally they should look clean and not burnt.



3.4.4 FINISHING THE PCB

To complete the PCB, follow these steps:

- Clean the Board: Remove any remaining toner or residue from the board using acetone or isopropyl alcohol.
- Inspect for Defects: Check for missing traces or other issues. Use a UV-resistant marker to fix any minor defects.
- Solder Components: Once the board is complete, you can solder electronic components to the PCB.



Test the Circuit: Test the assembled circuit to ensure proper operation.

3.5 COMPONENT REQUIREMENTS

Component List:

- MQ-5 GAS SENSOR
- Temperature Sensor DHT11
- Humidity Sensor
- AOF1010 Ultrasonic Oxygen Sensor
- Camera System (ESP32 Camera Module)
- PIR Sensor
- PIC18F4550 microcontroller

MQ-5 GAS SENSOR

Standard Work Condition

- Circuit Voltage (Vc): 5V ± 0.1V (AC or DC)
- Heating Voltage (VH): 5V ± 0.1V (AC or DC)
- Load Resistance (PL): 20kΩ
- Heater Resistance (RH): 31 ± 10% at room temperature
- Heating Consumption (PH): Less than 800 mW

Environmental Condition

- Operating Temperature (Tao): -10°C to 50°C
- Storage Temperature (Tas): -20°C to 70°C
- Relative Humidity (RH): Less than 95% RH
- Oxygen Concentration: The standard concentration is 21%, with a minimum of 2%.

DHT11 Temperature and humidity Sensor:

DHT11 is a basic, low-cost digital temperature and humidity sensor commonly used in various projects and applications that require monitoring of environmental conditions. Here's some information about the DHT11 temperature sensor.

Features of the DHT11 Temperature Sensor:

- Temperature Measurement: The DHT11 sensor is capable of measuring temperature
- in the range of 0°C to 50°C (32°F to 122°F).
- Humidity Sensing: In addition to temperature, it can also measure relative humidity
- in the range of 20% to 80%.

- Digital Output: The sensor provides a digital signal output that can be easily read by
- microcontrollers or other digital devices.
- Simple Interface: This protocol is specific to the DHT series of sensors and is different
- from standard communication protocols like I2C or SPI commonly used in other
- sensors and devices.
- Voltage range: 3.5 to 5.5V

AOF1010 Ultrasonic Oxygen Sensor:

AOF1010 Ultrasonic Oxygen Sensor is a specialized sensor designed to measure the concentration of oxygen in gases. Here is some information about this type of sensor.

Features of AOF1010 Ultrasonic Oxygen Sensor:

- Measurement Principle: The AOF1010 sensor uses ultrasonic technology to measure the concentration of oxygen in gases. Ultrasonic sensors emit ultrasonic waves and then measure the time it takes for the waves to travel through the gas medium and return.The oxygen concentration is determined based on this measurement.
- High Accuracy: These sensors are known for their high accuracy in measuring oxygen concentration, providing precise readings for various applications.
- Wide Range: They are capable of measuring oxygen concentration across a wide range of values, making them suitable for different industries and applications.
- Fast Response Time: Ultrasonic oxygen sensors typically have a quick response time, allowing for rapid and real-time measurements of oxygen levels in gases.
- Reliability: They are designed to be durable and reliable, often used in critical applications where accurate oxygen measurements are essential.
- Working voltage :5V.
- Uses Communication Protocol: UART.

ESP32 Camera Module:

The ESP32 Camera Module integrates a camera with the ESP32 microcontroller, providing the capability to capture images or video and process them directly within the ESP32 development board. This module enables the ESP32 to interface with a camera and perform various tasks like image capture, streaming, face recognition, object detection, and more. Here's some information about the ESP32 Camera Module.

Features of ESP32 Camera Module:

Camera Capabilities: The ESP32 Camera Module supports various types of cameras, including OV2640 and OV7670, among others. These cameras allow for image and video capture with different resolutions.

