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AN AUTOMATIC FIRE DETECTION & LOCALIZATION USING WEB CAMERA WITH VIDEO ALARM SYSTEM

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ABSTRACT:
This project is about a new way to automatically find and pinpoint fires using a regular camera. It uses a computer program (Haar algorithm) to watch live video from the camera and look for fire. If it sees a fire, the system sends a text message and calls someone (using Twilio) to let them know right away. The camera's position also helps the system figure out exactly where the fire is, so firefighters can get there faster and put it out easier.
This system is a reliable and fast way to find fires early, which can save lives and prevent a lot of damage. The project is built using Python computer code and uses tools called OpenCV libraries. Tests show that this new way of finding and pinpointing fires with a camera actually works.
This project is important because it can be used in many places, like apartment buildings, houses, factories, and anywhere else where safety is important. By finding fires right away and knowing where they are, this system can help keep people safe and make places safer from fire. In short, this project is a big step forward in fire safety and could help save many lives.

Keywords: Automatic Fire Detection, Surveillance Camera, Haar Algorithm, Computer Vision, Real-Time Video Analysis, Twilio API, Life-Saving Technology, Python Programming, Open CV Libraries.

INTRODUCTION

House fires are a major concern, spreading quickly and causing injuries and property loss. Since traditional fire alarms can be unreliable and prone to false triggers, this project proposes a new approach. By leveraging existing security cameras, the system aims to detect fires early on. This not only improves fire response times but also reduces the number of disruptive false alarms. The project utilizes image processing techniques to analyze individual frames from the camera footage. A free computer vision library called OpenCV helps the system "see" the video, while a program named Haar is trained to identify fire-like objects within the frames. This allows the system to detect fires regardless of their size or location in the video. Overall, using surveillance cameras for fire detection offers a valuable tool for public safety. By continuously monitoring spaces and sending out rapid alerts to authorities, these systems can significantly reduce the damage caused by fires. Testing has shown the project's effectiveness in real-world environments.

LITERATURE SURVEY

"FIRE DETECTION WITH IMAGE PROCESSING"

This paper, authored by Thanigaivel M, Maurya Vijayaramachandran, and Shabarish Haren, proposes a fire detection system using image processing.

What is Image Processing?

Image processing is a technique that manipulates digital images to extract valuable information. Unlike traditional analog processing, digital methods offer advantages like a wider range of algorithms and reduced noise and distortion.

Fire Detection through Color Analysis

This project focuses on color detection for fire identification. By training the system with processed images containing fire, the system can autonomously detect fires in real-time.

Automated Alerts and Prevention

Upon fire detection, the system automatically calculates the fire's intensity and sends an alert to a designated receiver. Additionally, the system could potentially activate fire prevention measures (depending on the specific implementation).

Benefits:

- Early fire detection for faster response times.
- Reduced false alarms compared to traditional methods.
- Potential for automatic fire prevention activation.

"FIRE DETECTION ON A SURVEILLANCE SYSTEM USINGIMAGE PROCESSING"

This paper by Prof. Amit Hatekar, Saurabh Manwani, Gaurav Patil, and Akshat Parekh proposes an automated fire detection system using image processing. Unlike traditional sensor-based systems, this approach relies on analyzing video footage from a surveillance camera.

The system uses OpenCV to capture real-time video frames. These frames are then processed through a series of steps:

1. **RGB to HSV Conversion:** The color information in each frame is converted from the RGB (Red, Green, Blue) model to the HSV (Hue, Saturation, Value) model. This allows for easier identification of fire-like colors.
2. **Thresholding:** This technique defines a specific range of color values within the HSV model that likely represent fire. Pixels outside this range are filtered out.
3. **Median Blurring:** This step reduces noise in the image, improving the accuracy of fire detection.
4. **Bitwise AND Operation:** The outputs from thresholding and median blurring are combined to create a final image highlighting potential fire pixels.

By analyzing the processed image, the system can detect the presence of fire without relying on physical sensors.

