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Digitizing parking area availability information using Canny algorithm based on Android application

Suci Ramadona[1*], Wira Indani [2], Mochamad Susantok[3], Maya Rahayu[4]
[1]Department of Electrical Engineering, Politeknik Caltex Riau
[2,3]Department of Telecommunication Electronics Engineering, Politeknik Caltex Riau
Jalan Umban Sari Atas No. 1, Pekanbaru, Riau, Indonesia
[4]Department of Electrical Engineering, Politeknik Negeri Bandung
Jl. Gegerkalong Hilir, Kabupaten Bandung Barat, Indonesia
[1*]suci.ramadona@pcr.ac.id , [2]wira@pcr.ac.id , [3]santok@pcr.ac.id , [4]mayarahayu@polban.ac.id

ABSTRACT

The Covid-19 pandemic is a factor in accelerating digital transformation in all aspects of community needs, especially in the parking area. Unmonitored and non-digitalized parking lots can cause delays that increase the transmission of Covid-19. In this study, a parking digitization system is created to make it easier for the public to know how dense is the area of the location to be visited, as well as a vacant area that can be occupied to park vehicles by users of the parking lot through a smartphone application. This study uses the Canny algorithm through an optical flow process captured by the IP Camera, next the data is processed and presented in the Android application. From the system that has been made, the system detects the presence of vehicles with an accuracy of above 95%.

Keywords: parking lot, Android, Canny algorithm, IP camera, optical flow

ABSTRAK

Pandemi Covid-19 menjadi faktor percepatan transformasi digital di segala aspek kebutuhan masyarakat, khususnya di area parkir. Tempat parkir yang tidak terpantau dan tidak terdigitalisasi dapat menyebabkan keterlambatan yang meningkatkan penularan Covid-19. Pada penelitian ini dibuat sistem digitalisasi parkir untuk memudahkan masyarakat mengetahui seberapa padat area lokasi yang akan dikunjungi, serta area kosong yang dapat ditempati untuk memarkir kendaraan dari pengguna tempat parkir melalui aplikasi smartphone. Penelitian ini menggunakan algoritma Canny melalui proses optical flow yang ditangkap oleh IP camera. Selanjutnya data tersebut diolah dan disajikan dalam aplikasi Android. Dari sistem yang telah dibuat, sistem mendeteksi keberadaan kendaraan dengan akurasi di atas 95%.

Kata kunci: *tempat parkir, Android, algoritma Canny, IP camera, optic flow*

1. INTRODUCTION

Despite having a bad impact, Covid-19 also has a positive effect on the world, namely where the digital transformation process increases rapidly. The use of digital technology increases the use of internet data and smart-device sales. Internet of Things (IoT) has been widely applied to various aspects of community needs, one of which is the parking lots. The level of need for the use of parking lots is increasing along with the increased building construction and the use of vehicles. The problem that occurs is a phenomenon where no exact information about the parking lot, as a result, many users of the parking lot park their vehicles on land that is not an official parking area when they found out that there is no available place left. Therefore, there is a lot of illegal parking and expensive parking fees, as well as an unsightly city layout. This can be prevented by digital notification of information, so that vehicle users can delay the trip or think of other good ways. Parking lots that are not monitored and are not digitized can also cause crowding which increases the risk of Covid-19 transmission.

Various studies have been carried out on digitizing parking lot areas. Authors [1] have researched to detect and simulate vacant parking lot areas using the EAST algorithm and Haar Cascade. The simulation runs using 60 seconds of a video stream, then observes the results every 10 seconds. The results obtained that the information can appear in the form of a text containing the available parking slots. Research [2] has studied a review on automatic parking space occupancy detection. This paper