- Integrated Microcontroller: The ESP32 microcontroller, known for its versatility and connectivity options, is integrated with the camera module, providing ample processing power for image handling and communication tasks.
- Wireless Connectivity: The ESP32 comes with built-in Wi-Fi and Bluetooth capabilities, allowing it to transmit captured images or stream video wirelessly to other devices or servers.
- Development Platform: Supported by the Arduino IDE and other development environments, the ESP32 Camera Module is relatively easy to program and use for a wide range of applications.
- Support for Libraries: There are libraries available for the ESP32 Camera Module that facilitate image processing, facial recognition, object detection, and more, simplifying the
- Operating Voltage: Usually operates at 3.3V, consumes approximately 60-80mA during image capture.
- Image Resolution: The OV7670 supports a maximum resolution of 640x480 pixels (0.3 megapixels) for still images.
- Video Resolution: It can capture video at lower resolutions, including VGA (640x480 pixels) and lower, with varying frame rates.

PIC18F4550 microcontroller:

The PIC18F4550 is a popular 8-bit microcontroller from Microchip's PIC18 family, featuring USB functionality and suitable for a wide range of applications.

Features of the PIC18F4550 microcontroller:

- 8-bit RISC architecture.
- 32 KB Flash memory, 2 KB RAM.
- 16 MHz oscillator, multiple communication peripherals.
- 10-bit Analog-to-Digital Converter (ADC): Enables the conversion of analog signals to digital for various sensor interfacing.

- Power-Saving Modes: Includes multiple low-power modes for efficient energy management.
- Watchdog Timer (WDT): Enhances system reliability by resetting the microcontroller if the software fails to restart it periodically.

PIC18F46K22: is a High-Performance 8-bit RISC CPU (40-PIN PDIP) with USB functionality, Low-Power, High Performance Microcontroller with XLP Technology here these types of microcontrollers are ideal for data processing and system control as they have C Compiler Optimized Architecture.

Buzzer: This 5V actuator works as a failure alert for the system, Alerting the operator at the time of deployment of the system. This makes the systems less prone to any in operation faults and helps them mitigate prior the deployments.

Lithium-ion Battery (12V): A constant 5V dc supply is essential for the system to perform its operations smoothly, any fluctuations would reset the whole system making it venerable to cause system errors. Therefore, it has been provided with a 12V DC supply which is then converted to 5V using a Line voltage regulator (LM7805CT) further a capacitor of 10 micro-farad is parallel to it to avoid any ripples for continuous switching of regulator. This fulfills the systems power needs.

16x2 LED Display: On board diagnostics time to time are essential to make sure that whether the system needs any service or is ok to use for any operation. These LED Display is used to check any crashed or corrupted components on to the system.

