IMPLEMENTATION OF EMPIRICAL ADAPTIVE THRESHOLDING METHOD IN A PROTOTYPE OF PARKING MANAGEMENT MONITORING SYSTEM

[1]TRI WIDODO, [2]SAHID BISMANTOKO, [3]ASEP HARYONO

Agency for The Assessment and Application of Technology -Indonesia
E-mail: [1]tri.widodo@bppt.go.id, [2]sahid.bismantoko@bppt.go.id, [3]asep.haryono@bppt.go.id

Abstract - The problem of parking systems on the street is a classic problem that occurs from year to year, many solutions are offered in solving the parking problem on the street. The problem is not only related to traffic jams due to in and out of vehicles from the parking spaces but also the parking management issues become polemic at this time. A prototype of parking management monitoring system tries to provide solution in managing parking by using image processing based smart camera. In a prototype the system test performed on day and night conditions, to anticipate the very contrast difference intensity of pixels during the day or night so as to develop vehicle detection program using adaptive thresholding. The results show that the program has been running quite well to identify vehicles during day and night conditions.

Index Terms - Smart Camera, Monitoring System, Management System and Adaptive Thresholding.

I. INTRODUCTION

Traffic congestion is one of the problems in urban areas, many factors are the cause of traffic congestion such as no discipline in parking the vehicle on street so as to disrupt the traffic around it. The irregularities in parking of vehicles on the street cause the availability of parking space become not optimum. Currently the parking management system in Indonesia still uses a manual system in which there is a parking officer to guide parking and receive payment. Technically problems arise during the development of vehicle identification in the parking lot during day or night. The difference in pixel intensity due to daytime lighting is more homogeneous but the object shadow is clearer, while at night the lighting is more uneven because it depends only on the street lighting. By using adaptive thresholding empirically the difference in pixel intensity becomes easier to find the boundary of the object.

In real conditions in the parking area, sometimes the presence of vehicles that are only "drop off or pick up" but not parked, in the development of the program is not counted as part of the vehicle parking, so it needs a verification method to find out whether the vehicle is parked or just "drop off or pick up". The research of parking management monitoring system is trying to monitor the parking space for the efficiency of parking management and utilization of parking space. Many researches have been done related to smart parking, one of them by using image processing-based camera [1].

In this research, the proposed of parking management monitoring system based on image processing using adaptive thresholding and verification methods to provide certainty whether the vehicle in the parking area on the street will be parked or just "drop off or pickup", because this needs to be ensured considering the parking data will be sent to the server, in order to avoid miscalculation in the delivery of parking data. This parking management monitoring system integrates the vehicle identification of image processing-based with database system. The purpose of this research is to simplify the parking management and monitoring system and provide parking information for users, by improving the accuracy in vehicle identification based on image processing and the use of web-based applications and mobile applications. In this research, metodology of a prototype of parking management and monitoring system, as below:

- Measurement of illumination level in the parking area
- Development of vehicle identification program
- Development of desktop and mobile application programs
- Trial in the street parking area

In this paper will be explained about the research that has been done, the proposed prototype of parking management and monitoring system, trial and test results.

II. RELATED WORK

Smart parking researches have been conducted which have the purpose of providing convenience for parking users by utilizing mobile applications [2] [3] [6] [9] [10], in addition to providing convenience and shortening time in finding parking spaces in the area

parking [6] [8]. The parking management system developed using image processing-based cameras [1] [3], [8], [9], also used sensors for the detection of vehicles in and out of parking areas [9]. While the object identification as the target is the vehicle body [8] [9] or the vehicle number plate [2] [4] [5]. An integrated parking management system that networking for many parking areas with the Internet of Thing (IoT) [7] has been researched. The study of parking management systems that have been conducted using different approaches, such as the development of smart parking systems by using a combination of image processing and sensor for vehicle detection and available parking spaces [9] in which the paper aims to develop intelligent transportation systems in managing and controlling these services, developing mobile devices to provide information regarding available parking lots, developing inexpensive hardware related to parking systems [9].

The development of vehicle identification program based on image processing has been done a lot of research, in this research that distinguishes with previous research are:

a) The program is developed to work in day and night conditions, so that the contrast in pixel illuminization is tried to be eliminated by using adaptive thresholding.
b) The verification method to ascertain whether the vehicle is properly parked or just "drop off or pickup"

III. PROPOSED A PROTOTYPE OF PARKING MANAGEMENT MONITORING SYSTEM

Research of a prototype of parking management monitoring system on the street begins with problems in parking system especially related to management system and traffic jam around the parking area. The proposed a prototype of parking management monitoring system is focused on the use of image processing-based smart cameras that are integrated with database systems so that every vehicle entering and exiting the parking space will be monitored. The image processing-based smart camera will be tested on day and night conditions in accordance with the operational parking time on the street.

