OpenCV and Machine Learning Implementation for the Vehicles Classification and Calculation in the Parking Tax Monitoring System at the Bantul Regency Regional Financial and Asset Agency (BKAD)

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Abstract. After regional autonomy has been implemented in Indonesia, local governments must maximize its revenue through various sectors, including the Bantul Regency government. One source of regional income is a local tax, based on law no 28 of 2009, one type of tax-managed by local government is the parking tax. Either an off-street parking lots, those provided in connection with the business principal, those provided as a business, or motor vehicle daycare (Indonesian Law No.28 of 2009). The parking tax is a self-assessment tax. Taxpayers will calculate their amount of tax that must be paid to the government. Therefore, the local government should conduct oversight of the reports of taxpayers. One form of supervision carried out is to monitor the number of vehicles at the taxpayer's location. Officers then record the number of vehicles based on vehicle classification, whether they were two-wheeled or four-wheeled vehicles or other vehicle types. Currently, monitoring is done manually using a mechanical counter. This monitoring may have the risk of being miscalculated or wrongly recorded due to the monitoring officer's oversight. Computer vision (OpenCV library) and machine learning (Mask R-CNN), is expected to minimize these errors and optimize the officers' performance on duty.

1. Introduction

Since regional autonomy implementation [1], there has been an authority division between the central and local governments. Following the applicable laws, regional governments are given the discretion to manage their respective government activities. Indonesian government structure divided into Central, Provincial, Regency/City, and the sub-district government.

As for regional autonomy implementation, local governments, either regency or city governments, are required to be independent in various income fields, including financial independence. To achieve regional financial autonomy, local governments need to optimize their Original Regional Income, including local taxes and levies. Local taxes [2] contribute by an individual or business entity for the government, based on obligatory law. Taxpayers wouldn't receive any direct compensation from it. Taxes are used for regional needs, for the greatest prosperity of the people (Law of Indonesian Republic Number 28 Year 2009). Bantul Regency Government, through the Bantul Regional Financial and Asset Agency (Badan Keuangan dan Aset Daerah/BKAD Bantul), is expected to make various efforts and innovations to be able to increase its regional revenues. There are two types of taxes, official-assessment

and self-assessment taxes. If the government determines official assessment taxes, self-assessment taxes are determined based on taxpayers' self-reports. To increase its local revenue, the government must conduct monitoring activities on its taxes. One of the local taxes that is collected by the local government is the parking tax. Parking tax is a tax on the operation of parking spaces outside the road entities, whether provided by the leading business or those provided as a business, including the garage rents for motorized vehicles (Indonesian Republic Law, Number 28 Year 2009). The parking tax is a self-assessment regional tax. Through BKAD Bantul, the local government is obliged to monitor and examine parking taxpayer reports' results. Based on the description above, this paper will discuss the Implementation of Opencv and Machine Learning for the vehicle classification and calculation for the Parking Tax Monitoring System at the Regional Financial and Asset Agency (BKAD) Bantul Regency. Automation of the classification process and the number of vehicles' calculations expected to assist related parties in monitoring the number of vehicles for parking tax monitoring activities.

2. Related Work

Nowadays, computer vision and machine learning are some of the emerging research studies. Computer vision can analyze, modify, and understand the information contained in images. Neither the image objects are photos nor videos. The primary purpose of computer vision is to understand objects and then provide the information needed from them. Machine learning is a widely used method for machines to analyze extensive data in recognizing objects. These followings are some of the literature studies referred to in this paper.

2.1. An Introduction to OpenCV using Python with Ubuntu [3]

OpenCV [4] is a free Image Processing library created by Intel. This library is available for many programming languages: C, C++, Java and Python, Windows, Linux, Mac OS, iOS, and Android. The latest version of this library is the version 2.4.13 and 3.1. OpenCV is an open-source library that easy to use and install. It is designed for the efficient computational process on real-time applications. The first implementation was on the C programming language. But, as version 2.0 launched, it's more popular used in C++ programs. Nowadays, OpenCV already supports other programming languages, such as Java, Python, and MATLAB/Octave. We can download the OpenCV library from the site, http://opencv.org. The site provides some versions of the library (currently, 3.0 beta) and older versions.