3.6 CIRCUIT DIAGRAM

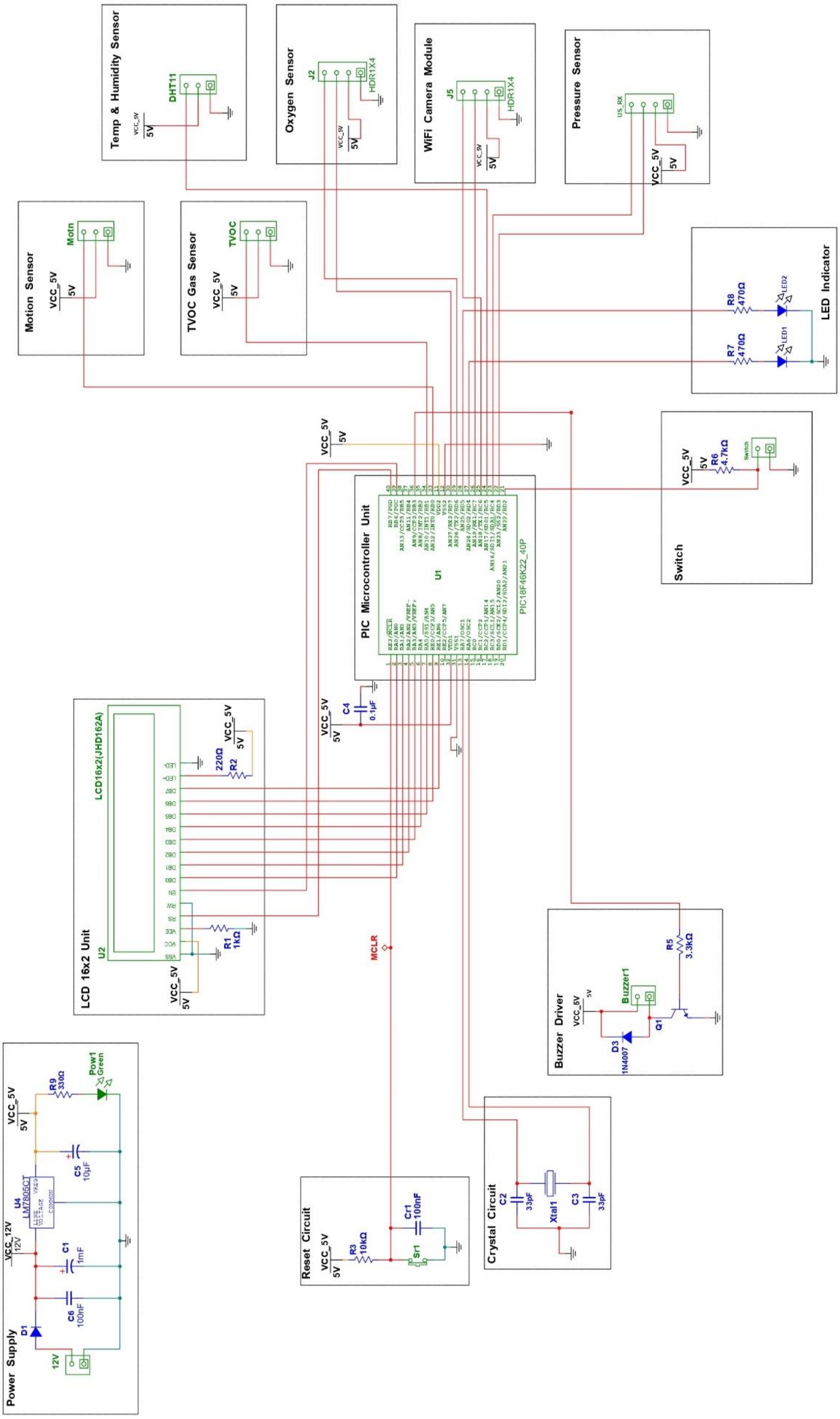


Fig 3.6 RBDR Interfacing with PIC18F46K22.

3.7 WORKING:

1] Research Design:

As the system is developed to assist in borewell operations there should be consideration of the borewell dimensions and history or rescue operation to manage the space and time. The system design is kept compact and light weight which can be easily supported with a grove or a pully and can be used for hours without any replacements.

In order to monitor the data being broadcasted over the local network in which the system is, there's a monitored on the ground surface from which data can be observed and on-board system components can be manipulated according to the need.

The systems work with three participants one the victim and the other two are 1^{st} the operator and the 2^{nd} one is humanitarian expert, the system keeps an eye on the victim, the operator keeps an eye on the system variables such as battery levels, temperatures, errors, fail safe etc. And the expert on conditions inside the borewell to assist in operation

2] Procedure:

Step1] System is powered ON the Green LED flashes thrice and then stays bright for the next 5 seconds. This is the system initialization state however if the red LED glows along with the green their might be changes of low power or any fault in any of the components onboard. Any of those faults can be corrected either checking them individually or setting a check sequence which automatically to find the fault.

Step2] Communication between the system and the monitoring device which is to be kept on ground surface is established. This network is formed between the devices over a local host and been accessed by any system present int that network. Which increase the reliability of the system. The real time data such as video footage, temperature, humidity, pressure, ethanol presence and oxygen concentration along with various parameters is streamed overt his network.

Step3] As the system is lowered the environmental variables varies, these can be tracked by the expert to analyze the victims' conditions prior the identification and to further reduced the suffering and minimize the recue time.

Step4] Once the victim is located the depth and the system stability is ensured by the operator. To maximize the system capabilities and to meet minimum power requirements. Further the following processing is done by the system.