"AN AUTOMATIC FIRE DETECTION AND WARNING SYSTEM UNDER HOME VIDEO SURVEILLANCE "

This paper, proposed by Md. Mahamudul Hasan and M. Abdur Razzak, utilizes the Internet of Things (IoT) to create an intelligent fire detection system. The system leverages knowledge of how fires behave in the real world to automatically warn people before they face danger.

Here's how it works:

- **Fire Detection:** The system analyzes a video stream to detect fire based on physical fire characteristics.
- **Alerting People:**
  - Primarily, the system sends SMS alerts to registered users through a GSM modem.
  - Additionally, if a fire is detected, a siren can be activated as a secondary warning.
- **System Control and Monitoring:**
  - An Arduino UNO R3 microcontroller manages the system's overall operations.
  - A Huawei GSM modem provides internet connectivity for SMS alerts.
  - A Liquid Crystal Display (LCD) panel displays the system's current status.

This IoT-based system offers an automated and informative fire detection solution, promoting safety by providing timely warnings.

"SURVEILLANCE, FIRE DETECTION AND PROTECTION SYSTEM FOR SUBSTATIONS"

This paper proposes a security system to monitor substations for fire. Here's how it works:

1. **Fire Detection with Cameras:** A computer program is trained to identify fire in videos using examples of fire and non-fire situations. This is similar to how Google's image recognition software works.
2. **Temperature Sensors:** In addition to cameras, sensors are used to check the temperature inside the substation.

The system combines these methods to effectively detect fire.

"COMPUTER VISION BASED FIRE DETECTION WITH A VIDEO ALERT SYSTEM"

This paper describes a fire alarm system using a Raspberry Pi computer instead of expensive security cameras. Here's how it works:

1. **Fire Detection with Webcam:** A regular webcam keeps an eye on the inside of a building.
2. **Smart Processing:** A computer program (using OpenCV software) analyzes the webcam video to look for fire. It uses a special method based on colors (Hue, Saturation, Value) to identify flames.
3. **Alerts and Action:** If a fire is spotted, an alarm goes off to warn people nearby. Additionally, a short clip of the live video gets sent wirelessly to security personnel or the fire department. This allows them to see the situation and take action quickly, like sending help to save people.

SCOPE OF PROJECT

The objective of this project is to develop an automated fire detection and localization system using a surveillance camera integrated with the Haar algorithm and Twilio API. The system will analyze video streams in real-time to detect the presence of fire and send alert messages via the Twilio API to

relevant personnel for prompt response. Additionally, the system will utilize the camera's position and angle to accurately determine the fire's location, aiding in the efficient deployment of firefighting resources.

The project will be implemented using Python and OpenCV libraries. Its accuracy, efficiency, and reliability will be evaluated through experimental testing, with a focus on detecting fires in various lighting conditions and environments. The proposed system has a broad range of potential applications, including residential and commercial buildings, industrial facilities, and public areas such as airports, shopping malls, and train stations.

The system's ability to detect and locate fires in real-time provides a critical layer of safety and protection, making it an invaluable asset for any organization concerned with fire safety. This project represents a significant advancement in the field of fire safety and has the potential to positively impact countless lives. The project scope includes developing a reliable and effective automated fire detection and localization system, evaluating its performance through experimental testing, and implementing it in various industries and environments.

METHODOLOGY

The principle behind the Fire Detection System is to detect the fire and localize it by alerting and sending messages and calls. Following is step-by-step procedure involved in proposed system.

1. Dataset Training

Data Collection: Collect a dataset of video footage containing both normal and fire scenarios to train and test the Haar algorithm.

Haar Algorithm Training: Train the Haar algorithm on the dataset to detect the presence of fire in the video footage. The algorithm should be optimized for real-time video analysis and work well under various lighting conditions.

2. System Implementation

Video Capture: The first step is to capture video using surveillance cameras placed in the building or the area to be monitored.

Image Processing: In this step, the captured video frames are analyzed using the Haar feature-based cascade classifier. The Haar cascade classifier is a machine learning-based approach that uses a set of Haar-like features to detect objects in an image or video frame.

