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Designing an Intelligent Traffic Control System at UGM Campus Portal

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ABSTRACT: The lack of smooth flow of vehicle traffic on the entrance and exit portals of the UGM campus is a major problem topic in regulating traffic on campus. Therefore, the design of the control system of the UGM campus portal is needed automatically and intelligently without official intervention. This successfully developed system consists of RFID long-range based vehicle detection units, portal door control units, and data storage and processing units. The system will automatically detect vehicles that enter and exit through RFID labels installed in vehicles, RFID data that is read automatically processed by the system, then forwarded to the portal gate control unit. RFID user data is stored in the UGM campus parking information system. Functional testing of the intelligent traffic control system on the UGM campus portal works successfully.

KEYWORDS: long-range RFID, campus parking, information system, campus portal

I.INTRODUCTION

The vehicle traffic monitoring system at the UGM campus area is still done manually, namely through vehicle ticket data surveys. The traffic monitoring system that has been developing so far, such as the use of magnetic loop detectors and radars, still has limitations in terms of measuring the parameters of traffic conditions, such as vehicle type, average number of vehicles, average vehicle speed and congestion that occurs. Conventional sensors cannot provide complete information about vehicle traffic conditions[1].

The use of the portal door feature is also rarely used because it is still manually controlled by the officer. Such control of the campus portal door system creates a lack of vehicle safety levels at the UGM campus area. Therefore, in this study, a prototype system of campus portals will be created that is controlled automatically and intelligently without the intervention of officers. The system developed is part of the master research on Intelligent Traffic Monitoring and Traffic Control System (ITMCS), with a focus on implementation in the UGM campus area. This system is used to regulate and monitor vehicle traffic entering the campus area. The system consists of RFID long-range based vehicle detection units, portal door control units, and data storage and processing units. Vehicles entering the campus area will be detected and identified by a camera sensor based vehicle detection unit. Identification data will be stored in the storage unit and used to control the campus portal door opening and closing automatically. RFID data from users will be stored in the campus parking information system under the name Campus Parking System (CPS).

III. LITERATURE SURVEY

Intelligent parking systems are classified into several systems, namely the centralized assisted parking search (CAPS), Non-Assisted Parking Search (NAPS), Opportunistically Assisted Parking Search (OAPS), Parking Guidance and Information Systems (PGIS), Transit based Information System (TBIS) Smart Payment System, Automated Parking, E-Parking, Car Park Occupancy Information System (COINS), Parking Reservation System (PRS), Intelligent Transport System (ITS), Intelligent Parking Assist System (IPAS), Agent-Based Guiding System (ABGS). The latest sensor technology used includes Passive Infrared Sensors, Ultrasonic reverse parking sensors, Electromagnetic parking sensors, Active infrared sensors, Inductive loop detectors, Magnetometers, Anisotropic Magnetoresistance sensors, Piezoelectric sensors, Pneumatic road tubes, Weight-in-motion sensors, Microwave radars , Ultrasonic sensors, Image processing, Vehicle license plate recognition, RFID, Sensor board[2].

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

The smart parking system has been successfully implemented using the Internet of Things (IoT) technology, where the system is integrated through the cloud. Also, the system can be accessed via device [3]. The use of RFID technology in intelligent parking systems makes it easier in terms of vehicle recognition. The parking system used integrates machine-to-machine technology and the Internet of Things system [4].

Parking system that uses sensors to detect vehicles and display information on the amount of available parking has been successfully implemented — recommended parking location which is the closest to the facility entrance [5]. Automatic intelligent parking system using IoT was successfully developed. The system uses Raspberry Pi which is installed Raspbian OS as an actuator control, pi-camera to detect vehicles, the nearest parking area navigation system, parking number information and applications for smartphone-based users [6].

IV. METHODOLOGY

A) HARDWARE DESIGN

The block diagram of the system to be built is shown in Figure 1. The system to be built consists of vehicle detection units, portal control units and processing, and data storage units. The vehicle detection unit consists of a webcam camera, Intel NUC single board computer (SBC), and a long-range UHF RFID tag reader [7]. Vehicle identification focuses on identifying vehicle number plates by using a webcam camera sensor. If this identification fails, the data used is data obtained from the results of reading the RFID reader. RFID data is obtained from student/staff cards.