This research focuses on:

- Development of a prototype of park monitoring and management system on the street using image processing-based cameras, optimizing the capture of objects by using adaptive thresholding.
- Adaptive thresholding is used to reduce intensity of pixels differences during day and night conditions.
- Verification methods are needed to provide confidence whether the vehicle that stops in the parking area is a parking vehicle or "drop off or pick up"
- Doing the testing in parking area on the street
- Integration with database systems

Generally, the architecture prototype of the parking management monitoring system as in figure 1. Where the process of catching the vehicle object in the parking area is done through the smart camera then the vehicle is verified as the correct vehicle will be parked, before the data is sent to the server as vehicle data parking then vehicle parking data can be accessed through applications on desktop based on web base and mobile application.

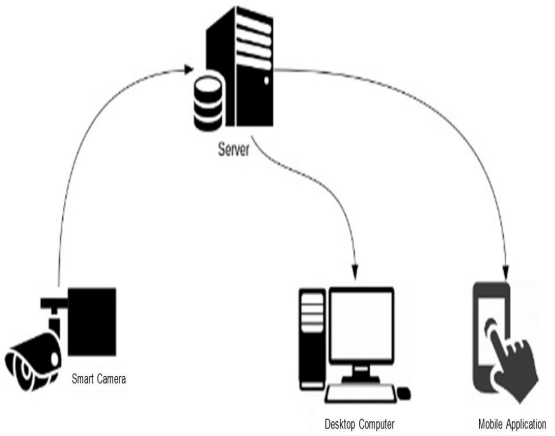


Figure 1. Architecture of Parking Management and Monitoring System

Stage of the proposed a prototype of parking management monitoring system is as follows:

- The object captured by the camera will be processed whether the vehicle is parked or not
- Data from the smart camera will be sent to the server
- Data can be displayed in a web-based application program
- Data can be displayed in mobile application programs.

A, Measurement of illumination level

Measurement of light intensity in the area is an attempt to know the amount of light illuminization in the parking area. This measurement is needed to find out how much light intensity in the parking area can be captured as a vehicle object so that it can be a threshold in the measurement. The result of the measurement in the parking area on the street is the distribution of different illumination level, where the distance away from the center of light (lamp) will have a decreasing intensity, from the experiment obtained the results are similar in Fig. 2.

