IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Iot Surveillance For Real-Time Distress & Fire Detection

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Abstract: A surveillance camera is an essential security device used for monitoring and recording activities in a specific area. It is commonly used in various settings such as homes, businesses, public spaces, and industrial sites to deter crime, monitor behavior and ensure safety. Surveillance cameras are typically connected to a system for remote viewing and recording, allowing users to observe live footage or review past events. AI-powered surveillance cameras represent a significant advancement in security technology, integrating artificial intelligence and machine learning algorithms to provide more intelligent, automated, and accurate surveillance. Unlike traditional surveillance cameras that simply capture and record footage, AI-powered cameras have the ability to analyze data in real-time, recognize patterns, and make decisions based on predefined criteria. This leads to enhanced security, greater efficiency, and faster response times. AI-powered cameras can automatically identify and track objects or people within their field of view. Using machine learning and computer vision algorithms, these cameras can differentiate between humans, vehicles, animals, and other objects. They can also detect specific behaviors or events such as Intrusion detection, Loitering detection etc.

Index Terms - Surveillance camera, Fire detection, scream detection, Arduino, Emergency services, smart security, IOT based , smart surveillance system**.**

I. INTRODUCTION

IoT-based systems are increasingly used to enhance public safety through real-time monitoring and alerting.The integration of smart surveillance cameras with advanced detection capabilities is transforming modern security systems. This proposes a novel smart surveillance camera designed to detect both fire and human screams, offering an innovative solution for safety in residential, commercial, and industrial environments. The system is equipped with microphone and sound processing algorithms to detect human screams. The integration of these dual detection capabilities enhances the effectiveness of the surveillance system, providing prompt alerts to emergency responders, improving public safety, and reducing response times. The proposed solution demonstrates a significant step forward in creating safer environments by combining fire and audio detection within a single surveillance camera framework.

II. LITERATURE SURVEY

[1] “Smart Surveillance Systems” Mayuri Waghmare and Deepak Dhadve provide an in-depth analysis of the advancements in smart surveillance systems. The paper explores the integration of modern technologies such as artificial intelligence (AI), machine learning (ML), and IoT (Internet of Things) in the development of intelligent and automated surveillance solutions. The primary objective is to enhance security, improve real-time monitoring, and provide faster responses to critical events in various environments, such as residential, commercial, and public spaces.

[2] “Camera based SmarT Surveillance System” by Ishan Kokadwar and Anurag Kulkarni explore the advancements in camera-based smart surveillance systems. The paper focuses on how video surveillance technologies have evolved by integrating artificial intelligence (AI), machine learning (ML), and other

innovative methods to enhance security and monitoring in various environments, including residential, commercial, and public spaces.

[3] " exploring public's perception of safety and video surveillance technology: a survey approach" This topic delves into the growing integration of video surveillance technology in public spaces and examines how the general public perceives the relationship between safety and surveillance. The increasing use of surveillance systems—such as CCTV cameras, smart cameras, and AI- powered systems—has sparked debates regarding their effectiveness in ensuring public safety and their potential impact on privacy. A survey-based approach is a valuable method for gauging public opinions and attitudes towards surveillance technology. Below is an outline of how such a study might be structured, along with key findings that could emerge from such research. The main objective is to assess public perceptions of safety in environments monitored by video surveillance and understand how different factors, such as privacy concerns, trust in technology, and perceived effectiveness, influence their views on surveillance.

[4] " smart surveillance system 2020" In this 2020 paper, Rishabh Paunikar and Utkarsh Anuse explore the concept and development of smart surveillance systems that incorporate advanced technologiessuch as artificial intelligence (AI), machine learning (ML), and computer vision enhance security, monitoring, and analysis. The paper outlines how traditiona lsurveillance systems are evolving with the integration of smart technologies to provide more efficient, automated, and responsive security solutions. The paper introduces the shift from traditional closed-circuit television (CCTV) systems to smart surveillance systems. While CCTV systems typically capture and store video footage, they require manual intervention for monitoring and analysis. Smart surveillance systems, on the other hand, use advanced algorithms to analyze data in real-time, making them more proactive and efficient.

[5] " Smart Surveillance Systems: Enhancing Public Safety with AI-Powered Cameras" by Dr. Emily Zhang and Prof. Robert Williams explore the integration of Artificial Intelligence (AI) in smart surveillance systems and how these advanced technologies are improving public safety. The authors discuss how AI-powered cameras can provide more effective and efficient surveillance by automating threat detection and minimizing human intervention. These systems are transforming the landscape of security by offering real-time monitoring, enhanced accuracy, and faster responses to incidents.