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*E-mail korespondensi

has been designed for reviewing various techniques which have been used for automated parking slot detection till now. The system should be intended for one sensor that can target many vehicles in parking areas. Accuracy is often important for ideal outcomes in real-time through which an intelligent parking slot or space detection can be implemented with a newly introduced technique. Another researcher has studied a multi-classifier image-based vacant parking detection system [3]. Following an initial edge detection stage, they combine edge density, closed contour density, and foreground/background pixel ratio, at every car parking spot, to identify whether a car is present or not. Combining the features above results in a robust vacant space detection system at a low computational cost. Researcher [4] has conducted research on car detection in roadside parking for smart parking systems based on image processing. This research aims to detect vehicles that are on the side of the parking lot so that it can be used as a smart parking system for parking management and find out information on the availability of parking spaces. The authors used the Haar Cascade Classifier and YOLOv3 then compared them to get the best accuracy in detecting parked cars. The paper [5] has implemented deep learning-based parking spot detection and classification in fish-eye images. This paper presents an efficient pixel-level parking spot instantiation and classification approach based on the object detection framework in deep learning. The approach uses MobileNet-V1 network architecture as backbone convolutional neural network (CNN) and modified Single Shot Detector (SSD) as object detection meta-architecture to perform parking spot instantiation directly in the fish-eye domain. Authors [6] have developed a system for a convenient vision-based system for automatic detection of parking spaces in indoor parking lots using wide-angle cameras. Meanwhile, various studies have also applied digitization to occupation sensors. Easiness in the system setup mainly comes from the use of a new camera model that can be calibrated using only one space line without knowing its position and direction, as well as from the allowance of convenient changes in detected parking space boundaries. Authors [7] have also made research on an intelligent classroom management system based on wireless sensor networks. The management system will determine the current conditions of the students and the classroom, and give proper feedback to the students, the teachers, and the wireless sensor-controlled equipment deployed in the classroom. The proposed intelligent classroom management system includes three subsystems. Then, the researcher [8] has implemented an algorithm for parking lot occupation detection. This paper presents an unsupervised vision-based system for parking lot occupancy detection. The proposed method exhibits low computation complexity and uses just a few frames per minute. The method is based on three main processing stages. Lastly, authors [9] have also implemented an autonomous self-parking robot. The proposed framework is completed with hypothetical calculation, equipment reconciliation, and the outcome demonstrates the capacity of vehicle stops.

This study aims to design an indoor location parking tracking system by reading through an IP camera using the Canny algorithm. In this system, the location of an empty area will be displayed on the Android application so that the client can know the parking position in real-time without the need to spend time around the parking area. Therefore, this system can shorten the search process and increase the level of user comfort and help the government to condition restrictions on community activities.

2. RESEARCH METHOD

2.1 Proposed System

The research system architecture is shown in Figure 1. The image of the parking lot captured using an IP camera is processed in several stages through the optical flow process. Next, the stages that have been processed by optical flow are stored in the database and processed into information displays on the android application in the form of date, time, and empty parking area blocks.

