Automatic Toll Payments in Smart Transportation

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***Abstract*— The background of this research is how to help toll road managers so that congestion does not occur when queuing to pay for toll gates. With the proposed system, it will be able to help parties, especially toll road managers, in supervising payments for vehicles entering toll roads. The problem raised in this study is how to reduce the level of congestion that exists at the gate of please, which makes payments still manually or with the E-Money card tap system. Therefore, this research develops the existing system so that it can make different system arrangements and the latest. The method used in this research is to use the literature review and survey method, by reading many journals that have almost the same research, with this research, you can find differences from previous research so you can find the latest research in this study. The result of this research is how to make a proposed system that can be applied to toll gates so that it can reduce congestion at toll gates if vehicles want to enter the toll gate. This resulted in 81% that agreed with the proposed system made in this study, the proposed system can solve problems that exist at toll gates, especially toll gate payments. Therefore, with this system, the problem of congestion at toll gates can be resolved.**

Keywords—automatic, payment, smart system, transportation, toll

I. INTRODUCTION

Changes to the toll flying system have existed several times, from human guards to using electronic cards to pay automatically. This proposed system can be even better because without having to interact with humans the system will only detect the balance on the device placed on the vehicle and at toll gates. Therefore, the creation of this system will help toll managers in making payment systems [1].

The method used in this study is to use literature reviews and trials on vehicles, with a literature review, the author will be able to read many references from journals and books to find new research problems [2].

The research problem raised is how to create a system that can help payments at toll gates so that there are no queues that can cause congestion at toll gates [3].

This research produces data that can be used as new data in the form of test results that can prove that the proposed system is successful and is approved by motorized vehicle users who pass through the toll road [4].

Currently, the availability of parking space has become an important need for the community. With the large number of vehicles due to human dependence on transportation facilities, especially cars, which are getting bigger to support daily activities, of course, it requires a wider parking space, especially in Malls or Offices [5]. The current parking system does not support the needs of motorists who only use the parking lot and parking attendants who control each incoming vehicle, and also often do not pay attention to the capacity of the parking lot they have. The problems that arise in the parking system are the lack of information about vacant parking lots and inappropriate vehicle placement so that it often takes vehicle owners a long time to just find an empty parking space [6].

Manual parking systems in mall parking services require management and development of systems that are more complicated and far from efficient. The information obtained by the parking manager regarding the condition of parking in the field every day is still lacking. Manual parking systems with hundreds or even thousands of motorized vehicles require extra close supervision because of thousands of motorized vehicles. The long time when manually recording vehicle number plates in the parking system creates queues [7].

This research develops an RFID-based automatic parking system and vehicle number plate image processing. The parking problem is sometimes a crucial thing to find a solution in order to provide practicality, safety and comfort for vehicle drivers as well as efficient use of limited parking spaces. And using the work system in this parking simulation works with an Arduino mega 2560 R3

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microcontroller chip as the main processor that controls all components. Other devices are 1 ultrasonic sensor for vehicle detection sensors at the entrance and 1 sensor at the exit. Next, the RFID rc522 module is also used as an electronic ticket so that vehicle security is maintained and also as a parking door lock that functions to open a parking portal using a servo motor. And for the condition of notifying the location of the vacant or full parking lot, several sensors are also installed in each parking slot so that the system can monitor the condition of the vehicle at the parking lot location by displaying it on the LCD monitor [8].

Theft of a vehicle is a common occurrence. Because there is still a lack of an adequate vehicle security system, motor vehicle theft happens [9]. There are numerous step procedures used in the preparation of this final project, including observation and literature review, tool design, tool fabrication, and test findings. Observation, in which the procedure is carried out by travelling directly to the field to collect the required data, literature study, in which reference materials are obtained from books, papers, papers, journals, or articles connected to Arduino, GPS (Global Positioning) [10].

Lack of supervision from vehicle owners is a factor in frequent theft cases. With the creation of a vehicle security system, it is hoped that parked vehicles can be monitored and controlled using an Android smartphone integrated with a microcontroller (Arduino), where later vehicles parked in front of the house or in public places can monitored by the android application [11]. The results of the tests carried out, it is known that the performance of the Vehicle Security Device Design Using a Mobile-Based Arduino with the overall test results of the tool can display information data as expected, namely as a warning when the vehicle is stolen and sends the location of the vehicle coordinates to the user's smartphone, then will automatically track the position of the vehicle is located. It's just that the GPS position in a closed place does not get a GPS signal. Overall, the conclusion obtained from this tool is that 90% of the tools can work well [12].

