Automatic Vehicle Identification and Inventory System using RFID Technology

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Abstract

*We developed an automatic vehicle identification and inventory system using RFID technology. RFID is a new identification technology which needs no direct contact between the object and the identifier. It is consisted of a transponder (tag) and a reader. The proposed system consists of automatic RFID reading, inventory, database, microcontroller and gate actuator subsystems for vehicles. According to the Ministry of Communication and Information, the reader works at 923-925 MHz frequency range. Middleware software has been developed using Borland Delphi 7. The experiment has been conducted to test the functionality and reliability of the system which consisted of vehicle identification, validation, inventory, opening/closing gates, and data recapitulat*ion for reporting.
Keywords: RFID, tag, reader, vehicle identification, vehicle inventory, Delphi

1. Introduction

Universitas Indonesia as a big university has been flocked by cars and motorcycles every day and the number of vehicles entering and leaving the campus is increasing from time to time. Those vehicles (especially cars) are verified manually at the gate and if there is no license, the driver has to pay to the officer. To pay, and take an entrance card at the gate, each car has to spend about 10 seconds. In peak hours (morning), vehicles have to wait in a very long queue before entering the campus as shown in Fig. 1. Since there is no authorization for each vehicle in the campus vicinity, so the security risk is very high. When leaving the university exit gate, the driver just gave the entry card back to the officer. There is no record on vehicle identity such as license plate number, vehicle type, color, owner's name, address, etc. Therefore an automatic vehicle identification and inventory which could work fast with high accuracy urgently needed.

Fig. 1. Vehicles queueing in the UI entrance

In this research, we developed an automatic vehicle identification and inventory system based on Radio Frequency Identification (RFID) technology. RFID is a new identification technology which needs no direct contact between the tag attached to an object and the reader. The technology could automatically detect and identify an object, track and store the information of an object or part of it electronically.

RFID technology consists of tag, reader and collection, distribution and data management system which usually interfaced by a middleware as shown in Fig. 2. In practice, RFID tags could be implemented as labels, key chains, stickers, cards, coins, rings, or other forms. These tags could receive radio wave transmitted from the reader, convert it as an electric energy, feed the memory circuit inside it and transmit the ID content back to the reader.The distance between the tag and the reader, depends on the reader power and working frequency could range from several centimeters to tenth meters.

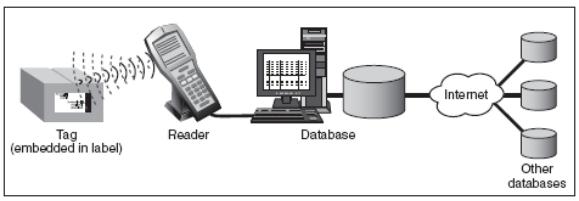


Fig. 2. RFID system and its components

The advantages of RFID are: needs no line-of-sight connection, dynamic information carrier, larger memory size, anti-collision (several tags could be read simultaneously), reliable and weather proof, affordable for long time investment, needs no human intervention

and maintenance-free. Therefore the system could be implemented to increase the effectivity and efficiency in parking and vehicle management system in the Universitas Indonesia.

1. Methods

Automatic vehicle identification and inventory system using RFID is implemented in the Universitas Indonesia. The system consists of tags and a reader which works at 923-925 MHz frequency range as recommended by the Ministry of Communication and Informatics. The reader is installed at the gate IN and OUT of the parking area. To control the gate opening and closing, a microcontroller is used as an interface between the PC and the gates. LED indicators are Fig. 2 showed the proposed system.

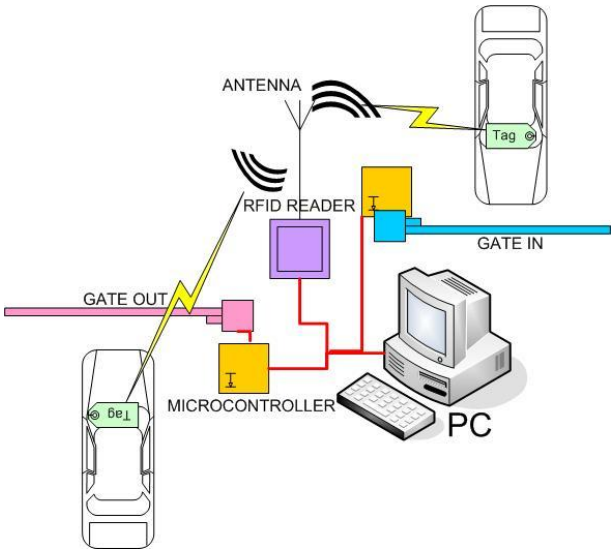


Fig. 3. Proposed vehicle identification and inventory system

As is generally the vehicle entrance gate, then there will be two routes, namely the entrance and exit. In design, this system uses only one RFID tag reader to detect the vehicles through this paths. Single RFID reader system itself can not distinguish directly enter the vehicle or the outside, but with the help of software. The software will run an algorithm to distinguish vehicles that enter or exit.

