CHAPTER 1

INTRODUCTION

Parking is one of the facilities that cannot be separated from the smart transportation system. Construction of buildings or places of public activity that often do not provide sufficient parking areas, makes drivers use part of the road to park vehicles. The rapid increase in the number of vehicles causes an imbalance between vehicles and parking lots that have been provided because most residents in big cities travel using private vehicles . This often makes it difficult for a driver to find a place to park his vehicle or ensure the availability of free space on a parking lot.

Drivers usually want parking in a place that is easy to reach, so they prefer to park on the side of the road. Public roadside parking is a type of parking placed along the edge of a road body, with or without widening the road body as a parking facility. Of course with excellent parking facilities and smooth circulation of passing vehicles.

Roadside parking is a place on the edge of a public road that has been determined by the Mayor, and this included in the regional regulation on Makassar City Vehicles Number 17 of 2006 concerning the management of Public Roadside Parking in Makassar City Region. Parking on the roadside is usually done in parallel, series, or oblique depending on the signs and markers set. Roadside parking is important for roadside business activities such as pharmacies, 24-hour shops, small offices, restaurants, and city tourism areas so that the existence of on-street parking can facilitate visitors to move in the area. Parking on the side of the highway can be used as a solution to the lack of available parking, on-street parking is also more suitable for disabled drivers to facilitate their access to the place they are going.

Currently, the roadside parking service that used is still conventional, which is using a handwritten parking ticket as proof of vehicle parking. When the vehicle exits the parking location, the ticket will be tearing up by the parking attendant. The conventional parking system does not have a special record of visitor data in and out of the parking area, and this will complicate the process of identifying the capacity of the vehicle in the parking area. Even parking attendants do not know the number of vehicles and the capacity of the parking space so that it can cause congestion.

Controlling parking on the road can be done in various ways, such as parking time restrictions and the application of progressive parking rates, the longer the vehicle parked, the more expensive the parking rates will be on the building or parking area. This is considering that parking on the street means reducing the capacity of the road concerned, therefore parking fees on the road body become expensive.

Therefore, in order not to cause congestion and spend time searching for parking slots, management, and information about the availability of parking spaces on the roadside is very important for drivers and parking attendants to find out how long a parking vehicle is. Smart Parking, specifically for roadside, is a system that will be designed in this study to make it easier for motorists to know the availability of parking slots and the location of parking slots that are still empty.

CHAPTER 2

LITERATURE SURVEY

- Rhodes et al. utilized the search of empty parking slots through the nearest lane to overcome the problem of parking queue congestion and resulted in a 58.92% reduction in congestion compared to conventional parking.
- Kotb et al. research on smart parking resulted in an application called Ippark based on smart computer system allocation, reservations, and pricing of parking, to optimize parking systems by maximizing parking usage by 21%, and increasing total revenue for parking management by up to 16% compared to conventional systems.
- Liu et al. developed an online parking guidance system that recommends parking spaces in real-time based on predicted parking availability, increasing the effectiveness of parking slots by 63.8%.
- Tooraj et al. in 2015 developed a guidance system and parking information that can predict parking availability at parking locations before the arrival of users with 95% accuracy that can be relied upon using Multivariate Autoregressive that takes into account the correlation of parking distance and availability.
- Bibi et al. in 2017 also researched parking availability through the online vision booking application to assist drivers in finding parking slots using the ANN algorithm with an accuracy of 99.5%.
- Bura et al., in 2018, created smart parking that adapted conventional parking to identify parking spaces that are occupied, empty, and special areas. The algorithm used is CNN to get an accuracy of 98%.

CHAPTER 3

PROPOSED SYSTEM

The camera is placed on the side of the road, which is used as a parking lot so that it can detect empty parking lots and parked vehicles.

The illustration of the proposed system can be seen in Fig. 3.1.

