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REAL TIME MONITORING SYSTEM FOR BOREWELL RESCUE OPERATION

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Abstract : This paper 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.

Keywords– Borewell Rescue, MicrocontrollerPIC18F4550, DHT11, ESP8266, IOT.

INTRODUCTION

Borewells have an important role in providing groundwater. To address the increasing demand and declining groundwater levels, there has been a trend of drilling deeper and larger bore-wells over time. In 1970, the average bore-hole size was around 2.5 inches, which increased to 4 inches by 1980, 7 inches by 1990, and surpassing 14 inches in the 21st century [1]. Despite advancements in drilling technology, there are no standardized regulations in India regarding the diameter and depth of bore-wells, nor for sealing dry bore-wells. As some industries have large sized borewells especially in Gujrat, Rajasthan, Bihar and Madya Pradesh because of that, many challenges are faced when accidents happen, like small children or animals fall into the borewell.

Typically, truck-mounted drillers start with a diameter of 4.5 inches, with the final size of the bore-hole influenced by the geological characteristics of the area. For instance, in regions like Rajasthan and Gujarat, where geological conditions vary, bore-hole diameters can range from 14 inches initially to as much as 20 inches.

In the tradition rescue operation the success rate is very less. The average numbers provided by NDRF team is 70% rescues are failed. On 4 January, 2024. A Three-year-old girl who fell in borewell about 30 feet into a borewell in Gujrat. The rescue operation takes 9 hours to rescue the girl, because she found as dead. Another incident in Madhya Pradesh five years old boy falls into borewell on 23 December 2023.This operation take 5 hours to rescue child. Also, he found dead when recovered from the borewell. In these two cases both girl and boy were found dead because the NDRF team did not had any real time information about victim. This is the main reason of operation failure.

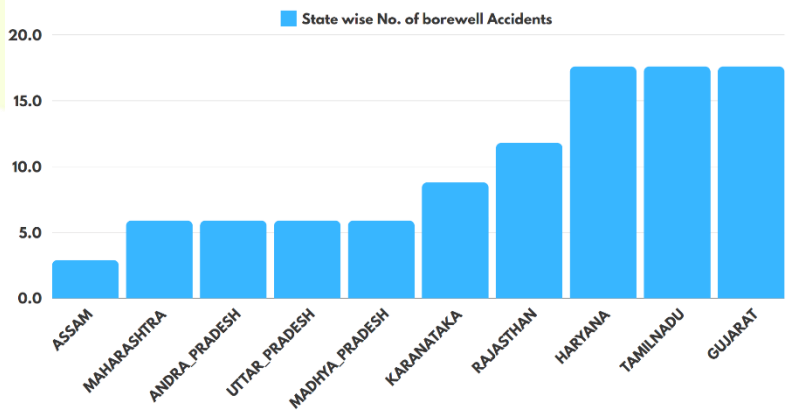

Fig1. No of Borewell Accidents: State-wise.

For that the device for borewell rescue operation is very helpful unlike traditional methods used for rescuing. This device checks all conditions inside borewell and monitor the victim continuously. It provides real time information about temperature, moisture, oxygen and visual data of Victim by using camera. This data proves to be most valuable to assist in the rescue operation. And the victim which is fallen in borewell is recovered in less amount of time.

So, these two cases prove and shows that how much this device is going to play crucial role in rescue operations.

LITERATURE REVIEW

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.

METHODS & MATERIALS

Component Review:

