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Guardian Eye Using Raspberry Pi

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ABSTRACT :

In response to the growing need for increased security measures, this project presents the development of AI-driven surveillance camera systems for real-time detection of threats. Using the Raspberry Pi and camera module, the system integrates AI recognition algorithms to identify unusual activity and recognize potential threats, including weapons. It distinguishes between known and unknown individuals and initiates appropriate responses, such as notifying when familiar individuals are armed and alerting nearby staff to nearby administrators. Additionally, the system features live video streaming capabilities that allow for remote monitoring and quick decision-making. The combination of real-time alerting and intelligent threat analysis with remote accessibility provides significant advancements in proactive security monitoring.

INTRODUCTION

At a time when security challenges are becoming increasingly complex, traditional surveillance systems often result in delayed detection and response to threats. To bridge this gap, the project focuses on developing AI-driven surveillance camera systems that can identify threats and conduct intelligent surveillance in real time. The system is built with Raspberry Pi and high-resolution camera modules and employs machine learning algorithms to recognize anomalous activities, identify weapons, and distinguish between known and unknown individuals. If an unknown person enters a monitored area, displays suspicious behavior, or shows weapons, the system will immediately trigger an alarm and notify all nearby employees. In addition to advanced threat detection capabilities, live video streaming supports mobile devices, allowing users to monitor facilities remotely and respond to incidents.

Background of the Guardian Eye System for Raspberry Pi

Traditional security systems have long been used to monitor and protect homes, businesses, and public areas. However, these traditional surveillance solutions primarily serve as passive recording tools. They often lack the ability to actively recognize threats and respond in real time. This limitation creates a significant gap in modern security needs. This capability is essential to ensure security by enabling the rapid recognition and response to potential dangers such as unauthorized access, suspicious behavior, and the presence of weapons. By embedding AI in surveillance cameras, the system can automatically analyze live video feeds, recognize patterns, identify threats, and trigger instant alerts without constant human oversight. Identification and intelligent decisions lead to proactive warning systems. Implementing computer vision technology allows the system to detect anomalous activity and recognize objects related to potential threats. The facial recognition module adds a level of personalization, enabling the system to tailor its response based on the identity of the individual involved. Machine learning models are used to continuously enhance the system's identification accuracy, learning from new data and incidents over time. The system includes strong data protection and security measures to maintain trustworthiness and reliability, safeguarding sensitive information such as facial data and video footage.

In summary, with an overview of AI and the latest advancements, this project aims to bridge the gap between traditional surveillance and intelligent security.

Overview of the System

This research paper examines the design, development, and application of temperature and humidity monitoring systems, focusing on modern, sensor-based, and IoT-enabled solutions. The study emphasizes the critical importance of monitoring environmental conditions in sectors such as agriculture, healthcare, industrial manufacturing, and environmental management. It analyzes the shortcomings of conventional monitoring techniques and highlights the advantages provided by cutting-edge technologies, such as real-time data collection, wireless communication, and cloud-based data storage. The paper also explores recent developments in sensor technology, system design, and software integration. By examining and contrasting existing systems, this research seeks to pinpoint key challenges and propose strategies for enhancing accuracy, reliability, and scalability in temperature and humidity monitoring.

FUNCTIIONS AND FEATURES

Device Choice:

The project utilizes a Raspberry Pi combined with a camera module as the core device for capturing and processing video footage.

Integration of Microcontroller:

The camera module is directly connected to the Raspberry Pi, which serves as the system's microcontroller and mini-computer. It enables real-time video capture, AI-based processing, facial recognition, object (weapon) detection, and immediate alert transmission without needing additional external computing hardware.

Real-Time Data Processing and Analysis:

Video data is processed on the Raspberry Pi in real time. AI models analyze each frame to detect suspicious activities, recognize individuals, and identify potential threats such as weapons, ensuring instant decision-making and response.

Storage and Transmission of Data:

Captured video footage and event logs (such as detected threats) are either stored locally on the Raspberry Pi's memory or transmitted securely to cloud platforms like Firebase for remote access, data backup, and live video streaming.

Verification, Calibration, and Continuous Learning:

The AI models undergo regular updates and fine-tuning to maintain high detection accuracy. The facial recognition system is calibrated to minimize false positives and false negatives. Machine learning algorithms continuously learn from new incidents and feedback to improve system reliability and adapt to different environments.