Fire Detection: The Haar classifier is trained to detect the presence of flames and smoke in the video frames. Once the Haar classifier detects flames or smoke, the system determines if it is a fire or a false alarm.

Alert Generation: Once the fire is detected and localized, the system uses Twilio API to generate an alert to notify the relevant authorities or emergency services about the fire. The Twilio API allows the system to send text messages phone calls to specified recipients. The alert may include the location of the fire and other relevant information. Also the Fire Alarm get initiated.

Deployment: Deploy the system in appropriate settings, such as commercial and residential buildings, industrial facilities, and public areas.

So, it involves a combination of computer vision, machine learning, and wireless communication technologies to develop a reliable and effective automated fire detection and localization system. By leveraging the strengths of these technologies, the system can provide early detection of fires, enabling prompt response and potentially saving lives and minimizing property damage.

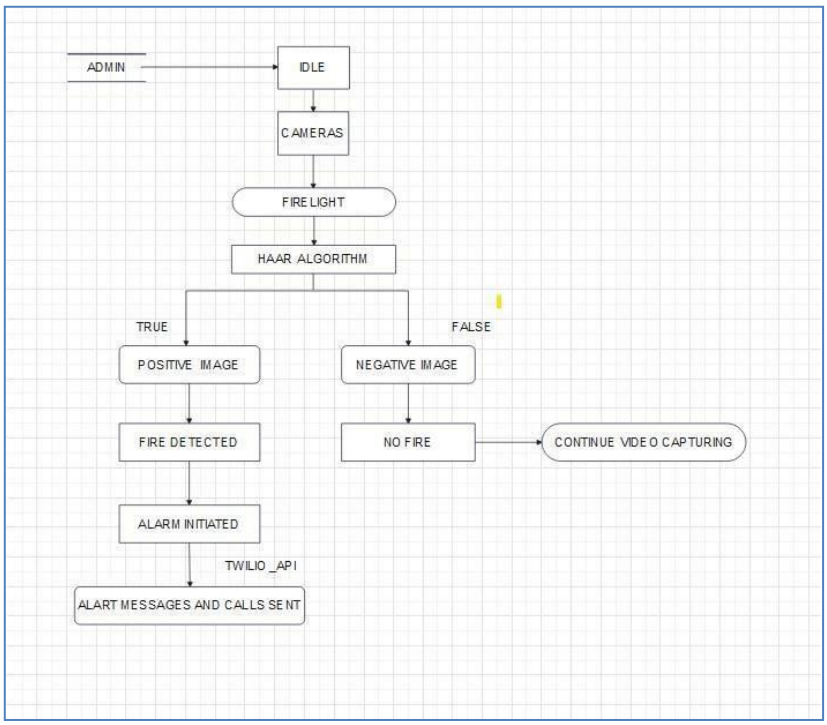

Fig: DFD Diagram for Fire Detection

This DFD depicts the data flow of the proposed automated fire detection and localization system using a surveillance camera with Haar algorithm and Twilio API. The surveillance camera captures video footage, which is processed by the Haar algorithm for fire detection. If fire is detected, the system determines the location of the fire using the camera's position and angle. An alert message is then sent via Twilio API to relevant personnel or authorities. The flow of data is unidirectional, with input from the surveillance camera and output to personnel or authorities.

