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YOLO - BASED EARLY FIRE DETECTION USING DEEP LEARNING AND PROTECTION SYSTEM

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Abstract - This project presents a smart fire detection and protection system using YOLO and Deep Learning techniques. It utilizes Computer Vision to identify fire and smoke in real-time through camera input. A Raspberry Pi acts as the main controller, integrating data from various sensors to improve detection accuracy. The system also includes GPS and GSM modules to send alert messages with location details. This ensures quick response and effective monitoring. Overall, the system provides a reliable solution for real-time fire detection and safety management.

KeyWords:YOLO,FireDetection ,DeepLearning ,ComputerVision,Raspberrypi,Sensors,GPS,GSM,Real-time monitoring.

1. INTRODUCTION

Fire accidents can cause serious damage to life and property, making early detection very important. This project proposes an intelligent fire detection and protection system using YOLO and Deep Learning techniques. By applying Computer Vision, the system can detect fire and smoke in real-time through camera input, providing faster and more accurate results compared to traditional methods.

The system uses a Raspberry Pi as the main controller, which processes data from sensors and controls the overall operation. It also integrates GPS and GSM modules to send alert messages with location details during emergencies. This ensures quick response and continuous monitoring, improving safety and reducing the risk of major fire hazards.

2. LITERATURE SURVEY

The development of fire detection systems has been greatly influenced by advancements in Internet of Things (IoT) and computer vision technologies. IoT provides a strong foundation for real-time monitoring by enabling communication between sensors and devices, which is essential for early fire detection and alert systems [2]. Secure and efficient monitoring in IoT environments has also been emphasized to ensure reliable operation of such systems [1]. Traditional fire detection approaches mainly depend on sensor-based techniques that use temperature, smoke, and gas sensors to identify fire hazards, offering cost-effective and simple solutions but sometimes lacking accuracy in complex conditions [4], [5]. To improve detection performance, researchers have introduced image processing and deep learning methods, where techniques like Convolutional Neural Networks (CNNs) enhance the accuracy of fire recognition in IoT-based systems [6], [10].

Real-time object tracking and efficient processing frameworks further support these systems in handling video data effectively [3]. Moreover, integration of IoT with computer vision has led to the development of autonomous fire detection and response systems that can not only detect fire but also trigger immediate actions[7]. Vision sensor-based approaches have also been optimized for resource-constrained IoT environments to ensure better performance and efficiency [8]. Surveys on intelligent fire detection highlight that vision-based methods are more reliable compared to conventional techniques, though challenges such as computational complexity and system scalability remain [9].

Overall, the literature indicates a clear transition from basic sensor-based systems to advanced intelligent fire detection solutions combining IoT and artificial intelligence for improved safety and reliability.

3. EXISTING METHODOLOGY

In existing systems, fire detection is mainly carried out using traditional methods such as smoke sensors, temperature sensors, and gas detectors. These systems are widely used to detect fire hazards and provide alerts. In addition to this, some methods use basic image processing techniques for detecting fire from images or videos. However, these approaches are not very efficient for real-time applications and often fail to detect fire at an early stage.Most of the existing systems do not use advanced deep learning techniques for accurate fire detection. They struggle to identify fire in complex environments such as varying lighting conditions, smoke interference, and background disturbances. Also, many systems only generate alerts and do not provide any automatic protection or response mechanism. As a result, these systems are limited in performance, accuracy, and early detection capability.

Limitations: Low accuracy, no YOLO-based detection, false alarms, no real-time detection, and no automatic protection system.

3. PROPOSED METHODOLOGY

The proposed system uses a YOLO-based deep learning model for early fire detection from images and video streams. It can detect fire in real-time with high accuracy by analyzing visual data. The system identifies fire at an early stage and quickly generates alerts. Additionally, it includes a protection mechanism that can automatically respond to fire incidents, improving safety and reducing damage.

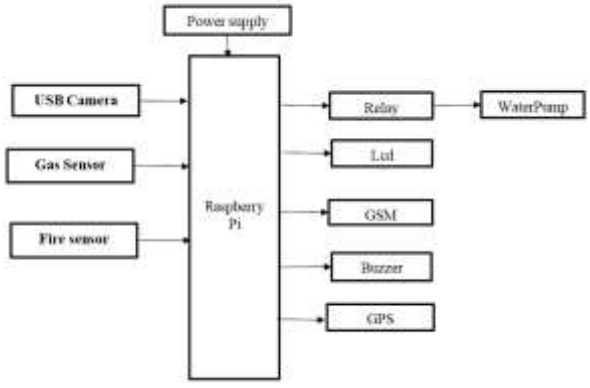

Figure 1: Block Diagram of Proposed System

4. WORKING PRINCIPLE

The proposed system works by continuously monitoring the surroundings using a camera, which captures real-time images or video frames. These frames are provided as input to a YOLO-based deep learning model that is trained to detect fire and smoke patterns. The YOLO algorithm processes each frame by dividing it into multiple regions and analyzing them simultaneously, which makes the detection fast and suitable for real-time applications.