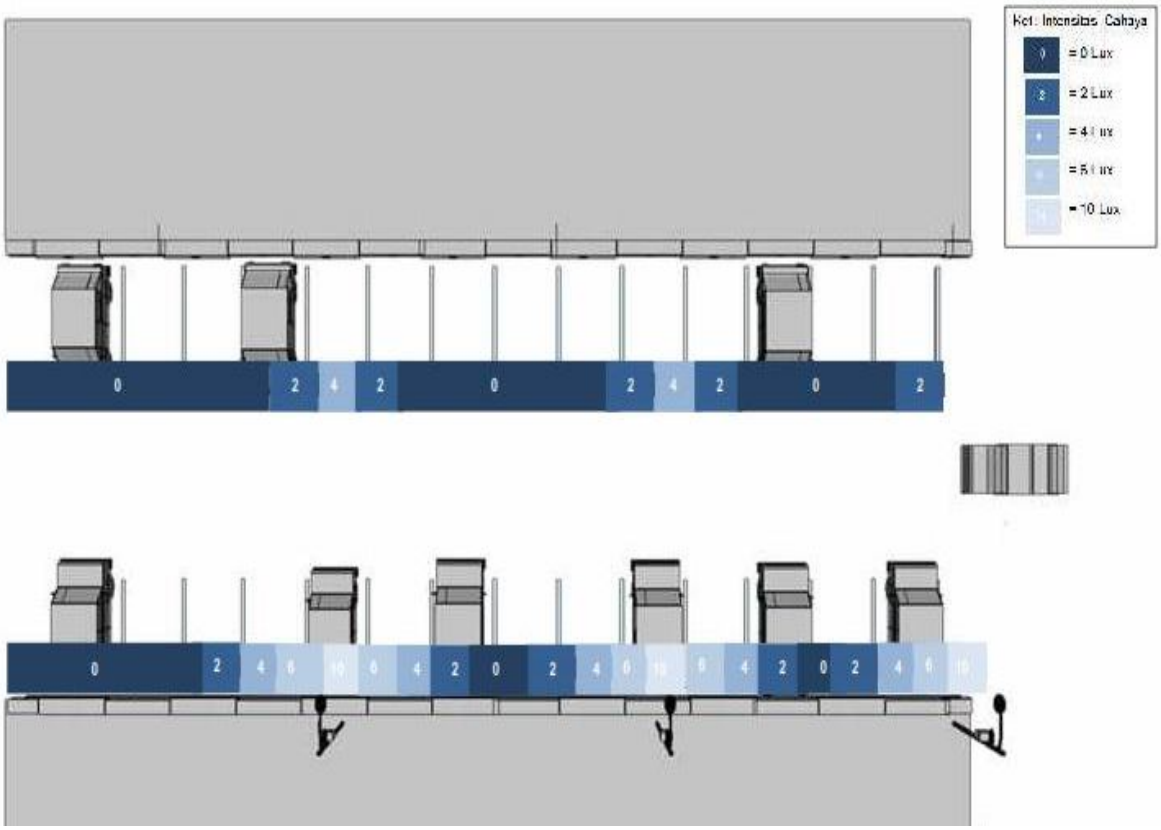


Figure 2. Result of Illumination Level in the parking area

Table 1. Result of Illumination Level using different color

Color					
Level	0	2	4	6	10

From Table. 1 and Fig. 2, it is clear that the closer to the center of light it will get the greater illumination level. The illumination value will be used as a reference camera to capture an image that can be identified as an object.

B. Proposed Vehicle Identification Program

a) Flow Chart of Program Development

In the development of object identification program using C ++ and Open CV library support, where the description of the development of the program such as fig. 3 is as follows:

The flow diagram of program development is as follows.

In the development of object identification program using C ++ and Open CV library support, where the description of the development of the program such as in Fig. 3 is as follows:

- Create a ROI (Rectangle Of Interest) and create a blur in the area, based on the values in the configuration file
- Calculate the Laplacian value of the ROI value already blur, with the function available in opencv cv
- Calculating the delta by means of the difference between the mean value of the result of the laplacian calculation and the ROI masking value
- Retrieve the value of used parking status
- Determine threshold value, threshold value is dynamic according to field condition, that is mean value
- If the delta value is smaller than the existing threshold value in the config file, then there is no object
- If there is no object and if the used parking status is equal to true, then the delay function is executed for the change to false status
- If there is no object and if the used parking status is equal to true, then the status remains true
- If the delta value is greater than the existing threshold value in the config file, then there is the object
- If there is an object and if the used parking status is equal to true, then the delay function is executed for the change to false status
- if there is an object and if the parked status is the same as false, then the status remains false