Vehicle that can go through the door of access into the parking area in the campus must have a tag that is registered on the database system. If the vehicle is detected by RFID reader, the software will match if the vehicle is registered in the database system or not. When the data obtained on the vehicle may not pass the gate access in the main program the software will provide information to the mikrokontroller action to set what should be done on the vehicle. If the data in the database have a vehicle then mikrokontroller will be ordered the doors to open access doors, if not then the door remains closed.

In general, the automatic parking system architecture consists of several parts. The first section is comprised of a RFID reader and tag. The second part is middleware or in the form of a computer system which contains the program and database. The third is microcontroller a function to set the exit and entrance gate, access entrance gate will be made by using the Servo motor. Figure 3 shows the system architecture of automatic vehicle inventory developed.

Read the data stored in the database system that is on the PC. Information read from the RFID reader to have a database on a PC using the software. The software used in the automatic parking system will be created using Delphi 7.

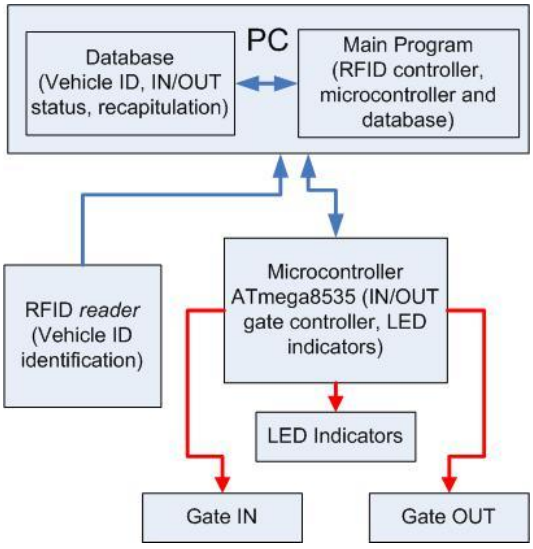


Fig. 4. System block diagram

Data communication between the RFID and the main program on the PC lasted only one direction, namely from RFID to the PC via RS232 serial port. And data communication between mikrokontroller with the main program on the PC also take direction from one PC to mikrokontroller through RS232 serial port. Communication from the PC to be used to run mikrokontroller Servo motor that serves as a parking lot gate. Servo Motor that will be used in this system amounted to 2 which functions as the entrance gate and gate to gate.

3.1. Flowchart Automatic Parking System

This flowchart describes the system-based automatic vehicle inventory RFID work, begining from RFID to be detected until stored in the database. Flowchart shown in Figure 4 with the following explanation:

1. System will continue detect by using RFID technology, if there are vehicles that pass the gate of access to parking or not.
2. If you have a vehicle that comes in, the system will detect whether the vehicle has entered the

appropriate code tags with the database system or not.

3. If it is not appropriate, the system will send commands to mikrokontroller to close the gate.
4. If the code tag in accordance with the database, the system will determine whether the vehicle entrance or exit by using the algorithms that run in the main program on the PC.
5. After that, information about the code tag will be entered into the database. Information is entered in the database, namely the identity of vehicles and their owners. In addition, the entry and exit times of vehicles will also be recorded on the database. Time of entry and exit this will be used to accumulate the cost of parking the vehicle owner listed in the database.
6. Then, the software will command the entrance or exit is opened or closed.
7. After the close the gate open, the system will return to the detection process vehicles as they are. This detection continues until the system is turned off manually.

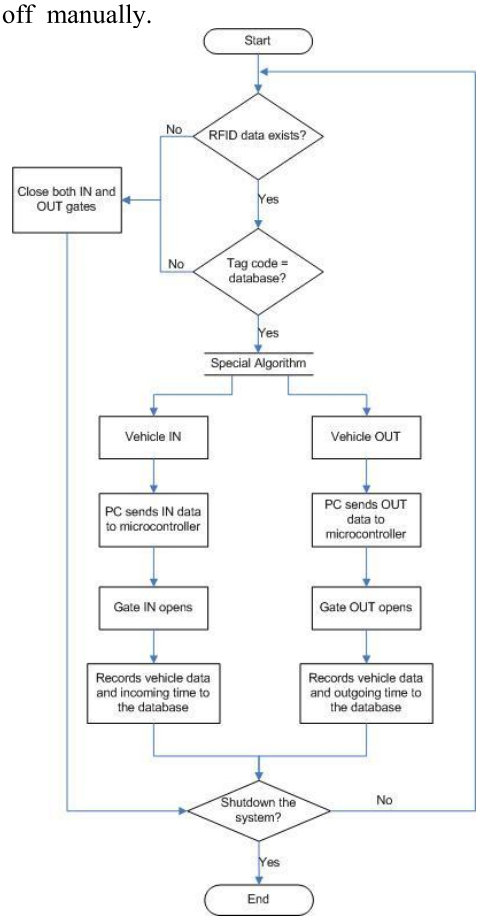


Fig. 5. Flow chart of the system

3.2. Automatic Vehicles Inventory System

In development, this system is gradually becoming some subsystem. In general, subsystems are responsible for certain functions, namely:

1. Subsystem with the vehicle identification RFID
2. Subsystem open-close gate
3. Subsystem software (the main program)
4. Subsystem database
5. Subsystem interfacing software with hardware

a. Vehicles Identification with RFID

The process of identification of vehicles with RFID is to place RFID tags on the vehicle and the RFID reader in a certain place in the parking lot near the gate. So if the vehicle through the gate of the identity of the vehicle will be directly recognized. This identification process will be based on the ability of the RFID reader is used.

Communication between the RFID reader with the PC itself can use some kind of communication, namely communication among parallel and serial communication. RFID communication depends on this component of the output is provided by the RFID reader is used. RFID tag data format is read by the reader as ASCII data with the following formats:

STX – MT – RT – 4 digits card number – 2 digits project number- EXT – LRC1 – LRC2 – CR – LF

Description:
STX = data prefix; MT = data type; RT = type RFID reader; 4 digits card number = 4-digit card number RFID tags in ASCII code; 2 digits project number = 2-digit project number in the RFID tag code ASCII; EXT = End of data; LCR1= first byte checksum; LCR2 = second byte checksum; CR = Carriage return (0x0D); LR = Line feed (0x0A)

b. Open – Close Parking Gate

In designing the system, opening and closing the gate using a Servo motor equipped with a latch. Latch to be used of the two: one for the entrance gate and one gate for exit.

The motor will be done by microcontroller that receive instructions from a computer to open or close the parking gate.

c. Software(Main Program)

Inventory control system for automatic vehicle uses software Delphi. Delphi itself is high-level language programming used in object-oriented Programs.

Software functions to the system and run the algorithm also connects with the database system so that the system is running well. To connect the database with Delphi components, are used in the Delphi ADO (Active Data Object).

In addition, this software also serves to connect the (interfacing) between the computer hardware that will be connected later as microcontroller and RFID. In communicating with the hardware, using a Delphi component called Com-Port.

d. Database

To save data vehicles in detail, required the database. MS Access is used in developing this system because it is a Microsoft Office database program so that easier for management. Database filled with data that are required such as RFID tag number, vehicle owner name, address, vehicle plate number, type and color of vehicle.

MS Access database will be accessible by the main program (in this case Delphi) using components found in the ADO (Active Data Object). With ADO, the distribution of the program only requires a program file (. Exe) and database (*. mdb) only. Database that are connected with the Delphi program shown in Figure 5.

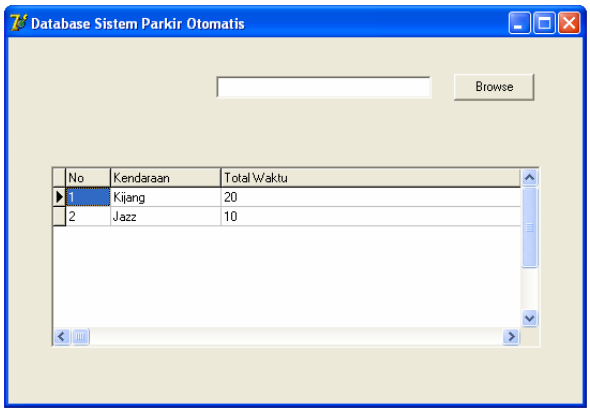


Fig. 5. Connection between DELPHI and *database*

e. Interfacing Software and Hardware

Inventory system has an automatic vehicle software and hardware devices which communicate with each other. Communication between software and hardware uses two communications, the serial communication and parallel communication.

But on this system later will use the serial communication as a means of communication between the hardware and software. In Delphi software itself is actually already available with the communication component of the hardware that is ComPort. ComPort akan disetting in accordance with the characteristics of the hardware. Figure 6 shows a description of the components ComPort is in Delphi.

