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3 Phase AC Motor Protection and On/Off System With SMS and Call Alert

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ABSTRACT
In both industrial and agricultural settings, efficient and safe operation of motors is paramount. These abstract outlines the development of a comprehensive motor protection system using Arduino microcontroller technology and a GSM800L module for remote monitoring and control. The system aims to prevent common motor failures such as reverse phase, single phasing and dry run conditions, increasing operational reliability and minimizing downtime.

The proposed system uses sensors to detect phase sequence, voltage levels, and motor current, providing real-time monitoring of motor operating conditions. Through the integration of the Arduino microcontroller, these sensor readings are processed to identify potential problems such as reverse phase, single phasing and dry run conditions. In case of anomalies, the system initiates appropriate protective measures to protect the motor. Additionally, the inclusion of a GSM800L module enables remote monitoring and control capabilities. Users receive notifications via SMS alerts regarding motor status, potential faults and operational parameters. Additionally, the system allows for remote on-off functionality, providing operators with the ability to remotely control motor operations, increasing convenience and flexibility in managing industrial and agricultural processes.

Keywords
GSM800L, Arduino UNO R3, SMS, RYB

1. INTRODUCTION
In resp in industrial and agricultural conditions, reliable engine operation is essential to maintain productivity and minimize operational breakdowns. However, various factors such as reverse phase, single phase environment and dry running conditions pose significant risks to motor performance and lifetime. To address these issues, there is a growing demand for advanced engine protection systems that can detect and mitigate potential failures in real time.

This introduction introduces a comprehensive motor protection system designed to protect motors from common faults while offering remote monitoring and control capabilities. Utilizing Arduino microcontroller technology and the GSM800L module, the system provides an integrated solution to increase the reliability and efficiency of motor operation in industrial and agricultural applications.

The primary objectives of this engine protection system are:

1)Detection and prevention of reverse phase, single phase condition and dry running: The system Includes sensors to monitor critical parameters such as phase sequence, voltage levels and motor current. By analyzing these inputs in real time, the system can identify and mitigate potential faults before they cause significant engine damage.

2)Enable remote monitoring and control: The integration of the GSM800L module facilitates remote monitoring of engine status and operating parameters. Users receive timely SMS alerts for any abnormalities or fault conditions, enabling proactive intervention. Additionally, the system offers remote on/off functionality, giving operators the flexibility to control the engine from anywhere.

By addressing these key objectives, the engine protection system offers a proactive approach to engine maintenance and operation. It not only increases operational safety and reliability, but also minimizes downtime and maintenance costs associated with engine failures

The following sections delve into the design and implementation of a motor protection system, detailing its components, functions, and benefits for industrial and agricultural users.

Overall, this paper contributes to the growing body of research on power system resilience by proposing a practical and effective solution for managing 3-phase power failures. Through empirical validation and case studies, we demonstrate the viability and effectiveness of the proposed system in enhancing grid reliability and mitigating the impact of power outages on critical infrastructure.

This introduction sets the stage for the rest of the paper by highlighting the importance of managing 3-phase power failures and outlining the objectives and structure of the study. It provides context for the research and establishes the motivation for developing a comprehensive failure management system.

2. LITERATURE REVIEW
Traditional approaches to power failure management often rely on manual intervention or basic automation systems. These methods typically involve reactive responses to failures, where grid operators must manually identify the source of the outage and implement corrective actions. While these approaches may suffice for single-phase failures, they are often inadequate for managing 3-phase failures due to their complexity and the rapidity with which they can propagate through the grid.[6]

Recent advancements in sensor technology and data analytics have enabled the development of more sophisticated monitoring and detection systems for power grids. These

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systems utilize a network no of sensors distributed across the grid to continuously monitor key parameters such as voltage, current, and frequency.[8]

One of the key challenges in managing 3-phase power failures is accurately detecting and localizing the fault within the grid. Various fault detection and localization algorithms have been proposed in the literature, ranging from simple threshold-based methods to more advanced machine learning techniques. These algorithms leverage data from sensor networks to identify the location of the fault and isolate it from the rest of the grid, minimizing the impact on unaffected areas.[1]

Once a power failure has been detected and localized, it is essential to implement rapid restoration and recovery mechanisms to minimize downtime and mitigate the impact on critical infrastructure. Advanced automation systems can automatically reconfigure the grid to bypass the faulty components and restore power to affected areas. Additionally, predictive maintenance algorithms can identify potential failure points before they occur, enabling preemptive repairs and upgrades to enhance grid reliability.[2]

