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DESIGN AND IMPLEMENTATION OF SOLAR POWERED DEWATERING SYSTEM WITH IoT-BASED MONITORING FOR MINING APPLICATIONS

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Abstract *– Groundwater accumulation in mining areas leads to operational delays, increased maintenance costs, and safety hazards. Conventional dewatering systems rely on diesel-powered pumps or grid electricity, which are costly and environmentally harmful. This paper presents the design and implementation of a solar-powered automated dewatering system using an Arduino-based control mechanism. The system utilizes an ultrasonic sensor to monitor water levels and a relay-controlled DC pump for automatic water removal. A solar panel integrated with an MPPT charge controller provides a sustainable energy source, ensuring reliable operation in remote locations. To enhance system capabilities, an IoT-based monitoring approach is proposed, enabling real-time data visualization and remote access through cloud platforms such as ThingSpeak or Blynk. The proposed system aims to reduce human intervention, improve efficiency, and promote eco-friendly mining operations. Experimental observations indicate stable operation, efficient energy utilization, and effective automation, making the system suitable for small and medium-scale mining applications.*

Keywords— *Solar Energy, Dewatering System, Mining Operations, IoT, Automation, Ultrasonic Sensor, Renewable Energy*

INTRODUCTION

Dewatering is a crucial process in mining operations, where accumulated groundwater must be continuously removed to maintain safe and efficient working conditions. Traditional systems depend on diesel engines or grid electricity, which result in high operational costs, environmental pollution, and limited reliability in remote areas.

With the growing demand for sustainable and energy-efficient solutions, solar-powered systems have emerged as a promising alternative. Solar energy is abundant, renewable, and suitable for off-grid applications such as mining sites. By integrating embedded systems and sensors, the dewatering process can be automated, reducing manual intervention and improving operational efficiency.

This paper presents a solar-powered automated dewatering system that utilizes sensor-based monitoring and microcontroller-based control. Additionally, an IoT-based enhancement is proposed to enable remote monitoring and smart control of the system.

LITERATURE REVIEW

Traditional dewatering systems in mining operations typically rely on the following:

1) Diesel Power Pumps : Diesel generators are commonly used to power water pumps in remote mining areas. These systems are reliable but involve high fuel consumption, continuous maintenance, and increased operational costs. They also contribute to environmental pollution due to emissions from burning fossil fuels.[1]

2) Grid-Powered electric Pumps : In mining areas with access to electricity, grid-powered pumps are deployed. Although efficient, they depend heavily on stable power availability, which is often lacking in remote or off-grid mining locations. Power interruptions can significantly impact dewatering performance.[2]

3) Manual Water Level Monitoring System : Many existing dewatering setups require manual supervision to check water levels and operate pumps accordingly. This method is labor-intensive, prone to inaccuracies, and less effective during sudden water inflows.[3]

4) Conventional Automatic Pumping System : Certain systems use float switches or basic sensors to control pump operations. While automated, they lack precision, adaptability, and remote monitoring capabilities. Existing literature highlights the need for more sustainable, automated, and cost-effective dewatering solutions that can operate reliably in remote mining environments.[5]

PROBLEM STATEMENT

"Design and Implementation of Solar-Powered Dewatering in Mining Operation"

Mining operations frequently encounter challenges due to groundwater accumulation in pits and excavation areas. Traditional dewatering systems depend on diesel or grid power, which leads to several problems such as:

- High operational cost due to fuel consumption or electricity bills.
- Environmental pollution and carbon emissions from diesel-powered pumps.
- Unreliable or unavailable power supply in remote mining locations.
- Frequent maintenance, mechanical failures, and downtime.
- Manual monitoring that requires constant human intervention.
- Lack of intelligent control based on accurate water level measurements.

Therefore, the problem identified in this project is the need for a cost-effective, automated, and sustainable dewatering system that can operate efficiently in remote mining environments without depending on non-renewable energy sources.

METHODOLOGY (SYSTEM DESIGN)

System Flow:

This system follows a sequence of logical operations that enable automatic water level monitoring and pump control using solar energy and IoT-based communication.

Step-by-Step Flow:

1. System Initialization

- ESP32 microcontroller boots
- Ultrasonic sensor, relay module, and pump are initialized
- WiFi connection is established using mobile hotspot

2. Power Supply Activation

- Solar panel generates electrical energy
- MPPT charge controller regulates voltage
- Battery stores energy and supplies power to the system

3. Water Level Detection

- Ultrasonic sensor measures water level continuously
- Distance data is sent to ESP32 for processing

4. Data Processing

- ESP32 compares water level with predefined threshold
- Determines whether pumping is required

5. Pump Control

- If water level is HIGH → Relay activates pump (ON)
- If water level is LOW → Relay deactivates pump (OFF)

6. IoT Monitoring

- ESP32 sends water level and pump status to cloud platform
- Data is accessible via mobile/web dashboard