The portal control unit consists of USBOpto RLY816 components which are connected directly to the SBC using the USB interface. The output and input of the USBOpto RLY816 device are connected to the portal gate control to open and close the gate and limit switch and magnetic loop sensors. The limit switch sensor functions to find out the current gate position whether it is open or closed, while the magnetic loop sensor is used to detect the presence of a vehicle or not. This sensor is placed before the gate and under the gate. The sensor placed before the gate serves to trigger the gate portal to open automatically, while the sensor placed under the gate serves to trigger the gate to close automatically when the vehicle has passed.

The data processing and storage unit consists of an IntelNUC and Server. The image data generated by the webcam camera sensor is processed and identified for number plate information by this section. After the vehicle information data is obtained through a webcam camera sensor and RFID reader (vehicle identification unit), the data is then temporarily stored in this section, which is then periodically stored for the server.

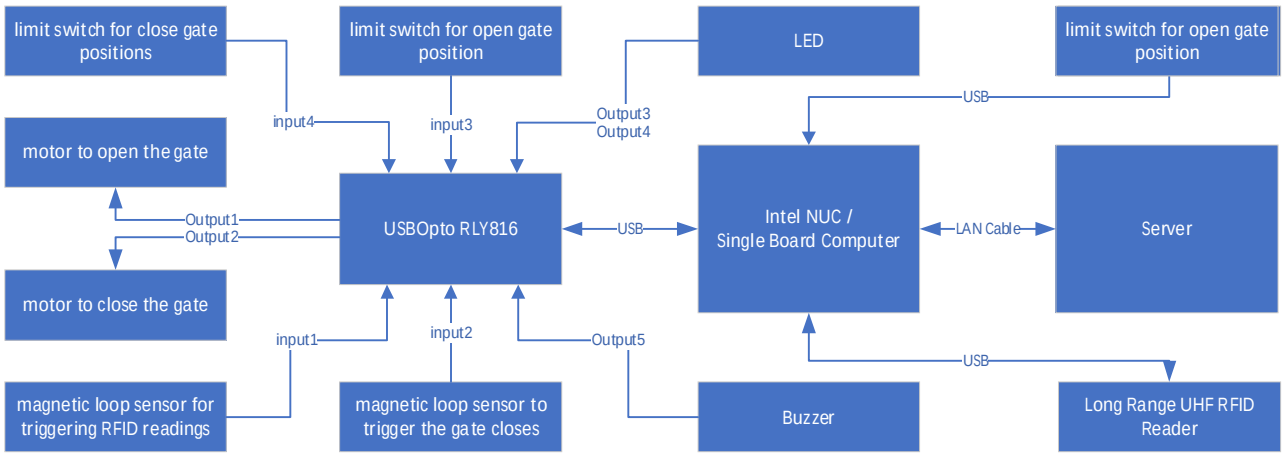

Figure 1: Hardware Design Diagram

ISSN: 2350-0328
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Vol. 6, Issue 2, February 2019

B) HARDWARE PLACEMENT DESIGN

The position of hardware placement in this parking system is shown in Figure 2.

