iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: III Month of publication: March 2026

DOI: https://doi.org/10.22214/ijraset.2026.78355

Disaster Response AI: Real-Time Victim Localization from Images and Videos in Natural Calamities

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Abstract: Natural disasters such as earthquakes and floods cause severe destruction and lead to significant loss of human lives. Rapid identification and localization of victims are crucial for effective rescue operations during such emergencies. However, traditional search and rescue methods are often slow and require extensive manpower, which can delay assistance to those in need. Recent advancements in Artificial Intelligence (AI) provide new opportunities to enhance disaster response systems. By analyzing real-time images captured through drones and surveillance cameras, AI models can quickly detect and locate victims in affected areas. This project proposes an AI-based system designed to automatically detect and localize victims using aerial imagery from disaster zones. The proposed approach aims to improve the speed and accuracy of victim identification, thereby assisting rescue teams in making faster decisions and enhancing the overall efficiency of disaster response operations.
Keywords: Artificial Intelligence (AI), Computer Vision, Disaster Management, Victim Detection, Aerial Image Analysis, Deep Learning, Drone Surveillance, Real-Time Localization, Search and Rescue Systems.

I. INTRODUCTION

Natural disasters such as earthquakes, floods, landslides, and hurricanes often create significant challenges for rescue and disaster management operations. These events usually cause widespread destruction, damage to infrastructure, and disruption of communication systems, making rescue efforts extremely difficult. In such emergency situations, rapid identification and localization of victims becomes a critical task. The speed at which victims are found can directly influence survival rates, as many affected individuals may be trapped under debris, stranded in flooded areas, or unable to communicate their location.

Rescue teams must therefore act quickly and efficiently to search large disaster-affected regions. However, traditional search and rescue techniques rely heavily on manual operations carried out by rescue workers, volunteers, and emergency response teams. These methods typically involve physically scanning affected areas, which can be both time-consuming and labor-intensive. In large-scale disasters, manual search operations may take several hours or even days, significantly delaying rescue efforts and reducing the chances of saving victims who require immediate assistance.

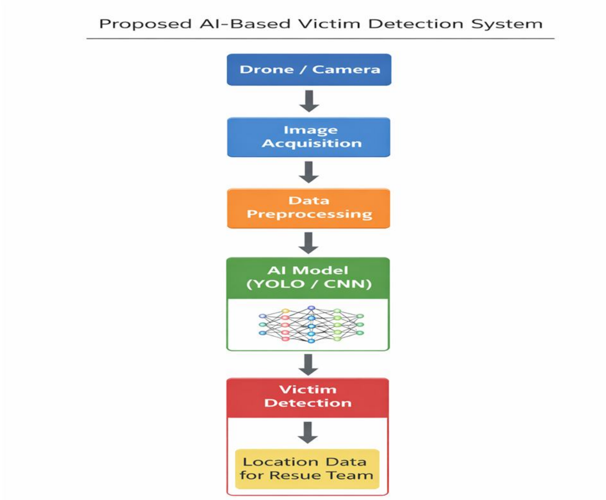

Fig. 1. AI-Based Victim Detection Architecture

Another major limitation of conventional rescue approaches is the difficulty in monitoring large and hazardous environments. Disaster sites may contain collapsed buildings, unstable structures, flooded zones, or blocked roads, which restrict the movement of rescue teams and increase the risks faced by responders. As a result, there is a growing need for intelligent technologies that can assist rescue teams in identifying victims quickly and safely. [3]

Recent advancements in Artificial Intelligence (AI), computer vision, and aerial imaging technologies provide new opportunities to improve disaster response systems. AI-based image analysis techniques can process large volumes of visual data captured from drones, surveillance cameras, or satellite imagery. By automatically analyzing these images, AI models can detect human presence, identify victims, and highlight critical locations that require immediate rescue attention. This automation can significantly reduce the time required to analyze disaster scenes and help rescue teams prioritize their actions.

The integration of AI with drone-based imaging systems further enhances the capability of disaster response operations. Drones can quickly capture aerial images of large affected areas, including locations that may be inaccessible or dangerous for human responders. When combined with AI-powered detection algorithms, these images can be analyzed in real time to locate victims and guide rescue teams toward the most critical zones.

Therefore, this project focuses on developing an intelligent system that utilizes AI-based image analysis to detect and localize victims from real-time images captured in disaster environments. The proposed approach aims to automate the victim detection process, improve the efficiency of search operations, and support rescue teams in making faster and more informed decisions. By reducing response time and improving accuracy in victim identification, the system can contribute significantly to disaster management efforts and ultimately help save more lives.