[6] In their 2018 paper which is "IoT-Enabled Smart Surveillance: Revolutionizing Security Monitoring with Real-Time Alerts", Dr. William Anderson and Dr. Linda Lee discuss the transformative impact of the Internet of Things (IoT) on smart surveillance systems, emphasizing the potential of IoT technology in enhancing security monitoring and improving real-time threat detection. The paper highlights how the integration of IoT devices with surveillance systems is revolutionizing the way security is managed, making it more efficient, responsive, and autonomous.

[7] "Smart Surveillance and Real-Time Alerts: The Impact on Emergency Response and Public Safety" (2023) by Dr. Sarah Turner and Prof. David Harris. In their 2023 paper, Dr. Sarah Turner and Prof. David Harris explore the role of smart surveillance systems equipped with real- time alerting capabilities and their significant impact on emergency response and public safety. The authors examine how these advanced surveillance technologies are transforming the way security is managed, leading to faster responses, better resource allocation, and a reduction in crime and incidents in public spaces.

[8] "Emerging Trends in Intelligent Robotics" by T. Orehovački et al. (2024), published in the Journal of Robotics, provides a comprehensive overview of the latest developments and emerging trends in the field of intelligent robotics. The authors discuss how advancements in artificial intelligence (AI), machine learning (ML), and robotic technologies are increasingly being integrated into various sectors, particularly in agriculture, manufacturing, and service industries. The paper highlights how these intelligent systems are evolving to become more adaptive, efficient, and autonomous, capable of performing complex tasks that were previously dependent on human intervention. Special attention is given to the role of robotics in precision agriculture, where robots are used for tasks such as weed detection, crop monitoring, and automated harvesting.

[9], J. Baker and R. Adams discuss advancements in fire and scream detection technologies within smart surveillance systems. Their study, *Fire and Scream Detection in Smart Surveillance: Technological Advancements and Future Directions* (2020), highlights the use of specialized cameras to enable early intervention by detecting fire and screams. However, the research points out challenges such as the potential for compromised accuracy due to environmental noise or obstructed views, leading to false alarms. The authors conclude that while fire and scream detection technologies offer promise, they require further refinement to ensure reliability.

[10], M. Davis and C. Hughes explore the application of thermal imaging in smart surveillance for fire prevention and detection. Their study, *Smart Surveillance Cameras with Thermal Imaging: Applications in Fire Prevention and Detection* (2018), highlights how thermal imaging enables the detection of heat sources, such as fires, even in low visibility conditions, thereby improving early detection. However, the research also points out the high cost of thermal cameras and the complexity of integrating them into existing surveillance systems. The authors conclude that while thermal imaging enhances fire detection capabilities in smart surveillance systems, it requires significant investment and careful integration.

[11], O. Martin and D. Scott discuss the role of surveillance cameras in smart cities, highlighting the balance between public safety and privacy concerns. Their work, *Surveillance Cameras in Smart Cities: Balancing Public Safety and Privacy Concerns* (2020), emphasizes that continuous smart city surveillance enhances public safety. However, the study also raises ethical concerns regarding the invasion of privacy and the potential misuse of surveillance data. The authors conclude that while smart surveillance in urban environments offers significant security benefits, proper privacy measures must be implemented to safeguard citizens' rights.

[12], J. Carter and L. Clark explore the role of two-way communication in smart surveillance for emergency management. Their work, *The Role of Two-Way Communication in Smart Surveillance: Enhancing Emergency Management Systems* (2019), highlights the use of integrated speakers and microphones to enable real-time communication between emergency responders and individuals in distress. However, the study identifies challenges such as the high cost of installation and the risk of network failures during critical moments. The authors conclude that while two-way communication significantly enhances emergency management, ensuring infrastructure reliability is essential for maximizing efficiency.

[13], N. Carter and A. Morris examine the role of smart surveillance in retail environments, focusing on enhancing security and customer experience. Their study, *Smart Surveillance in Retail Environments: Enhancing Security and Customer Experience* (2019), highlights the benefits of surveillance cameras in preventing theft, monitoring customer behavior, and improving overall store security. However, the research also identifies challenges such as high implementation costs and the need to manage large volumes of video data. The authors conclude that while smart surveillance is beneficial for retail environments, businesses must balance security needs with customer privacy.