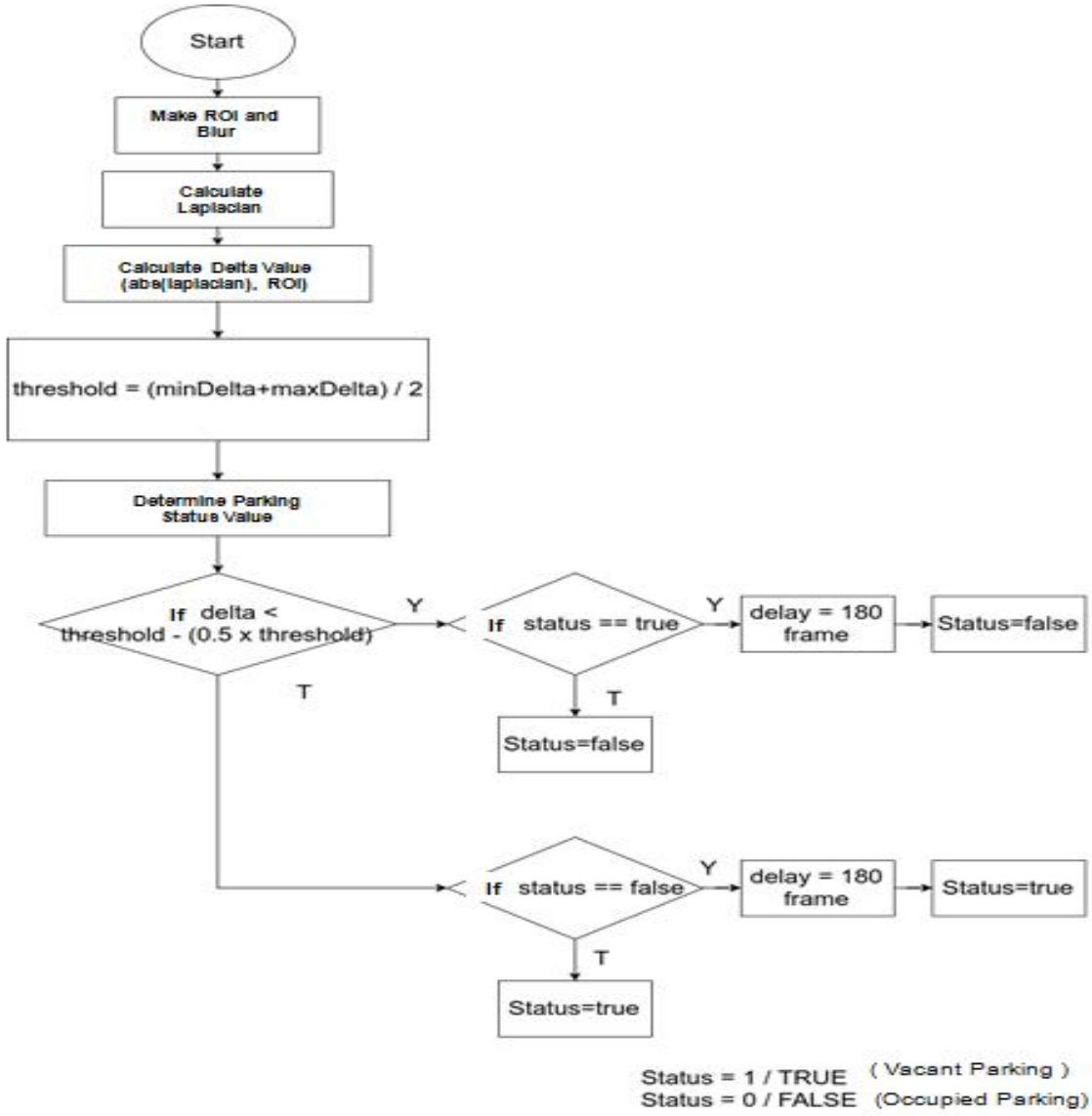


Figure 3. flow diagram of program development

b) Adaptive Thresholding

Adaptive thresholding is a change in adaptive threshold value that occurs when there is a contrast of pixel intensity differences in an object. The difference in adjacent pixel illuminization values is large, making it difficult to uniform thresholding values to one value, hence this is called local adaptive thresholding. The method used to determine the local adaptive threshold value by using mean of the threshold value, to get the value by segmenting the object, so that each sub object will have its own threshold value because the threshold value for each pixel depends on the location of the pixels in the sub object. To obtain empirically the adaptive threshold value by using assumptions and statistical calculations as refer to (2):

$$T = \frac{\mu_1 + \mu_2}{2} \quad (1)$$

Where T is adaptive thresholding, μ_1 is intensity min of pixel and μ_2 is intesity max of pixel so from the value of adaptive thresholding as refer to (1), it was developed empirically to obtain the appropriate adaptive thresholding value as refer to (2)

$$T_g = \left(\frac{\mu_1 + \mu_2}{2}\right) - \left(F \times \left(\frac{\mu_1 + \mu_2}{2}\right)\right) \quad (2)$$

Where T_g is adaptive thresholding obtained empirically, μ_1 and μ_2 are intensity min of pixel and intesity max of pixel, and F is Factor (0.5 – 0.6).

c) Verification Method

The verification method in this research is an attempt to ascertain whether the parking vehicle is a parking vehicle or "drop off or pick-up". This verification is required because the parking area is on the street. The verification method is done by setting up the time delay of the vehicle object in the program, if the

vehicle stops more than 15 seconds means the vehicle is parked and if less than 15 seconds means the vehicle is not parked.

C. Proposed A Prototipe of Parking Management Monitoring Information System

Proposed a prototipe of parking management monitoring information system is an effort to provide information to users and simplify in parking management. Information system architecture used such as in Fig 4.