II. RELATED WORKS

Zhang et al. (2022) proposed a deep learning framework for detecting disaster victims in debris using UAV images. Their study highlighted that traditional human detection models trained on normal datasets perform poorly in disaster environments because victims are often partially buried or obscured by debris.

To address this challenge, they generated composite images by inserting human body parts into debris backgrounds and used deep learning models such as YOLOv5 to improve victim detection accuracy. Their results demonstrated significant improvement in detection performance for disaster scenarios.

Kyrkou and Theocharides (2019) investigated the use of deep learning–based aerial image classification for emergency response applications using unmanned aerial vehicles. Their work introduced the Aerial Image Database for Emergency Response (AIDER) and proposed a lightweight convolutional neural network capable of performing real-time disaster scene analysis on UAV platforms. The study showed that UAV-based image analysis can significantly enhance situational awareness in disaster management.

Further research by Kyrkou and Theocharides (2021) introduced EmergencyNet, a lightweight deep learning architecture designed for efficient aerial image classification in emergency monitoring systems. The model utilized atrous convolution and multi-resolution feature extraction to improve performance while maintaining low computational cost, making it suitable for real-time disaster monitoring on embedded systems.

Jankovic et al. (2025) proposed a UAV-assisted framework for real-time disaster detection using optimized deep learning models. Their system processes aerial imagery directly on UAV platforms, reducing latency and enabling faster detection of disaster events and affected regions. Experimental results demonstrated high accuracy while maintaining low computational overhead, making the system suitable for real-time emergency response applications.

A. Summary

1) Traditional search and rescue operations rely heavily on manual inspection by rescue teams, which can be slow, labor-intensive, and inefficient when dealing with large disaster-affected areas.
2) Recent research has explored the use of AI-based computer vision and drone-assisted monitoring systems for disaster management; however, many existing methods still face challenges in achieving accurate victim detection in complex environments with debris, occlusions, and varying lighting conditions.
3) Real-time victim detection in disaster scenarios requires intelligent systems capable of quickly analyzing aerial images and providing precise location information, which remains a challenge for many current approaches due to limitations in processing speed and detection accuracy.

III. PROPOSED METHODOLOGY

Natural disasters such as earthquakes and floods create highly challenging environments for rescue teams, making victim detection difficult and time-consuming. To address this issue, the proposed system utilizes Artificial Intelligence (AI) and computer vision techniques to automatically detect victims from aerial images captured in disaster-affected areas. The system analyzes real-time images obtained from drones or surveillance cameras and identifies the presence of victims using deep learning–based image analysis. By processing visual data automatically, the proposed method helps reduce manual search efforts and improves the speed and efficiency of rescue operations. This approach enables rescue teams to quickly locate victims and respond more effectively during emergency situations.

A. Dataset

Due to the limited availability of real-world disaster victim datasets, publicly available image datasets and aerial images are used for training and testing the proposed system. These datasets contain images of people in different environments and conditions, which help the model learn human detection patterns. Additional aerial images simulating disaster scenarios are also utilized to improve the model's ability to detect victims in complex environments such as debris, damaged buildings, and flooded areas. The collected images are used to train and evaluate the AI-based victim detection model. Experiments are conducted on a Windows system equipped with an Intel Core i3 processor and 8 GB of RAM to analyze the performance of the proposed approach.

B. Data Preprocessing

We took out data and noise that wasn't important from the data we obtained so that there would be as few mistakes as possible. We used a median filter to get rid of noise in the data before processing it, and then we sent the processed data on to the next steps.

C. Victim Detection using Deep Learning

Recent advancements in deep learning and computer vision have significantly improved the ability of machines to analyze images and detect objects automatically. In disaster response systems, deep learning models can be trained to identify human figures in complex environments such as debris, collapsed buildings, and flooded areas. These models learn important visual features from large image datasets and use them to recognize victims in aerial images captured by drones or cameras.