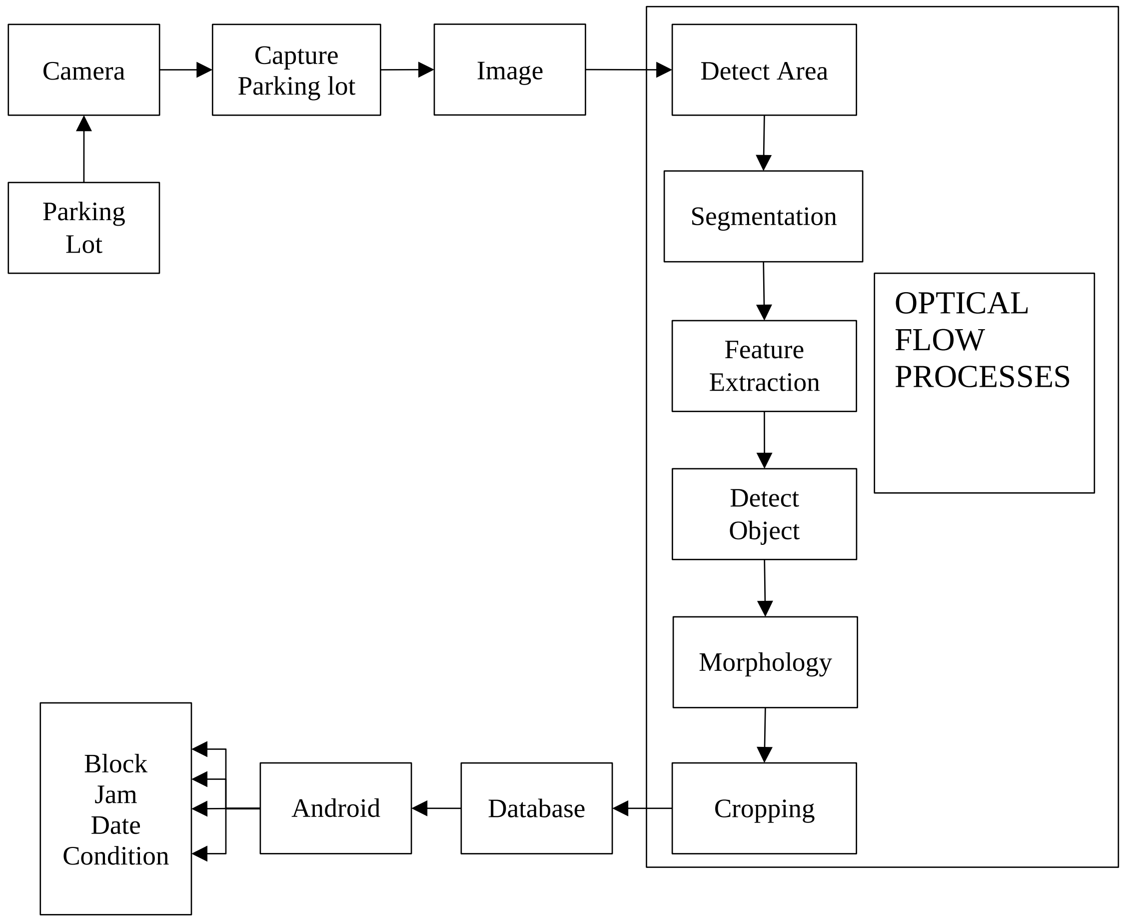

Figure 1. System architecture

Figure 1 shows the system architecture. The first stage after capturing the image and detecting the area is segmentation by optical flow. In this process, the research object (i.e. four-wheeled vehicle/car) is separated from the object's background. Segmentation will read the first image frame as a background frame, then calculate the threshold value. When there is a difference in the threshold value, where the threshold value is less than or equal to, then the vector array value is classified as 0. The second is the feature extraction stage. In this process, the focusing object is performed by converting the frame to grayscale. The third stage is object detection by marking the part that becomes the detail of the object and improving the blurred object. This method uses the modern canny detection algorithm, where the Canny Edge Detector has advantages, such as the flexibility of convolution parameters, the resulting edge detection distance is very minimum with the edges of the original object, and by using a Gaussian filter it can remove noise in image smoothing. The fourth stage is morphology, which is the process of removing image imperfections due to being distorted by noise. The last stage is cropping, this stage classifies objects to crop red and green boxes. The red box indicates that the parking area is occupied and the green box indicates that the parking area is vacant.

2.2 System Hardware

The system hardware is shown in Figure 2. The system is made using one IP Camera with a monitoring area only in one corner. The other devices consist of a router, server, database, PC server, and smartphone.

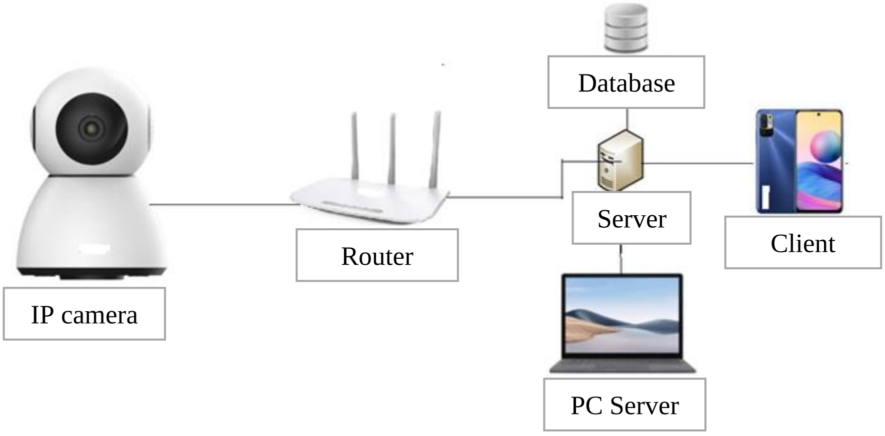

Figure 2. Hardware architecture

2.3 Canny Algorithm

The following Figure 3 is the workflow of the system using the Canny algorithm. The Canny algorithm is an edge detection method proposed by John Canny in 1986. This algorithm is known as an optimal edge detection system, which can provide a low error rate, and low edge detection between the edge of the detection area and the real edge, it can also provide one response for one edge.