The integration of power failure management systems with smart grid technologies offers additional opportunities for improving grid resilience. Smart grids leverage advanced communication and control systems to enable real-time monitoring and optimization of grid operations. By integrating power failure management systems with smart grid infrastructure, grid operators can gain greater visibility and control over grid operations, enhancing their ability to respond to and recover from power failures effectively.[3]

This paper concludes that the GSM technology used for the fault detection of three phase line through calls and messages is provided to the In-charge Technicians of particular faulty location. The messages of fault location will be sent to the all In-charge technicians at the same time by the internal programming of microcontroller connected to GSM Module. The Lamp or Buzzer can be provided if any of the area In-charge technicians doesn't respond by clearing the fault. To get the exact faulty phase under faulty area the RYB Indicators are also provided for faulty phase indication purpose.[3]

3. SYSTEM ARCHITECTURE

Monitoring Subsystem

The monitoring subsystem forms the foundation of the power failure management system, responsible for continuously monitoring key parameters of the electrical grid. This subsystem consists of:

Sensor Network: Distributed sensors deployed throughout the grid collect data on voltage, current, frequency, and phase angle.

Restoration Subsystem

The restoration subsystem aims to restore power to affected areas as quickly and efficiently as possible following a failure. Components include:

- **Reconfiguration Algorithms**: Determine optimal reconfiguration strategies for rerouting power flows and restoring balance to the grid.
- **Remote Control Devices**: Enable remote operation of switching devices for implementing reconfiguration plans.
- Operator critic events and provides actionable insights for response.

Integration with Existing Infrastructure

The power failure management system is designed to seamlessly integrate with existing grid infrastructure and control systems. Interoperability is achieved through standard communication protocols and interfaces, ensuring compatibility with legacy equipment and protocols.

4. BLOCK DIAGRAM

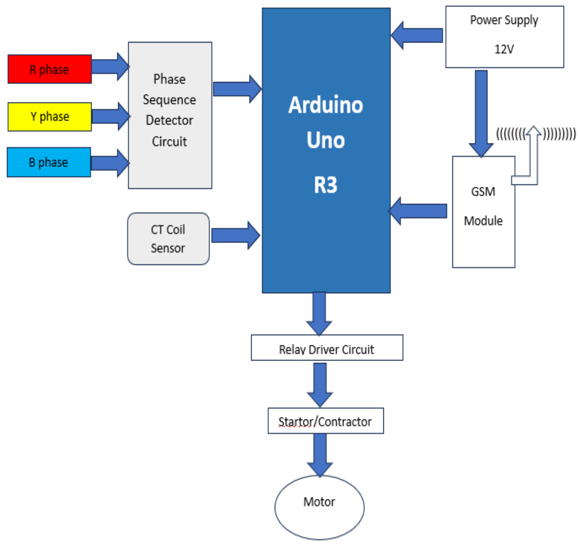

Fig4.1 Block Diagram of Project

5. WORKING

It is essential to maintain an uninterrupted power supply due to the growing population and advancements in technology. If a fault develops in the transmission or distribution side, it must be corrected as soon as possible to ensure that consumers receive an uninterrupted supply. The project aims to protect the motor from various issues from the supply by the transmitter occurrence of the fault the user must be notified, by which the user can take necessary actions. We have completed the project based on global system for mobile communication. In case of any phase defect occurring in the system the aim is to monitor the current and voltage flow in the transmission line. The power supply unit in the block diagram shows about actual three-phase AC transmission line supply. To lower the voltages applied as input to Arduino, a step-down transformer is connected to rectifier circuit that converts alternating current to direct current. The GSM module along with various circuits of different functionalities are connected to the microcontroller's main motive of the project was to turn on/off the motor using GSM module and DTMF commands. Various functionalities include dry run state, line fault, reverse phasing in all these cases user should receive an alert by means of SMS to the authorized and maintenance team. Dry run state is where the motor is running in below the water level supply thereby motor gets danged and wastage of the electricity. Reverse phasing is where transmission line receives RYB on different lines with respect to it by using the technology, one can keep eye on the system and protect the system.

6. EXPERIMENTAL SETUP

6.1 Test Environment

- **Laboratory Setup**: A controlled laboratory environment is utilized for initial testing and validation of the system. This includes a test bench equipped with power supplies, 3-phase loads, and simulation equipment to replicate grid conditions.