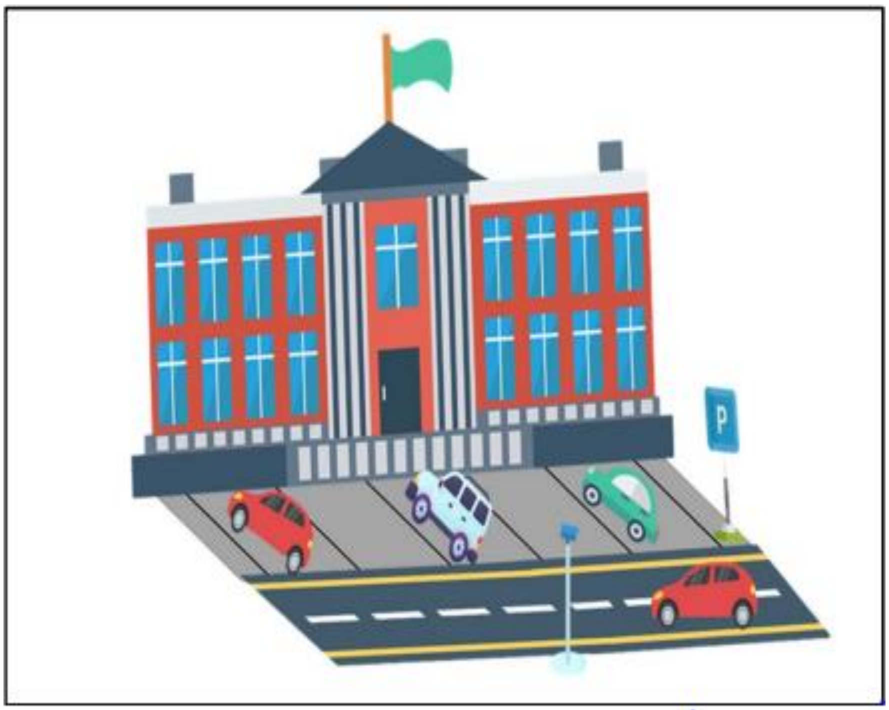

Fig. 3.1. System illustration.

3.2 INPUT DATA

The input data used in this study is a video taken using a CCTV camera with a height of 2.5 meters in one of the roadside parking lots. The parking capacity available at this parking roadside is five cars.

3.3 DATA PREPROCESSING

The input data in the form of video is converted into a frame to make it easier to detect cars parked on the highway.

Next, change the image to grayscale. In computing, a grayscale or greyscale digital image is an image where the value of each pixel is a single sample. The image displayed from this type of image consists of gray, varying in black at the weakest part of the intensity and white at the strongest intensity. The grayscale image is different from the "black-and-white" image, wherein a computer context, black and white images, consist of only two colors, namely "black" and "white" only. In grayscale images, the color varies between black and white, but there are very many color variations. Grayscale imagery is often a calculation of the intensity of light at each pixel in the single band electromagnetic spectrum. Image conversion from RGB to the grayscale mat is very necessary for image processing purposes, including to reduce file size and to meet the requirements of several identification algorithms that require a single matrix image. Process of converting from RGB to Grayscale can be seen in fig. 3.3.

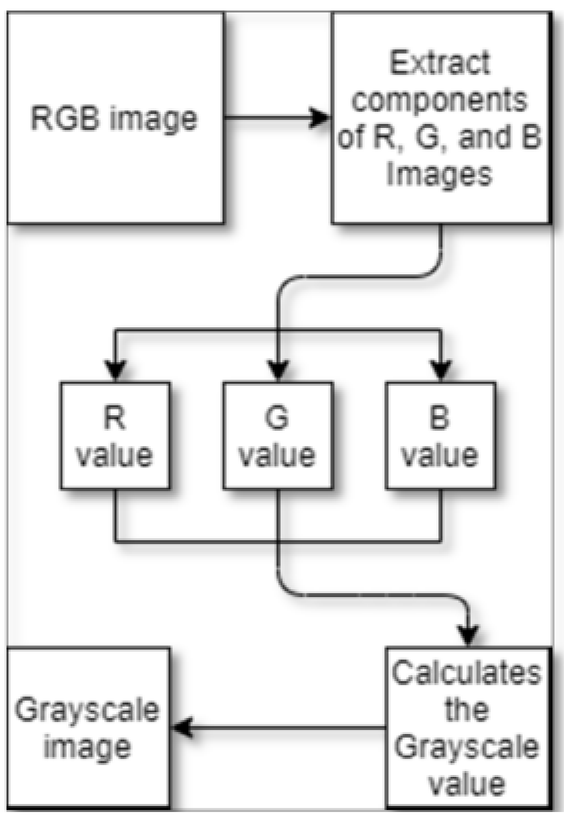

Fig. 3.3. Convert the RGB image to grayscale.

To conversion of RGB images to Grayscale can be seen in the following equation:

$$\text{Grayscale} = \frac{R+G+B}{3} \qquad (1)$$

Where:

R = Red

G = Green

B = Blue

3.4 DETECTION OF PARKED CARS USING THE HAAR CASCADE CLASSIFIER

In this study, haar cascade classifier and YoloV3 methods are used to detect vehicles, in this case, cars parked on the side of the highway. Accuracy results from each method will be compared in Chapter 4.