The basic principle of the Canny algorithm is to find the first-order derivative of the Gaussian function in any direction as noise filtering [10]. Using this filter can determine the maximum value of the local gradient so that the edge of the image can be detected [10]. The steps for the Canny algorithm are as follows.

1. Noise Removal
   This step involves smoothing the image to remove noise. This system uses a Gaussian filter, which is widely used to remove noise. The step taken is smoothing the signal by rolling the image with the Gaussian Kernel [11].
2. Differentiation
   This step involves searching the image gradient to highlight areas with high spatial derivatives [11].
3. Non-maximum suppression
   The highlighted area will be tracked, and the number of pixels that do not match the maximum value will be suppressed.
4. Double thresholding
   Uses two threshold values to identify strong and weak edges. Only when the strong edge is connected to the weak edge will the output contain the weak edge.
5. Edge tracking
   This step is used to check the remaining pixels that have not been suppressed by non-maximum suppression. Two thresholds T1 and T2 were used to classify gradients in three sections [12]:
   - Gradient > T2 is clearly an edge-point
   - Gradient < T1 is clearly non-edge-point
   - Otherwise, a decision will be made depending on the direction of the point and the existing edge paths.

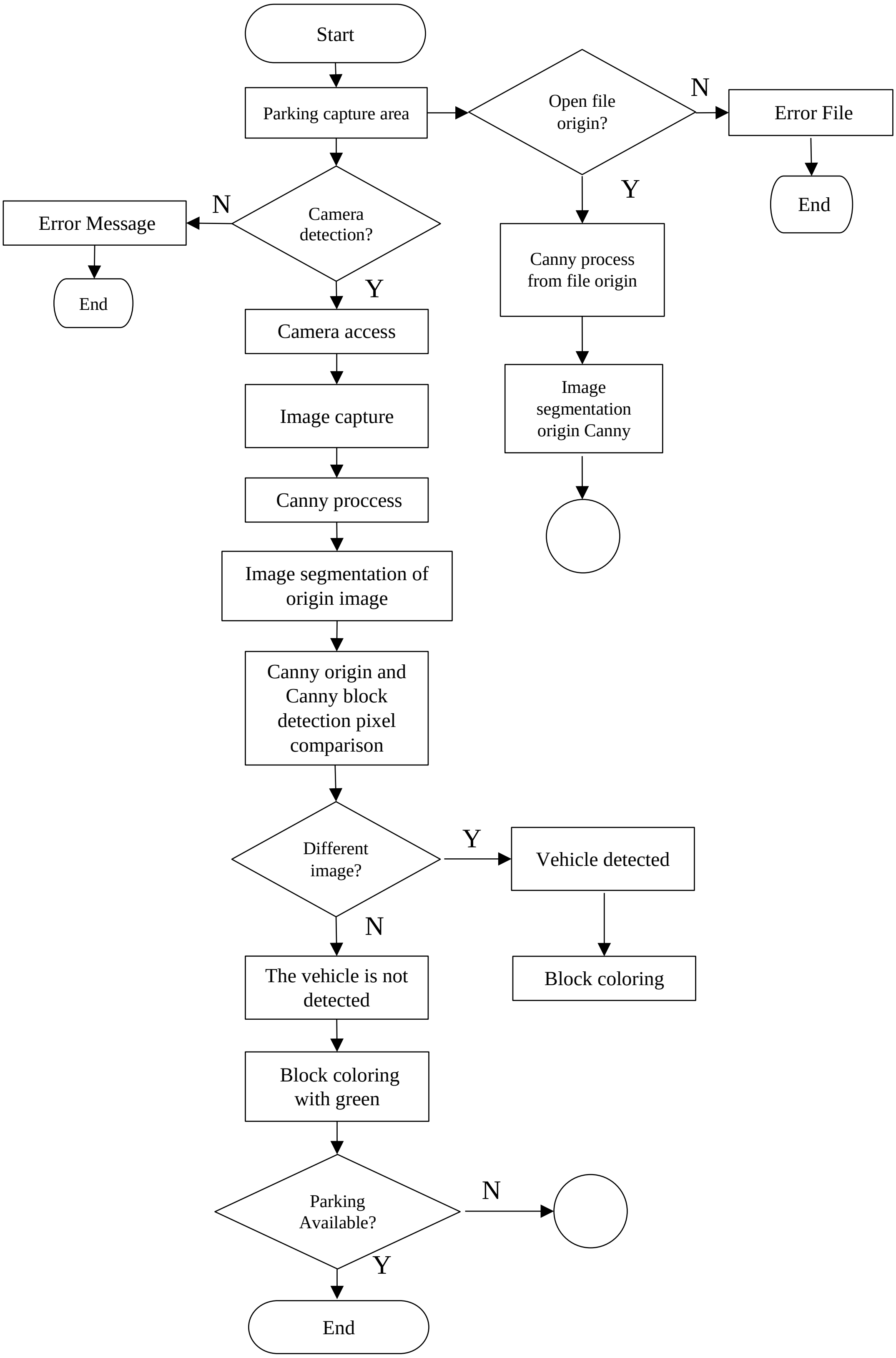

Figure 3. Canny algorithm workflow

3. RESULT AND DISCUSSION

