A Computer Vision Approach to Ambulance Classification in the Philippines using YOLOv5 Small

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INTRODUCTION

One of the major problems that the Philippines is continuously facing is heavy traffic. This main problem leads to sub-problems that produce negative impacts on society [31]. A big portion of the medical field is affected, particularly to the emergency response vehicles or the ambulances. With this, the study describes the development of an object detection model that uses YOLOv5 Small to detect and classify the ambulances on the road, identifying them based on numerous types and attributes. In this study, the researchers set the following questions that will serve as a guide towards the objectives. (1) Is the YOLOv5s model able to attain high performance metrics in detecting and classifying different types of Philippine ambulances and its features? (2) By using the Structural Similarity Index (SSIM) to evaluate the dissimilarity between clean and augmented images, what is the average SSIM score, on a scale from 0 to 1, indicating the degree of diversity and non-redundancy achieved in the dataset? (3) By applying hyperparameter tuning, what is the optimal set of hyperparameters that should be used to maximize the performance of the YOLOv5s model? This study is made to close gaps and open opportunities. These are mainly the opportunity to bring computer vision application in terms of ambulance classification, the use of a small weight model for YOLOv5, and the opportunity to explore augmentation techniques with different hyperparameter tuning. Main significance of the paper is to make a cost-effective alternative to the traditional way of detecting ambulance and be able to test the best hyperparameter tuning. Furthermore, the study is limited to the utility of YOLOv5 model with small weight, application of the augmentation techniques of Flip, Hue, Saturation, Brightness, Bluer, and Noise, and hyperparameter tuning which includes the batch sizes for 8, 16, and 32. The dataset will be localized which includes the Philippine ambulances and the three types which are the type I, II, and III. The figure 1 below shows the different classes and types of vehicles that are included in the study. Figure 2 shows the effective detection and classification of the ambulances using the YOLOv5 small model.

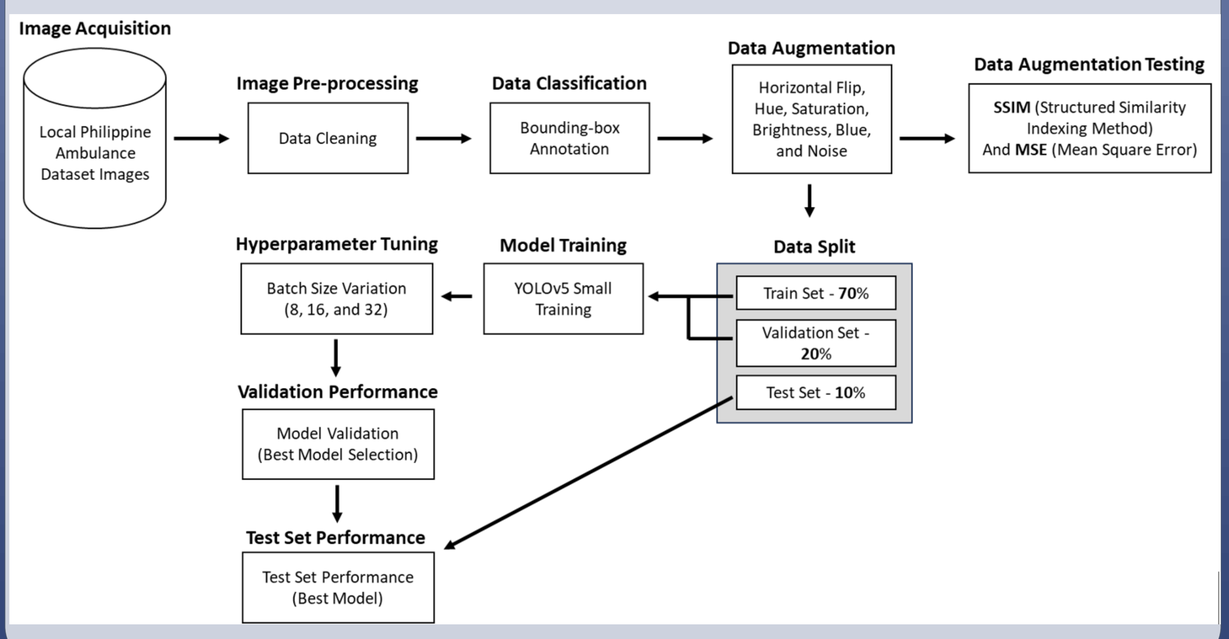
OBJECTIVES

This project aims to develop a customized vehicle dataset for ambulance detection in the Philippines and explore the scalability of an existing framework to create an improved YOLO model (YOLOv5s) for identifying ambulances different types and classes among standard vehicles on the road, facilitating their prioritization in traffic. The objective is to expedite ambulance travel times, enhancing patient care, and be able to utilize a model with hyperparameter tuning and augmentation techniques applied that is accurate for detecting and classifying the types of ambulances on the road. The researchers have created the following objective declarations to meet the research's goals:

