Measurement of Deep Pit Using Ultrasonic Sensor with Servo-Based Scanning and Integration with Mobile Application

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***Abstract*—Accurate measurement of deep pits, bore wells, and vertical rigid structures is essential in civil engineering, mining, water resource management, and safety inspection. Traditional manual measurement methods are time-consuming, unsafe, and prone to error. This paper presents the design and development of an affordable, wireless deep pit measurement system using an ultrasonic sensor, servo motor, and mobile application for real-time visualization. The proposed system is simple, cost-effective, and suitable for both academic and field applications.**

***Index Terms*—Deep pit measurement, Ultrasonic sensor, Servo motor, IoT, Mobile application, Distance measurement**

I. INTRODUCTION

Accurate depth measurement of structures such as bore wells, inspection shafts, and underground tanks is critical for analysis and safety. Conventional methods like rope or measuring tape are inefficient and hazardous.

With advancements in embedded systems and sensors, non-contact measurement techniques have gained importance. Ultrasonic sensors are widely used due to their low cost, simplicity, and reasonable accuracy. By integrating a microcontroller, servo motor, and mobile application, an intelligent and automated measurement system can be developed.

This paper presents a deep pit measurement system using ultrasonic sensing with servo alignment and real-time mobile-based monitoring.

II. LITERATURE REVIEW

Ultrasonic distance measurement has been extensively studied for non-contact applications. Qiu et al. discussed time-of-flight techniques and highlighted challenges such as noise and temperature variations. Jia et al. improved measurement accuracy using signal processing methods.

Microcontroller-based systems developed by Aung and Mar demonstrated cost-effective real-time measurement solutions. Other studies explored ultrasonic applications in automation and safety systems. Servo-based scanning mechanisms have also been used to reduce blind spots.

However, most existing work focuses on obstacle detection or liquid level measurement. The integration of servo-based scanning with mobile applications for deep pit measurement remains relatively unexplored, which this study addresses.

III. METHODOLOGY / EXPERIMENTAL SETUP

A. System Components

The system consists of:

1. Ultrasonic sensor (HC-SR04)
2. Microcontroller
3. Servo motor
4. Mobile application

B. Working Principle

The ultrasonic sensor measures the distance between the top and bottom of the pit using sound wave

reflection. The servo motor ensures proper alignment of the sensor. The microcontroller processes the data and transmits it wirelessly to a mobile application for display.

C. Hardware Implementation

1) Ultrasonic Sensor

The sensor operates on the principle of sound wave reflection. It emits ultrasonic waves and receives echoes from the pit bottom. Distance is calculated using:

Distance=Time × Speed of Sound

2) Servo Motor

The servo motor positions the ultrasonic sensor perpendicular to the pit surface, minimizing measurement errors.

3) Microcontroller

The microcontroller controls all components, processes distance data, and manages wireless communication.

4) Power Supply

A regulated DC supply or battery powers the system, ensuring portability.

D. Software Design

1) Embedded System

The system is programmed using Arduino IDE. Functions include:

- Triggering the ultrasonic sensor
- Calculating distance from echo time
- Controlling servo motor
- Transmitting data wirelessly

2) Mobile Application

Developed using Python/HTML, the application:

- Receives data from the microcontroller
- Displays real-time depth
- Provides user-friendly interface
- Stores measurement data

IV. RESULTS AND DISCUSSION

The developed system accurately measures small to medium pit depths. The non-contact method improves safety and reliability. Real-time data visualization on the mobile interface enhances usability and accessibility. The system demonstrates good performance with low cost and ease of implementation.

V. FUTURE SCOPE

The system can be enhanced by:

1. Cloud data storage
2. AI-based depth prediction
3. Solar-powered operation
4. 3D pit mapping
5. Data logging and graphical analysis

VI. CONCLUSION

This paper presents a simple and efficient deep pit measurement system using an ultrasonic sensor, servo motor, and mobile application. The proposed system improves safety, accuracy, and ease of measurement compared to traditional methods. It is suitable for academic projects and can be further developed for industrial applications.

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