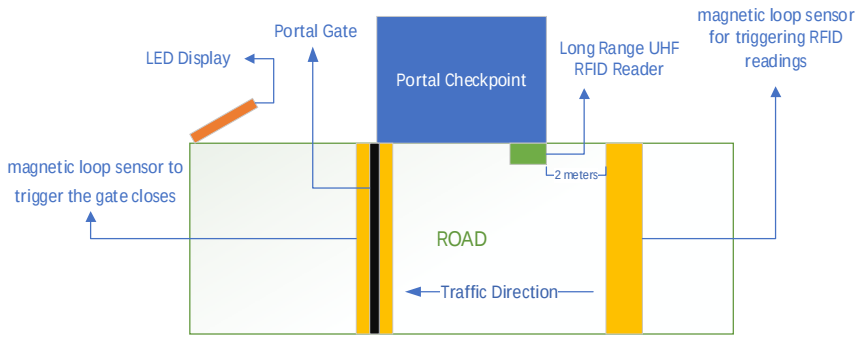

Figure 2: Hardware Placement Design

C) SOFTWARE DESIGN

When the portal exits, the vehicle will pass through the loop detector. The loop detector will then activate Long Range RFID Reader. The long Range RFID reader will wait for 2 seconds. If within 2 seconds there is a sticker that is legible, it will immediately record it and store it in local storage. The LED will then display the text "Lecturer / Employee" or "Student" according to the data contained in the sticker and add a counter out. If the card is not detected within that period, the buzzer will broadcast a sound to notify the clerk to check the driver who will come out manually. In this second case, the LED will display the text "Guest" and add an exit counter. This process flow is shown in the main program flow diagram in Figure 3.

ISSN: 2350-0328
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Vol. 6, Issue 2, February 2019

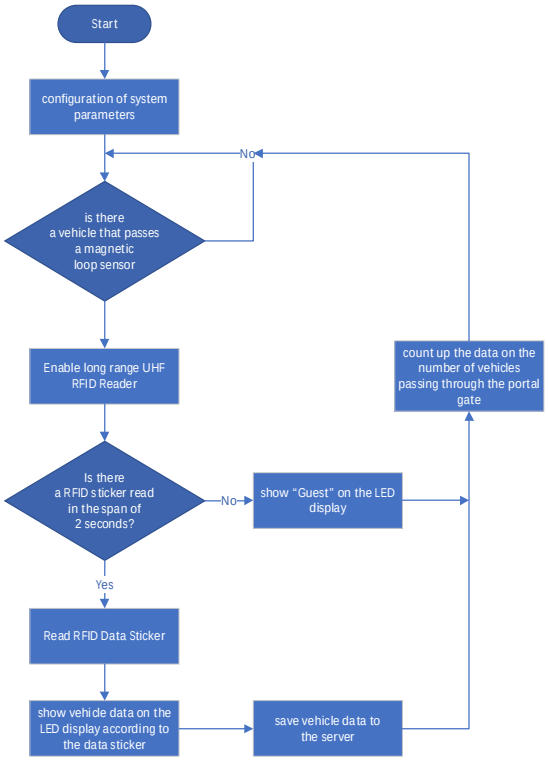

Figure 3: Software Design Flowchart

V. IMPLEMENTATION RESULTS

A) IMPLEMENTATION FOR RFID STICKER WRITING AND IDENTIFICATION OF LONG-RANGE RFID READER

Setting car parking is different from the arrangement of motorcycle parking. In the car parking arrangement, transactions are needed to enter and exit the parking portal faster. If an RFID reader is used, a long queue can be formed. Therefore, in this development, a Reader and a Long RFID Reader Sticker were used.Unlike the previous RFID reader, reading with Long RFID Reader does not require the card/sticker to be attached to the reader. The sticker can be read up to a distance of approximately 3 meters. Data stored in the RFID reader is the driver's identity number, namely the student's ID number and staff ID number. However, the data is stored in a random state on the sticker, so when reading the sticker, it is necessary to rearrange the readable data from the sticker so that staff ID or student ID data is obtained. The sticker data rearrangement code is shown in Figure 4.The RFID sticker affixed to the car glass is shown in Figure 5.

```
string tmpData = ShuffleExtensions.DeShuffle(BitConverter.ToString(data, 2,
12).Replace("-", ""),
int.Parse(Config.Config.getInstance().configParameter["key"]));
```

Figure 4: RFID Sticker Data Configuration Code

In the code, the data is the result of reading the sticker and Config.Config.getInstance(). The config parameter ["key"] contains key numbers that are used as the basis for data rearrangement. After obtaining rearranged data, the determination of the data is student ID or staff ID is to look at the length of the data. If the length is less than nine, it means that the data is student ID data, whereas if the length is more or equal to 9 it means that the data is staff ID data.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