1. Assess the performance metrics of the YOLOv5 model, specifically in the small weight, in detecting and classifying Philippines ambulances and their key features.
2. To assess the dissimilarity between clean and augmented images using SSIM in order to determine the average Structural Similarity Index (SSIM) score, which would reflect the diversity and non-redundancy attained in the dataset.
3. To identify the right set hyperparameters through hyperparameter tuning in order to maximize the performance of the YOLOv5 small model.

CONCEPTUAL FRAMEWORK

This section discusses the process of detecting and classifying Philippine ambulances using the proposed framework. Since there's a lack of research on ambulance detection models specific to this region, the researchers aim to utilize an existing YOLO object detection model with a localized dataset of Philippine ambulances. Collecting the dataset involves considering parameters such as ambulance type, siren lights, and label lettering. The methodology process involves data acquisition, image preprocessing, model training, and performance testing, all to improve ambulance detection through computer vision.



CONCLUSION

To classify ambulances according to its different types namely type 1, type 2, and type 3, this study had several objectives. The primary objective of this study was to evaluate the performance metrics of the YOLOv5 model, with a specific focus on its small weight configuration. The task involved the detection and classification of Philippines ambulances, along with the identification of key features. The achieved validation score of 92.8% mAP and a test score of 93% indicate a robust and reliable performance of the YOLOv5 model in meeting the specified objectives. The high accuracy in both validation and test phases highlights the model's proficiency in detecting and classifying Philippines ambulances, thus fulfilling the first research objective.

The second objective aimed to assess the dissimilarity between clean and augmented images using the Structural Similarity Index (SSIM). The obtained SSIM score of 0.1574 indicates a low structural similarity between the original and augmented images. This low SSIM score suggests that the augmentation process introduced significant diversity and non-redundancy into the dataset. A low SSIM score is desirable in this context, as it reflects the successful augmentation of the dataset, meeting the intended purpose of creating diverse and non-redundant data.

The third objective involved the identification of the right set of hyperparameters for the YOLOv5 small model through hyperparameter tuning. The experimentation with different batch sizes (8, 16, and 32) while maintaining a constant epoch of 150 revealed that a batch size of 8 yielded the best results. The selected batch size achieved a validation score of 92.8%, showcasing the effectiveness of hyperparameter tuning in maximizing the model's performance. This finding affirms the importance of fine-tuning hyperparameters for optimal results in object detection tasks using the YOLOv5 model.

RECOMMENDATION

This study has seen promising evidence that implementation of an ambulance vehicle detection and classification. However, further research is needed to build, strengthen, validate, and to advance these findings. Implementing advanced optimization techniques may further enhance the YOLOv5 model's performance. Exploring methods such as fine-tuning, transfer learning, or leveraging more sophisticated architectures could lead to improved accuracy and efficiency in detecting and classifying Philippine ambulances. Continuous refinement of the model through optimization is essential for ensuring its reliability in practical deployment. Recognizing the potential real-world impact of the model, it is recommended to explore applications in prioritizing ambulances at intersections. This would involve studying the model's performance in identifying and prioritizing emergency vehicles in traffic, thereby contributing to more efficient emergency response systems in the Philippines.

To ensure robust performance across various real-world scenarios, efforts should be made to create a more uniform dataset. This includes capturing images under different lighting conditions, weather scenarios, and traffic densities. A uniform dataset will contribute to a more generalized model that can effectively handle the diverse conditions encountered in the Philippines setting. Recognizing that real-world scenarios are dynamic; it is crucial to establish a system for continuous monitoring and updates. Regularly updating the model with new data and adapting it to evolving conditions will ensure its continued effectiveness in the ever-changing environment of Philippine traffic management.

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