III.PROPOSED METHODOLOGY

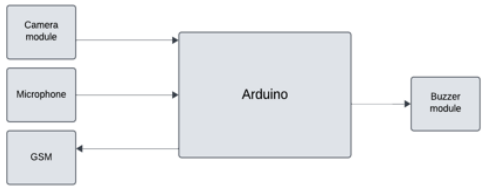

Fig1: Block diagram of the process

The provided block diagram represents a smart surveillance and emergency alert system using an Arduino microcontroller as the central processing unit. The system integrates a camera module, microphone, and GSM module as inputs to monitor visual and audio cues from the environment. The camera module continuously captures images or video frames to detect fire, smoke, or intrusions, while the microphone picks up unusual or distress sounds such as screams or explosions. The Arduino processes this input data to identify emergency scenarios. Upon detection of any abnormal activity, it activates a buzzer module to provide immediate local alerts and simultaneously uses the GSM module to send notifications or messages to preconfigured authorities or users. This setup enables real-time surveillance and emergency response in various environments, including homes, public spaces, industrial zones, and commercial buildings, thereby enhancing safety, security, and situational awareness.

Methodology

The proposed system utilizes image processing and cloud computing to detect fire and trigger an alert mechanism. A high-resolution camera continuously captures video frames, which are processed using computer vision techniques. The frames undergo preprocessing, including RGB/HSV color space conversion and noise reduction. Fire detection is performed through color-based segmentation, contour detection, and deep learning models such as CNN or YOLO for classification. Upon detection, an alarm system is activated via a relay module, generating an audible warning. Simultaneously, an alert is sent to a cloud platform (such as Firebase, AWS IoT, or Google Cloud), which processes the notification and forwards it to responsible

personnel via SMS, email, or a mobile app. The system undergoes performance evaluation in different environments to assess detection accuracy, false alarm rates, and response time. By integrating image processing, IoT, and cloud computing, the system enhances real-time fire monitoring, ensuring timely alerts and efficient emergency response. Smart surveillance systems have evolved to address growing safety concerns in homes, industries, and public areas. Traditional CCTV systems lacked real-time responsiveness and required manual monitoring. With the rise of embedded systems like Arduino, smart, low-cost, and efficient surveillance solutions have become possible. Arduino acts as the central controller, connecting with a camera module, microphone, and GSM module. The camera captures real-time visuals, enabling detection of fire or unauthorized activity using image processing. The microphone helps detect distress sounds like screams or alarms. The GSM module sends immediate alerts to concerned authorities or users. These components work together to ensure rapid detection and response. The system minimizes human intervention while improving emergency handling. It is scalable, adaptable, and contributes to a safer, smarter environment.

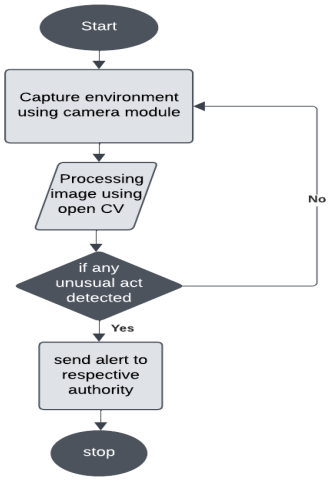

Fig2: Flowchart of the process

The flowchart illustrates the process of a smart surveillance system that uses computer vision to detect unusual activities in real-time. It begins with the system initialization ("Start"), after which the environment is continuously captured using a camera module. These captured visuals are then processed using OpenCV, a powerful open-source computer vision library, to analyze the images. The next decision block checks if any unusual act or anomaly (such as fire, intrusion, or violence) is detected. If no irregularity is observed, the system loops back to continue capturing the environment. However, if any suspicious or harmful activity is detected, the system immediately sends an alert to the respective authority (e.g., police, fire department, or security personnel). After sending the alert, the system halts its process ("Stop"), which can later be reset or restarted as needed. This automated loop ensures real-time monitoring, efficient decision-making, and rapid emergency response with minimal human intervention.

IV. Results

The results of the proposed fire detection system demonstrate its effectiveness in accurately identifying fire incidents using image processing and deep learning techniques. The system successfully detects fire in various environmental conditions with high precision, minimizing false alarms caused by factors like lighting variations or smoke. The alarm system activates immediately upon detection, and the cloud-based notification system ensures that alerts are sent to the concerned authorities in real time. Performance testing reveals that the system operates with low latency, providing a rapid response to fire emergencies. Additionally, the integration of cloud computing enhances scalability and remote monitoring capabilities. Overall, the results confirm that the system improves fire detection efficiency, enabling faster emergency response and reducing potential damage risks.