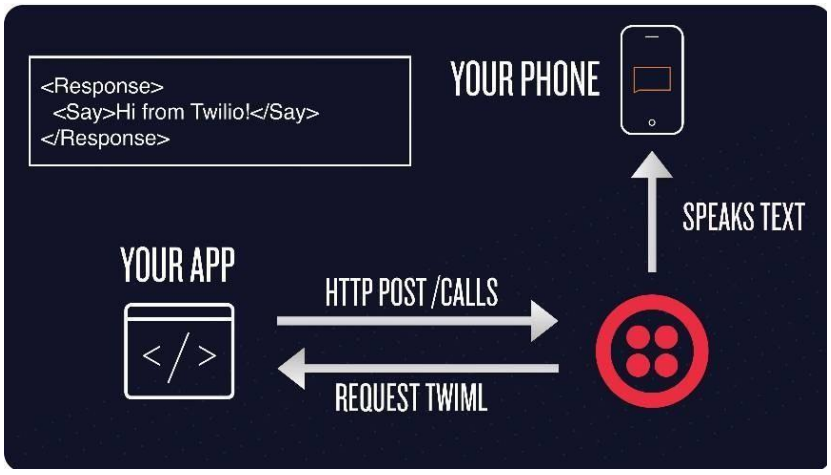

Fig: TwilioAPI Outbound Call

Twilio is a cloud communication platform that provides various APIs and services to enable developers to easily integrate messaging, voice, and video functionalities into their applications. One of the features provided by Twilio is outbound calling. Outbound calling is a functionality that allows your application to initiate a phone call to a phone number or multiple phone numbers. When the call is initiated, Twilio will connect to the phone network and establish a voice connection between the user and the called party.

ALGORITHM

Step 1: The system captures video frames from one or more surveillance cameras.
Step 2: The frames are preprocessed to enhance image quality and remove noise.
Step 3: The Haar Cascade Classifier is used to detect potential fire regions in the preprocessed frames. If a potential fire is detected, an alert is sent to the Twilio API.
Step 4: The system uses image processing and machine learning algorithms to localize the detected fire by alert message.
Step 5: The Twilio API is used to send alerts to specified recipients via text messages, emails, or phone calls.
Step 6: The system continues to monitor video frames for potential fires, and repeats the detection and localization process as necessary.

RESOURCES AND CONSUMABLES REQUIRED

A. Hardware components: Surveillance Cameras
B. Software apps: Twilio API Integration. Python IDLE.
OpenCV library (We will use it for image processing, video capture, and analysis).Threading library (We will use to creating and managing thread).