Object Detection using Haar feature cascade classifiers is an effective object detection method, this method was proposed by Paul Viola and Michael Jones in their paper entitled, "Rapid Object Detection using Cascade Booster of Simple Features" in 2001.

Several processes are carried out to detect objects using the haar cascade classifier method before finally, it will produce an object output that is detected in an image. The process is Haar-Like Feature, Integral image, Adaboost (Adaptive Boosting), and Cascade Classifier. Schematic of the process of each stage traversed by an image to obtain the results of the detection of vehicle objects can be seen in Fig. 3.4.

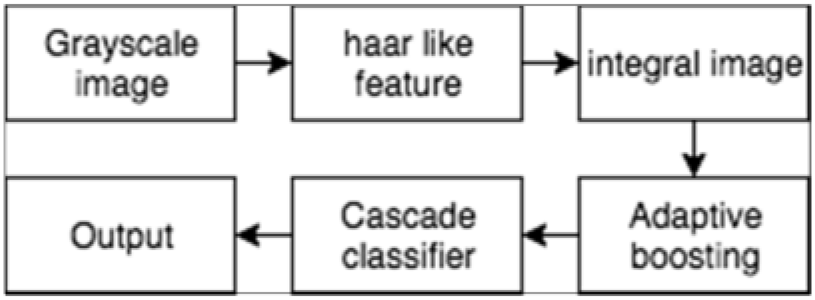

Fig. 3.4. Car detection scheme uses the haar cascade classifier.

3.5 YOLOv3 DETECTION

You Only Look Once (Yolo) is an algorithm developed to detect an object in real-time. The detection system is done by using a repurpose classifier or localizer to make a detection. A model is applied to an image in several locations and scales. The area with the image that is given the highest score will be considered as a detection.

YOLO uses an artificial neural network (ANN) approach to detect objects in an image. This network divides the image into several regions and predicts each boundary box and probability for each area. These bounding boxes then compared with each predicted probability. YOLO has several advantages compared to classifier-oriented systems, seen from the entire image at the time of the test with predictions that are informed globally on the image. In general, classification is the process of identifying labels from the data being tested, whereas in Yolo, classification is by localization, i.e., there is an additional assignment of the location of objects in the form of bounding boxes (bx, by, bh, bw)

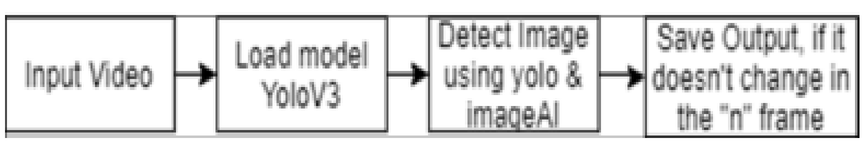

Fig.3.5. Flow detection of cars using YOLOv3.

The following are some parameters used to detect cars parked on the side of the highway:

• **PROBABILITY:**

Probability is set to 90%, so the system only detects cars with a probability score above 90%. This probability value was chosen because, in the roadside parking lot, there are many cars caught on camera. Still, only five car parking slots must be detected correctly by the system.

Therefore, if the probability is set below 90%, then passing cars will be counted by the system as parked cars. If the probability is set to 100%, the system will not be able to detect a parked car because the position of the vehicle on the edge of the parking lot captured by the camera is only half the car body.

•**TOTAL FRAME TO KEEP:**

Cars that are detected by the system will only be saved if the car remains in the parking area of the highway more than five frames.

CHAPTER 4

EXPERIMENT

Furthermore, an experiment carried out using several scenarios, where there were several cars parked, and cars were going in and out of the roadside parking lot. This scenario recorded using a CCTV camera.

In Table I, there can be seen several test scenarios used in this study:

TABLE I. TESTING SCENARIO

No	MP1	MM	MK	MP2
1	1	0	0	0
2	5	0	2	3
3	5	0	1	4
4	4	1	0	5
5	2	0	1	1
6	1	1	0	2
7	3	1	0	4
8	3	0	0	3
9	3	1	1	3
10	2	0	0	2

1. In the first video, there is one parked car and no cars going in and out.

2. Five cars are being parked, and then there are two cars coming out of the parking lot.

3. There are five cars parked, and then one car left so that the remaining four cars in the parking lot.

4. There are four cars in the parking lot, and then one car is added to the parking lot, so there are five cars.

5. Two cars are being parked, then one of the cars exits the parking lot.

6. There is one car parked then one car enters the parking lot.

7. There are three cars in the parking lot then one more car is added to the parking lot.

8. There are three cars in the parking lot and no cars going in and out.

9. There are three cars in the parking lot, one car left the parking lot, then replaced by one other vehicle entering the parking lot.