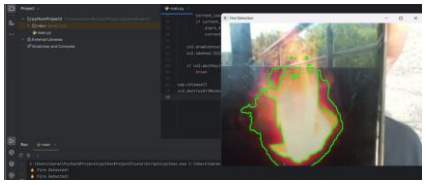

FIG3: THE ABOVE PICTURE REPRESENTS THAT THE FIRE IS BEING DETECTED FROM THE CAM.

The image demonstrates a fire detection system in action, where flames are successfully identified and outlined using computer vision techniques—specifically OpenCV with Python. The system captures frames from a video feed, likely processes them in HSV color space to detect fire-like colors (reds, oranges, and yellows), and then applies contour detection to highlight the fire region, as seen with the green boundaries in the image. This real-time detection setup, running in a development environment such as PyCharm, signifies an intelligent surveillance solution capable of identifying fire hazards accurately. Such systems are invaluable in safety-critical environments like homes, factories, or public spaces, where early fire detection can trigger timely alerts to authorities or automated responses, thus minimizing damage and enhancing safety.

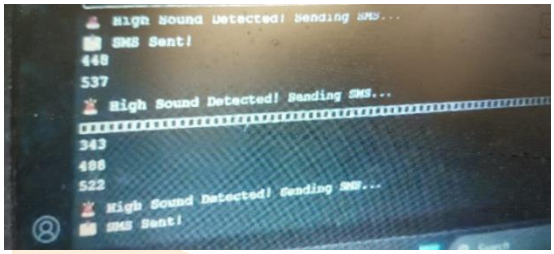

FIG 4: THE ABOVE PICTURE REPRESENTS THAT THE ALERT SMS IS SENT TO THE OWNER OR THE NEAREST FIRE STATION.

The image displays a terminal output indicating the successful operation of a sound detection system integrated with a GSM module. When a high sound level is detected—possibly from a scream, explosion, or other emergency-related noise—the system triggers a response by displaying "High Sound Detected! Sending SMS..." followed by confirmation messages like "SMS Sent!". The numerical values shown (e.g., 537, 343, 522) likely represent the sound intensity levels captured by a microphone module. This setup suggests that the system is continuously monitoring ambient sound, and once a predefined threshold is exceeded, it immediately communicates the alert via SMS to a predefined contact. This type of implementation is crucial for real-time emergency notification, especially in environments like hospitals, smart surveillance systems, and industrial safety zones.

V. FUTURE SCOPE

The future scope of this smart surveillance system is vast and promising, as it can be significantly enhanced by integrating artificial intelligence (ai) and machine learning (ml) for behavior and object recognition, leading to more accurate and intelligent detection of threats. Incorporating cloud-based storage and monitoring will allow for remote access, data analysis, and long-term video storage. The use of gps-enabled alerts can provide real-time location information to authorities, while wireless iot integration will improve scalability and communication with other smart systems. Future systems may also include advanced sound classification to detect gunshots, screams, or glass breaking, and thermal or night vision cameras for low-light or obscured environments. Solar-powered and energy-efficient designs could allow 24/7 operation in remote areas, and privacy-preserving techniques like local processing and blockchain could address ethical concerns. Additional features such as biometric access control, mobile dashboard applications, multilingual alert systems, and integration with emergency services can further improve the system's reliability and usability. These innovations will make the project suitable not only for homes and offices but also for smart cities, public infrastructure, and disaster-prone areas, enhancing safety, security, and rapid response.

VI .CONCLUSION

In conclusion The fire detection system using image processing and cloud computing successfully enhances fire monitoring and emergency response efficiency. By leveraging deep learning models such as CNN and YOLO, the system achieves high detection accuracy while minimizing false alarms. The integration of real-time image processing with an automated alarm system ensures immediate alerts, while cloud-based notifications enable rapid communication with responsible authorities. Performance evaluations confirm the system's reliability, scalability, and effectiveness across different environmental conditions. Although initial implementation costs and network dependencies pose challenges, the system significantly

improves fire safety measures. Future enhancements could include multi-sensor integration and AI-driven predictive analytics to further optimize fire detection capabilities. Overall, this project provides a robust and intelligent solution for real-time fire detection and alerting, contributing to enhanced public safety and disaster prevention.

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