Testing on the detection of parking availability requires a database as a summary of the results of reading the image/frame of the vehicle object. PC server is used as media running and recording software. In the segmentation process, the object and the background are separated, then the feature extraction process is performed, such as edge detection. Figure 4 below shows that the test is carried out with an IP camera from the front.

(a) (b) (c)

Figure 4. (a) background frame (b) detection frame, and (c) feature extraction

After the feature extraction process, as shown in Figure 4(c), the object detection process is carried out. The first detection process is morphology, which compares the object pixel value with the comparison pixel value. This comparison value is used as a measurement limit for the pixel size results of the erosion and dilation processes that have been carried out. The comparison value is set to 5000 as the pixel limit.

Table 1. Object detection value

Object Value			
Condition	**Block 1**	**Block 2**	**Block 3**
000	378	195	199
001	3708	4686	6278
010	3297	6592	3963
011	2500	7391	6509
100	7725	4108	3987
101	8649	4991	4877
110	8437	7564	3885
111	8569	7336	6511

It can be seen based on Table 1 that there are three counting blocks of parking areas with eight conditions. Condition 101 indicates that the vacant parking area is in the middle position, and so on to understand each condition of the parking lot.

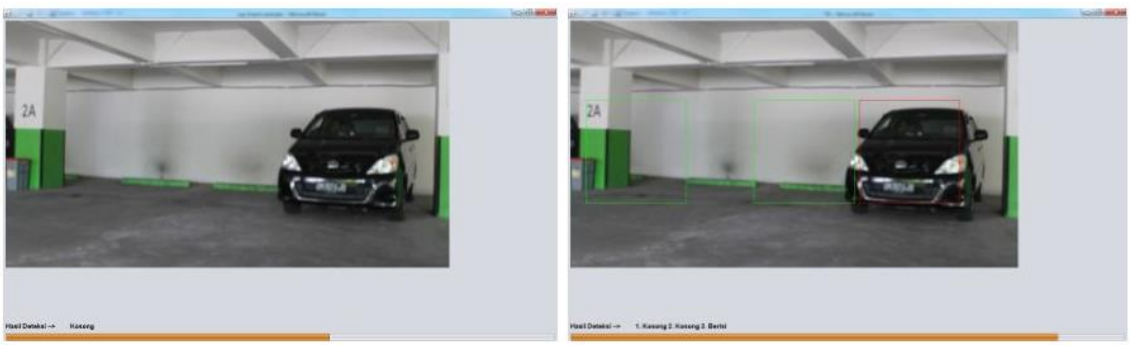

Figure 5. Detection of parking lot stages by cropping

Figure 5. shows the cropping area, which is the marking of the box. The green box is an empty parking area, while the area marked with red indicates that the parking lot is occupied.