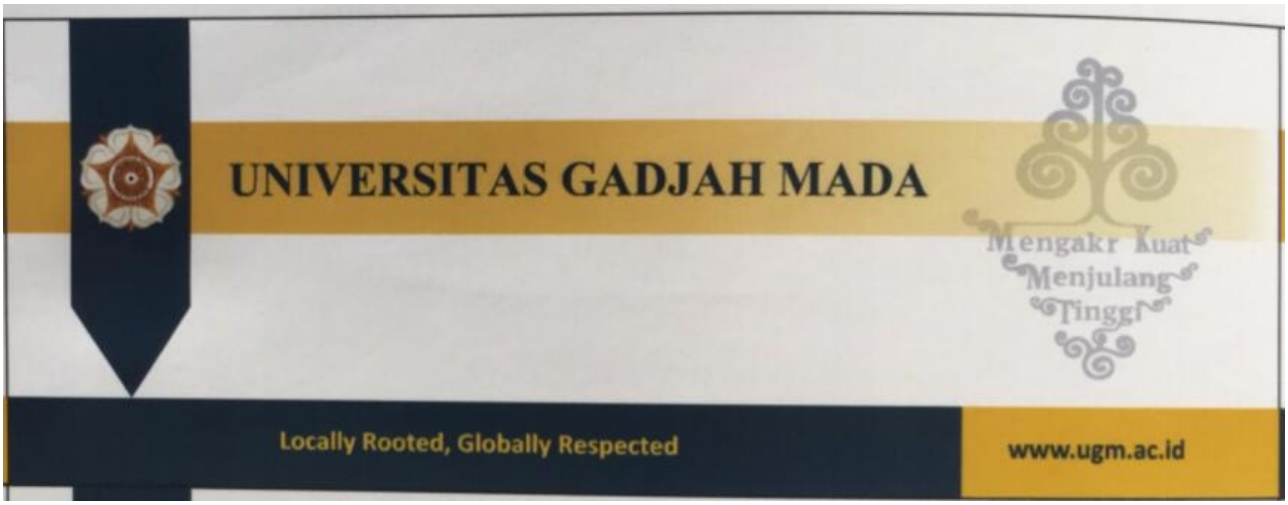

Figure 5: Long Range RFID Sticker

B) IMPLEMENTATION OF THE LOOP MAGNETIC SENSOR SYSTEM

Magnetic loop sensor is a proximity sensor or more commonly described as a sensor that can know the existence of an object [8]. The loop sensor installed on the portal is placed below the road surface. In the UGM campus parking information system, two magnetic loop sensors are installed. One is placed 2 meters before the long range RFID reader, and the other is thrown under the exit gate. The purpose of installing this sensor is to provide a trigger for the RFID Reader to start reading RFID sticker data from the vehicle. Another function of the loop sensor is to count the number of vehicles that exit. Every time a vehicle passes above the loop sensor, the sensor will send data to the information system software located at Intel NUC. The software then gives commands to the LED to add numbers to the number of vehicles. The program code used to read the magnetic loop sensor values is shown in Figure 6.

```
protected void DataReceivedHandler(byte[] received)
{
  var stringData = BitConverter.ToString(received, 0);
string[] arrData = stringData.Split('-');
  int newInLoopState = int.Parse(arrData[1],
System.Globalization.NumberStyles.HexNumber);
  int newOutLoopState = int.Parse(arrData[0],
System.Globalization.NumberStyles.HexNumber);
  …
}
```

Figure 6: Code for reading magnetic loop sensors

The data obtained is in the form of byte array data that contains state from 8 input channels on USBOpto RLY816. Channel 1 is connected to a magnetic loop sensor to activate a long range RFID reader, while channel two is connected to a magnetic loop sensor to trigger a closed gate. So to get the value of the loop sensor, the received sensor loop data is converted into a string, then separated into a string sequence with a '-' separator, after which it is parsed to integers in the 1st array data value to get the state value loop in the entry and parsing position to integers in the second array data value to get the loop state value in the exit gate.

