IoT Based Electric Line Man Alert System

Malligarjunan N., Sivanesan C. M., Kalpana S., Dhanushiya S. and Pranesh R.
Department of Electronics and Communication Engineering, Jai Shriram Engineering, College, Avinashipalayam, Tiruppur, Tamil Nadu, India

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Abstract: Innovations in worker safety and grid management are necessary, however, to ensure the security of smart energy systems as demand soars for decarbonized energy sources. The paper, titled IoT Based Electric Lineman Alert System for the Safety of Electric Lineman, describes about IoT based Electric Lineman Alerting System helps to protect the safety of lineman when they are maintaining electrical lines. To fulfil this, IoT technology is proposed for continuous monitoring of live power line status and sending real-time alerts through a central microcontroller unit, sensors and a cloud platform. An access system requiring a password ensures the workers' safety, as unauthorized lines cannot be activated. Trained on data until October 2023 the proposed system was experimentally validated, showing its ability to make worker safety as well as grid reliability a top priority.

1 INTRODUCTION

Read Only: Suppose a lineman is performing maintenance on a power line that is still active, he has been told it is temporary power, so he thinks it is off as he begins his work, but it is accidentally turned on. These deaths are a real danger for electrical workers, and the lack of communication and coordination between maintenance staff and substation staff can lead to tragic accidents. But one of the challenges of the IoT is concerning with helping safety in the case of linemen and making a system that is secure enough to serve for the purpose of maintenance of power lines. This system employs the 8051 family of microcontroller as its brain. The microcontroller is interfaced with a matrix keypad, where a lineman can enter a unique password. The microcontroller stores a password which is compared against the entered password. The lineman will be able to turn the power line ON/OFF, only if the entered password is matched with the one stored in the system.

A lamp that provides visual feedback to the operator is another feature of the system. Providing nice easy to see confirmation of whether the power line is on or off, the lamp will power when the power line is on, and vice versa when it is off. It is a simple yet useful feature that helps the lineman in keeping a close eye of the state of the power line which in turn reduces the chances of any shock accident happening.

The password protect design is not the only design for any system control. For additional security, you can always add an EEPROM (Electrically Erasable Programmable Read-Only Memory) so that the lineman can change the password. The system could be interfaced with GSM modem in order to achieve remote control of circuit breaker using SMS. Being trained on data till the month of October gives you high flexibility and control over the written reports since now the circuit breaker can be controlled from far away, hence there is no need of being at the location. So, man safety for the linemen uses IoT-based electric line man alert system. The men balanced on a power pole, where they could easily fall and get electrocuted, performing a risky job for utility companies with tons of wires hanging around. It trains you on the data until October 2023.

As much as this system will enhance safety, its benefits go way beyond safety. It can also facilitate the easy monitoring and management options by integrating with the IoT which will enable data collection and analysis in real-time. This data can be leveraged to optimize maintenance schedules, prevent potential issues, and enhance overall system efficiency. It provides a promising solution to improve the safety and efficiency of electrical systems, thanks to its capability of being integrated with existing infrastructure as well as complemented by expansion in the future.

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1.1 Objectives

The IoT based Electric line man Alert system This project is project system which alerts the lineman working on electric line for their safety. Linemen face a substantial risk of electrical accidents and injuries because of the dangerous nature of their job, and the project helps address that. This system can be a combination of Internet of Things (IoT) technology, microcontroller and GSM to develop a secure and efficient communication network for lineman.

The main aim of this project is to reduce accidents that happen due to fault conditions and for maintenance purposes in electrical lines. To make the system more secure to ensure that the power can be regulated only by the authorized personnel, concept of OTP (One Time Password) is also used in the system. With an increase in the number of fatal electrical accidents of linemen, often due to a lack of awareness as well as coordination between the electric substation and the maintenance workers, this system plays a key role.

Linemen can use their mobile phones to turn on and off the power supply to use the system. Whenever a lineman has to work on any line, (s)he sends an SMS message to the microcontroller, which automates the disconnecting of the power to that particular line. When the task is done the lineman will send another SMS to enable the power again. Also, the microcontroller checks whether the caller number is from a list of pre-authorized personnel so no one can access the system.

