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PashuRaksak: IoT-Driven Automated Livestock Rescue System

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Abstract: The PashuRaksak: IoT-Driven Automated Livestock Rescue System aims to address the critical need for protecting livestock from fire emergencies caused by accidents such as firecrackers, electric short circuits, and other fire outbreaks in rural areas. The system uses IoT technologies to detect fire in real time and automatically initiate a rescue protocol. This includes opening gates, releasing livestock, and notifying emergency responders such as firefighters. By minimizing human intervention and accelerating response times, the system enhances animal welfare, reduces losses, and supports the broader goal of creating smart, disaster-resilient agricultural communities.

Keywords: IoT, Livestock Safety, Fire Detection, Automated Rescue System, Smart Farming.

I. INTRODUCTION

With urbanization and increased use of electric infrastructure in rural areas, the frequency of fire incidents affecting livestock has risen sharply. Traditionally, livestock rescue during fire emergencies depends on human intervention, which is often delayed, inefficient, and unable to respond promptly to fast-moving fires. Furthermore, natural calamities like fires caused by firecrackers, electric short circuits, and similar accidents put the lives of animals at significant risk, resulting in casualties and damage to property. In response to this challenge, the PashuRaksak system introduces an IoT-based solution for real-time fire detection and automated livestock rescue.

The goal of the PashuRaksak system is to utilize fire detection sensors and automated mechanisms to ensure the immediate release of livestock from enclosures during fire outbreaks. The system will also notify emergency responders, particularly firefighters, about the incident's exact location, enabling them to act swiftly.

II. PROBLEM STATEMENT

In rural areas, livestock rescue during fire incidents often relies on delayed human responses, limited communication infrastructure, and the unpredictability of fire behavior. These factors result in preventable injury and loss of life among livestock. Traditional firefighting and rescue methods are inadequate because they cannot respond to fires quickly enough, especially in remote locations where manual intervention is impractical. The lack of real-time fire detection and automated evacuation increases the risk to livestock and, consequently, to the farmers' livelihoods.

To mitigate these risks, a solution is needed that can automatically detect fire, activate the appropriate rescue mechanisms, and notify emergency responders without human intervention.

III. PROPOSED SYSTEM

The PashuRaksak system is an IoT-enabled solution that combines real-time fire detection, automated evacuation mechanisms, and real-time alerts to ensure the safety of livestock. The system employs sensors for detecting smoke and flames, servo motors to open gates and untie livestock, and communication modules to notify emergency responders. The design of the system focuses on minimizing human intervention, reducing the response time to fire outbreaks, and providing reliable, automated action when the risk to livestock is imminent.

IV. SYSTEM ARCHITECTURE

The system’s architecture is composed of the following main components:

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Fire Detection: Smoke and flame sensors are deployed within the animal enclosures to detect early signs of fire. The sensors continuously monitor the environment and send real-time data to the central control unit.

Automated Evacuation: Upon fire detection, servo motors are activated to automatically open gates and release livestock. This mechanism ensures that animals are freed from enclosures without the need for human intervention.

Fire Incident Notification: The system sends immediate alerts to emergency responders, including firefighters, notifying them of the fire's location and the system's actions. This information allows responders to act more efficiently.

Microcontroller-Based Decision-Making: A microcontroller processes the sensor data, evaluates fire risks, and controls the activation of evacuation mechanisms. This intelligent decision-making process ensures that the system reacts appropriately in different fire scenarios.

Communication and Cloud-Based Monitoring: The system is connected to cloud-based platforms, which allow farmers and emergency responders to monitor the situation in real-time. Notifications and updates are sent through SMS, email, or app alerts.

Power Supply: The system is designed to be solar-powered to ensure uninterrupted operation in remote rural areas where electricity supply may be unreliable.

V. SYSTEM DESIGN

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A. Hardware Components

Flame and Smoke Sensors: Used for real-time fire detection, these sensors trigger the rescue protocol when flame or smoke levels exceed predefined thresholds.

Servo Motors: These motors are responsible for automating the opening of gates and releasing ropes that restrain livestock, enabling them to escape.

Microcontroller (Arduino/NodeMCU): The microcontroller serves as the central brain of the system, processing sensor data, making decisions, and activating the evacuation mechanisms.

Communication Module (GSM/Wi-Fi): This module sends real-time fire alerts to firefighters, farmers, and other emergency responders.

Solar Panel: Ensures that the system remains functional even in areas with unreliable power supply.

B. Software Components

Fire Detection Algorithm: The fire detection system uses threshold-based logic to analyze sensor data (flame and smoke) and make decisions about when to trigger the evacuation.

Real-Time Notification System: As soon as fire detection occurs, the system sends alerts via SMS, email, or a mobile app to the relevant stakeholders, including emergency responders and farmers.

Cloud Monitoring Dashboard: The cloud platform enables live monitoring of sensor data and evacuation status. It also stores historical data for future analysis and optimization.

Data Analytics: The system stores historical data from fire incidents, sensor performance, and evacuation times to refine its algorithms and improve efficiency.

VI. RESULTS AND DISCUSSION

In preliminary testing, the system successfully detected simulated fire incidents and triggered the automated evacuation mechanism. The servo motors opened the gates and allowed livestock to escape from the enclosures. Additionally, the system sent real-time alerts to farmers and emergency responders, notifying them of the fire and the system's actions. The cloud-based dashboard provided real-time updates on sensor data, evacuation status, and other relevant information.

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Results show that the system is capable of reducing the time to evacuate livestock, minimizing the need for manual intervention, and ensuring that emergency responders are notified immediately. By automating the process, the system not only ensures a quicker response to fire incidents but also reduces the physical risk to both humans and animals.

VII. CONCLUSION

The PashuRaksak IoT-Driven Automated Livestock Rescue System provides an effective, scalable, and reliable solution for livestock protection during fire emergencies. By leveraging IoT technologies, the system automates the detection of fire, triggers the evacuation of livestock, and notifies emergency responders in real time. This system reduces the dependency on human intervention and minimizes the loss of life and property during fire incidents.

The success of this project paves the way for further innovations in smart farming and disaster preparedness. Future enhancements could include integrating AI-based fire prediction, advanced sensor fusion, and better communication protocols with local emergency services. The system's scalability and adaptability make it an ideal solution for rural areas and agricultural settings, where livestock safety remains a critical concern.

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