C) IMPLEMENTATION OF LED DISPLAY

In the development of CPS, an LED was added which contained some information for drivers passing through the parking portal. The first information available on the LED is the type of driver that is obtained from the reading of the

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Vol. 6, Issue 2, February 2019

card affixed to the vehicle. There are three types of vehicle drivers, namely Guests, Students, and Staff. The next information displayed on the LED is a counter that displays the number of vehicles passing through the portal, both the number of vehicles entering and leaving. This counter is reset every day at midnight. This counter information is not only displayed on LEDs but also stored in different log files every day. That way, it can be seen the number of vehicles entering the portal from day to day. List of LED command codes:

- Change the writing of the type of driver to be a student: 1
- Change the writing of the type of driver to become a staff: 2
- Vehicle counter up: 3
- Vehicle counter down: 4
- Counter reset and driver type writing: 5
- Change the writing of the type of driver to be a guest: 6

These commands are sent by sending the command to the LED device using the following code:

```
ledSerialPort.Write([command code], 0, 1);
```

`ledSerialPort` is an object that contains access to LED devices that are initialized with the following code:

```
ledSerialPort = new SerialPort(Config.Config.getInstance().configParameter
["comLED"], 9600, Parity.None, 8, StopBits.One);
```

`[command code]` contains commands that will be sent in bytes
- 0 is the initial index of the byte sent
- One is the length of the byte sent.

The display of information coming out on the LED displayis shown in Figure 7.

Figure 7: Information on the LED display

D) IMPLEMENTATION OF DATA STORAGE AND PROCESSING UNIT SYSTEMS

Intel NUC is used as the main data processing device. The NUC Intel is the Next Unit of Computing (NUC) which is a small PC. With the use of Intel NUC, the CPS system can run without the role of the (humanless) officer. The operating system used on this device is Ubuntu Server version 16.04. This Intel NUC is configured to be accessible via SSH so that maintenance and checking of programs can be done remotely. As the main data processing device, the Intel NUC

ISSN: 2350-0328
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Vol. 6, Issue 2, February 2019

is responsible for receiving data from Long Range UHF RFID Reader and magnetic loop sensors from USBOpto RLY816 and is tasked with sending commands to USBOpto RLY816 and LED displays. Data received from USBOpto RLY816 is a data state of magnetic loop sensors, whether there are vehicles that pass or not. If there is a vehicle passing, a command will be sent to the LED to add the vehicle counter in the direction that corresponds to the location of the sensor and activate the long range RFID reader to read the presence or absence of readable stickers. If there is no sticker read, it means that the passing driver is considered a guest, then the program sends a command to USBOpto RLY816 to sound the buzzer and turn on the red light and send commands to the LED display to display guest posts. Whereas if there is a readable card, the program will send a command on USBOto to turn on the green light and send a command to the LED display to display the Student/staff writing according to the results of reading the sticker. A list of driver IDs that pass through the portal is also recorded in a file and will be uploaded to the server in real time. Driver ID registration in the form of staff ID or student ID is done after processing the sticker data. Writing the data into a file using the following code:

```
File.AppendAllText (logFilePath, driverId + "," + unixTimestamp + Environment.NewLine);
```

The resulting file is a CSV file with two columns, the first column contains the driver ID and the second column contains the time the driver passed through the portal. The image of an Intel NUC device on the implemented system is shown in Figure 8.Intel NUC is also connected with a webcam. This webcam is used to take pictures of every vehicle that passes through the gate. The webcam image resolution used is 2 MP. The image is then stored on localhost and then sent to the server.