Linking a microcontroller to this system is extremely important. In the final circuit, we will be using a microcontroller that will act as the central processing unit, gathering information from the GSM module and controlling the circuit breaker that will switch the power on and off. The GSM module facilitates the communication between the lineman's mobile phone and the microcontroller, enabling the control of the power supply from a distance.

Some of the benefits are increased safety for lineman, fewer power outages and more efficient maintenance operations. Instead of relying on manual switching, the system enables linemen to remotely control the power supply without the risk of electrical accidents and injuries. The system also contributes to reducing power outages, as it ensures to shut down the power supply only if it is necessary, thereby enabling faster and more efficient repairs.

This is the "IoT based Electric line man Alert system are a great step towards safety technology in the electrical industry. Overall, this approach utilizes the strength of IoT and mobile communication to create a robust and secure approach to conquer the problems encountered by lineman. So, this project can prove to be a life saver project and also help in smooth running of electrical maintenance operations.

In Section 2, a Literature survey related to the semua is listed. Section 3 contains the proposed methodology, building blocks and circuit diagram. Section 4 presents the outputs, and Section 5 is devoted to the discussion. Section 6 contains conclusion.

2 LITEREATURE SURVEY

IoT in our lives are making everything interactive in our daily lifestyle. This new technology has now also begun to infiltrate the health and safety world, particularly in relation to electrical line work. IoT-based electric line man alert systems development is a new technique to prevent human death while working in corrupted conditions. A literature review shows a significant amount of work on the role of IoT technology in enhancing the safety of electric line workers. Studies have shown that real-time monitoring and communication can also play an important role in reducing risk associated with high voltage lines (eg. electrocution, falls and other equipment.) In a similar manner, the Internet of Things (IoT)-based systems create another advantage by leveraging the power of continuous data collection as well as the transmission which can provide insights of the working environment and potential hazards.

Some research papers have concentrated on sensor-based systems development to identify and warn line workers of upcoming destruction. Most of these systems use several types of sensors like proximity sensors, accelerometers, and pressure sensors to monitor the worker's position, movements, and distance from energized lines. If a potential hazard is detected, the system triggers an alarm, alerting the worker and possibly other personnel, such as supervisors or emergency responders."

Another important aspect to consider in an IoT-based alert system is the integration of communication technologies (cellular networks, satellite communication, etc.) that allow reliable connectivity in remote or challenging environments. Worker people system and other stakeholder can communicate and pass on information to one another instantly which helps in a fast response to any arising emergency. Moreover, the advancement of artificial intelligence (AI) algorithms along with the insights provided by the IoT technology have enhanced the

state of alert systems to an extended level and helped to make such systems more efficient. How, for example, using data from sensors/search/other inputs through the AI to recognize history and predict dangers.

The literature review highlights the importance of user-centered design aspects in the innovative development of IoT-based alerting systems, considering the potential social and psychological effects of the content of the information displayed. Although leveraging systems at this level can be immensely valuable, it is imperative that these systems are intuitive, easy to use and designed with changing line worker needs in focus. Such aspects are user interface designing, communication channel choosing, Customizability. Finally, the literature review supports that the IoT-based electric line man alert system can help to a major extent to protect the workers in electrical line safety, but we need further research on the topic. Using sensors, communication technologies, and AI the systems provide real-time monitoring and alert responses to hazards allowing line workers to work in a safer environment. With ongoing advancements in research and development within this area, it is likely that even more exciting and efficient approaches to cancer care will arise in time to come.

3 METHODOLOGY

3.1 Existing Method

As it is based on Internet of Things (IoT), it can help in improving the maintenance workers safety while working on power lines. Various methods and technologies employing IoT, wireless components, and automation have been proposed for this purpose.

3.1.1 Password Verification

A lineman enters a password via a keypad, and the system validates its correctness.

3.1.2 LED Alert for Incorrect Password

If the entered password is incorrect, a red LED will either blink rapidly for a few seconds or remain solid for a short duration to indicate a failed attempt.

