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Real-Time Human Detection in Search and Rescue Missions using YOLOV8

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Abstract: In general, search and rescue operations are carried out in hostile and uncertain situations in places such as collapsed structures, disaster areas, forests, and remote regions. It is vital to quickly locate missing people in these situations in order to improve their survival rates. In general, existing techniques in searching rely on intensive inspection processes, which are time-consuming and dangerous for rescue teams. This research aims to introduce a real-time human detection system using a YOLOv8 model. It is a system that utilizes images or video feeds obtained during a search and rescue scenario to automatically detect humans within a given area. It is anticipated that through the use of a YOLOv8 model, a proposed system could automatically detect humans in real-time even in complex situations. It processes images, recognizes the presence of humans, and indicates their presence using bounding boxes.

It is shown in this research that a proposed system could achieve high detection rates while ensuring fast processing speeds, thus proving its potential in real-time applications. This research aims to demonstrate the potential of computer vision and deep learning technologies in assisting rescue teams in searching for missing people more efficiently and safely.

I. INTRODUCTION

Search and Rescue (SAR) operations play a vital role during critical situations where people are stuck, lost, or injured due to natural or man-made calamities. Situations such as earthquakes, floods, landslides, industrial mishaps, and building collapses occur, creating a chaotic environment where the search for the injured is extremely difficult. In such scenarios, the speed at which the SAR operations are conducted is directly related to the survival rate of the people. However, the conventional method of conducting SAR operations relies heavily upon the manual search conducted by the rescue team. This method is extremely time-consuming, labor-intensive, and sometimes hazardous for the rescuers. Moreover, the large area of the disaster, poor visibility, and the hazardous environment during the rescue operations add to the difficulties of locating the injured.

In the past few years, the development of Artificial Intelligence (AI) and computer vision has opened up new avenues for the development of more efficient emergency response systems. Computer vision is the branch of artificial intelligence that enables the computer to interpret visual information such as images and video streams. Using computer vision, the computer is able to identify the objects present in the visual environment. This technology has been widely used for the development of various computer vision-based systems. Some of the fields where computer vision has been successfully implemented include surveillance systems, autonomous vehicles, medical image processing, security monitoring, and disaster response systems. Using intelligent algorithms, the computer is able to interpret the visual information present before it. Using computer vision, the computer is able to generate important insights from the visual environment. Deep learning techniques, especially the use of Convolutional Neural Networks (CNNs), have significantly improved the accuracy of computer vision-based systems. Using this technique, the computer is able to identify the objects present before it. Among the computer vision-based systems, the object detection algorithms play a vital role. One of the most influential object detection frameworks developed in recent years is the YOLO (You Only Look Once) family of object detection algorithms. Unlike earlier object detection techniques, where multiple processing steps are involved in feature extraction and classification, YOLO follows a unique approach where object detection is done in a single forward pass through the network. Such a unique approach makes YOLO family object detection algorithms extremely fast and accurate in their outcomes. In recent years, various versions of YOLO have been developed, each enhancing performance, efficiency, and overall usage of the algorithm in object detection tasks. The latest in the series of YOLO object detection algorithms is YOLOv8, where various advancements have been made in network architecture, training, and overall detection outcomes.

YOLOv8 enhances object detection outcomes through various feature extraction mechanisms and advancements in object detection techniques. Such a unique approach makes it easier for objects to be detected more accurately in different scales and complex backgrounds. Furthermore, YOLOv8 is optimized to ensure high speeds and computing efficiency, making it a highly viable solution in situations where quick decision-making is required in disaster response operations.

In disaster response situations, one of the most critical tasks is the identification of human presence in a disaster area. Victims are often partially hidden in disaster sites, where they are buried under debris, surrounded by complex environments, and in some situations, in complex terrain where searching becomes inefficient. Such situations require highly efficient computer vision mechanisms where human detection systems are integrated into disaster response operations to help rescue teams in their operations.

II. LITERATURE SURVEY

Nor Wahidah Zailan, et al. conducted a study on search and rescue operations within a forest environment and analyzed various search patterns based on grid shapes like square, triangular, and polar shapes. The results indicated that a rectangular grid pattern along with sweep search techniques can produce better outcomes within a larger search area. However, these techniques are based on manual effort and lack automation, which can hinder their performance within larger disaster areas.[1]

Nikite Mesvan, et al. developed a human detection system based on a UAV using Convolutional Neural Networks with Single Shot Detector architecture. The authors tested their model with a quadcopter to conduct experiments on detecting humans within a simulated environment that mimicked a disaster scenario. The model was successful in detecting humans with reasonable accuracy but was limited to only 3 FPS as a consequence of hardware limitations within the embedded device.[2]

