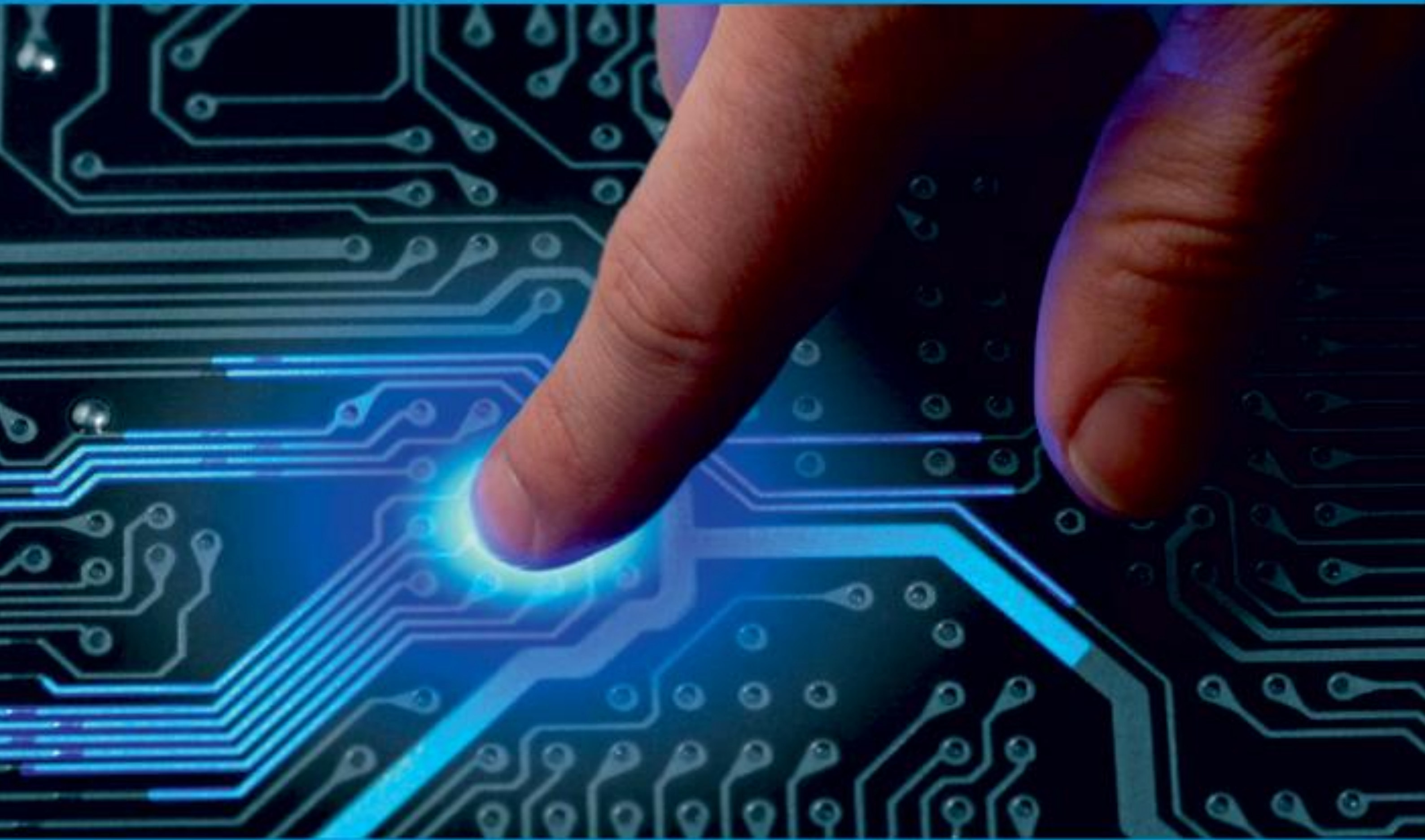
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 7, July 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 7, July 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1207062 |

Deep CNN Detectors for Automatic Person Detection in Search and Rescue Operations