Data Collection: All of the onboard sensors measure real-time environmental data (TVOC, Temperature, oxygen and Humidity) in the borewell. As the device contains numbers of sensors, communicating with all of them by the controller at a time is not possible. Therefore, switching between them frequently is necessary as the controller won't withstand such high processing and may become power hungry. Hence to avoid these unpredicted processing there's a need of buffer IC here (CY74FCT2244T) which can temporarily store the sensor data and the controller would then fetch this data. Thus, in this manner the controller communicates with all the sensor efficiently one by one without any data loss.

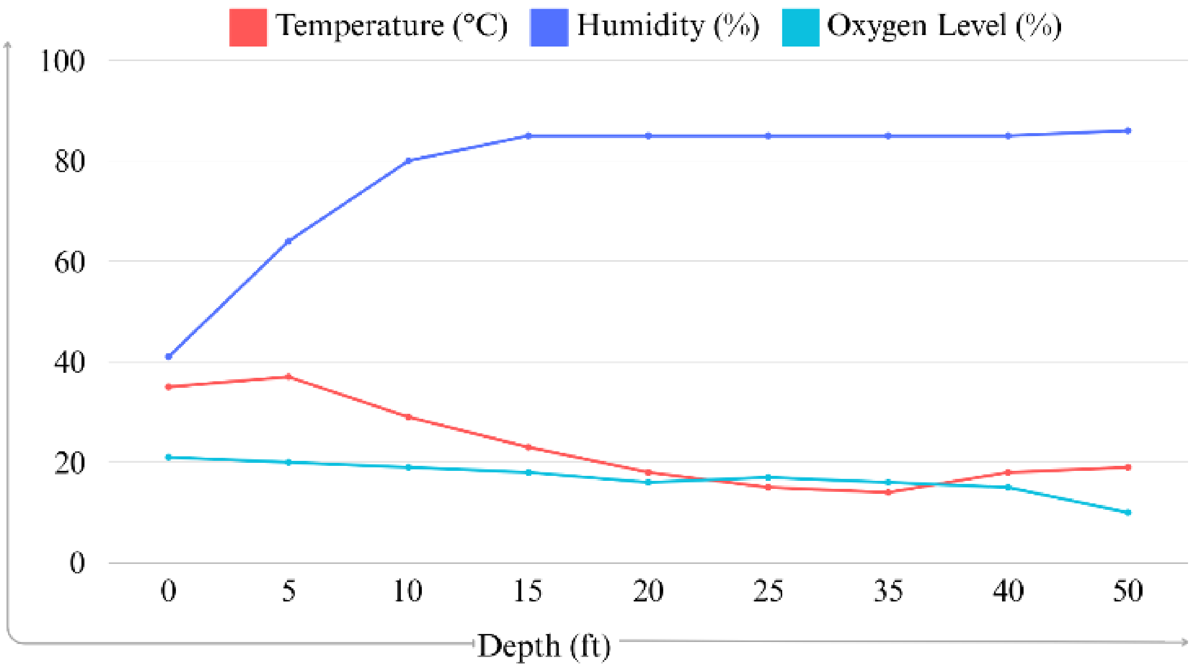


Fig 3.7. Environmental data w.r.t Depth. [4]

Wireless Transmission: Then the collected data is transmitted to the ESP32 module by UART communication. These two devices communicate two ways with each other, establishing a proper duplex wired connection. The ESP module along with the cam data send this environmental data to the to a receiver unit using a local Wi-Fi network. This transmission is controlled by the ESP32 microcontroller, which handles the wireless communication with the receiver.

Data Reception: The receiver then displays the received data on the laptop screen for further analysis. By the operator and the expert.

Data Analysis: Upon reception, the collected data is processed by the App for further analysis and decision-making. The data is then evaluated to identify any abnormal conditions or potential hazards.

Alert Generation: If any abnormal conditions are detected, then alerts or notifications are generated to prompt immediate actions. These alerts are in the form of visual indicators on the laptop screen or audible alarms, which then ensures interventions to overcome risks.

Continuous Monitoring: The system is created for continuous monitoring of environmental conditions in the borewell, which provides timely interventions and ensures the safety of personnel and equipment. This system is an integration of hardware and software components, which facilitates effective remote operation and continuous monitoring, which increases the overall safety and efficiency in borewell operations.