Roberto Douglas Guimaraes de Aquino, et al. developed a compact Convolutional Neural Network model to conduct human detection within a search and rescue scenario using a UAV device. The authors used data augmentation techniques to improve the performance of their model and achieved high accuracy within a sea surface search scenario. However, the model lacked diversity with regards to datasets used within the experiment, which affected the model's ability to generalize with different terrains.[3]

Khadiza Sarwar Moury, et al. developed a CNN-based model to conduct human detection with different orientations and scales using datasets related to disaster scenarios. The authors achieved an accuracy of 94.18% with regards to detecting human figures within a given image. However, the model's accuracy was affected when humans formed a very small part of the entire image taken by the camera.[4] Several research works based on different deep learning and machine learning techniques for efficient underwater/disaster area sensing were explored, each with varying accuracy and computational costs.[5]

Xu Liu et al. proposed an improved VGG-16 deep learning method for the identification of acoustic images for underwater search and rescue. Using the transfer learning method, the accuracy of the system was high for the identification of underwater objects. However, the processing of acoustic images in real-time was associated with high computational costs.[6]

Mykyta S. Kozlov, Eugene V. Malakhov, et al. proposed a multi-level network of drones for the identification of humans during the search and rescue process. A hybrid CNN-LSTM method is used for the identification of humans. The accuracy of the method is high, but the method is associated with high computational costs, which limits the real-time processing of the images.[7]

Jiya Adama Enoch et al. proposed the use of different classifiers such as SVM, KNN, and ensemble methods for the identification of humans behind the walls using radar signals. Among the different classifiers, the KNN method has the highest accuracy of 85%. However, the method is associated with high computational costs, limiting the real-time processing of the images.[8]

Hovannes Kulhandjian, et al. proposed a hybrid method for the identification of people using micro-Doppler radar signals along with infrared images. Deep CNNs are used for the processing of the images, resulting in high accuracy, i.e., 98%.[9]

III. METHODOLOGY

A. *Proposed Architecture*

The system is designed to detect people in real-time to aid in search and rescue operations using a YOLOv8 deep learning algorithm. It combines image processing, a deep learning detector, and a notification system to ensure successful rescue operations. Several modules work in conjunction to convert visual data into real-time detection outcomes.

B. *Gathering Input Data*

It collects data from different sources, such as images and videos from drones, cameras, and user-submitted data. It uses this data as input to provide real-time images and videos from disaster zones.

In rescue operations, images are often distorted by factors such as insufficient lighting, fog, rain, and motion blur. It processes images carefully to ensure accurate detection.

C. Image Preprocessing

Before images are passed to the detector, it preprocesses images to improve their quality and help the detector perform more accurately, especially in adverse weather.

It includes the following preprocessing techniques:

- Contrast Limited Adaptive Histogram Equalization (CLAHE) to improve image contrast
- Gamma correction to improve images in dark environments
- Median filtering and others to reduce noise in images
- Resizing images to match the detector's input size

It preprocesses images to improve their quality and help the detector perform more accurately in adverse weather conditions.

D. YOLOv8 Human Detection Model

At the center of the system lies the YOLOv8 model. This model will be responsible for the detection of human figures within the images or video frames that the system processes. YOLOv8 will employ a one-stage approach to object detection. This model will combine the localization and classification functions within a single network.

The model will divide the given image into a grid. Each cell in the grid will predict boxes that contain the coordinates of the human figure. Each cell will also predict a score that reflects the probability of the presence of a human figure. This model will be able to detect human figures at different scales with high accuracy due to the presence of the anchor-free feature.

Once the model processes the video frames, it will produce the following outputs for each detected human figure in the frames:

- Bounding boxes that contain the coordinates of the human figure
- Confidence scores that represent the probability of the presence of the human figure
- Class labels that identify the detected object

These outputs will be passed to the detection visualization module.

E. Detection Visualization Module

After the detection of human figures within the video frames, the system will proceed to visualize the results. This will be done through the drawing of bounding boxes around the detected human figures. Each box will contain a score that reflects the probability of the presence of the human figure. This will allow the rescue team to easily interpret the results. The team will be able to identify the position of the human figure within the scene.

F. Geolocation and Alert System

The system will employ a geolocation system that will be able to generate alerts upon the detection of human figures. Each detected human figure will be logged with the corresponding time and location. The system will be able to generate the following alerts upon the detection of a human figure:

- Email notifications
- SMS notifications
- System logs

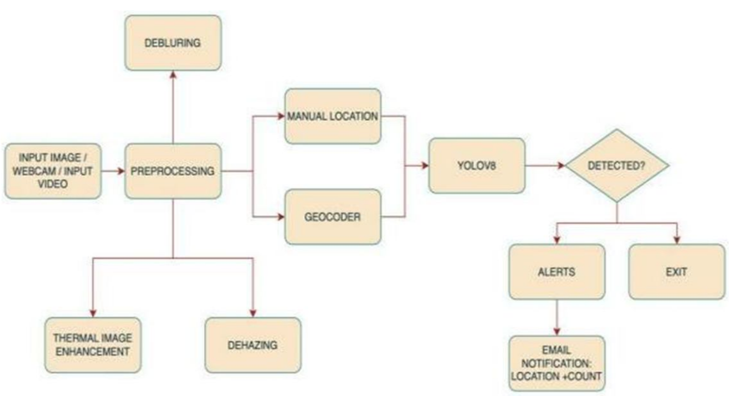

Figure 1: Architecture diagram

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G. *Proposed work*

The project is based on the development of a real-time human detection system specifically designed for search and rescue operations. This system is based on the YOLOv8 deep learning model. The system will be able to identify humans in images or videos captured in the affected areas. The process begins with the collection of images or videos from various sources. These images or videos may have been captured through various devices or may have been stored in the system. Once the images or videos have been collected, the system will begin the preprocessing stage. This stage will include the resizing of images or videos to make them compatible with the system.

After the preprocessing stage is complete, the images or videos will enter the YOLOv8 model. This model will identify humans in the images or videos. The model will run through each image or video frame to identify humans. Once the model has identified a human in the image or video, the system will mark the area of the image or video where the human is. This system will be able to identify multiple humans in the images or videos. A user interface will be created to allow the system to be used in real-time. The system will allow the user to input images or videos to identify humans. The system will send a notification once a human is detected. This will allow the system to increase the speed of the search and rescue operations.

IV. EXPERIMENTAL RESULTS

In summary, the proposed system exhibits a high level of efficiency and robustness for various SAR-related situations. Given the capability of weather awareness-based enhancement, real-time alarms, and graphical user interface, it is evident that the system can be used as an instrument for automatic rescue monitoring and surveillance. In general, the major advantages identified in the course of testing are:

- Ensures more than 40 FPS throughout the test scenarios.
- Demonstrates map from 0.74 to 0.81 depending on the situation.
- Provides alerts within 1.5 seconds on average.
- Weather awareness-based enhancement improves map up to 18% for poor visual conditions.

Consequently, these results prove the feasibility of utilizing this tool in practice.

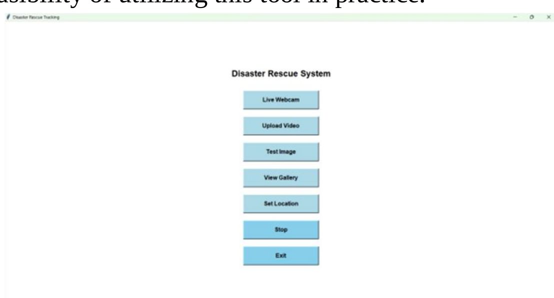

Figure 2 GUI Display after execution of code

Figure 2 : The above figure shows the output after executing the commands, which is a GUI interface with all the available options.

Figure 3 Detection when video is uploaded

Figure 3: In the above figure, cars are detected with an accuracy of 83% when video is uploaded.