RESULTS AND APPLICATIONS

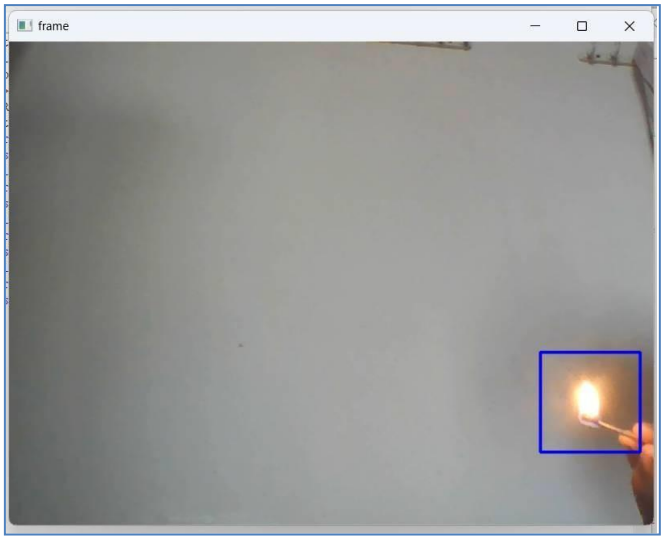

Fig : Detecting the Fire

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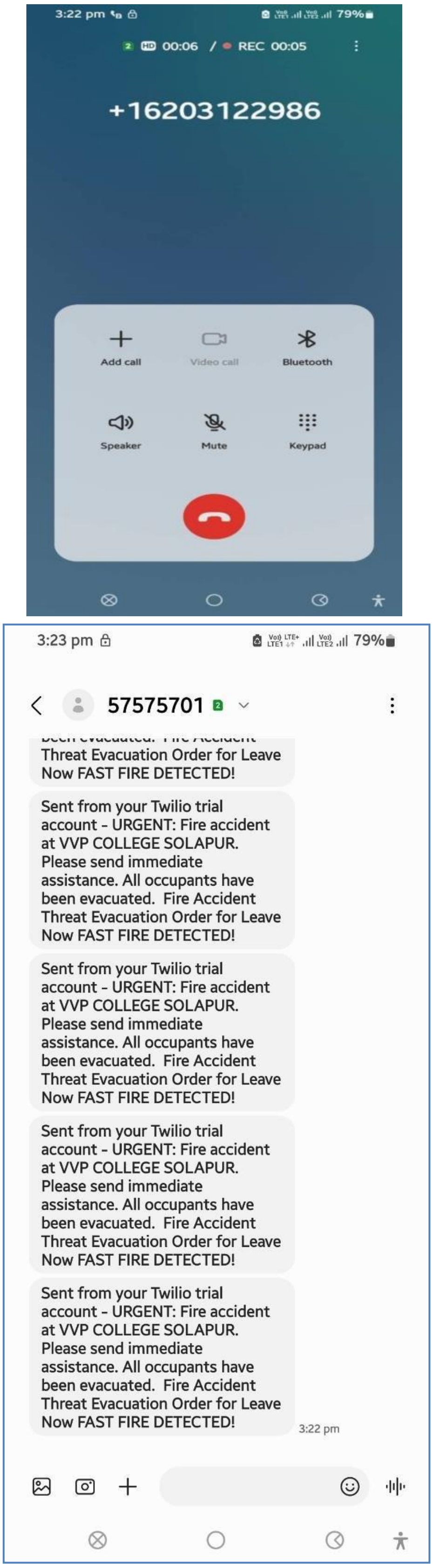

Fig: Receiving an alert message from Twilio API

APPLICATIONS

- Forests and natural habitats.
- Residential buildings.
- Industrial plants and warehouses.
- Smart Homes.
- Public Places.

CONCLUSION

In conclusion, the development of an automatic fire detection and localization system using a surveillance camera equipped with the Haar algorithm and Twilio API represents a significant advancement in fire safety technology. This system has the potential to prevent fires, protect lives, and minimize property damage in various settings, including residential buildings, industrial facilities, public places, forests, wild lands, and smart homes. The Haar algorithm ensures accurate and reliable fire detection and localization, while the Twilio API enables immediate communication of fire alerts to relevant authorities or individuals.

By integrating these two technologies, we have created a system capable of detecting, locating, and alerting individuals of potential fires in real-time, facilitating a prompt response to prevent the spread of fires. This project highlights the potential for combining multiple technologies to address complex problems and can serve as a foundation for further research and development in fire safety technology.

We hope this system will contribute to enhancing fire safety across various environments, protecting lives, and safeguarding property. However, it is important to note that the system's accuracy and effectiveness depend on specific implementation details, the quality of the surveillance cameras, and the availability of resources for continuous monitoring and maintenance.

FUTURE SCOPE

The development of an automatic fire detection and localization system using a surveillance camera equipped with the Haar algorithm and Twilio API marks a significant advancement in fire safety technology. However, there remains ample opportunity for improvement and future research. Here are some potential areas for further exploration:

Multi-Camera Integration: Currently, the system uses a single camera for fire detection and localization. Integrating multiple cameras could expand the system's coverage area and improve accuracy, enabling more effective fire detection and localization.

Integration with Other Sensors: Incorporating additional sensors, such as smoke detectors, temperature sensors, and gas sensors, could enhance the system's accuracy and reliability in detecting and localizing fires.

Machine Learning-Based Algorithms: Utilizing machine learning algorithms could improve the system's ability to detect fires in challenging environments, such as areas with heavy smoke or low lighting conditions.

Real-Time Fire Suppression: Integrating fire suppression systems, such as sprinklers, could enable the system to automatically trigger fire suppression in real-time, minimizing property damage and reducing the risk of casualties.

Cloud-Based Monitoring: The system could be integrated with cloud-based monitoring platforms, allowing for real-time monitoring and analysis of fire data. This could provide valuable insights into fire behavior and enhance the system's overall effectiveness.

The potential for future research and development in fire safety technology is significant. By integrating multiple technologies, such as the Haar algorithm and Twilio API, innovative and effective solutions can be developed to enhance fire safety and protection.

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