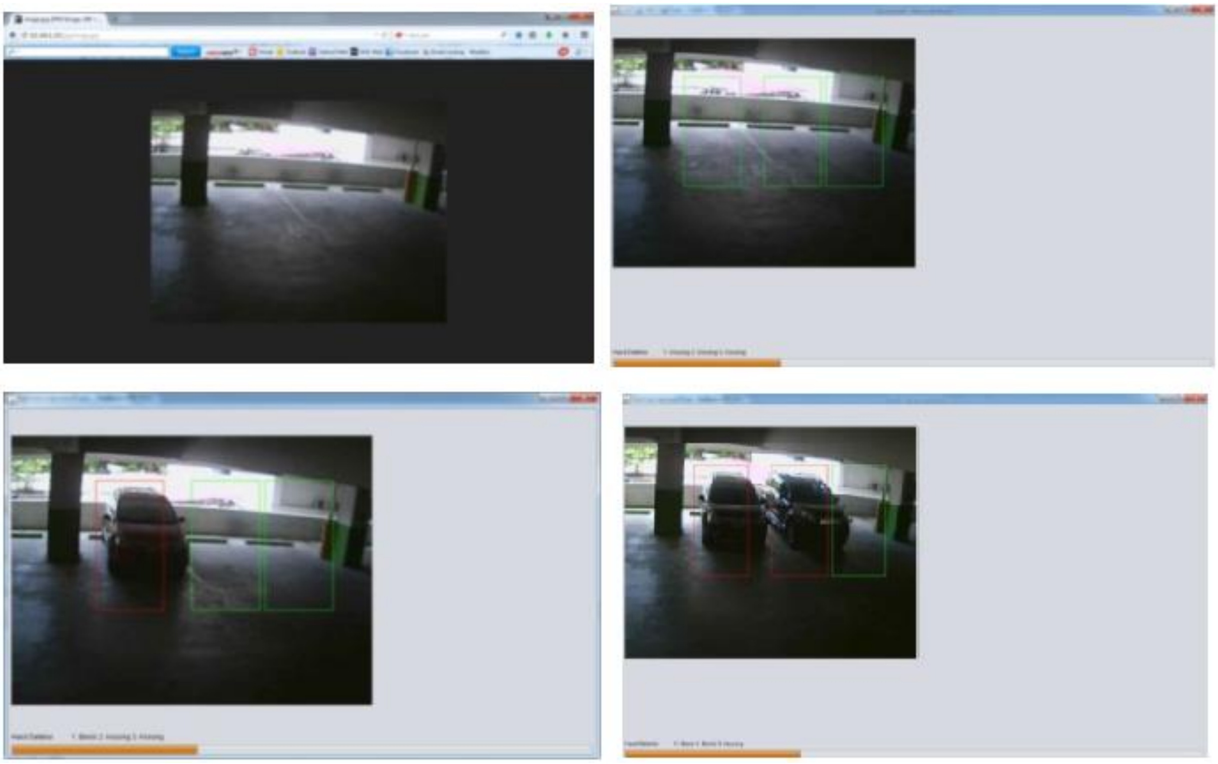

Figure 6. Parking lot detection with IP camera

In Figure 6, an IP Camera view is positioned like a CCTV. Every 5 seconds, the system will automatically capture an image of the parking area and compare the capture with the original image to detect whether the parking lot is vacant or occupied. After the detection results, the data is presented to the android application on the smartphone.