Chapter 4: RESULTS AND DISCUSSION

4.1 RESULTS AND DISCUSSION

A system was tested inside an unused water pipeline with a dummy victim. This pipeline was previously used for irrigation purposes in dry regions. The dimensions of the pipeline were 8 to 10 inches wide and 4 to 5 feet deep.

The system was checked on the ground surface for any errors and with ensured strong communication establishment. Once confirmed okay, the system was lowered by the operator until the victim was located. Upon successful location identification of the victim, the system was then used to gather real-time information, continuously displayed on the laptop screen.

Fig. 4.1 Onboard display for system diagnostics.

It was tested in extreme conditions and with fail-safe protocols, such as long reuse time. Then, expedited tests were conducted on battery backup and connection interference to ensure reliability over the system.

Chapter 5: CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION AND FUTURE SCOPE

In Conclusion, the system plays crucial role in assisting the NDRF team. The live video surveillance and environmental data such as temperature, humidity, oxygen, harmful gas helps the expert to take immediate action and to avoid further life threating risk to the victim. Also, the onboard light on the camera module gives a psychological belief of hope and somehow lowers the victims fear. The receiver side module which displays the victims condition brings hope to the family and rescue team this has some advantage in removing negativity and to bring a positive impact on rescue mission.

This device is not only limited for borewell rescue operation but also for other industrial uses like under water pipe inspection where humans can't reach or where risking a life is not worth. The system still admits some drawbacks such as removing the victims from the borewell and lags behind the hardware which might the helpful in the same.

Still future upgrade are yet to be seen and society will truly contribute to this system.

References

[1] B. Bharathi, B. Suchitha Samuel "Design and Construction of Rescue System and pipeline inspection Using Zigbee" International Journal of Scientific Engineering and Research (IJSER) Volume 1 Issue 1, September 2021.

[2] G. Kavianand, K. Gowri Ganesh, P. Karthikeya, “Smart child rescue system from Borewells” (SCRS), Published in: Emerging Trends in Engineering, Technology and Science (ICETETS), International Conference on, 24-26 Feb. 2017.

[3] Kurukuti, Nish Mohit, Et Al. "A Novel Design of Robotic System for Rescue in Borewell Accidents." 2016 International Conference on Robotics and Automation for Humanitarian Applications (Raha). IEEE, 2016.

[4] K. P. Sridhar, C. R. Hema, S. Deepa Published online: “Design of a Wireless Sensor Fusion System to Analyse Conditions Inside Bore Wells”. Wireless Peers Common (2017) 94:1951–1962 DOI 10.1007/s11277-016-3299- 4 on 12 April 2016.

[5] M R Chaitra, Monika P, Sanjana M, Shobha Sindhe. "International Journal of Engineering Research & Technology," 2019.

[6] Nitin Agarwal, Hitesh Singhal, Shobhit Yadav, Shubham Tyagi, and Vishaldeep Pathak "Child Rescue System from Open Borewells" International Journal of Trend in Scientific Research and Development, 2020.

[7] N. M. Kurukuti, M. Jinkala, P. Tanjeri, S. R. Dantla and M. Korrapati, “A novel design of systemic system for rescue in bore well accidents”, 2016 International Conference on Systemics and Automation for Humanitarian Applications (RAHA), Kollam, 2016, pp. 1-5.doi: 10.1109/RAHA.2016.7931875 International Journal of Trend in Scientific Research and Development (IJTSRD) @www.ijtsrd.com eISSN: 2456-6470 @ IJTSRD | Unique Paper ID - IJTSRD23847 | Volume – 3 | Issue – 4 | May-Jun 2019 Page: 642.

[8] Preedipat Sattayasoonthorn, "Battery Management for Rescue System Operation," 9th July 2017. 6. K. Saran, S. Vignesh, Marlon Jones Louis "Borewell Rescue System" International Journal of Research Aeronautical, VOL 1, Issue 4, pg.61-80, April 2016.

[9] Seibel, BA (2011). "Critical oxygen levels and metabolic suppression in oceanic oxygen minimum zones". Journal of Experimental Biology. 214 (2): 326–336. doi:10.1242/jeb.049171. PMID 21177952. S2CID 16469678.