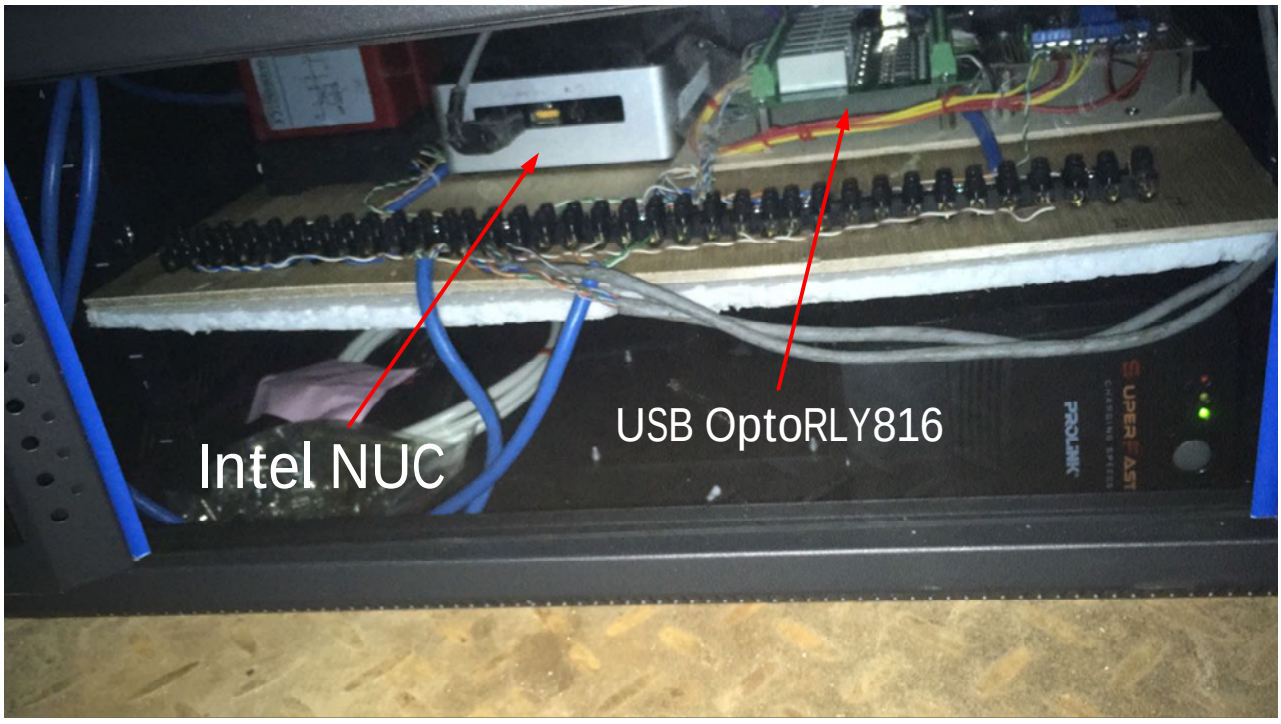

Figure 8: Intel NUC device on CPS

E) IMPLEMENTATION OF PORTAL GATE CONTROL UNITS

USBOpto RLY816 device is an intermediary for communication between magnetic sensor loops, limit switches for knowing open and closed gates, gate drive motors, LED indicators, and buzzers with Intel NUC. The output of the magnetic sensor loop is in the form of digital data with the output value in the form of "high" and "low" signals only so that a device capable of converting the high/low value is needed to be read by Intel NUC. USBOpto RLY816 is a series of relays with input and output channels. Magnetic loop sensor, limit switches to determine the status of open and

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

closed gates, connected to the input channel on USB Opto. This input value will be translated into a code that can be read by Intel NUC via a USB connection. In the output section, USB Opto RLY816 is connected to the buzzer, LED indicator and gate drive motor open and close. The following program code is used:

```
optoSerialPort.Write ([command], 0, 1);
```

`[command]` is loaded with the command byte that is appropriate for the operation of the buzzer or sign light: code 101 to open the gate, code 102 to close the gate, code 106 to turn on the buzzer, code 107 to turn on the red light, code 108 to turn on the green light and code 110 to reset the buzzer and sign lights.

- 0 is the initial index of the byte to be sent
- 1 is the length of the byte to be sent

USBOpto RLY816 device, LED indicator and buzzer are shown in Figure 9.Buzzer is a device that will emit a sound when electrified. Control of this alarm uses USBOpto RLY816 [9]. The alarm will sound when there is a vehicle with an RFID sticker that is not suitable.