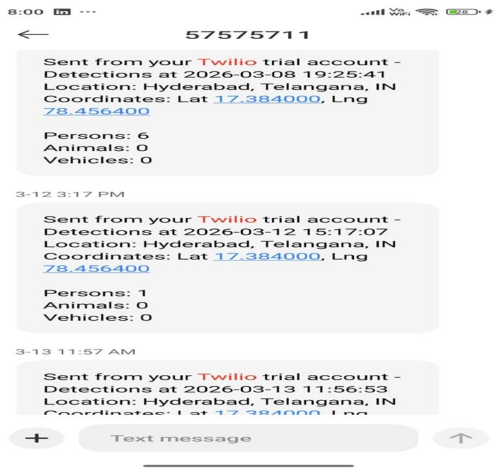

Figure 4 SMS Alert message

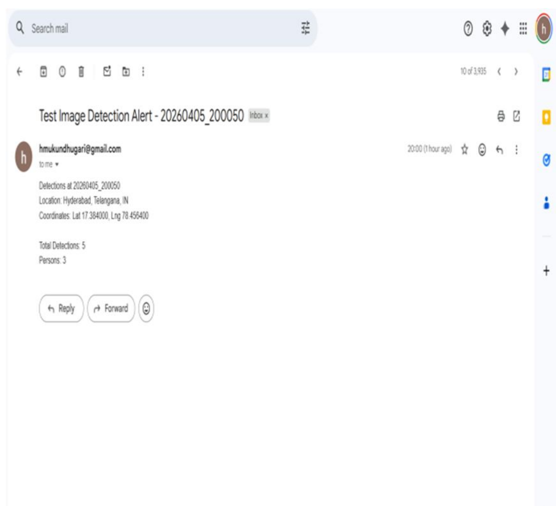

Figure 5 Email Alert message

V. CONCLUSION

The combination of real-time object detection with adaptive image enhancement based on changes in weather conditions can be considered a significant achievement in the field of intelligent surveillance systems. In this project, the use of YOLOv8 is complemented by such methods of image enhance-ment as histogram equalization, gamma correction, CLAHE, and median filtering, which increase the quality of object detection in fog, rain, and night conditions using OpenCV and NumPy libraries. Another important feature isthe user-friendly GUI designed using the Tkinter library that allows us to import media, stream video, select objects of interest, and get instant alerts. Moreover, the application has the option of simulating weather conditions, enabling us to use it in research and practical work. Another important feature is the real-time alert system implemented with the help of SMTP services for emails and Twilio services for SMS messages. It allows us to notify about the presence of selected objects in the image as quickly as possible. The system has a modular structure, which allows us to implement scalability in it. We can update any module independently. Experimental tests show that the use of this approach increases object detection accuracy and robustness in various conditions.

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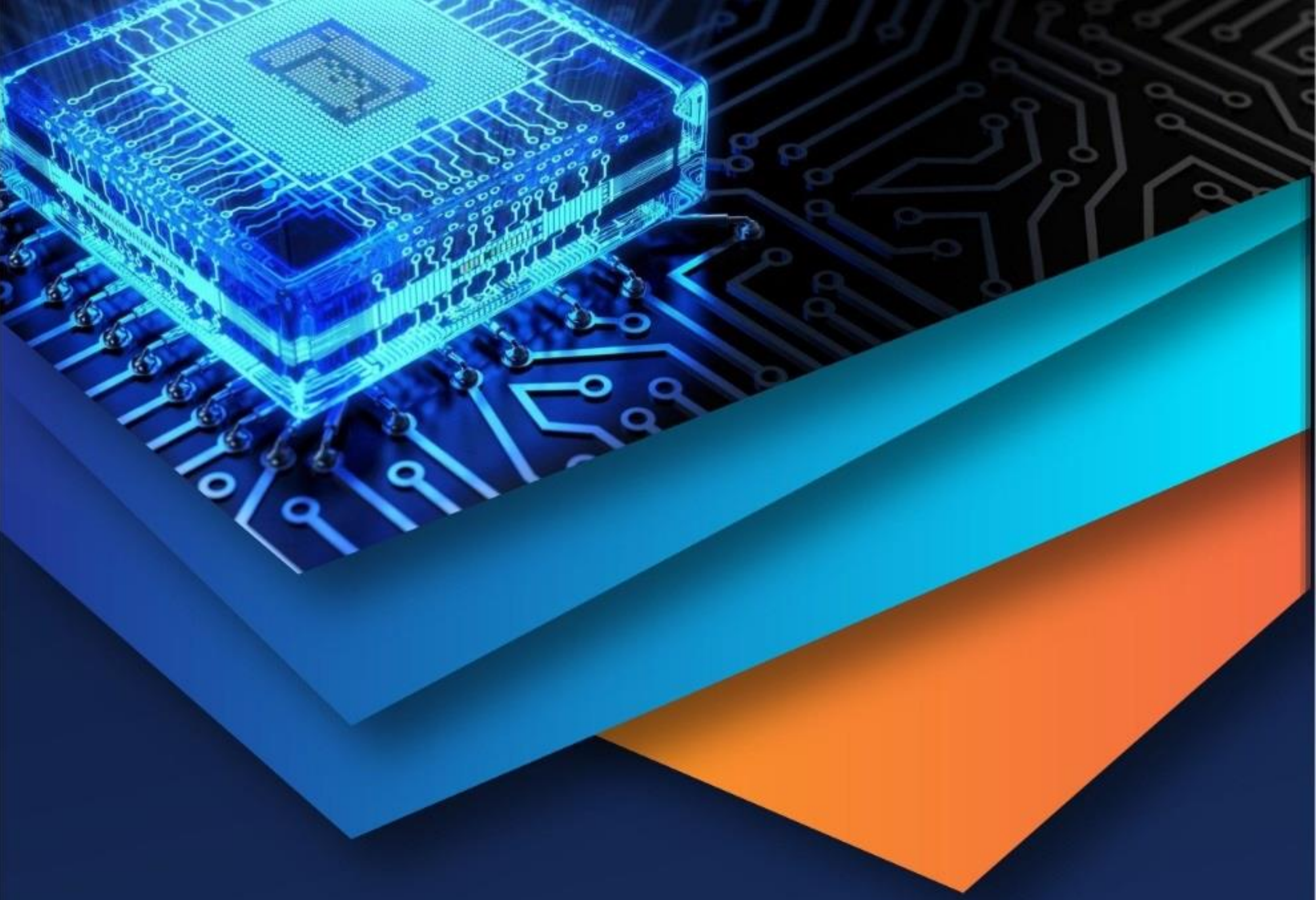

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