The model identifies fire based on important features such as color (reddish/orange tones), shape, texture, and motion characteristics. Since YOLO performs object detection in a single step, it provides high speed and accuracy compared to traditional methods. The system continuously checks every frame to ensure early detection of fire at the initial stage.Once fire is detected, the system immediately generates an alert such as an alarm or notification to warn the user. At the same time, the protection system is activated to take necessary actions like triggering safety mechanisms. This reduces the response time and helps in minimizing damage.Overall, the system combines deep learning and real-time processing to provide fast, accurate, and reliable fire detection along with immediate response, making it more effective than existing methods.

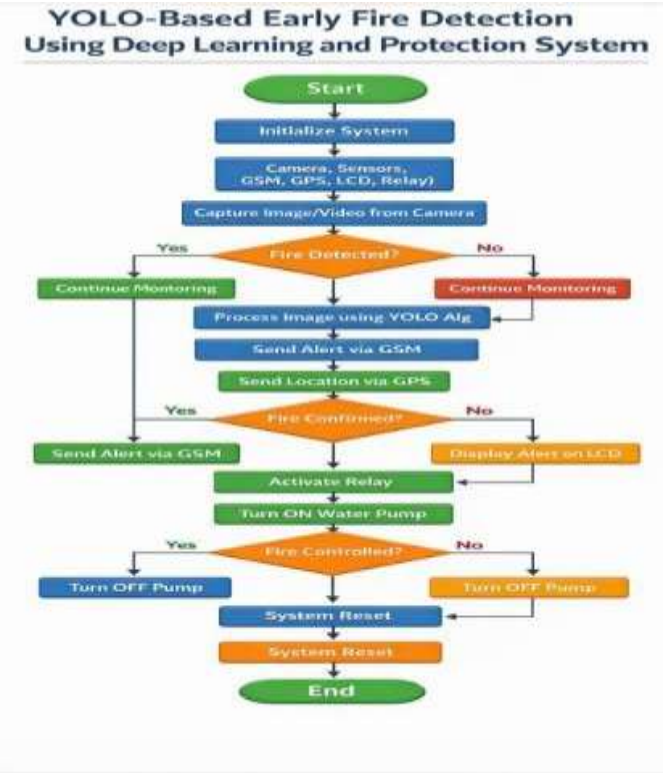

Figure 2: Flow Diagram of proposed System

6. RESULTS AND DISCUSSION

The system successfully detected fire and smoke in real-time using the YOLO-based deep learning model. The model accurately identified fire from images and video streams, and alerts were generated immediately upon detection. The protection system was activated to respond quickly to fire incidents. The system demonstrated high accuracy, fast response time, and reliable performance under different conditions, thereby improving safety and reducing potential damage.

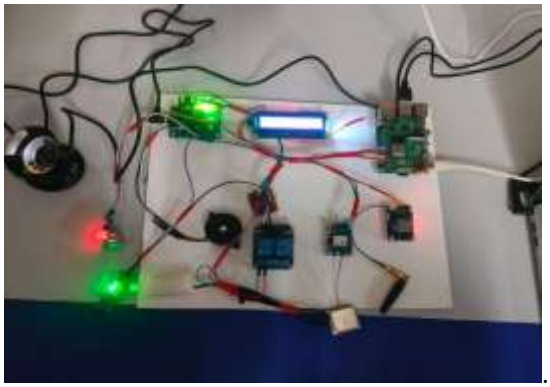

Figure 3: Hardware Display

Figure 3: system when Fire Detected

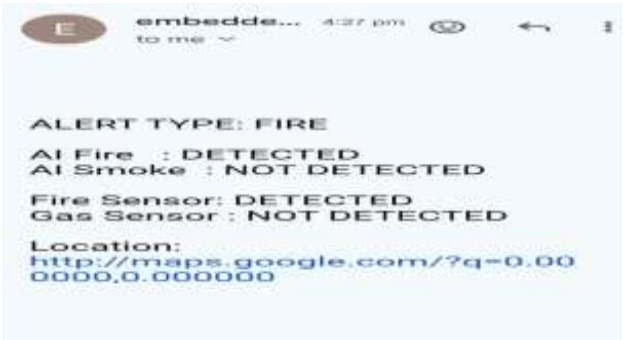

Figure 4: Fire Alert via Gps

7. CONCLUSIONS

The YOLO-based Early Fire Detection and Protection System was successfully designed and implemented to detect fire in real-time using deep learning techniques. The system analyzes images and video streams to accurately identify fire and smoke at an early stage. It provides quick alerts and activates a protection mechanism to respond immediately to fire incidents. This system improves detection accuracy, reduces false alarms, and ensures faster response compared to traditional methods. Overall, the system enhances safety and helps in minimizing damage caused by fire hazards.

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