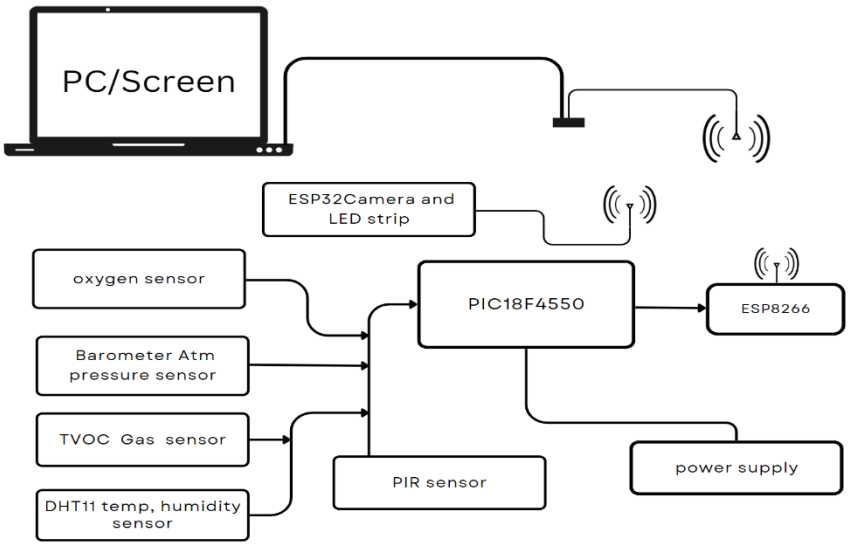

Fig 2. Block Diagram of model.

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.

TVOC Gas Sensor: Used for the Detection of volatile organic compounds (VOCs) in the air, this is crucial for determining indoor air quality and industrial safety. Its main features include I2C communication, 0.1245W power rating and measuring range from 0 ~ 99999 ppb.

DHT11 Temperature and Humidity Sensor: This is used to measure the temperature (0°C to 50°C) and relative humidity (20% to 90%), these parameters are vital for environmental monitoring. This has serial communication (single wire two way) with 3.3 to 5 v operating voltage.

AOF1010 Ultrasonic Oxygen Sensor: An industrial grade oxygen sensor used for the measurement of oxygen concentration using ultrasonic technology, this sensor offers high accuracy and reliability. Support UART communication mode with 5V operating voltage.

ESP32 Camera Module: This is an Integration of a camera with the ESP32 microcontroller, which helps in enabling image and video capture for surveillance and analysis. The data inside the borewell can be transmitted over the ESP Cam network. Thus, by setting the UART Bauds of controller and communication Module the controllers can easily communicate with each other.

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.

LED2X: These are used to indicate the ongoing system process, whether it may be initialization or data transmitting or receiving. The two-color combinations and ON-OFF timing indicates various process occurring on the board. Such as when red glows continuously it indicates low battery.

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.

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 1st the operator and the 2nd 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.

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.

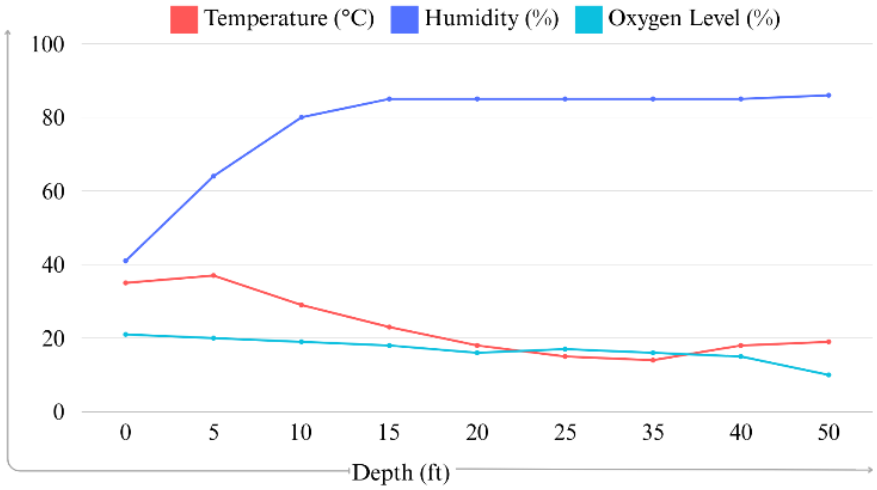

Fig 3. Environmental data w.r.t Depth. [4]

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.

RESULTS

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. 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.

CONCLUSION

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 has removing the victims from the borewell and lags behind the hardware which might the helpful in the same. Still future upgrade is yet to seen and society will truly add value to the system.

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