Vinay D G[1], Dr. T. Vijay Kumar[2]

MCA Student, Department of Computer Application, Bangalore Institute of Technology, Bangalore, India[1]

Head of the Department, Department of Computer Application, Bangalore Institute of Technology, Bangalore, India[2]

ABSTRACT: Search and rescue operations (SAR) are essential during natural disasters and emergencies. Drones are increasingly utilized in SAR due to their ability to cover large areas rapidly. However, detecting individuals in aerial images remains a significant challenge. This study evaluates the performance of advanced detectors (Faster R-CNN, YOLOv4, RetinaNet, and Cascade R-CNN) using a custom SARD dataset and the VisDrone benchmark. We propose a prototype model developed with TensorFlow and YOLO, which delivers high speed, accuracy, and minimal false detections. Our model demonstrates outstanding results in person detection for SAR scenarios, proving to be a valuable tool for future SAR operations.

I. INTRODUCTION

Search and rescue operations (SAR) are critical during natural disasters. Drones play a crucial role in SAR efforts, yet detecting people in aerial imagery remains challenging. Existing datasets do not adequately address SAR-specific challenges, prompting us to employ transfer learning and fine-tuning of state-of-the-art detectors (Faster R-CNN, YOLOv4, RetinaNet, and Cascade R-CNN) on a customized SAR dataset. This study analyzes detection performance across varying weather conditions and motion blur to propose a prototype model for robust person detection in SAR scenarios, ultimately enhancing search efficiency and potentially saving lives.

II. LITERATURE SURVEY

Several studies have tackled challenges in rescue systems using machine learning and computer vision techniques. For instance, researchers have explored detecting bodies in maritime rescue operations employing drones equipped with multispectral cameras. Additionally, advancements include systems for detecting live humans using semiautonomous mobile rescue robots. Studies have also addressed human detection in nighttime imagery with CNNs, as well as tracking human bodies using stereo image analysis. Further developments include automated indoor monitoring systems using pan-tilt-zoom cameras for detecting individuals in unclear images. These studies highlight diverse algorithms and techniques applicable to SAR operations for detecting and tracking humans in various environmental conditions.

III. MOTIVATION & PROBLEM STATEMENT

In India, floods and natural disasters have tragically claimed lives due to challenges in locating individuals trapped under debris. There is an urgent need for efficient SAR operations to provide timely assistance and medical aid. SAR operations aim to cover large areas swiftly and locate injured persons within the critical "golden hour." While drones are increasingly deployed in SAR missions, effectively analyzing recorded data remains problematic. Even experienced rescuers struggle to identify individuals in vast areas, especially when obscured by vegetation or in unconventional positions due to injury or exhaustion. This project addresses these challenges by developing a system using machine learning and computer vision to detect individuals in aerial images and videos.

IV. SCOPE OF THE PROJECT

This project aims to develop a highly accurate system for detecting missing persons in aerial images and videos, crucial for time-sensitive SAR operations. The primary challenge lies in identifying small targets within expansive environments, posing difficulties for human concentration and attention.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |
|| Volume 12, Issue 7, July 2024 ||
| DOI: 10.15680/IJIRCCE.2024.1207062 |

V. OBJECTIVES OF THE PROJECT

This project aims to achieve the following objectives:
1. Develop a human detection system using drones optimized for challenging SAR conditions.
2. Ensure compatibility across multiple domains, operating systems, and hardware configurations.
3. Implement real-time functionality, including robust performance in adverse weather conditions.
4. Provide an invaluable tool for disaster response teams to conduct efficient, real-time SAR operations.