7. Continuous Operation

- System runs in a loop for real-time monitoring and automatic control

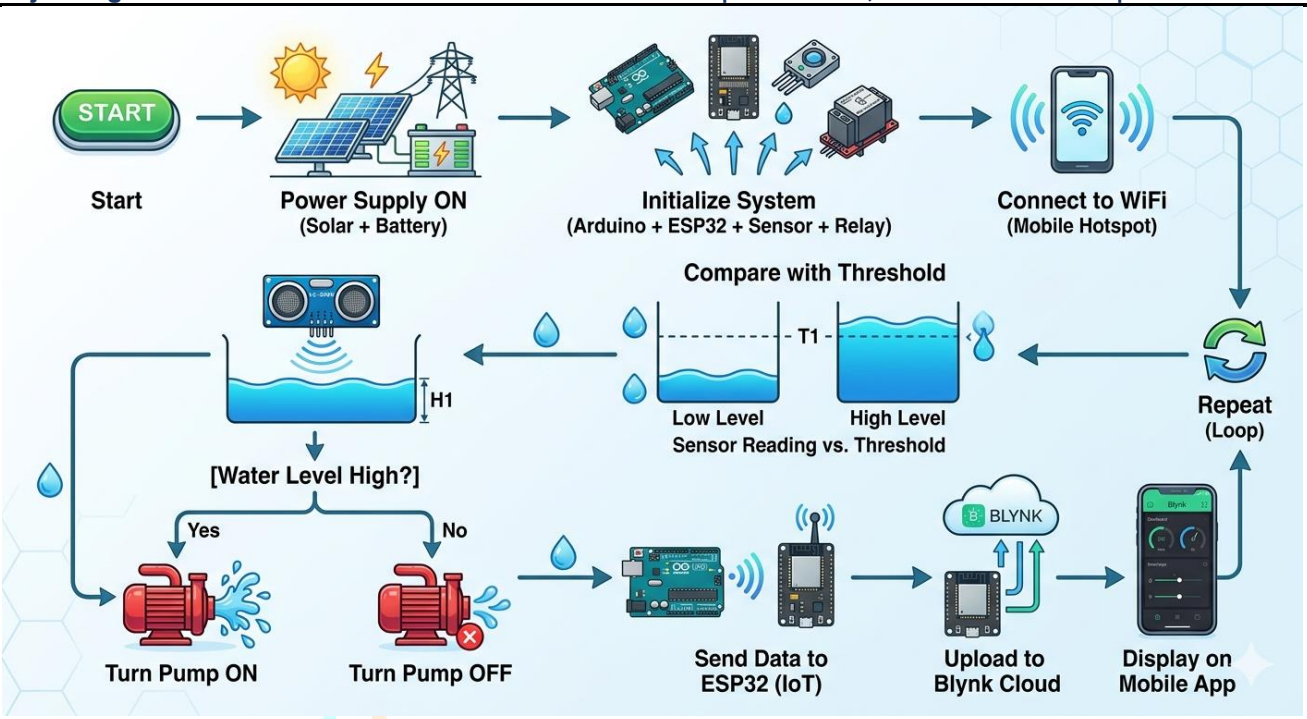

Fig. 1 System execution

ALGORITHM

Step-by-Step Algorithm

1. Start System

- Power ON the system using battery/solar supply

2. Initialize Components

- Initialize ESP32 microcontroller
- Initialize ultrasonic sensor and relay module
- Connect ESP32 to WiFi (mobile hotspot)

3. Measure Water Level

- Ultrasonic sensor measures the distance to water surface
- Send measured value to ESP32

4. Compare with Threshold

- Set predefined water level threshold
- Compare current water level with threshold

5. Control Pump Operation

- If water level is HIGH → Turn pump ON
- If water level is LOW → Turn pump OFF

6. Send Data to Cloud (IoT)

- Transmit water level and pump status to cloud platform
- Update data on mobile/web dashboard

7. Repeat Process

- Continuously monitor water level
- Repeat steps in loop for real-time operation

CONCLUSION

The proposed solar-powered dewatering system offers an efficient and eco-friendly solution for mining applications. Using an ESP32 microcontroller and ultrasonic sensor, the system automates pump operation based on water level, reducing manual effort.
The integration of IoT enables remote monitoring through cloud platforms, improving system reliability and efficiency. Overall, the system is cost-effective and suitable for use in remote locations.

EXPECTED RESULTS

The proposed system is expected to perform efficient water removal using solar energy with minimal human intervention. The pump will operate automatically based on real-time water level detection, ensuring optimal energy usage.
With IoT integration, the system will provide real-time monitoring of water level and pump status through a mobile or web interface. This will improve reliability, reduce manual effort, and enhance overall system efficiency.

DISCUSSION

The proposed system demonstrates an effective approach for automated dewatering using solar energy and Arduino + ESP32-based control. The integration of an ultrasonic sensor ensures accurate water level detection, while the relay-controlled pump enables reliable operation.
Compared to conventional systems, this solution reduces dependency on fuel and manual monitoring. The addition of IoT enhances system functionality by providing real-time data access and remote monitoring.
However, system performance may vary depending on sunlight availability and network connectivity. Despite these limitations, the system offers a practical and efficient solution for small and medium-scale mining applications.

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