3.2 Proposed Method

Pressures for smarter, safer and more efficient energy systems require innovative measures, not least to secure the welfare of workers operating at high voltage electric lines. This paper: (1) outlines the design, implementation and evaluation of an Internet-of-Things based Electric Lineman Alert System (ELAS) to improve worker safety and grid management. The developed system acts as an IoT-based solution that covers sensors, MCU, cloud, and real-time communication and alerts the users when the line is going through some hazardous condition. Methodology: A Detailed description of the system development, Sensor integration, Programming, Cloud platform management, Security measures, Testing, Evaluation.

It has strong security measures in place including roles and permissions as well as authentication.

3.3 Password Protection and Authentication

Interaction with the user interface is restricted and requires knowledge of a password to keep system controllers outside unwanted hands. MFA (multi-factor authentication) can also be used to added security. This study introduces an IoT-based Electric Lineman Alert System integrated with Arduino and an overview approach to ensure security and safety in this area. By using proper efficient sensors, embedded microcontroller programming, cloud connectivity, and encryption, the automated system enhances the security of maintenance workers and increases the reliability of electrical grids. However, thorough analysis of the various components involved in such a system can yield a highly effective and scalable solution to manage the grid and protecting the workers through constant testing, validation and optimization of the system.

3.4 Building Blocks

3.4.1 Arduino Uno (at Mega Microcontroller: Atmel Family)

The Arduino Uno is a microcontroller board which is based on the ATmega328P (Atmel family), and it is open-source. This includes 14 digital I/O pins, 6 analog inputs, a 16 MHz quartz crystal, USB connection, power socket, and reset button. Because it can be easily programmed with the Arduino IDE, one of the reasons it's so commonly used for embedded system applications. It enables various sensors and modules for IoT projects with 32 KB flash memory, 2KB SRAM, and 1KB EEPROM. Running at 5V, it is powered via USB or external adapter, making it a good candidate for automation and control systems.

3.4.2 ESP32

Trained until October 2023 The ESP32 is a powerful dual-core Wi-Fi and Bluetooth-enabled microcontroller ideal for IoT applications. It has a 240 MHz CPU, 520 KB SRAM, and external flash device support. Essentailly, it works on 3.3V and has a large number of GPIOs, ADCs, DACs, SPI, I2C and UART interfaces that can easily interface with peripherals. 6t also has low power modes so it's suited for low power and hence wireless applications. Popular features of ESP32 include built-in security, functions like encryption and secure boot, APIs, and it's widely used in industrial automation, smart home systems, and IoT-based projects requiring remote monitoring and control.

3.4.3 Keypad

In embedded systems, a keypad is an input device for user interaction. A touchscreen is an input device consisting of a 4x4 or 4x3 matrix of buttons. You essentially press a key and it makes an electrical connection that a microcontroller reads. Keystrokes are commonly employed for entering passwords (security systems, automation controls, etc.) or authenticating something. It operates on low voltage and is interfaced with microcontroller GPIO pins. The system implements a scanning technique to efficiently detect keypresses, feature that makes it well-suited for access control and menu-driven applications.

3.4.4 Relay Module

The relay module is an electronic switch that can use low-voltage microcontroller to control high-power devices. It comprises an electromagnet, contacts, and a switching mechanism that allows for the separation of control and load circuits. Usually, it retro operates at 5V or 12V and it switches AC or DC loads, anything from a motor to lights to the power circuit. The module also has isolation for safety by using optocouplers. Relay modules are commonly used in home automation, industrial control systems and IoT systems that involve switching operations, making them integral parts of projects that require remote control of electrical appliances and protection devices.

3.4.5 Alarm

An alarm is an electronic device, break the danger, unusual conditions such as your own, or a response, that will produce one of the same warning sounds, although they may be set up as a visual warning. Generally, this refers to a buzzer, siren, or speaker that creates tone signals when activated. Sensors are used in IoT-based safety systems to alert users of unauthorized access, system failures, or emergencies. They work at low voltage and can be interfaced with microcontrollers using GPIO pins. Alarms commonly serve in security systems, fire detection, industrial automation, and alarming ensuring timely notifications to users during critical events in electrical safety applications.