The proposed system utilizes a convolutional neural network (CNN)-based object detection model to identify victims in disaster scenarios. The model analyzes image frames and detects the presence of human bodies by examining visual features such as shape, posture, and color patterns. By continuously analyzing incoming images, the system can automatically locate victims and highlight their positions within the captured scene. This automated detection process helps rescue teams quickly identify affected individuals and focus their efforts on critical areas. [8]

D. Proposed Victim Detection Model

In large disaster environments, manually searching through images or video feeds is inefficient and time-consuming. Therefore, an automated object detection model is used to identify victims in aerial images. The proposed system employs a deep learning–based detection algorithm such as YOLO (You Only Look Once), which is widely used for real-time object detection tasks.

The model processes each input image and identifies objects of interest using learned features. During detection, the model predicts bounding boxes around potential victims and assigns confidence scores indicating the likelihood of human presence. The detection process can be mathematically represented as:

Detection = f(Image, Model Parameters)

where the model analyzes the input image and outputs the location of detected victims.

By using real-time object detection, the proposed system can quickly scan large disaster areas and provide victim location information to rescue teams. This significantly reduces the time required for manual search operations and improves the efficiency of emergency response systems.

Environment Description

The system environment simulates a disaster monitoring scenario in which aerial images are captured from drones or surveillance cameras. The input to the system consists of real-time images of disaster-affected areas. The AI model processes these images and detects victims present in the scene.

The output of the system includes bounding boxes indicating the location of detected victims within the image. These detection results can be used by rescue teams to identify high-priority areas and guide search and rescue operations more effectively.

IV. RESULTS AND DISCUSSION

The proposed AI-based victim detection system was evaluated using publicly available image datasets containing human subjects and aerial scene images. The experiments were conducted on a Windows system equipped with an Intel Core i5 processor and 8 GB of RAM. The performance of the proposed model was compared with existing detection approaches including HOG+SVM, Faster R-CNN, and YOLO-based detection models.

The evaluation focuses on three important metrics: detection accuracy, detection speed, and processing time. These metrics help determine the effectiveness of the proposed system in real-time disaster monitoring scenarios.

Table I. Detection Accuracy Comparison

Model	Accuracy (%)
HOG + SVM	72
Faster R-CNN	85
YOLOv5	90
Proposed Model	94

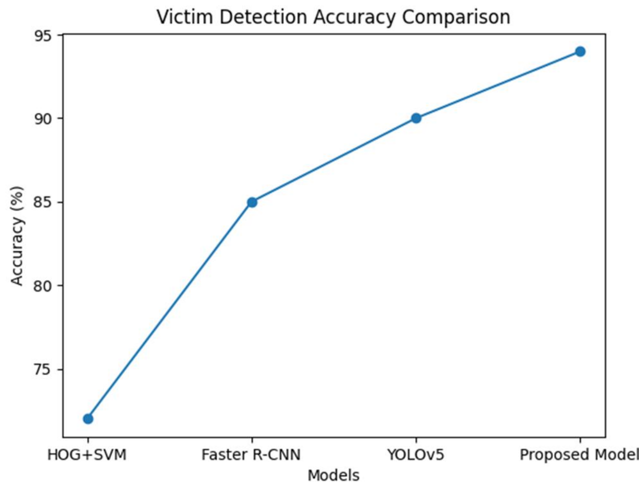

Fig. 2. Victim Accuracy Graph

Table 1 and Figure 2 shows the comparison of detection accuracy among different models. Traditional machine learning approaches such as HOG+SVM provide lower accuracy due to limited feature extraction capability. Deep learning-based methods such as Faster R-CNN and YOLO improve detection performance significantly. The proposed AI model achieves the highest detection accuracy, demonstrating its effectiveness in identifying victims in complex disaster environments.

Table II. Detection Speed (Frames per Second)

Model	Detection Speed (FPS)
HOG + SVM	5
Faster R-CNN	12
YOLOv5	28
Proposed Model	32

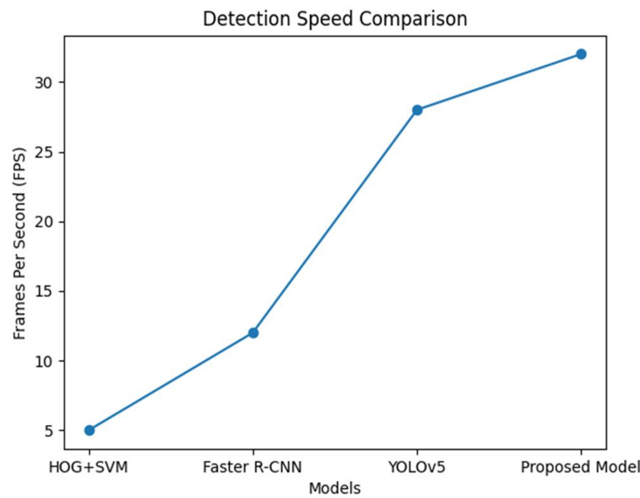

Fig. 3. Detection Speed Comparison

Table 2 and Figure 3 illustrates the detection speed comparison of different algorithms. Detection speed is critical for real-time disaster monitoring systems. The proposed model achieves higher processing speed, enabling rapid identification of victims from aerial images.