VI. PROPOSED METHODOLOGY WITH BLOCK DIAGRAMS

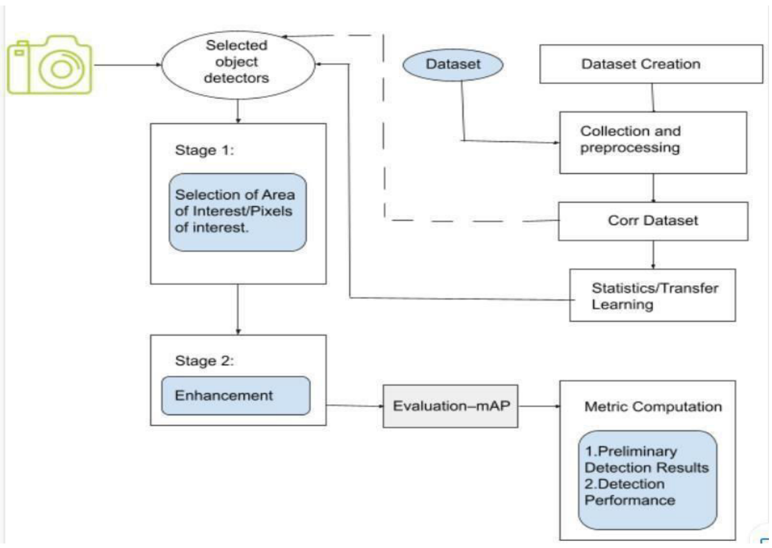


Fig.1: Block Diagram of our Working Model

Dataset Creation:
SARD Dataset Collection & Preprocessing: The process involves gathering and preparing a specialized dataset tailored for SAR operations (SARD). This includes compiling diverse aerial images and videos relevant to search and rescue scenarios, ensuring comprehensive coverage of potential environmental conditions and challenges.

CORR Dataset Generation: Additionally, a complementary dataset (CORR) is generated to augment the training process. CORR focuses on refining the detection capabilities by incorporating specific challenges encountered in SAR missions, such as varying weather conditions and terrain complexities.

Dataset Statistics for Transfer Learning: Comprehensive statistical analysis of the datasets is conducted to facilitate effective transfer learning. This step ensures that pre-trained models can adapt efficiently to SAR-specific contexts, enhancing detection accuracy and robustness.

Object Detection:
Stage 1: Initial detection utilizes state-of-the-art algorithms including Faster R-CNN, YOLOv4, RetinaNet, and Cascade R-CNN. These models are trained and evaluated on the SARD and CORR datasets to assess baseline performance in detecting persons under various conditions.

Stage 2: Advanced techniques such as the Feature Pyramid Network (FPN) are employed to enhance multi-scale object recognition. Evaluation metrics, including mean Average Precision (mAP), are computed to quantify and compare the models' performance across different scenarios and challenges encountered in SAR operations.

Results:
Preliminary Detection Results: Initial findings from the experimentation phase highlight the efficacy of the deployed models in detecting human subjects within SAR imagery. These results serve as a foundational assessment of the models' capabilities and guide further refinement efforts.

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 7, July 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1207062 |

Detection Performance/Accuracy: Detailed analysis of detection performance metrics, including precision, recall, and F1-score, provides insights into the models' accuracy in identifying individuals across varying environmental conditions and motion blur scenarios.

Robustness to Weather Conditions & Motion Blur: The study evaluates the robustness of each model against adverse weather conditions and motion blur effects commonly encountered in SAR operations. This analysis informs strategies for improving detection reliability under challenging real-world conditions.

VII. TOOLS USED FOR THE PROJECT WORK

Software: Python will be the primary programming language utilized for implementing deep learning and machine learning algorithms, particularly CNN-based object detectors such as Cascade R-CNN, Faster R-CNN, RetinaNet, and YOLOv4.

Hardware: The project will leverage drones equipped with integrated cameras and UAV capabilities to capture aerial imagery essential for SAR operations.

IDE: Development and experimentation will be conducted using popular IDEs including PyCharm, VS Code, and Jupyter Notebook, providing robust environments for coding, testing, and analysis.

VIII. IMPLEMENTATION PROCESS (HARDWARE & SOFTWARE)

The implementation strategy involves leveraging pre-trained models such as VGG, ResNet, ResNeXt, and MobileNet, initially trained on datasets like ImageNet, OpenImages, and the custom SARD dataset. Transfer learning techniques will be applied to adapt these models specifically for person detection in SAR environments.