10. There are two cars parked.

CHAPTER 5

RESULT

The results of detecting cars on the roadside parking using the Haar Cascade Classifier method can be seen in Table II, and YOLOv3 can be seen in Table III. Where MM is a car that enters the parking area, MK is a car that comes out of the parking area, MP1 is the number of vehicles that parking at the start of the video, and MP2 is the number of cars parked when the video ends.

Next, a confusion matrix is used to evaluate the performance of the car detection system for smart parking. Confusion Matrix can present predictions and actual conditions. Accuracy is one of the metrics for evaluating classification models.

Accuracy is defined as the level of closeness between the predicted value and the actual value. To calculate accuracy can be seen in the following formula:

$$\text{Accuration} \frac{\textit{The amount of data detected correctly}}{\textit{Total data}} \quad (2)$$

Testing using the Haar Cascade Classifier only works well in scenario 1 and scenario 5, it can be seen in Table II.

TABLE II. HAAR CASCADE CLASSIFIER

No	MP1	MM	MK	MP2	Average accuracy / Scenario
1	1	0	0	1	100
2	2	0	1	1	55.83
3	2	0	1	1	66.25
4	1	0	0	1	36.25
5	2	0	1	1	100
6	1	0	0	1	62.50
7	2	0	0	2	54.17
8	1	0	0	1	66.67
9	1	0	0	1	16.67
10	1	0	0	1	75.00
The average results of Haar cascade classifier accuracy					63.34

In scenario 1, only one car is parked, and no cars enter to park or exit the parking lot, and for scenario 5, there are two parking cars and one car coming out of the parking area.

While for other scenarios, the Haar Cascade Classifier does not work well in terms of the number of vehicles that are not detected correctly.

An example of detecting a car parked on the roadside using the haar cascade classifier method can be seen in Fig. 5.1.

Fig. 5.1. One example of the results of detection of cars using the Haar Cascade Classifier.

Detection results of parked cars using YOLOv3 with ImageAI produce an average accuracy of 96.88%. The wrong detection data is in scenario 7, where one of the parked vehicles only looks less than half of the car body on the camera. Therefore the system cannot detect the car because the probability set is 90%, the result of detecting cars using YOLOv3 can be seen in Table III.

TABLE III. YOLOV3

No	MP1	MM	MK	MP2	Average accuracy / Scenario
1	1	0	0	1	100
2	5	0	2	3	100
3	5	0	1	4	100
4	4	1	0	5	100
5	2	0	1	1	100
6	1	0	0	2	100
7	3	0	0	3	68.75
8	3	0	0	3	100
9	3	1	1	3	100
10	2	0	0	2	100
The average result of YoloV3 accuracy					96.88

Furthermore, for the YOLOv3 method with Image AI, the test results can be seen in table 3 and example of detecting a car parked on the roadside using the yolov3 method can be seen in Fig. 5.2.

Fig. 5.2. One example of the detection results using YOLOv3.

Detection is a complicated thing compared to classification, classification can recognize objects but cannot tell where the exact location of objects is in the image and classification will not work correctly if the image contains more than one object.

The average time to detect a parked car based on the test scenario above using the haar cascade classifier is 89.87, while the Yolov3 with normal speed is 1423.10 ms.

CHAPTER 6

FUTURE SCOPE

Future research will be focused on security parking system as a complement of this smart parking space detection. Additional guidance devices such as light guidance to the available parking and placing LED at each car parking lot is also considered.

By using GPS system we can find where the car park and also we can find number of vacancy available in parking system

CHAPTER 7

CONCLUSION

The data used in this study were taken using a CCTV camera with a height of 2.5 meters, the method used was Haar Cascade Classifier and YOLOv3 with their respective accuracy. The test was carried out using ten different scenarios. The highest accuracy obtained using YOLOv3 is 96.88%, while the Haar Cascade Classifier gets an accuracy of 63.34%.

The car detection on roadside parking for smart parking system based on image processing was designed and tested. By identify the rounded brown image drawn at each parking lot as a reference on image detection, it makes the process of detecting image as a reference more efficient compared to the use of a moving object. The conceptualization of this project is to discover the parking system by using image processing instead of using sensor base. Smart parking system is developed using an integrated image processing approach to reduce cost of sensor and wiring hassle.

Getting the land in metropolitan cities and other higher order cities for parking space is proving infeasible.

The solution for the parking requirements is the multilevel car parking system to maximize car parking capacity by utilizing vertical space, rather than expanding horizontally.

Car detection on roadside parking for smart parking system reduces parking and retrieval time. saves time spend in searching for empty parking slots and time spend is searching the parked car.

CHAPTER 8

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