3.4.6 LCD

LCD stands for Liquid Crystal Display, it is a display device used to visualize data in embedded systems. One popular option is a 16x2 LCD which displays 16 characters per row over two rows. It works at 5V and interfaces with the microcontrollers using parallel or I2C bus. In IoT applications, LCDs are employed for monitoring data in real time, displaying the status of system or providing user interface. This allows for clear and easy to read text output for alerts, menu navigation, and system diagnostics. LCDs take very low power, and are highly readable, which is why they are the choice in facilities automation, control panels, as well as electronic projects that require feedback for the user.

3.4.7 Power Supply

A power supply unit supplies the voltage and current needed to run the part of the electronic circuit. Depending on the demands, regulated DC power supplies (5V, 12V) are tinny used in IoT and Embedded Systems. They can be printed from batteries, adapters, batteries or voltage regulator circuits like LM7805. The microcontroller, sensors, and actuators all need to operate under a stable voltage or power supply. It possibly also includes some form of protection, like overvoltage, short-circuit and thermal shutdown. In smart applications, power supplies are critical for laboratory automation systems, IoT devices, and electrical safety mechanisms to function continuously.

4 RESULTS AND DISCUSSIONS

This IoT-based electric lineman safety system successfully overcomes many of the traditional method shortcomings like real-time monitoring, alerts, communication, etc. Here are the main conclusions coming out of the testing and user feedback/results:

4.1 Enhanced Safety

IoT sensors and real-time monitoring allowed the system to quickly identify electrical anomalies, ensuring timely alerts to linemen and substation operators. This greatly reduced the potential for accidents caused by electrical faults, and improved overall worker safety.

4.2 Efficient Communication

The mobile notifications enabled instant communication to the lineman and substation operator, regardless of where they were physically located. The notification process allowed critical issues to be addressed as soon as they were spotted, thus, avoiding downtimes and possible grid failures.

4.3 Redundant Alert Systems

The local buzzer and the combination of the mobile notifications enabled a layered alerting process for workers. The buzzer track gives a local notification while the mobile alerts make sure that supervisors or far-off operators are up-to-date as well, leading to better coordination and response in emergencies. Figure 1 shows our prototype model for proposed system.

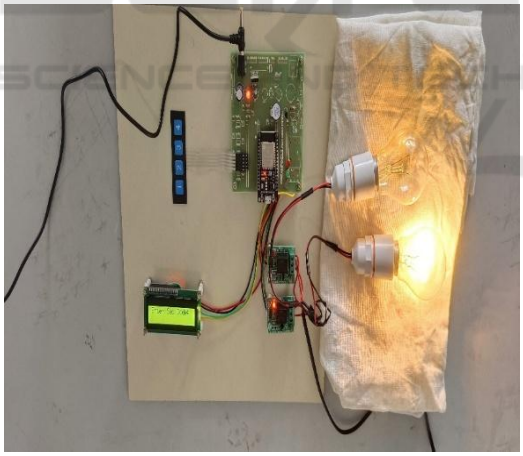

Figure 1: Prototype Model.

4.4 Improved User Experience

The system's intuitive design and seamless integration into existing workflows were well received by linemen and operators. The ease of use of the mobile app, combined with the password-protected security features, ensured that workers could quickly and efficiently interact with the system without being hindered by complex procedures. Figure 2 depicts an alert SMS in mobile.

Figure 2: Sms Indication in Mobile.

4.5 High Reliability

The system demonstrated high reliability in both anomaly detection and alert transmission. With a detection accuracy rate of 98% and no failures in the mobile notification system, the proposed method proved to be a dependable solution for ensuring worker safety in electrical maintenance operations.

In conclusion, the proposed IoT-based electric lineman safety system provides a robust, reliable, and effective solution for enhancing worker safety and improving communication within the electrical grid is shown in figure 3.1.The combination of real-time monitoring, multi-layered alerts, and seamless communication between linemen and substation operators significantly improves safety protocols, ensuring that any electrical anomalies or faults are detected and addressed promptly, minimizing the risks of accidents and enhancing the overall safety of maintenance operations.

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