Detector Configuration: The system will utilize both one-stage detectors (YOLO, SSD, RetinaNet) and two-stage detectors (R-CNN, Fast R-CNN, Faster R-CNN, R-FCN) to optimize detection performance under varying conditions.

Additional Techniques: Feature Pyramid Network (FPN) will enhance multi-scale object recognition capabilities. Techniques such as image segmentation, contrast enhancement, and the use of SSD detectors will further refine the accuracy of person detection.

IX. RESULTS (EXPERIMENTATION & SIMULATION)

Our project enables rapid and cost-effective access to extensive aerial data, facilitating efficient mapping of search zones and identification of potential locations of missing individuals. The system has demonstrated robust capabilities in detecting and accurately identifying humans within drone and aerial imagery, thereby enhancing the effectiveness of search and rescue operations.

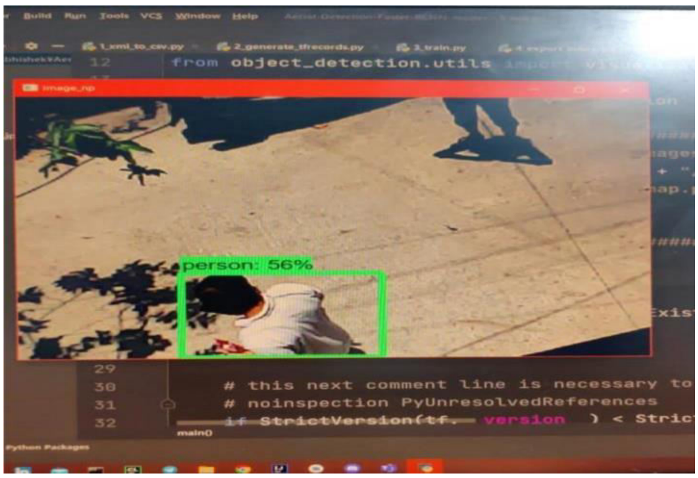


Fig.2(a): Human detection using images captured by drone along with probability/efficiency of detection

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 7, July 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1207062 |

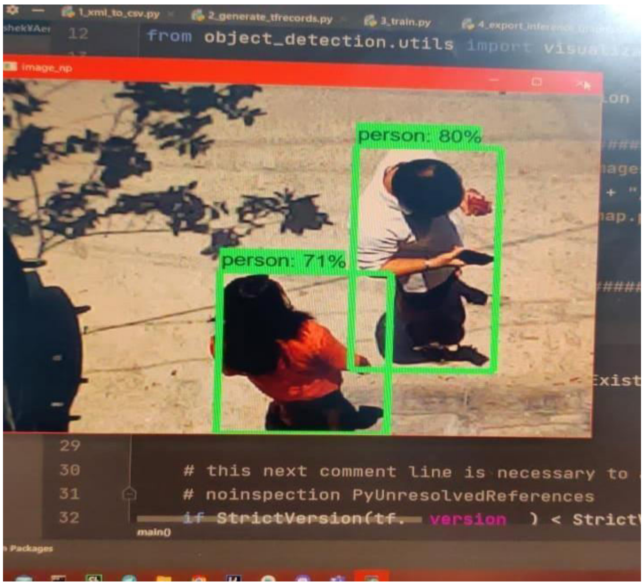


Fig.2(a): Human detection using images captured by drone along with probability/efficiency of detection

X. ADVANTAGES AND APPLICATIONS

1. Rapid Deployment: Drones can be deployed in under 2 minutes, significantly reducing response times in critical search and rescue operations.
2. Enhanced Safety: Drones enable safe operations in challenging environments such as mountains, forests, and bodies of water, minimizing risks to human rescuers.
3. Efficient Search: Drones efficiently cover large areas, enhancing the scope and speed of search operations.
4. Automatic Detection: Automated detection capabilities of drones streamline the search process by identifying persons and objects in images and videos.
5. Enhanced Vision: Thermal and infrared cameras on drones provide vital information that is invisible to the naked eye, aiding rescuers in detecting heat signatures and identifying individuals.
6. Cost-effectiveness: Drones offer a cost-effective alternative to traditional aerial platforms like helicopters or planes, reducing operational expenses significantly.