Because the use of vehicles has grown significantly in the country of Iraq, and this growth is not supported by the expansion, but now in Iraq the traffic light system is still implementing a timer-based system that is controlled manually. All of this causes uncontrollable problems at crossroads resulting in very high waiting times on the road [13].

A magnetometer sensor will be inserted at a distance of 30 meters from either side of the intersection to execute the smart traffic signal system. Each sensor will be attached to a microprocessor that will manage the sensor's numerous signals in order to assign a green light based on the response received from the jammed sensor [14]. To begin, all queue values and sensor readings for either side of the intersection are removed. When a signal from one of the sensors indicates that the required threshold on one side has been reached, a green light on that side will turn green, allowing automobiles on that side to pass. The red light will be assigned to the preceding side after another signal from another sensor is received. Each side will be granted a green light according to the queue priority scheme, which is FIFO (First In First Out), with a 3 minute elapsed period on each side. This Smart Traffic Light System (STLS) is also an Intelligent Transportation System (ITS), and it uses Arduino to implement it [15].

Intelligent Transportation Systems (ITS) have been employed for a wide range of reasons, including enhancing road safety and lowering pollution. As a result, the journal's authors recommend developing a modularly upgraded Roadside unit (SERSU) that can collect data for use in multifunctional ITS. Intelligent Transportation Systems (ITS) paired with Adaptive Speed Limits (ASL), pollution control, and weather guidance are all part of the present SERSU architecture. The designed system will connect to multiple system components using the Internet of Things (IoT) concept [16].

The Master Control Center (MCC) is the central unit in this system that receives information from individual SERSU modules on the side of the road. One of the services that PKS may give is the Speed Adaptive Traffic Control System (SATC). The SATC's job is to offer ASL for specific road segments depending on local traffic and meteorological data [17].

Plusi Adaptive Traffic Control System (PATC) is a feature that uses traffic jam and pollution data to monitor and regulate traffic flow. The Weather Information System (WIS) is in charge of tracking the weather and coordinating road repair activities, as well as delivering severe weather warnings to drivers and maintenance staff. The Ada SERSU, on the other hand, is a modular unit that collects formations and sends them to PKS at regular intervals along the roadside [18].

We offer a hypothetical ITS setting in which speed rating and pollution adaptive traffic control technologies are combined with meteorological guidance in this study. For data gathering and communication, the embedded SERSU module supports Intelligent Transportation Systems (ITS) [19].

These include the high number of passengers involved in traffic accidents, transit vehicle congestion, and vehicle pollution, all of which contribute to traffic congestion. To improve the issue, research is being performed for transit vehicle tracking systems, with the goal of finding a solution to the problems listed above. Review the services of state-of-the-art vehicle tracking systems, with wireless, communication technologies, usage of specialized algorithms, and intelligent transportation systems [20].

Intelligent transportation system services take into account in this regard, find a way to somewhat measure vehicle emissions for improved decision making, and can also measure fuel consumption, as well as evaluate the results obtained, and take appropriate action in the case concerned [21]. Also consider the standardization and interoperability in considering the architecture and services of the intelligent transportation system proposed in the previous research, adding components that can help performance even if they are not relevant [22].

LoRa technology is widely used in the world which is used as an alternative to GPS as positioning with the presence of parameter systems (SF and BW) and technology (RFID, BLE) to find vehicles. Use the systems mentioned above as primary or backup options [23].

The creation of an Automatic Vehicle Speed Control System is to reduce pollution levels of traffic congestion and

is useful in reducing the level of accidents on the road. The number of vehicles at high speed is one of the main factors in the occurrence of accidents, mistakes like this can have a big effect such as trauma, permanent physical disability, and even the loss of questions. Many people with high egos are not responsible for obeying the maximum speed limit rules, they only think about themselves, not with those around them [24].

With the Automatic Vehicle Speed Control System, we can control the speed of the vehicle in accordance with the provisions of the speed limit in each zone. This system will automatically detect the existing speed limit and then regulate the vehicle so that it does not exceed the specified limit. Arduino Board Mega (2850), HC-0 Bluetooth Module, L298 Motor Driver, IR Sensor, SIM800L, Gear Motors, Arduino Board Nano, System development suitable for Vehicle Speed Control System [25].