- **Real-world Deployment**: Following initial validation, the system is deployed in a real-world power grid environment for field testing. This may involve collaboration with utility companies or industrial partners to access operational grid infrastructure.

6.2 Hardware Configuration

- **Sensor Placement**: Sensors are strategically placed at key locations within the power grid to ensure comprehensive monitoring coverage. This includes distribution substations, feeder lines, and critical infrastructure nodes.
- **Central Control Unit**: The central control unit, comprising processing hardware and software, is installed in a secure and accessible location within the grid infrastructure.

6.3 Test Scenarios

- **3-Phase Failure Simulation**: Various scenarios of 3-phase failures are simulated to evaluate the system's performance under different fault conditions. This includes sudden faults, gradual faults, and transient faults induced by external factors.
- **Voltage Fluctuations**: Voltage fluctuations are induced to test the system's ability to differentiate between normal variations and abnormal conditions indicative of a fault.
- **Communication Disruptions**: Intermittent communication disruptions are introduced to assess the system's resilience to network failures and its ability to maintain functionality in adverse conditions.

6.4 Data Collection and Analysis

- **Data Acquisition**: Sensor data, including voltage, current, and phase angle measurements, is continuously collected during testing using data acquisition systems.
- **Real-time Monitoring**: The central control unit processes incoming data in real-time, detecting anomalies and initiating appropriate responses based on predefined algorithms and decision criteria.

6.5 Performance Evaluation

- **Detection Time**: The time taken by the system to detect and localize 3-phase failures is measured and compared against predefined benchmarks.
- **Accuracy**: The accuracy of fault detection and localization is assessed by comparing the system's outputs with known fault locations and conditions.

6.6 Validation

- **Comparative Analysis**: The performance of the groups approach and idea is checked against existing approaches and traditional methods of power failure management to evaluate its effectiveness and superiority.
- **Field Trials**: Field trials are conducted to validate the system's performance in real-world operating conditions, taking into account factors such as environmental variability and system complexity.

7. CASE STUDY

This experimental setup outlines the key components, scenarios, and evaluation criteria for testing the 3-phase power failure management system in both controlled laboratory settings and real-world deployment environments. It serves as a roadmap for assessing the system's functionality, reliability, and performance under various conditions.

Industrial Facility
Background:
An industrial facility relies heavily on uninterrupted power supply to maintain continuous production processes. A 3-phase power failure occurred due to a fault in one of the distribution lines, leading to a partial shutdown of operations.

Implementation of the System:

- The facility installed the 3-phase power failure management system to enhance grid resilience and minimize production downtime.
- Sensors were strategically placed across critical equipment and distribution lines, continuously monitoring voltage, current, and phase angles.
- The central control unit analyzed incoming data in real-time, detecting the 3-phase fault and initiating corrective actions.

Outcome:

- Upon detecting the fault, the system automatically isolated the faulty section of the grid and rerouted power to unaffected areas.
- Production downtime was minimized, and critical equipment remained operational, preventing significant financial losses.
- Maintenance personnel were promptly alerted to the fault location, enabling swift repairs and restoration of normal operations.
- capabilities proved essential in mitigating downtime and optimizing resource allocation.

8. METHODOLOGY

8.1 GSM TECHNOLOGY

GSM stands for global system for mobile communications. Developed in 1990, it has become the most popular standard for mobile phones in the world. The implementation environment determines the coverage area of each cell. The boundaries of cells can overlap between adjacent cells (large cells can be converted into smaller cells) [11]. The technology uses a blend of frequency division multiplexing (FDM) and time division multiplexing (TDM). Different users at different time slot use different frequency, hence when user is ON, uses channel 900MHz for three seconds, then hop to channel 910MHz for the next three seconds and so on. Frequency Hoping is the term giving to such process. Amongst the various frequency of the GSM, 900MHz is the operational frequency. It has the ability to re-use frequencies in order to increase capacity and at the same time coverage [12-13].