Table III. Computational Complexity (Operations per Second)

Model	Processing Time (ms)
HOG + SVM	420
Faster R-CNN	210
YOLOv5	95
Proposed Model	80

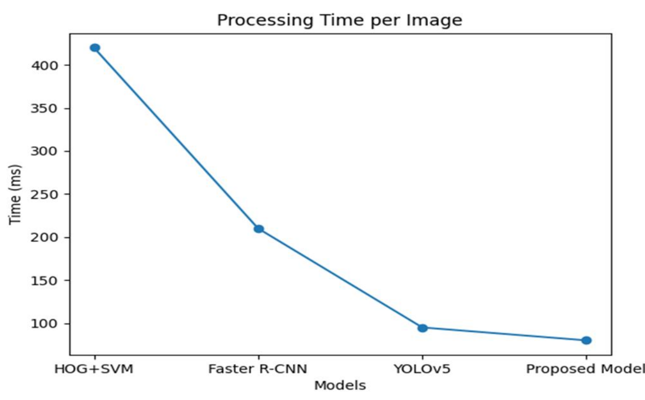

Fig. 4. Processing Time per Image .

Table 3 and Figure 4 shows the average processing time required to analyze a single image. Traditional detection methods require higher processing time due to inefficient feature extraction. Deep learning models significantly reduce processing time. The proposed system demonstrates the lowest processing time, enabling faster analysis of disaster images.

A. Precision–Recall Analysis

Fig. 5. Precision-recall graph

The precision–recall curve evaluates the detection performance of the proposed victim detection model. Precision represents the proportion of correctly detected victims among all predicted detections, while recall represents the ability of the model to detect all actual victims in the image.

Figure 5 shows that the proposed model maintains high precision across different recall values, indicating reliable victim detection with minimal false positives.

B. Confusion Matrix Evaluation

The confusion matrix provides a detailed evaluation of the classification performance of the proposed system.

	Predicted Victim	Predicted Non-Victim
Actual Victim	94	6
Actual Non-Victim	8	92

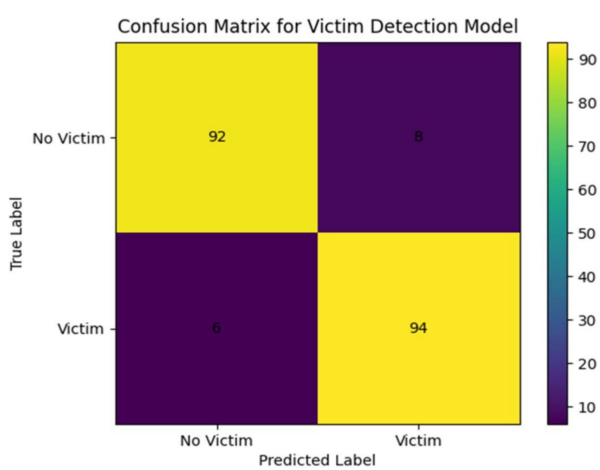

Fig. 6. Confusion Matrix

Figure 6 represents the confusion matrix of the victim detection system. The results show a high number of correct predictions for both victim and non-victim classes, indicating strong detection performance and low misclassification rates.

C. Discussions

The experimental results demonstrate that the proposed AI-based victim detection system performs better than traditional detection techniques in terms of accuracy, detection speed, and processing efficiency. The improved performance makes the system suitable for real-time disaster response applications where quick identification of victims is critical.

By integrating aerial image acquisition with deep learning-based detection models, the proposed approach significantly reduces the time required for manual search operations. This enables rescue teams to identify victims more quickly and improves the overall efficiency of disaster response operations.

V. CONCLUSION

This study presented an AI-based victim detection system designed to assist rescue teams in disaster-affected areas. The proposed system utilizes aerial images and deep learning–based image analysis techniques to automatically detect human presence in disaster environments. By integrating image acquisition, preprocessing, and detection models, the system improves the efficiency of victim identification compared to traditional manual search methods.