The designed system can reduce reckless drivers, can reduce accident rates, and can save lives. This method is considered effective, because it uses sensors, electronic components, and simple systems.

The goal of this work is to give a basic description of an automatic car parking allocation system that uses components like a microcontroller to solve the problem of automobile parking allocation. [26].

On our visit to the LULU mall in Kerala, a scenario arose to park our car. Parking allocation systems in retail complexes, multi-store buildings, and residences normally have parking slots, and garages are governed by human intervention hours. Due to the fact that it is rush hour, numerous cars are there, causing delays and high traffic at the entrance.

These are some of the system's advantages. While this might be beneficial, there is no certainty that speed will be regulated when more vehicles arrive. He can control traffic, but this system will not be particularly useful during spare time and will not function optimally. The concept of pre-booking parking spaces is novel, but it is likely to cause some confusion. If the person who reserved the parking space arrived lately, the area should be maintained clear of other people.

The design of the car parking sensor was carried out because there were several problems such as the lack of parking spaces so that the researchers took the title based on Arduino Uno Car parking distance controller using ultrasonic sensors in this study using 3 main components, namely Arduino UNO, Arduino MP3 Shield and Ultrasonic HC-SR04. Arduino MP3 Shield is a module used to play sound.

Parking users have difficulty adjusting the position of the vehicle so that the car can be parked properly. In fact, if the parking process can be assisted with a more modern system, it will be very profitable, both for industry, parking management companies, parking users and for vehicle owners who have private parking spaces at their homes. Therefore, a parking system is needed that can make it easier for car drivers to park their cars with Arduino Uno devices using ultrasonic sensors [27].

Based on the results of the analysis, design and implementation that have been carried out. So some conclusions can be drawn, among others, as follows: This parking design is a distance control system that can perform commands through the voice issued by the speaker so that it is easier to park the car.

The proposed system is the latest because no one has yet used the Node MCU and Wi-Fi Module ESP10 at toll gates, and the development of electronic money that makes toll gate payments easier. Therefore, the proposed system can help toll road managers in the financial sector to clarify financial reports [28].

II. Research Method

The research method used in this study is to use the review literature method, using the basis of 150 journals and 30 books based on the same research, therefore with the basis of journals and books will be able to find the latest research problems, and can find novelty from the problem of the previous research problem, therefore by using a literature review, it will continue with a trial so that it can be known whether this system runs well according to the research method raised.

The software used in the study this time is to use Macromedia Dreamweaver and My SQL Server software, using the software, the data to be obtained from hardware detection, will be stored in the existing database on the toll gate that has a system raised in this research.

The hardware used in this study is to use Android, namely the MCU node and WIFI ESP8266 module, with the two tools, it will simplify the toll gate payment, the MCU node will store data on the vehicle and along with the balance in the vehicle, then the WIFI ESP8266 module Will read the data in the MCU node on the vehicle, therefore with the existence of the system it will be able to help the toll gate payment and toll gate do not need to be kept again, so the system will take over in the toll road payment.

The completeness of the analysis in this study there are 2 kinds, namely hardware and software, hardware using MCU Node and Wi-Fi Module ESP10. Simulation study by conducting trials by conducting tests on the highway in the city of Jatiwaringin, Bekasi. The accuracy of the data by calculating the existing deductions on the MCU node tool. The accuracy of the proposed model is very high because it has been tested.

Based on Fig. 1 it will continue the direction and objectives of the research method raised, the first stage is the review literature based on 100 journals that have the same research, the second stage is to find the research problem, the third stage is doing research, and the fourth stage is how the research produces a novelty, until it can contribute to research science for the entire world community. By using the method shown in Fig. 1, in order to determine the direction and purpose of the research conducted on the writing of the paper, by using clear images and directions, the stages carried out in this study will be able to provide a more detailed description of the research conducted.

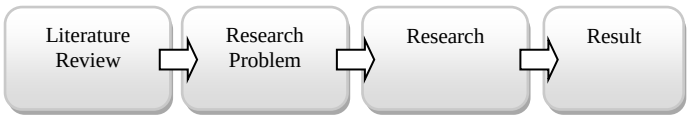

Fig. 1. Research flowchart

III. MODEL PROPOSED

In this section it will explain how this system is proposed, and how this system runs so that novelty can be found for the future studies.