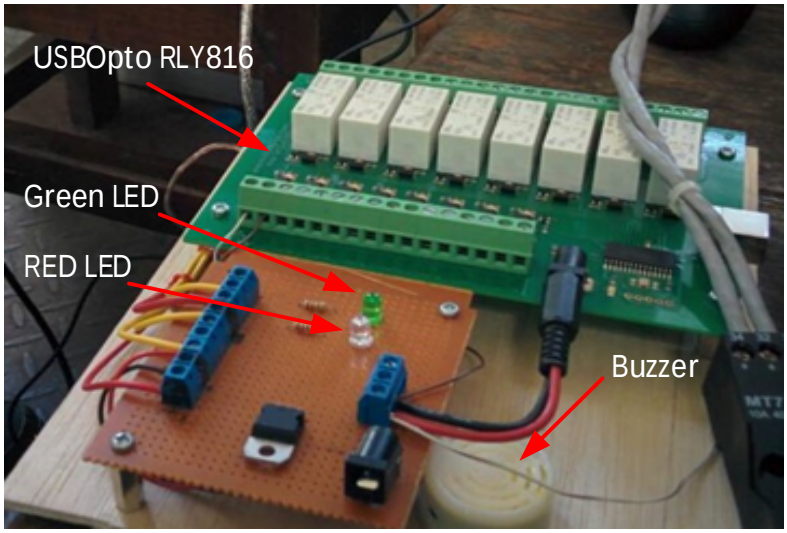

Figure 9: USBOpto RLY816 devices, buzzer,and LED indicators

F) IMPLEMENTATION OF CPS INFORMATION SYSTEMS

Data for every vehicle that passes through the gate will be processed and stored to the CPS Information System server in real-time.To be able to run the features needed by the CPS information system, several modules were created to be able to accommodate the necessary codes, along with a list of modules and their functions. This information system can only be accessed through the UGM local network, https://10.13.247.124/cps2/. The CPS Information System login page is shown in Figure 10. The function of making vehicle stickers on the CPS information system is shown in Figure 11.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

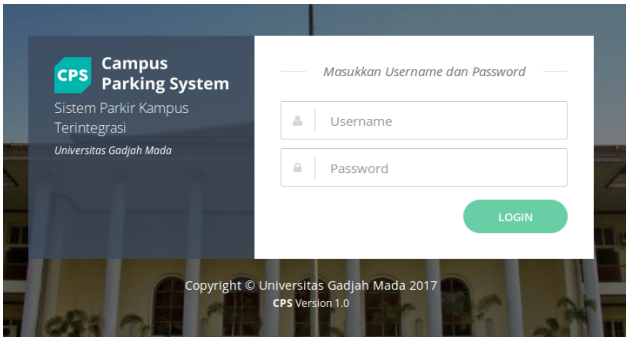

Figure 10: CPS Information System login page

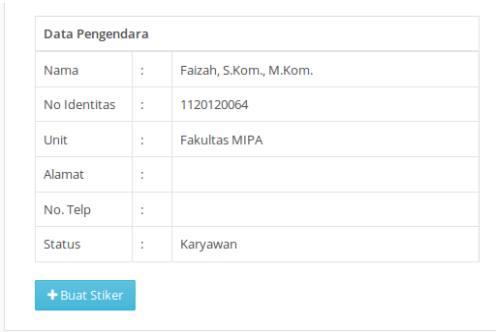

Figure 11: RFID vehicle data sticker writing page

Modules made as shown in Table 1are completed with their respective models, controllers, and views. Some functions only require copying and adjusting from the Laravel framework[10]. However, some other functions require recoding from the start. In general, the functions needed have been successfully implemented into the destination framework, namely UGMFW [11], some functions in the admin still haven't run as expected because database queries are not yet appropriate, the display of the CPS information system is shown in Figure 12.