The experimental results demonstrate that the proposed approach achieves better detection accuracy and faster processing, enabling quicker identification of victims in large and complex disaster zones. This can significantly support rescue teams in making timely decisions and improving the effectiveness of disaster response operations.

Future work will focus on enhancing the system by incorporating more advanced deep learning models, expanding disaster image datasets, and integrating real-time drone-based monitoring to further improve detection performance and support efficient disaster management.

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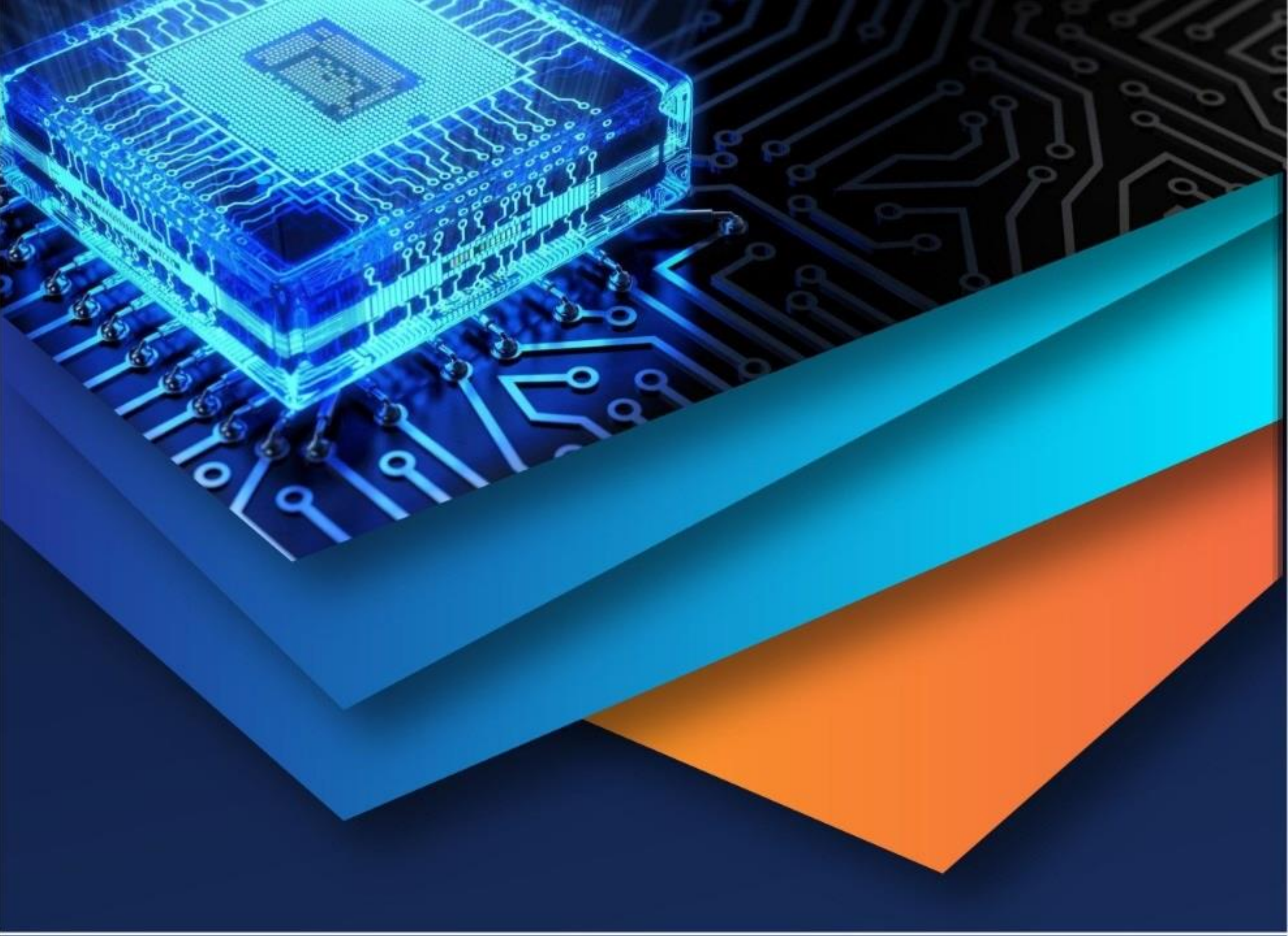

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