IoT based detection of bore-well unclosed holes using automated drone operated cameras in a remote area

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Abstract. In the current era, most of the accidents occur due to the borewells that are left unclosed and many children got trapped in them. Those borewells remain as a hell to many children. These borewells have played endlessly in most of the innocent lives. This process is very difficult to rescue the children away from the borewells. To avoid this critical situation, we must prevent the children from falling in borewells. Here, we came up with an idea to take precaution in order to save many infant lives. The main objective of the system is to fix a Drone camera in a remote area to find the borewells that remain uncovered. After finding the borewells, we have to find whether it is a normal hole or a depth pothole. So to detect the size of a hole, we attached an ultrasonic sensor on the bottom of the drone for identifying the potholes and also to measure the height and depth of a bore well respectively. If the depth and height of the bore well is large, the information will be send to the respected officials to properly close the bore well accordingly. These details will be updated to the cloud for maintaining the information in timeline. Hence, we can save number of lives of children from falling in borewells.

1. Introduction

Nowadays, India is one of the most developing and significant countries in the world. But there are many problems related to water scarcity. Water scarcity is one of the major problems in most of the cities. Due to water scarcity, many peoples have drilled bore well in their own places. These borewells appears as devil to most of the children. Some of the borewells are very deep and it is not covered properly. Due to this many of the children get trapped in the potholes and their lives are at risk. Some of these children are saved because of the advanced technology and based on their health conditions while some are very weak and due to some careless peoples in the society they are died. To avoid such circumstances, we have come up with the idea of prevention to identify the potholes in remote areas with the help of drone cameras. So that we get to know about the potholes in remote areas and measure the depth of that pothole. And also after identifying the borewells we need to measure the height and depth of that pothole. This can be found using an ultrasonic sensor attached to the bottom of the drone to discover the length and width of the pothole respectively. This in turn saves many innocent lives of the people accordingly.
2. Literature survey

Kavianand et al., proposed a paper which suggests an alert system by giving alert information to the control room for the children who come near the borehole. This term gives buzzer to the surroundings to aware about the accident, The PIR sensor which is fitted at the top of the borehole sense the people who falls inside the borewell. So that we get to know about the children who gets inside. The PIR Sensor is attached to raspberry which gives alert and location to the control room.

Siddharth singh et al., newly proposed system is being identified to rescue the children from the boreholes with the help of hand gripper method. This can be implemented with the help of ZigBee microcontroller with surveillance cameras attached to it. It takes real time data sensors to calculate the range of long distance applications for predicting the hole. In addition to that a LCD Display is also attached to get communication with the ZigBee microcontroller.

Rajeshwari Madli et al., proposes an ultrasonic sensor which is used to identify the potholes and humps in the Road for instructing the drivers. This location along with the pothole information is sent to the cloud for future purposes. A mobile application using android is created for informing the drivers and other higher officials for saving time and manpower. The messages are sent through audio mode with the GPS Coordinates using GSM Communication.

Sumit pandey et al., established a system which secures the children from falling in borewells. In olden days, they used methods like drilling a parallel pit near the borehole and save children who falls inside the borewell. This takes lot of time and the child will be dead in some cases. So, he proposed a system which consists of IR sensors down the bore well so that if any mud or some particles fell down, the IR Sensor will alert the people by giving a buzzer sound. So that it can save many lives of people.

Dhwani Desai et al., described a system which develops, describes the test for using automatic pothole detection and system for alerting the drivers for their safer travel. The Raspberry attached with the ultrasonic sensor and the camera will save the information to the cloud database or to the server and sends the message to the driver is 4 sec. The picture of the pothole and their measurement of height and depth is also sent to the driver for notification. We can maintain vehicle consumption by avoiding the speed breaks, potholes and humps respectively.

Nitin Agarwal et al., presented a paper which has a camera to watch the moving position of the child. A robotic arm is used to help the child from being taken away from the bore well. The camera is attached with a mic to chat with the children for the lonely convenience. so, the metal plates are attached with robotic arm to get the children. This can successfully save the folks to have a happy life with the robotic arm in order to save the time without any human loss.

Chellaswamy et al., established a system which consists of an accelerometer attached with an ultrasonic sensor using HBO technique. This will update the information to the cloud server. The location along with the size of the pothole is updated to the server. If any vehicle passes on that road, they will check the information on the server and it estimates the speed according to the humps and potholes. So, the drivers can pass the road with safety and alert.

Jayasudha et al., presented a paper which has a webcam which monitors the position of the child. It consists of a parallel pit method which has a robotic arm fitted with a gripper underneath the belt to easily recover the children from getting in bore well. The section consists of two units recovering system and protecting system. These sensors are attached with belt for underarm belt with the motor gear for dragging the children away from the bore well.