2.2. Moving Vehicle Detection for Measuring Traffic Count Using OpenCV [5]

Vehicle detection is important for many fields, like military, civilian, and government applications. The government needs real-time automatic vehicles counting on every road to manage the traffic. It either can use streams or pre-recorded video as classification and counting image objects. This paper use th visual C++ as the programming language to present an inexpensive, portable, and computer vision-based system for moving vehicle detection and counting. The video is extracted into some video sequences to detect moving vehicles. Then it was classified whether it was a light vehicle, a heavy vehicle, or a motorcycle. The project was developed by background subtraction, image filtering, image binary, and segmentation methods and tested on a laptop powered by an Intel Core Duo (1.83 GHz) CPU and 2GB RAM.

2.3. Vehicle Detection And Counting In Traffic Video Based On OpenCV [6]

With the modern social economy increasing, vehicle number in countries is growing rapidly, including China. Therefore, getting real-time traffic parameters very important because of the limited road space significance. Nowadays, the vehicle video detection method based on image processing develops rapidly. The project used real-time traffic video and processed to get each frame. Then the video was filtered by the Gaussian denoising. After that, it marked the region of interest (ROI) and applied a background subtraction algorithm. Next, they get the binarization foreground image, set threshold to eliminate moving objects (whose space is just too small), and check the boundary of ROI to evaluate the moving vehicle and count. These steps are used to get parameters results of intelligent transportation.

2.4. Mask R-CNN [7]

This project paper uses a simple, flexible, and general framework to segmenting object instance. It detects an image object while simultaneously generate the instance's high-quality segmentation mask. It

used Mask R-CNN; it's an extension of Faster R-CNN. Mask R-CNN added a branch for object prediction mask for bounding box recognition. It was simple to train and add a small overhead to Faster R-CNN. It was running at 5 Fps. Mask R-CNN an also use to estimate human poses in same framework. This picture below shows COCO results, including instance segmentation, bounding box, and key-point person detection. Because of the performance, Mask R-CNN has won the COCO 2016 challenge, as shown in Figure 1.

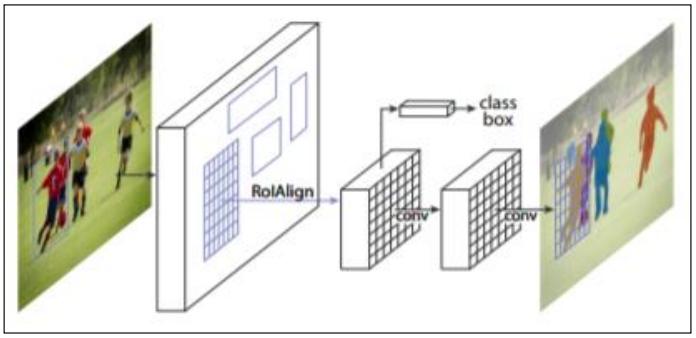

Figure 1. The Mask R-CNN Framework for Instance Segmentation

3. Methods

This research will use computer vision and machine learning [8] to process image data. We will implement Computer vision and machine learning for various user needs, including classifying and counting the number of vehicles recorded by the camera; the processed object can be a video or a photo. In computer vision, we can use several steps in the OpenCV [9][10] library in the coding process. Opening models and classes (1), reading input (2), and processing frames (3). The steps are available at www.opencv.org. After that, we can use mask R-CNN [11] to predict whether the image object has met the criteria or not, as shown in Figure 2.

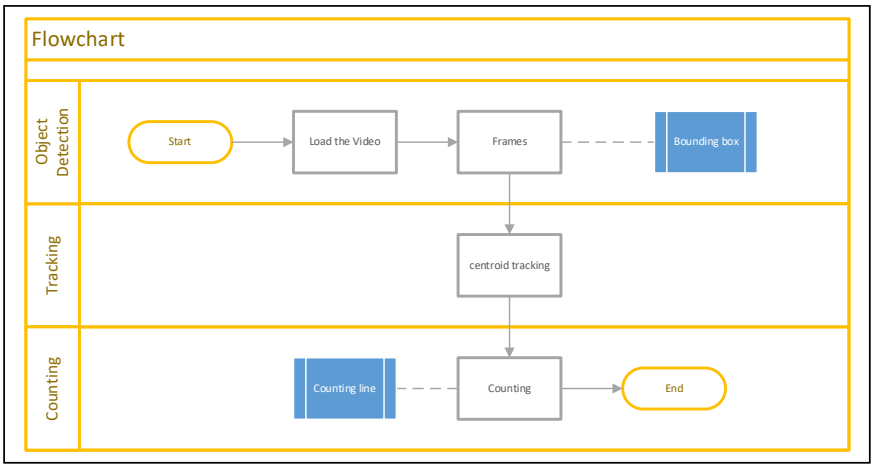

Figure 2. Flowchart

4. Implementation

The objective of this research is to count every vehicle that will enter the parking area. Every vehicle that will enter the parking area will pass a camera installed at the entrance. The method used in counting it passing through the parking gate is the same as the method used to classify and count it on the road. This study's video sample is a video of vehicles' flow on the road with various vehicle types at different speeds.