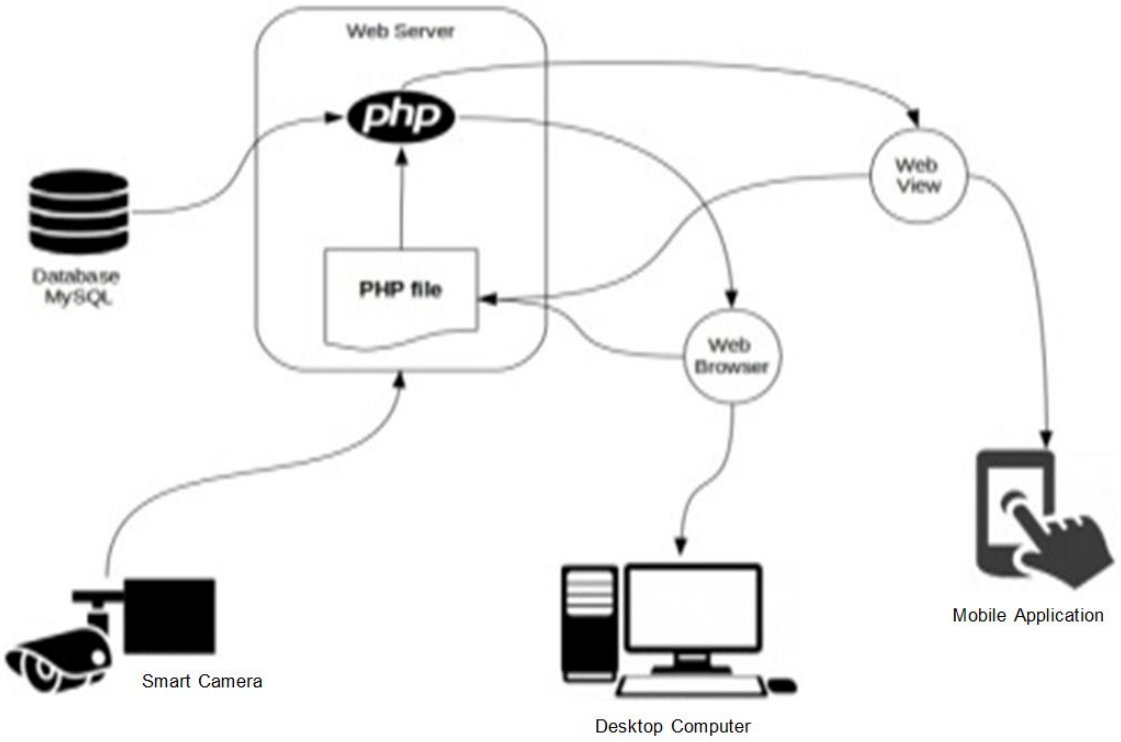


Figure 4. Architecture of Parking Management Monitoring Information System

In the information system architecture as in figure 4, the taken steps are as follows:

- Users of desktop computers access web pages by entering the url address whereas mobile application users access the android application in which there is already web view client.
- Web server software (appache 2.0) will recognize the request of a php script file and then the server will translate the file with php plug-in before the response by the page request.
- PHP with the Yii Framework will connect to the MySQL database and request content that matches the web page.
- The MySQL database will respond by sending the content requested by the PHP script.
- The php script stores the content into one or more PHP variables and then an function will display the appropriate content on the web page.
- The PHP plug-in makes a copy of the html created by the web server

The web server sends an html to the web browser/ web view written with the HTML file provided by the PHP plig-in.

The software used in the proposed of this information system is as follows:

- Linux as Operating System
- PHP 5 as a programming language
- Yii 1.1.11 as a PHP Framework
- MySQL database as Database Management System
- Netbeans IDE 8.1 as Integrated Development Environment
- Libreoffice Draw for the creation of detailed flowcharts
- Google maps API as Map View to display the map
- Mozilla Firefox and Google Chrome as browsers to access the system
- Android Studio 2.3 As an android IDE

IV. TRIAL

The prototype test of the parking management monitoring system is carried out in the parking area, while the description of the parking area used is as shown in Fig. 5.

The trial is carried out under the following conditions:

- Number of cameras, mini PCs, modems and Power Over Ethernet (POE) mounted on poles of 3 units each (see in Fig. 5)
- Trials are conducted day and night

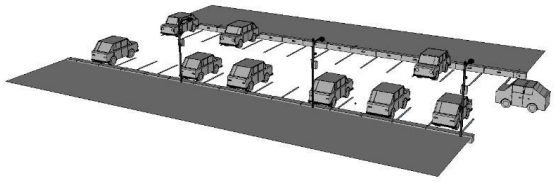


Figure 5. Parking Area on street

The equipment used in this trial:

Hardware :

- IP Camera
- Mini PC
- Modem
- POE (Power Over Ethernet)
- Terminal
- Power Supply
- Server

Software

- Development of Vehicle Identification Application Program
- Development of Desktop Web Application Program
- Development Mobile Application Program
- My SQL Database

A. Trial Results

The test results of a prototype of parking management monitoring system is as shown in Fig. 6, 7, and 8.