3. Proposed system

In the previous existing systems, child rescue is a very difficult and challenging task to save the child from the big trap. But in this newly proposed system, we reduced human efforts and offered work to machines in performing dangerous activities. This block diagram figure 1 explains the connection of hardware components that determines the working method for the system architecture.
The above diagram describes the Hardware components which are connected with the microcontroller and later stored in the cloud memory for future references. It consists of four modules.

- Module 1: Activate the Drone Camera
- Module 2: Identify the bore well
- Module 3: Find the Distance of the borehole using an ultrasonic sensor.
- Module 4: Cloud Updation.

3.1 Hardware components
- Drone camera
- Ultrasonic sensor
- Raspberry pi Microcontroller
- GPS Receiver
- GSM Modem

3.2 Module 1: Activate the drone camera
In the First step, the Drone Camera will be moved in a tragic path from one location to another location. The Drone is moving in a linear path with 1 feet left, 1 feet right and 1m back until the end of a 1 acre land.

3.3 Module 2: Identifying the bore well
The Drone Camera finds the borehole in different locations with differences in size of boreholes. The Drone camera consists of an ultrasonic sensor which is attached bottom that measures the height and depth of potholes accordingly.

3.4 Module 3: Find the distance of pothole
After finding the potholes in a land, we need to find the distance of potholes to calculate whether it is a normal hole or a depth hole. The ultrasonic sensor will calculate the distance by emitting the sound from to and fro direction. If the distance measured is more than 3 feet or above 90cm then it is considered as a Red Zone. The formula for calculating the distance using ultrasonic sensor,
Distance = \frac{\text{Time} \times \text{speed of sound in air}}{2} \quad (1)

\text{Speed of sound} = 340\text{m/s} = 0.034\text{cm/µs} \quad (2)

Total time T will be calculated by the starting time t1 and ending time t2. So by applying this distance formula we can calculate the depth of the pothole and predict the size of the bore well.

- ABOVE 3 FEET: RED ZONE
- BELOW 3 FEET: YELLOW ZONE
- 1 FEET: WARNING ZONE
- BELOW 1 FEET: GREEN ZONE

These are the zones considered for predicting the size of the bore well for ensuring child safety in remote areas.

3.5 Module 4: Cloud updation

If the pothole is in the Red zone, then the alert message will be sent to the respected officials to close the bore well properly. Along with that this information will be stored in the cloud for future references. Thus, we proposed a new model for uncovered borewells using IOT based automated drone cameras in Remote areas.

4. Working mechanism

![Figure 2. Circuit diagram for proposed system.](image)

The figure 2 Circuit diagram consists of the components which are connected with the sensors to get the output from the readed values.

4.1. Step 1: The Raspberry pi is connected with the power supply of external battery and ultrasonic sensor with the Drone camera as in figure 3. The Drone camera will be connected in a tragic path in a one acre land.

![Figure 3. Connection with Raspberry using ultrasonic.](image)
4.2. **Step 2**: The drone camera works on the principle of Image Processing. Image processing undergoes checking for presence of any object, object detection and measurement, identification and verification of any objects.

4.3. **Step 3**: If a drone captures an obstacle, it will take the image as a matrix form with rows and columns. This matrix will calculate the images as pixels. The pixels are divided into a number of bits which are 256 shades and known as grayscale images.

4.4. **Step 4**: The image processing undergoes filtering, Feature Detection, Optical flow which are pre-processing methods. After that it is split into corner’s mean, split frame which are Grouping methods. Examples of Preprocessing are Noise Reduction, brightness as well as contrast enhancement.

4.5. **Step 5**: The Drone Camera is moving in the land to see the boreholes which are uncovered as in figure 4. The Drone will identify the boreholes using image processing and measure the distance using ultrasonic sensors.

![Figure 4. Boreholes which are left unclosed.](image)

4.6. **Step 6**: The Drone will capture the potholes and the distance will also be stored in the cloud. Then the Drone will come back and move to another location searching for boreholes.

4.7. **Step 7**: The figure 5 Ultrasonic sensor which has a transmitter and receiver will transmit the sound waves and reflect it back. The timing will be calculated based on the difference between the waves. The distance is measured using the formula,

$$\text{DISTANCE} = \frac{\text{TIME} \times \frac{340 \text{m/s}}{20,000}}$$  

![Figure 5. Working model of ultrasonic sensor.](image)
4.8. Step 8: As the time increases, the distance also increases and the speed remains constant in air. Depending on the time travelled, we can calculate the distance of the borehole respectively as in figure 6.

![Figure 6](image_url)

**Figure 6.** Distance of borehole with 120 feet.

4.9. Step 9: We are measuring the distance to check it is a normal pothole or a Depth Zone. Sometimes, the rain will make the closed bore well open because of the mud flooded away from the borehole. So as to alert the people, an ultrasonic sensor is being used.

4.10. Step 10: For example in a 10*10m, the ultrasonic sensor in the Ground surface will emit the sound waves and travel front and back in the air to measure the size of the pothole.