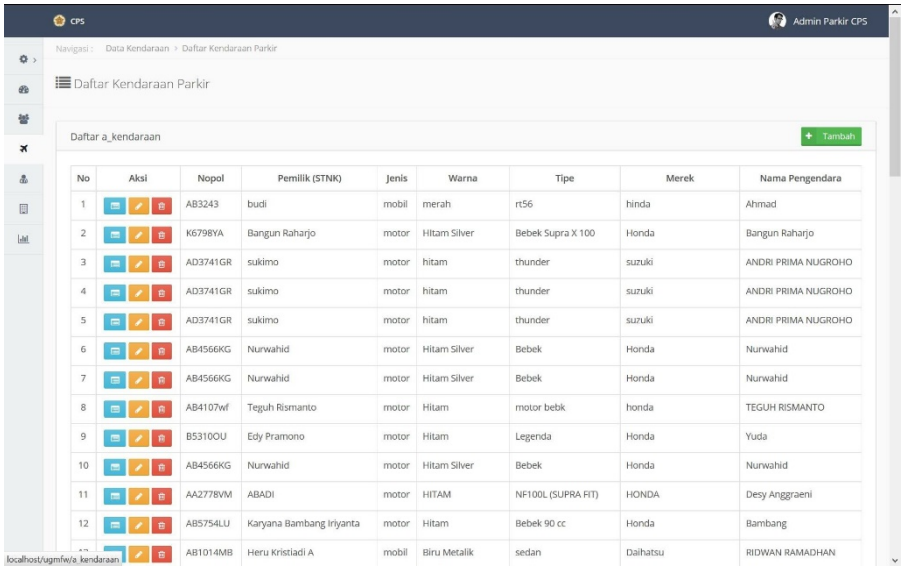

Figure 12: Vehicle Data in the CPS Information System

Table 1: CPS information system module

Module Name	User	Function
kantong_parkir	Officer	Provides system user interface functions
a_dashboard	Admin	Provides an overview of the data in the system
a_kantong_parkir	Admin	Displays parking bag data along with functions to add, change, and delete
a_petugas_parkir	Admin	Displays parking attendant data along with functions to add, change, and delete
a_kendaraan	Admin	Displays vehicle data and functions to add, change, and delete
a_pengendara	Admin	Displays driver data and functions to add, change, and delete
a_ringkasan_transaksi	Admin	Displays transaction history data per day

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International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Issue 2, February 2019

VI.CONCLUSION AND FUTURE WORK

The design of an intelligent traffic control system at the UGM campus portal has been successfully carried out. Detection of long-range RFID-based vehicles works well,and RFID data can be recorded into CPS information systems. The weakness of this system is that the system cannot read long-range RFID properly if there is a long queue of vehicles. From the information system side, the information system developed is not perfect because there is a migration process from the old framework to the new UGM framework system.

The design of this system needs to be developed by adding the vehicle plate number detection feature automatically if the user does not have an RFID label installed on the vehicle.

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REFERENCES

[1] Guolin Wang, Deyun Xiao, and J. Gu, "Review on vehicle detection based on the video for traffic surveillance," in *2008 IEEE International Conference on Automation and Logistics*, 2008, pp. 2961–2966.
[2] G. Revathi and V. R. S. Dhulipala, "Smart parking systems and sensors: A survey," in *2012 International Conference on Computing, Communication and Applications*, 2012, pp. 1–5.
[3] A. Khanna and R. Anand, "IoT based smart parking system," in *2016 International Conference on Internet of Things and Applications (IOTA)*, 2016, pp. 266–270.
[4] M. Fraifer and M. Fernström, "Investigation of Smart Parking Systems and their technologies," 2016.
[5] D. Zulkarnain and E. S. Julian, "PERANCANGAN SISTEM PARKIR DENGAN REKOMENDASI LOKASI PARKIR," *JETri J. Ilm. Tek. Elektro*, vol. 14, no. 2, pp. 17–28, Feb. 2017.
[6] S. R. Basavaraju, "Automatic Smart Parking System using the Internet of Things (IoT)," *Int. J. Sci. Res. Publ.*, vol. 5, no. 12, pp. 629–632, 2015.
[7] I. Mayordomo, R. Berenguer, A. Garcia-Alonso, I. Fernandez, and I. Gutierrez, "Design and Implementation of a Long-Range RFID Reader for Passive Transponders," *IEEE Trans. Microw. Theory Tech.*, vol. 57, no. 5, pp. 1283–1290, May 2009.
[8] N. K. Singh, L. Vanajakashi, and A. K. Tangirala, "Segmentation of vehicle signatures from inductive loop detector (ILD) data for real-time traffic monitoring," in *2018 10th International Conference on Communication Systems & Networks (COMSNETS)*, 2018, pp. 601–606.
[9] N. Barodawala, B. Makwana, Y. Punjabi, and C. Bhatt, "Home Automation Using IoT," 2018, pp. 219–242.
[10] Taylor Otwell, "Laravel - The PHP Framework For Web Artisans." [Online]. Available: https://laravel.com/. [Accessed: 12-Feb-2018].
[11] Developers UGM, "Developers UGM," 2016. [Online]. Available: http://dev.ugm.ac.id/front/home/detail_aplikasi/38. [Accessed: 11-Feb-2018].