Based on Fig. 2, there is a flowchart image, which will be explained as follows, first is Start where the system starts, then the balance is known, there are two options yes or no, if yes, the data in the MCU note will be detected by the Wi-Fi device ESP module, the data will be read and the balance will be reduced, after that the data is saved in the database, then if you choose not then the system will end and the balance if the balance is not enough.

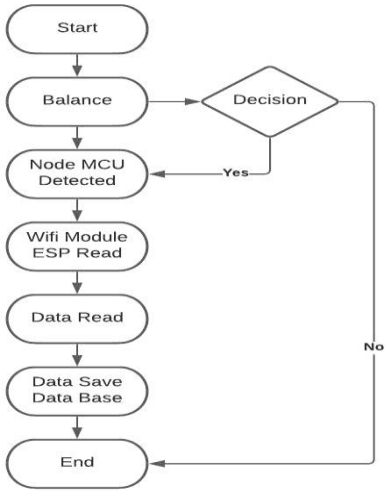

Fig. 2. Flowchart of decision making in the system

Based on the Fig. 3, there is a process that has two vectors, the first is the driving factor, the second is the system factor is connected to the balance payment data record and the system factor database is related to the cash payment data record and database with a connected diagram, the driver will connected to the system so that it can help drivers pay for the door please automatically.

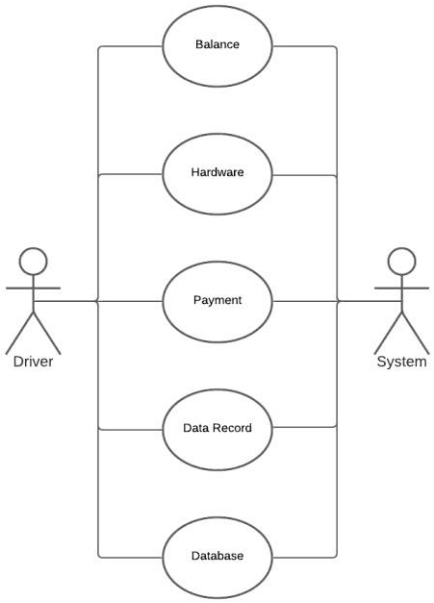

Fig. 3. Use case diagram

Based on Fig. 4, the image is an activity diagram image. There are 2 activities carried out by the user and the system first starts and then he has a balance, then the system checks the balance, then the user reads the data on the node After checking the MCU, the balance data will be known, in the MCU Node the balance is always deducted by the system, and read again by the Wi-Fi ESP module, after that the new data will be stored so that it can be stored in the database of interested parties.

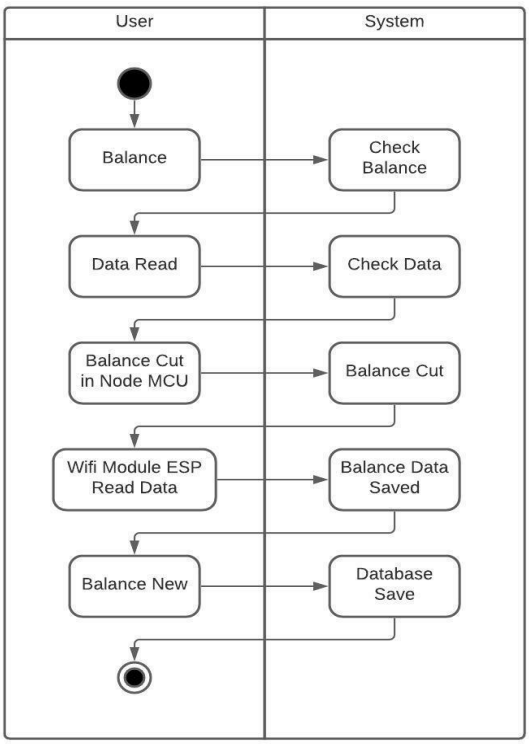

Fig. 4. Activity diagram

Fig. 5 is the tool used to read the MCU node, namely the module Wi-Fi esp8266 tool, the tool is placed at the toll gate, then the data contained in the MCU node, especially balance data, will be read and will decrease significantly. Automatically, if the car is placed by the MCU node tool and passes the predetermined sensor.