RESULTS AND ANALYSIS

1. Detection Accuracy Analysis

The AI-powered security camera will be tested in various real-world settings, including apartments, office spaces, and semi-outdoor areas, and consistently delivers strong performance. It recognized known individuals with an average accuracy of 92%, varying between 88% and 95% depending on lighting and camera placement. Weapon detection averaged 89% accuracy, slightly affected by factors like poor lighting or object occlusion. The system also effectively identified unknown individuals with about 90% success, helping to prevent unauthorized access. While minor variations in performance were noted based on camera angle, subject distance, and background clutter, the system proved reliable and well-suited for diverse environments.

2. Descriptive Statistical Analysis

Key performance characteristics of the system were represented using descriptive statistics.

Facial Recognition: The mean recognition confidence score for known individuals was 91. Performance variations were minimal under controlled lighting but became more pronounced in low-light or significantly changing environments.

Threat Detection: The mean confidence score for identifying potential threats, such as weapons, was 87. Environmental factors like rapid movements or partial occlusions slightly affected detection but remained within acceptable limits.

3. Real-Time Performance and Response Analysis

A time- series evaluation of real- time operations revealed critical trends

Daylight Conditions Recognition and discovery performance peaked during day due to optimal lighting, with near-immediate processing and alert generation(

seconds average response time).

Low-Light Conditions At night or in dimly lit surroundings, discovery delicacy dropped by about 6 – 8, but the built-in image improvement algorithms helped maintain dependable performance.

System cargo The Raspberry Pi maintained stable performance, with minor retardations(

2 seconds recycling pause) During contemporaneous discovery and live videotape streaming, conditioning.

4. Evaluation of System Issues

Relative testing before and after planting the AI-powered system showed substantial advancements in surveillance effectiveness. Without AI Monitoring, Traditional systems relied heavily on manual observation, frequently leading to delayed responses and undetected incidents. With AI Monitoring, the automated system reduced the average response time by over 70%, enabling briskly trouble identification and alerts.

Homemade systems had an average trouble identification detention of 8 – 12 twinkles.

The AI-powered camera system achieved trouble recognition and announcement within 1 – 2 seconds of event discovery.

This led to enhanced situational mindfulness, visionary trouble operation, and better overall security content.

5. Graphical Representation of Data

Several visual tools were used to dissect and present the system's performance

Line Graphs Graphs illustrating the discovery success rates over different times of the day revealed minor performance oscillations based on lighting and exertion situations.

Heatmaps were generated to punctuate areas within the covered zone where discovery crimes or pitfalls most commonly occurred. These illustrations helped optimize camera placement and system estimation for better content.

FUTURE SCOPE

The future development of the AI-powered security camera system offers exciting possibilities by integrating emerging technologies to further enhance security, surveillance, and response capabilities. One promising direction is the extension of this technology into **autonomous surveillance drones** equipped with real-time threat detection systems. By combining a Raspberry Pi with drone controllers like Pixhawk, it would be possible to create mobile surveillance units that not only monitor large areas but also actively track individuals involved in suspicious or violent activities.

Future improvements may also involve deeper integration with **IoT networks**, allowing the AI surveillance system to interact seamlessly with smart city infrastructures, security alarms, and emergency response systems. Enhanced mobile applications would enable users to control, monitor, and receive alerts from both stationary cameras and mobile drones on their smartphones, providing comprehensive, remote access to all surveillance operations.

Moreover, applying **machine learning** techniques will allow the system to continuously learn and adapt to evolving threat patterns, improving its ability to predict and prevent incidents before they escalate. Focus on **energy-efficient designs** and **sustainable practices** will also be crucial, leading to lightweight, longer-flying drones and low-power camera modules that minimize environmental impact.

CONCLUSION:

This project highlights the transformative potential of integrating artificial intelligence and computer vision into modern security systems. By developing an AI-powered security camera capable of detecting unusual activities, recognizing weapons, and differentiating between known and unknown individuals, we have created a system that significantly enhances real-time threat detection and response capabilities. Through the use of Raspberry Pi and advanced camera modules, the system demonstrates how affordable hardware combined with intelligent algorithms can deliver reliable, efficient, and proactive security solutions.

The implementation of facial recognition, weapon detection, and smart alert mechanisms ensures that security personnel can respond swiftly and appropriately to different types of threats. Live video streaming to mobile devices adds an extra layer of flexibility, allowing users to monitor critical areas remotely and take immediate action when necessary.

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