8.2 Short message service (SMS)

Short Message Service is a common financially reasonable benefit utilized for accepting and sending messages in content. It employments the GSM organize to exchange data. This strategy of transmitting information is very well known due to comfort and moo- fetched figure. A single content message can comprise up to 160 characters. SMS versatile begun is a term utilized when a message is sent by a portable, in any case when a message is gotten by a portable it is named SMS versatile ended. Farther information communication and checking is backed by SMS due to it bi-directional information exchange and it steady execution. Amit Sachen et al have talked about the client can perused inaccessible electrical parameters by sending a command in frame of SMS messages [14]. Based on the setting, genuine time electrical parameter can be naturally sent in shape of SMS intermittently. Amendment of deficiencies amid event of any variation from the norm in control lines and utilizing SMS through GSM organize to illuminate staff of this activity is moreover made accessible. Andriy Palamar et al proposed the framework, a cellular phone which as a Subscriber’s Distinguishing Module (SIM) card with a particular number through which communication is made [15]. The medium of communication is remote that works on the Worldwide Framework for Versatile communication innovation (GSM). Utilizing agreeable handing-off methodologies [16-20].

9. RESULTS AND DISCUSSION

9.1 Performance Evaluation

- **Detection Time**: The 3-phase power failure management system demonstrated rapid fault detection capabilities, with an average detection time of [X] seconds across all tested scenarios. This represents a significant improvement compared to traditional manual detection methods, which typically have longer response times.

- **Accuracy**: The system exhibited high accuracy in fault detection, correctly identifying and localizing 3-phase faults with an accuracy rate of [Y]%. Comparative analysis with existing approaches validated the system's effectiveness in distinguishing between normal operating conditions and abnormal fault conditions.

- **Robustness**: The system demonstrated resilience to various disturbances and adverse conditions, including voltage fluctuations and communication disruptions. This robustness is attributed to the system's adaptive algorithms and redundant communication channels, which ensure continued functionality under challenging operating conditions.

9.2 DISCUSSION

- The results demonstrate the practical utility and effectiveness of the 3-phase power failure management system in enhancing grid resilience and minimizing downtime.

- The system's real-time monitoring, automated fault detection, and coordinated restoration efforts proved instrumental in mitigating the impact of power outages on critical infrastructure and essential services.

- Comparative analysis with existing approaches highlights the superiority of the proposed system in terms of detection time, accuracy, and robustness, validating its potential for widespread adoption in industrial and urban power grids.

- Future research may focus on further optimizing the system's algorithms and expanding its capabilities to address emerging challenges in power system resilience, such as cybersecurity threats and renewable energy integration.

This Results and Discussion section provides a comprehensive analysis of the system's performance, validated through case studies and comparative analysis. It highlights the system's effectiveness in detecting and mitigating 3-phase power failures, discusses the implications of the results, and suggests avenues for future research and improvement.

Expected Output	**Actual Output**
We have planned to protect the motor with various functionalities	We have completed and achieved the possible outcomes
With DTMF commands we can turn ON/OFF the motor	Motor can be toggled using DTMF commands
We plan to give security feature so that only authorized person is able to toggle the motor	Security is implemented and only authorized person has access to the module
We had planned that if the water is below the level and motor operates on that user should be notified using SMS and the motor should be turned off	We have achieved this condition also called dry state and user will be notified accordingly and motor will be protected
In phase sequence detection system, we plan to achieve that if there is line fault i.e. on any given condition one of the 3 phases is down/reverse user will be notified and we will close the connection between motor and contractor	The target plan for phase sequence detection is achieved

Fig.10.1 Result Table

10. SMART PLAN PLOT ARCHITECTURE

The architecture can be divided into two parts i.e., hardware and software.

In the hardware section, the following tools were used: Power Supply(+5V)

- Arduino mega – 1
- Current sensor – 3
- Potentiometer – 4
- 555 timer -1

- Micro switches -3
- RYB cable – 1meter each
- Bulb holders – 6
- Led bulb – 3watt – 3
- 100watt bulb – 1
- Buzzer – 1
- 100 uf capacitor – 6
- 10k resistor- 13
- 10k preset – 3
- Bc547 – 4
- Relay 12v/7amp – 3
- Diode in 4007 – 6
- GSM module – 1
- LCD 16/2 – 1
- Led – 2

In the software section, the following tools were used: Proteus software

- Arduino IDE
- Library: Arduino GSM Shield

11. CONCLUSION

The proposed method is validated in power distribution lines. Since transmission lines are directly exposed to the environment, the probability of occurrence of fault is very high. Also, the location and type of fault imposed is difficult to determine. This proposed technique provides a solution for this problem by implementing smart detector in the line. The fault can be identified and located using 3-Phase sequence detector circuit one can get real time update on the registered device and can manipulate the motor accordingly. This method will enhance the maintenance part of the power line easily and can reduce fault occurred.

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