XI. CONCLUSIONS

In conclusion, this project underscores the critical role of automatic person detection using drone imagery in advancing search and rescue operations. By leveraging state-of-the-art person detectors and proposing a robust model tailored for SAR scenarios, the study has achieved remarkable detection performance and resilience to challenging weather conditions. The YOLOv4 model, in particular, has demonstrated superior accuracy, achieving optimal results on our custom dataset with high IoU precision and minimal false detections. The outcomes of this project hold promise for enhancing the efficiency of search and rescue efforts, ultimately saving lives and optimizing resource utilization. Future research directions include enhancing detection capabilities with thermal cameras and developing advanced models for activity recognition and human tracking in SAR environments.

XII. POTENTIAL OUTCOMES OF THE PROJECT

Creation of a novel dataset (SARD) specifically tailored for drone imagery in SAR operations.
Comparative analysis of various CNN-based detectors for SAR applications, evaluating their performance metrics and suitability.
Detailed exploration of network resolutions, detection accuracies, and optimization strategies, focusing on enhancing the YOLOv4 model's performance in person detection for SAR missions.
Proposal of new evaluation metrics (ROpti) designed to assess the effectiveness and efficiency of detectors in SAR scenarios.
Recommendation of the YOLOv4 model as an optimal solution for person detection in SAR operations, offering high accuracy and minimal false positives.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 7, July 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1207062 |

REFERENCES

1. Girshick, R., Donahue, J., Darrell, T., Malik, J. (2014) - Rich feature hierarchies for accurate object detection and semantic segmentation. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pp. 580-587.
2. Girshick, R. (2015) - Fast R-CNN. In: Proceedings of the IEEE International Conference on Computer Vision (ICCV), pp. 1440-1448.
3. Ren, S., He, K., Girshick, R., Sun, J. (2015) - Faster R-CNN: Towards real-time object detection with region proposal networks. In: Advances in Neural Information Processing Systems, vol. 28.
4. Redmon, J., Divvala, S., Girshick, R., Farhadi, A. (2016) - You Only Look Once: Unified, real-time object detection. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pp. 779-788.
5. Redmon, J., Farhadi, A. (2017) - YOLO9000: Better, faster, stronger. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), July 2017.
6. Redmon, J. (2018) - YOLOv3: An incremental improvement.
7. Tan, M., Pang, R., Le, Q.V. (2020) - EfficientDet: Scalable and efficient object detection. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 10 781-10 790.
8. Lin, T.-Y., Goyal, P., Girshick, R., He, K., Dollár, P. (2017) - Focal loss for dense object detection. In: Proceedings of the IEEE International Conference on Computer Vision, pp. 2980-2988.
9. Rethinking Drone-Based Search and Rescue with Aerial Person Detection (2021) - This study discusses the challenges of aerial person detection using high-resolution drone imagery.
10. Towards Real-Time Human Detection in Maritime Environment Using Embedded Deep Learning (2020) - This research focuses on real-time human detection in maritime environments using embedded deep learning techniques.
11. Dalal, N., Triggs, B. (2005) - Histograms of oriented gradients for human detection. In: Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), vol. 1, pp. 886-893.
12. Lowe, D.G. (2004) - Distinctive image features from scale-invariant keypoints. Int. J. Comput. Vision 60, 91-110.
13. COCO - Common Objects in Context (2020) - This dataset is widely used for training and evaluating object detection models.
14. EfficientDet: Scalable and Efficient Object Detection (2020) - Discusses a scalable object detection model that achieves high accuracy with fewer computational resources.
15. Examining YOLO for Real-Time Face-Mask Detection (2020) - Explores the application of YOLO models for real-time detection tasks.