4.11. Step 11: The Raspberry pi gets input from the sensors and sends the output out of it. The waves are transmitted in analog form to read the values from the sensor.

4.12. Step 12: The threshold value of the pothole is 3 feet. If the distance exceeds the threshold range, it is considered as a Dangerous zone in figure 7. The outcomes of the values from Ultrasonic sensor to Raspberry pi gives a message to GPS and GSM modules to alert the control room.

![Figure 7](image_url)

**Figure 7.** Dangerous borehole above threshold range.
4.13. **Step 13**: The Global positioning system works on the timing module to know the position, latitude and longitude values with the help of GSM. Global system for Mobile Communication which is used to communicate with mobile and the network as mentioned in the figure 8.

![Figure 8. Connection of GPS and GSM module.](image)

4.14. **Step 14**: The sim 900A works in communication with the people. The figure 9 shows the message will be received in the registered mobile number about the location details of Latitude and longitude respectively.

![Figure 9. Latitude and Longitude values.](image)

4.15. **Step 15**: At the last, these Data will be stored in the cloud for later use to know the information about the borewells as shown in figure 10.
4.16. Step 16: The advantage of using cloud is we can store the information anytime and anywhere. Not like our personal laptop and hardware, we can get the data’s on a network connection with any device.

4.17. Step 17: These data’s will be added to the cloud. This will mainly help the people to save the lifespan of innocent people by avoiding such tragic accidents.

5. Results and analysis

This System is tested with different inputs and parameters are tested with various locations and measured the distance of borewells using ultrasonic sensors. The threshold value of the distance using an ultrasonic sensor is 3 feet. Distance of boreholes defines the classification of zones namely Red zone, Yellow Zone, and Green zone. To classify the Zones, we have to calculate the distance of Pothole by calculating the starting time $t_1$ and ending time $t_2$ of an ultrasonic sensor. At 5 seconds, the distance of the pothole is 0.2788 feet. This indicates Green zone. Here, the time travelled increases with respect to the distance travelled from and back by Ultrasonic sensor.

At a time of 50 seconds, the distance is measured as 2.78 feet which is considered a Yellow zone. These distances can be calculated by using the waves which travel through a high level, by vibration of waves which gets reflected back. At a time of 200 seconds, the distance is measured as 11.15 feet which is considered as highly dangerous zone and as Red Zone. The X axis is considered as Time and Y axis is calculated by Distance. We will analyze the Time calculated and Distance travelled by using graphical analysis method for interpreting data and important methods.
The figure 11 describes the color of zones such as Red zone, Yellow zone, Green zone with respect to Time and distance travelled based on the values of the sensor.

The next figure 12 shows the Distance of borehole and Depth of pothole is calculated using x and y axis. The size of the area is measured using the Distance and depth of the borehole with respect to x and y axis. These variations are mentioned based on the difference of colours such as green and yellow respectively.

The figure 13 describes the size and depth of pothole.
The table 1 below shows the Detection of boreholes by calculating distances by using parameters such as Location, Time, and Distance, classifications of zones, longitude and latitude by predicting the accuracy of the graph.

### Table 1. Detection of borehole using ultrasonic sensor

| Location | Time (sec) | Distance (ft) | Classification of zones | Longitude       | Latitude          |
|----------|------------|---------------|--------------------------|-----------------|-------------------|
| 1        | 5          | 0.2788        | Green                    | 80°18'26.12"E   | 13°34'3.82"N     |
| 2        | 50         | 2.798         | Yellow                   | 80°19'44.78"E   | 13.2°8.02"N      |
| 3        | 200        | 16.728        | Red                      | 80°26'52.67"E   | 80°18'7.22"N     |
| 4        | 52         | 2.95          | Yellow                   | 80°26'52.67"E   | 80°14'7.22"N     |
| 5        | 300        | 25.783        | Red                      | 80°10'7.22"E    | 80°12'7.22"N     |

6. Conclusion and future work

The Proposed system consists of 4 modules. The modules consists of Activating the Drone camera, identifying the bore well, finding the distance of a bore well using an ultrasonic sensor and updating the information in cloud. The Drone camera will be activated in a remote area for finding the bore well and ultrasonic sensor is used to calculate the distance of the bore well. By using this method, we can detect the presence of bore well which is uncovered. By measuring the distance we can find whether it is a red zone or normal zone. If this is a Red Zone, this gives alerts to the control room for closing the borehole. It helps to save people's lives. So, we used IoT machineries in a beneficial way. This system can be implemented in a further way by fixing the Passive Infrared Sensor at the top of the borehole and if any object is detected before 10m, the system also gives a beep sound about the borehole nearby. So, the people can easily aware about the bore well and informs this message to the land owners to prevent this accident from occurring. Thus, we can implement this system in intelligent way for future use.

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