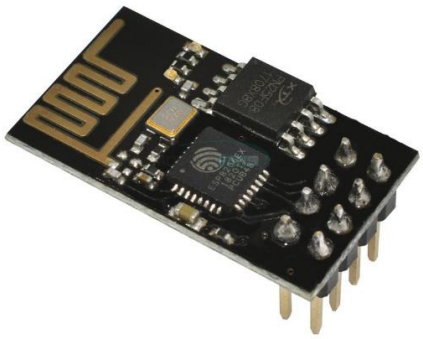

Fig. 5. Module Wi-Fi esp8266

Fig. 6 is an image that stores data on drivers, and vehicles, also the most important thing is storing data on the balance contained in the vehicle, because the balance will be used to pay for entering the toll gate and if you have to pay. Therefore, the balance on the MCU node is very important because it is a means of payment used to pay for entering the toll gate.

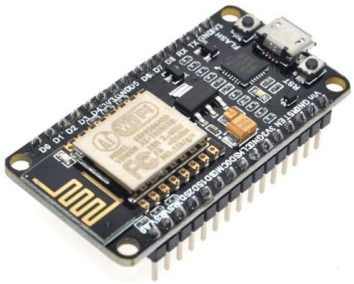

Fig. 6. Node MCU

Fig. 7 shows that there is a framework model of the proposed system, this system will provide an illustration that if the vehicle has been installed with the MCU node tool, and will store data, especially balance data on the vehicle, because it will be used to pay for the door. toll gates, at toll gates there is a tool called the Wi-Fi module ESP 8266, with this tool it will read the data contained in the MCU Node tool that has been placed on the vehicle that will pass through the toll gate, after reading the data and recording it will be stored into the database so that it can be used as data at a later date.

Fig. 7. Model framework smart toll gate

Table I, shows the result of a software that can view the data that has been recorded by a tool called the esp8266 Wi-Fi module. After the data is obtained, it will be stored in the software and stored in the toll gate database. All vehicles passing through the toll gate will be recorded and stored as data.

TABLE I. DATA RECORD

Plat Number	Name	Time	Balance
B 2030 SUK	Arman Syah Putra	15.00	Rp. 90.000
B 2030 SUK	Arman Syah Putra	17.00	Rp. 80.000
B 2030 SUK	Arman Syah Putra	20.00	Rp. 70.000

A question have been given to 100 toll road users regarding the proposed system is shown in Table II. The method used in testing the questionnaire is with a survey method to 100 vehicle users who pass through the toll gate, so they can find out the direct impact on its implementation.

TABLE II. QUESTIONS ASKED TO TOLL ROAD USERS

No	Questions
1	Do you agree with the implementation of the existing system at the toll gate and make payments automatically?

Fig. 8 shows the results of the survey conducted to users of 100 vehicle drivers passing through the toll gate. Based on the results, 81% agreed with the proposed system, and 19% disagreed with this proposed system.

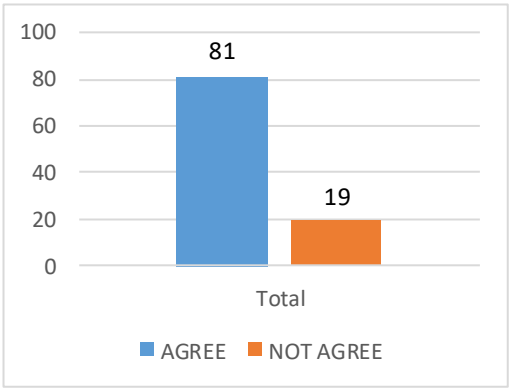

Fig. 8. Results of a survey of 100 vehicle drivers

IV. CONCLUSION

Based the results of the research above, concluded that the proposed system is widely liked by the wider community. According to a survey of 100 motorists, 81% agreed if this system was implemented and this system would be able to help reduce congestion at toll gates when motorized vehicles enter the toll road. The system, all vehicle data passing through toll roads can also be recorded and recorded for data from toll road parties, and can also be used as financial reports for the costs of vehicles passing through toll roads, future research by implementing the proposed system in order to help the manager toll roads in maintaining toll road gates and their payments.

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