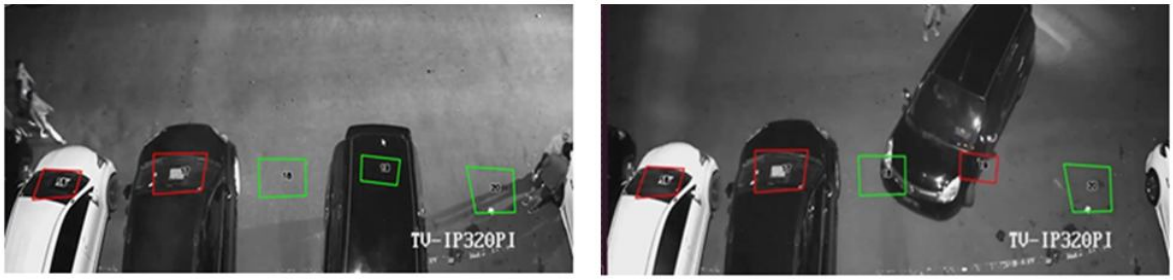
a) Smart Camera Test Results

In this trial aims to determine the effectiveness of the use of smart cameras in monitoring the parking system during day and night.



(a) (b)

Figure 6. (a) Initial Condition (b) After Running Program at the night



(a) (b)

Figure 7. (a) Initial Condition (b) After Running Program with different camera at the night



(a) (b)

Figure 8. (a) Initial Condition (b) After Running Program with different camera at the night

From the above test results where in Fig. 6, 7 and 8 use different cameras. The test runs at night, the vehicle identification program runs quite well where in Fig. 6, 7 and 8. Point a shows the program has not run perfectly while point b shows the program has been running well. The green virtual boundary shows an vacant parking lot and red virtual boundary shows occupied parking lot. In Fig. 9 shows that the identification of vehicles during day with different camera view angle, the camera catch show that the camera focuses on only 5 vehicles, one vehicles object has error in the identification of vehicle caused by the position of the boundary that has not been precise, resulting in running program for errors in edge detection.



Figure 9. Parking Vehicle Identification Result during the day

b) Information Systems Test Result

Trial of information system is experiment which started from parking vehicle data captured by camera then data is sent to server. Data on the server is processed to be displayed in web-based applications and mobile applications.

The test results of information systems are as follows:

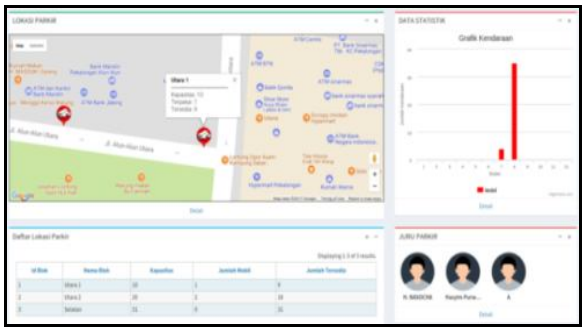


Figure 10. Information System Display on Desktop

In Fig. 10 is an information system on the desktop, with the features provided are as follows:

- The number of vehicles in the parking area in real time
- Number of the parking officers on duty
- Recapitulation of the number of vehicles per day / week / month / year

While the display in mobile applications are as follows:



Figure 11. Display on the Mobile applications

The information provided in the mobile application as in Fig. 11. with features as follows:

- Amount of parking space available
- Location of map-based parking area

CONCLUSIONS

The results of the development of parking management monitoring system obtained that the application program related to vehicle identification needs to be improved since there is sometimes an error in the identification of the vehicle if the color of the vehicle parking the same as the color of the road (asphalt) because the difference in intensity between pixels is very small. The existence of vehicle identification that sometimes error where the object is not a vehicle is considered as a vehicle, but the number of errors in thus case is very little. The initial setting for the camera position becomes an important factor in creating a virtual boundary in the parking space The prototype of the parking management monitoring

system is an implementation for cars, so further research is needed for the implementation of motorcycle parking.

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