FIRE DETECTION SYSTEM

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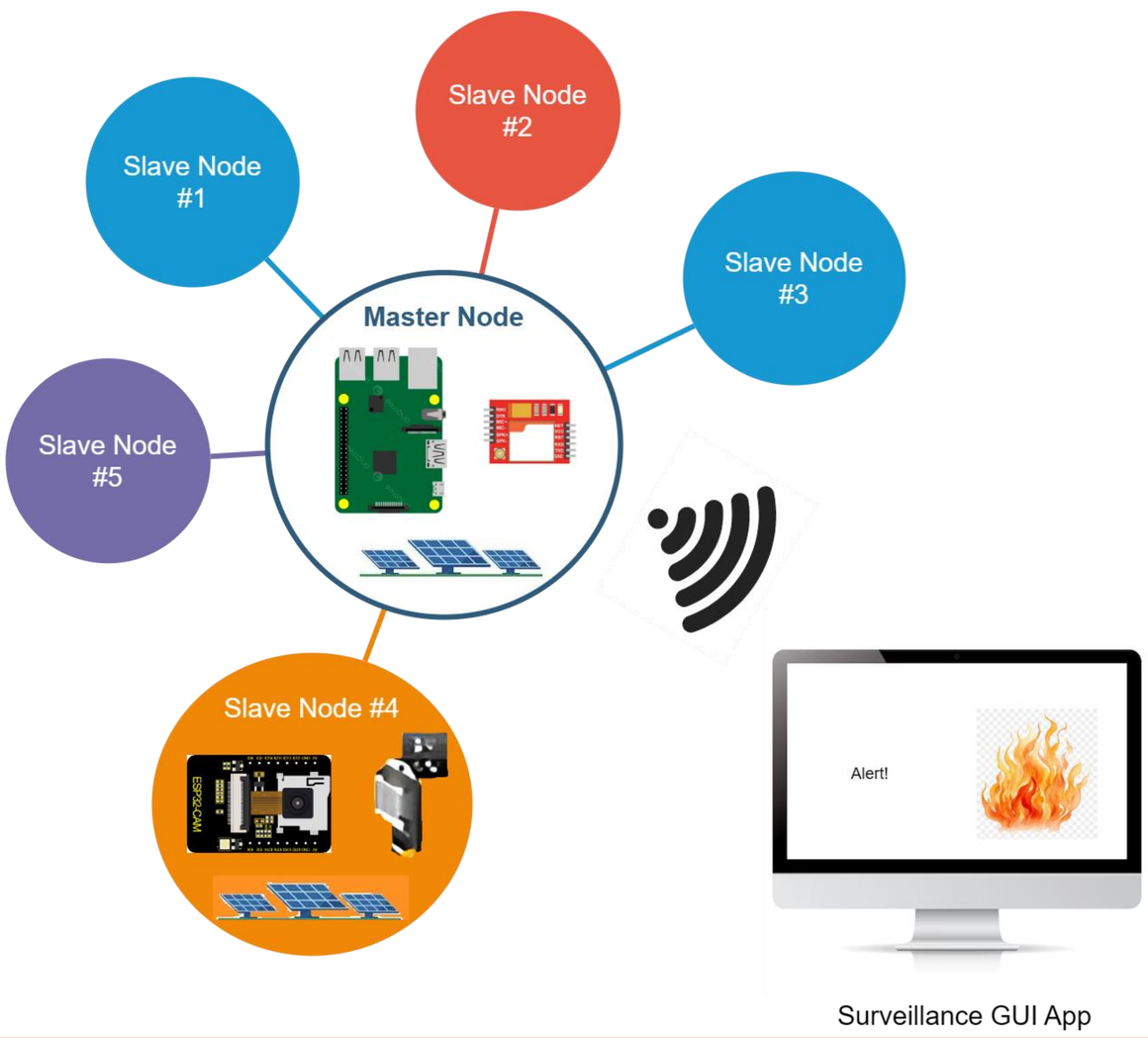
Introduction

- **Purpose:** The Fire Detection System project aims to create a cost-effective and efficient solution for early forest fire detection. Using ***a mesh network*** of sensor nodes, the system monitors large forest areas and quickly alerts authorities to potential fire hazards, helping to prevent widespread damage and save lives.
- **Scope:** This project involves developing a small-scale prototype to demonstrate the system's functionality. The focus is on designing ***inexpensive sensor*** nodes powered by ***solar energy*** to ensure continuous monitoring, simulating the operation of a larger, real-world system.
- **Significance:** Forest fires cause severe environmental and economic damage. Traditional detection methods often result in delayed responses. This project's automated system enhances ***early detection*** and ***rapid alerting***, significantly reducing fire impact and improving forest fire management.
- In summary, the Fire Detection System provides an innovative approach to forest fire monitoring, showcasing the potential for advanced, scalable solutions in fire management.

Methodology

HARDWARE DESIGN

The hardware design of the Fire Detection System includes solar panels for energy generation, batteries for storage, and low-cost optical cameras for fire detection during the day and night. Sensors monitor the percentage of humidity and ambient temperature. Power management is optimized for efficiency. Data is transmitted from slave nodes, which consist of ESP32-CAM boards with cameras, sensors, and power components, to the master node, which consists of a Raspberry Pi and power components, through a mesh network, mapping their identities to coordinates. The data received by the master node is quickly transmitted to a database via the internet connection of the SIM800L module, ensuring reliable and efficient early detection of forest fires.



SOFTWARE DESIGN

The software design of the Fire Detection System integrates lightweight database management system SQLite, user-friendly interface development tool Streamlit, and powerful image processing library OpenCV, all within the Python programming language. OpenCV analyzes images captured from ESP32-CAM cameras to detect signs of fire and distinguishes real fires from false positives. Steps such as data flow, sensor data collection, image processing, data transmission over the network, and updating the user interface of the Streamlit application are implemented. This comprehensive software design establishes a robust foundation for early detection and management of forest fires.

Relevant Applications

- The Fire Detection System has broad applications beyond forests, like urban fire safety, industrial facility protection, wildlife conservation, smart city resilience, agricultural risk management, and remote area monitoring, contributing to safety, environmental protection, and resource management in various sectors.

Results and Discussion

- The Fire Detection System's performance is assessed based on detection accuracy, false alarm rate, and response time. Early detection capabilities contribute to prompt mitigation efforts, while remote monitoring enhances situational awareness. Challenges include adverse weather conditions affecting visibility, power management in remote areas, and reliable data transmission. Addressing these challenges is crucial to enhance the system's effectiveness and resilience in mitigating forest fire risks.

References

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