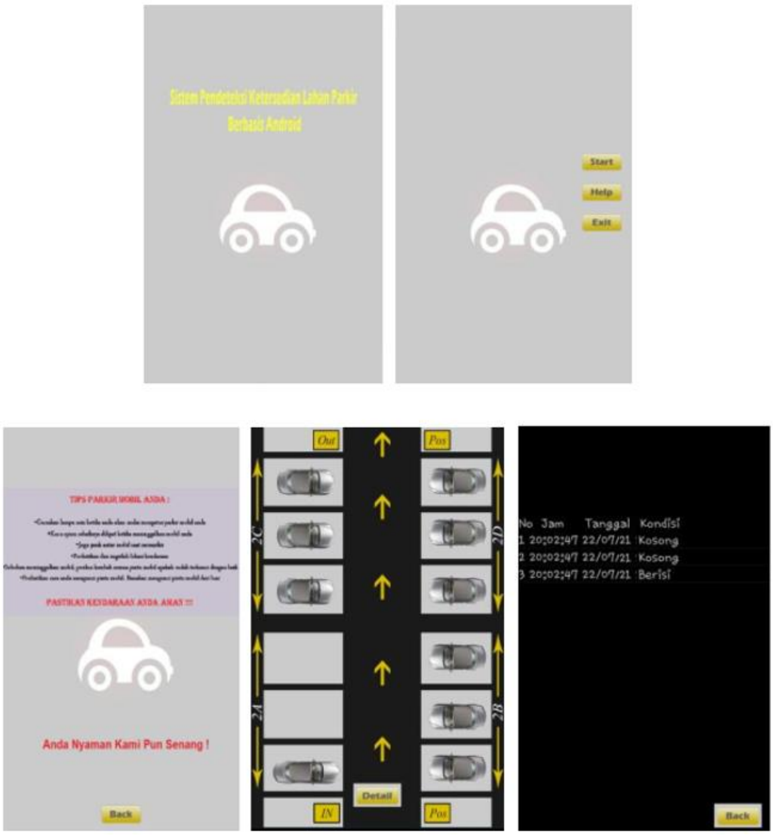

Figure 7. The information displayed on the Android application

In Figure 7, the Android application page is shown on a smartphone. By pressing the "detail" button, information data will be shown in the form of an empty block, time, and date for the parking area. Within 5 minutes, the application can be accessed and presented to the user.

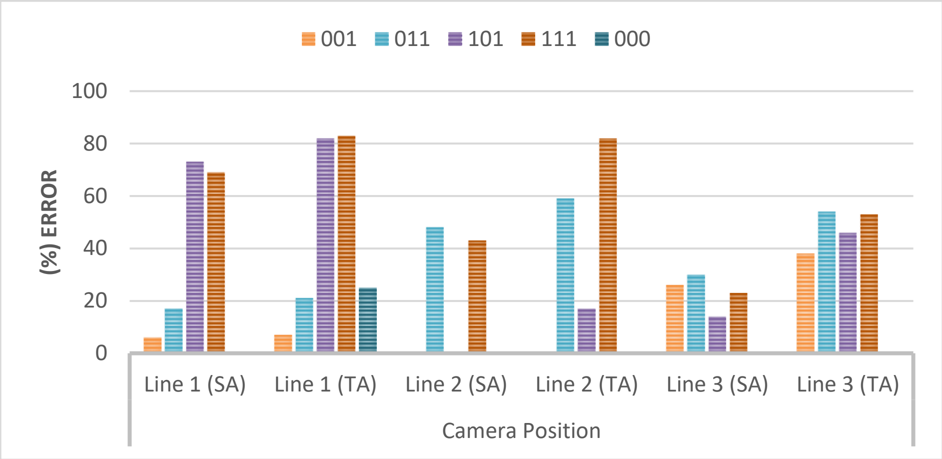

Figure 8. Graph of error value between the comparison of original image pixels with detection image

In Figure 8, it can be seen that if the camera is placed in the middle, it will be difficult to capture images with a wide angle because what is needed is the condition of the parking lot where the parking blocks are clearly visible. From the point of view of system processing, there is no significant effect, except for external factors, such as lighting, the type of camera used, and the size of the vehicle entering the parking lot block. Since the program used for this image processing has a limited ability to carry out its functions.

4. CONCLUSION

This digital design of parking availability information has been successfully carried out in this study. From the testing stage, it was found that the system can detect the presence of vehicles to monitor the availability of parking lots with accuracy reaching 98%. The position of the IP Camera greatly affects the results of this study, where the position of the IP Camera is better at the front corner of the parking block at an angle of 45° to the limit of visible vehicles. The results obtained are more accurate if the comparison value is less than 50%. For further research development, it is expected that more IP cameras can be utilized and applied to a large parking area.

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