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Improvement of Vehicle detection and classification performance with Region of Interest

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Abstract-Paper presents an innovative approach to improve the performance of vehicle detection and classification in the context of computer vision. This study proposes the use of Region of Interest (ROI) to identify and process vehicle information in traffic images. The proposed method is based on a combination of deep learning-based object detection algorithms with a more focused ROI-based approach. First, we use state-of-the-art convolution neural networks to perform object detection in traffic images, which involves a visual recognition process to identify vehicle locations. Then, using ROI, we reorder and reduce the dimensions of irrelevant data to remove background areas and increase attention to vehicle objects. This aims to reduce the computational load and speed up the detection and classification processes. We evaluate the proposed approach on a wide traffic dataset and compare the results with conventional object detection approaches without using ROI. The experimental results show that the proposed method outperforms the conventional approach in terms of vehicle detection speed and accuracy. In conclusion, this study succeeded in improving the performance of vehicle detection and classification by leveraging Region of Interest, which allows better focus on relevant regions and reduces computational complexity. These results can make an important contribution to the development of a more efficient and reliable traffic control and transportation system.

Keywords: ROI, Detection, Tracking

1. INTRODUCTION

In the era of increasingly advanced information technology, vehicle detection and classification systems have become very important for traffic control and transportation mobility. Computer vision, especially deep learning-based object detection techniques, has made a significant contribution to addressing this challenge[1][2]. However, there are still some hurdles that need to be overcome, such as computational complexity and detection accuracy which is affected by the background context in traffic images[3].

Previous research has tried to improve the performance of vehicle detection and classification by using various methods such as reducing data dimensions, applying transfer learning techniques, and adjusting model architectures[4][5]. However, research is limited to conventional approaches that ignore the importance of focusing attention on the more relevant areas in the traffic picture[6].

In this paper, we propose an innovative approach that integrates Region of Interest (ROI) to improve vehicle detection and classification performance[7][8]. ROI is a concept that has proven effective in a variety of computer vision applications, where attention is paid to certain parts of the image that are more relevant to the task to be accomplished.

The approach proposed in this paper will use a combination of deep learning-based object detection algorithms with a more focused ROI approach[9]. By identifying areas containing vehicles and removing the irrelevant background, it is hoped that this approach can improve detection accuracy and efficiency[10].

Through careful experimentation, we will evaluate the performance of the proposed approach by comparing it to conventional approaches[11]. The experimental results will provide insight into the extent to which the use of ROI can provide performance improvements in vehicle detection and classification[12][13].

It is hoped that the results of this research will make a significant contribution in the development of a more sophisticated and reliable transport mobility and traffic monitoring system. In addition, this paper can also be a basis for further research in the field of computer vision and image processing to address increasingly complex challenges in this domain.

2. RELATED WORKS

Based on previous research, it takes a long time to get vehicle detection accuracy[5]. When implemented in real time[14], vehicle detection becomes inaccurate. The arrival time of frames is faster than the processing time of each frame. The processed area is all the pixels contained in the frame[15][16]. The average processing time for processing image data, starting from the separation process between background and foreground, thresholding, to vehicle tracking. This study proposes a solution by providing a processing area using ROI.

3. METHOD

In this study, it was carried out by comparing detection with the help of ROI and without ROI which were then compared. Following are the steps taken:

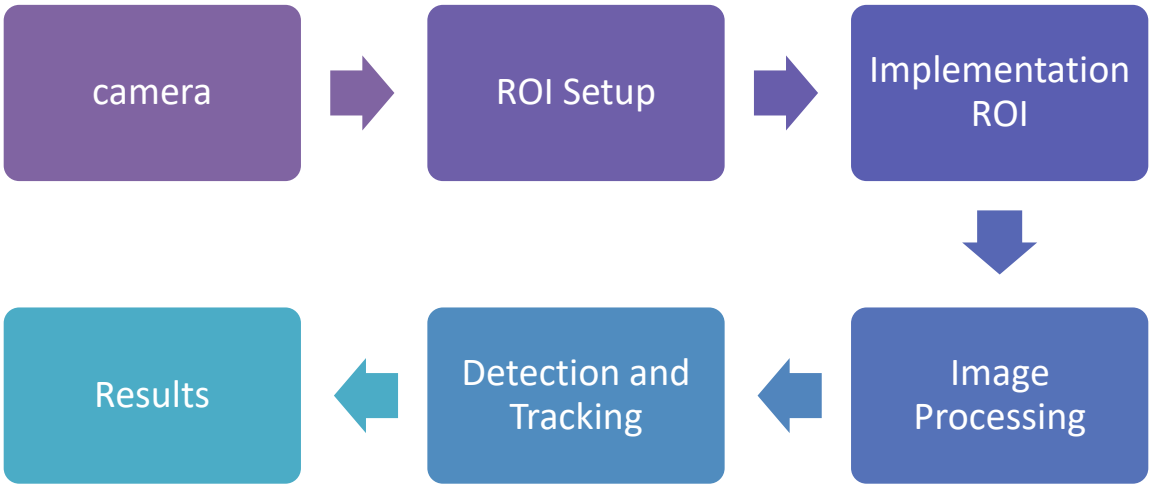

Figure 1: Propose Method Implementation ROI

3.1 ROI Process

The ROI process that occurs is by selecting an area in the video frame. The ROI process in this study is used to limit or reduce the processing area. Limiting the processing area is done by determining the road area[17]. Restricting the highway area is done so that objects that are outside the area do not add noise to the image to be processed . The purpose of implementing ROI in this study is to increase processing time so that it can be implemented on a mini PC (Personal Computer) such as the Raspberry Pi. The implementation of ROI in this study has two stages, firstly determining the determination point for the ROI area and secondly applying ROI in the system program, so as to speed up processing time. ROI is used to limit the vehicle detection area, the video used was taken at the Jombor Yogyakarta underpass using a Logitech C270 webcam with a resolution of 1280 x 960, with a maximum of 30fps. The video format is saved in the mp4 extension. The time of data collection is carried out in the morning, afternoon, evening and night at the same point , provided that the data is collected in sunny weather conditions. Image data processing is carried out using the Python programming language and using OpenCV for the image data processing library[18]. Testing is carried out using a video that has been previously recorded at the time mentioned in the previous section.

The application of the ROI algorithm is carried out by processing the frame as a whole[19]. ROI is used to optimize the algorithm by limiting certain areas of the frame so that the process is only carried out on the ROI part and not on the entire frame. The implementation of ROI on the frame can be shown in Figure 2. Shows the original frame before the addition of the ROI process, showing that there is still a lot of noise or interference during the vehicle tracking process. Figure 2 shows that after adding the ROI process, noise or interference can be reduced so that processing time can be faster.

The stages of determining the ROI area on vehicle detection are as follows:

Step 1. Take the outermost point of the counter line which is right on the edge of the road

Step 2. Use the right and left outer points on the edges of the path

Step 3. The location of the outermost pixel point on the left, reduced by a predetermined constant. Then on the right, place the outermost dot pixels plus the specified constants.

Step 4. Draw parallel straight lines at the four points so that the ROI area is formed.

The ROI area determination starts from the top left point to the bottom right point. The ROI depiction process is shown in Figure 5. The ROI implementation process is carried out as follows:

1. Declare the ROI function

2. Call the ROI function to implement it on the frame to be processed.

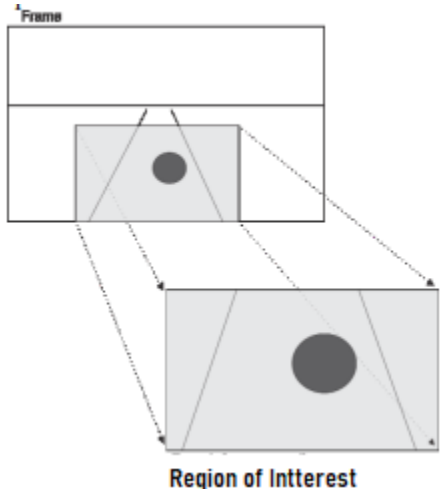

Figure 1: Selected Region of interest

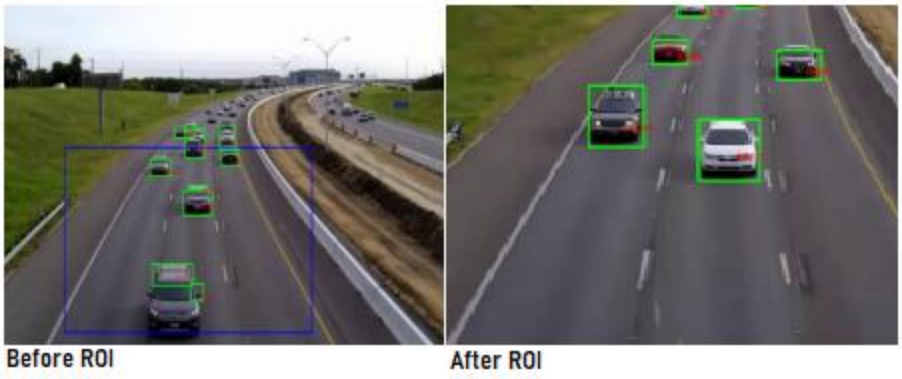

Figure 2: Implementation of ROI

Image processing in research has five (5) stages, namely:

- Separation of objects with their background using the MOG2 Background Substractor.
- The use of thresholding to emphasize the edge of the object
- Image smoothing using Gaussian Blur
- Thresholding returns to emphasize the object
- Closing holes in objects using closing morphology.

3.2 Detection and Tracking

The detection process is carried out using the Contouring function found in OpenCv. The contour function is an introduction to the contours of the image, the contour function can be used to detect the shape of an object by combining the dots formed from each curve on a contour. In addition, the Contour function can also be used to analyze the shape of an object, detect and recognize an object. After the detection process, the tracking process is carried out.

same object so as not to miss the object to be detected, in this case tracking is useful for knowing the direction of movement of an object. The tracking function is performed by using the midpoint of the object so that it can be stored in an array. The tracking function is implemented by using the existing functions in OpenCV, namely, the convexHull function to correct the shape by ignoring concavity on the edge of the object and boundingRect to give a square-shaped frame to the object so that you can find out the size of an object.

4. RESULTS AND DISCUSSION

Testing is carried out by collecting video data that has been determined by the limits of capture, for example camera height, camera fps, shooting time and others. Testing is done by looking at the processing time that occurs when the algorithm is used before using ROI and then a comparison is made by looking at the processing time that occurs when the ROI process is added which is run on several machines, including (laptop, raspberry pi3 and odroid xu4) . The test results using a laptop are shown in Table 2, the test results using a Raspberry Pi3.

The following are the results of testing at different times of the day and night

Table 1: Comparison of processing time with ROI and without ROI

No	Afternoon			Evening		
	No ROI	ROI	Difference	No ROI	ROI	Difference
1	0.035	0.007	0.028	0.025	0.007	0.018
2	0.018	0.007	0.011	0.039	0.008	0.031
3	0.034	0.005	0.029	0.044	0.009	0.035
4	0.056	0.004	0.052	0.037	0.014	0.023
5	0.037	0.003	0.034	0.062	0.011	0.051

From the comparison data using ROI at night will increase processing time by 85.5% during the day while at night by 76.3%.

5. CONCLUSION

In this paper, an innovative approach has been proposed to improve the performance of vehicle detection and classification by utilizing the Region of Interest (ROI). The aim of this study is to overcome the constraints in vehicle detection and classification systems, such as computational complexity and accuracy which are affected by the background context in traffic images. Through careful experimentation, it has been possible to evaluate the performance of the proposed approach by comparing it with conventional approaches. The results of the experiments show that the use of ROI has provided a significant increase in vehicle detection and classification performance. Applying ROI to traffic images has enabled the system to focus more on a more relevant area, i.e. vehicles, and reduce the influence of background that does not contribute to the detection process. This leads to increased detection accuracy and reduced computational complexity, which in turn increases the efficiency of the detection and classification processes. The experimental results also show that the proposed approach has achieved a good balance between accuracy and speed, making it a very promising solution in traffic control and transport mobility. In the context of this study, ROI has been proven to be an effective technique in improving vehicle detection and classification performance. However, this research also opens the door for follow-up research for further exploration of the use of ROI in various domains of computer vision and image processing.

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