4.1. Object Detection

We use recorded traffic on the underpass road in Yogyakarta province as a research sample. Then we use these videos for vehicle classification and calculation implementation, as shown in Figure 3.

Figure 3. Road traffic sample

After being loaded, we create a detection box to identify the counting area (red box). After that, we create a bounding box around each object (green box). The object detector computes every frame in the video. Any object detector can produce bounding boxes, such as color thresholding + contour extraction, SSDs, R-CNNs, etc. This paper uses mask R-CNN to compute object detection and put the bounding box around an object, as shown in Figure 4.

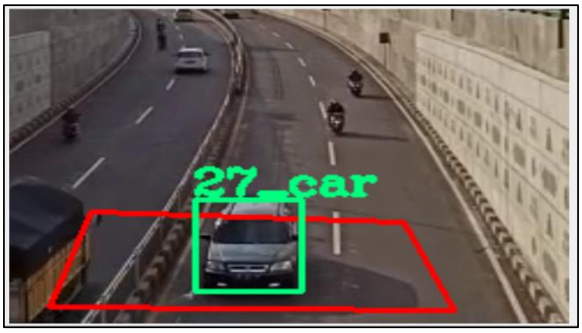

Figure 4. Detection box and bounding box

4.2. Tracking

Once we have the bounding box, we have to calculate the "centroid." The centroid is the center coordinates (x, y) of the bounding box. It uses to track the object movement in the video. Whether the object is passing through the imaginary red box or not, a shown in Figure 5.

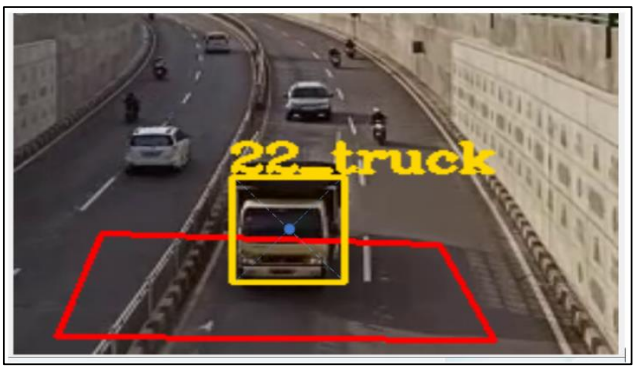

Figure 5. Centroid

4.3. Counting

As the vehicles pass by, the system will automatically classify the vehicle, count them one by one, and then show us the results, as shown in Figure 6.

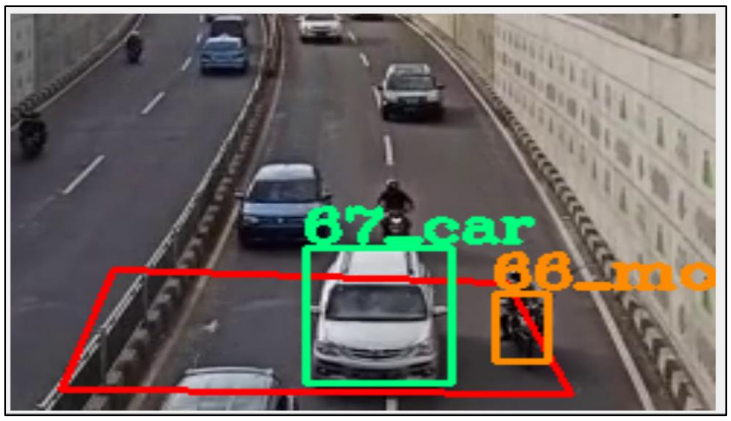

Figure 6. Classification and counting

5. Conclusion

Access to these technologies has gotten easier. The use of information technology can be applied in many fields, included in government activities, such as monitoring parking tax revenue. Vehicle classification and calculation can use computer vision technology and R-CNN masks. An example is the OpenCV library and R-CNN mask'. This technology is not limited to the classification of vehicles and can also use in other sectors.

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