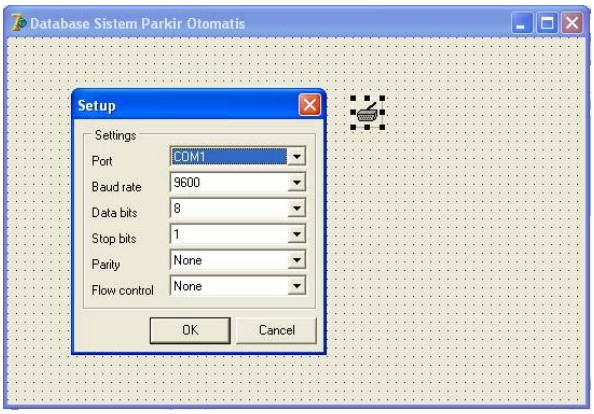


Fig. 6. The components ComPort in Delphi

Each of the hardware that is connected in the system will be configured first, starting from the port number to the parity is not used. Disettingnya with the hardware, the system will run properly and in accordance with the design.

2. Results and Discussion

The system was tested to verify the hardware and software functionalities of the system.

a. Hardware functionalities
b. Software functionalities
c. Overall system functionalities
d. Real-time functionalities

2.1. Hardware functionalities

The RFID reader (model DL910) has the reading distance capability up to 15 meters. The direction of readings are set as shown in Fig. 7.

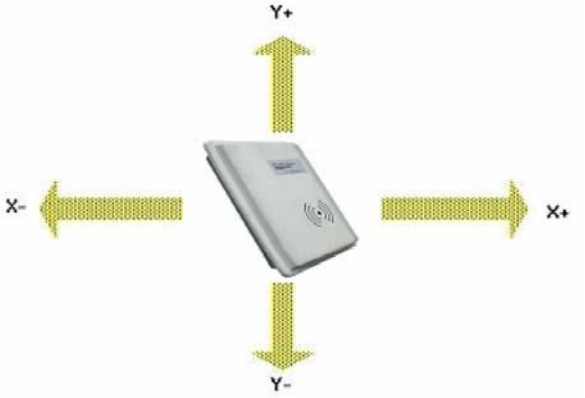
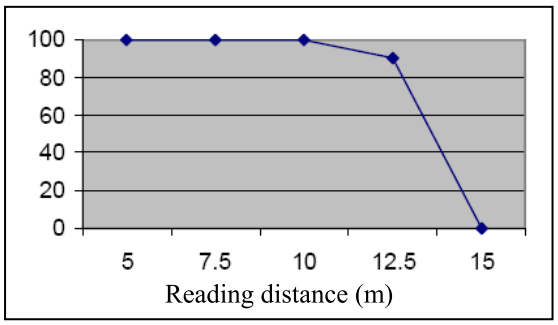


Fig. 7. The directionality of reading

Reading capability (in % of output power) of the reader in 4 directions (no angle, -30°, +30 and) are shown in Fig. 8, 9, and 10, respectively. The data was taken for 10 times for each direction. The results showed a relative strong reading capability for distance less than



10 meters.

Fig. 8. Reading capability (in %) for -30° of X+ direction

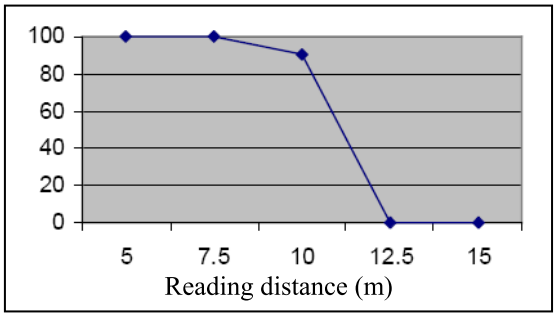


Fig. 9. Reading capability (in %) for +30° of X+ direction

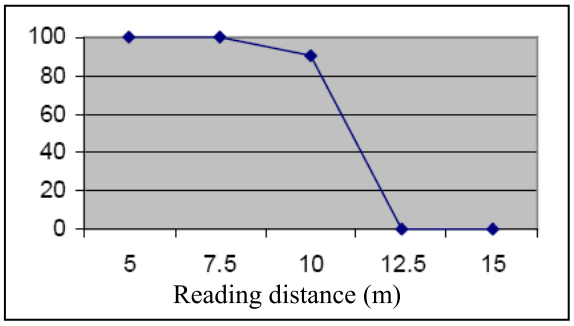


Fig. 10. Reading capability (in %) for -30° of X+ direction

2.2. Software functionalities

To test the software functionality, we checked the system durability for about 8 hours continously. The sample vehicles (for total 5 cars) with tag attached on its windshield are moved in and out and the test results showed a perfect recognition without any errors. The durability test of 5 tags is shown in Table 1.

Table 1. Durability of 5 tags for full performance

Tag distance	Tag1	Tag2	Tag3	Tag4	Tag5
5 m	×	×	×	×	×
4 m	×	×	×	×	×
3 m	✓	✓	✓	✓	✓
2 m	✓	✓	✓	✓	✓
1 m	✓	✓	✓	✓	✓

As shown in Table 1, the system could not recognize the tags attached in the cars for distance more than 3 meters. Therefore the system could be applied in real condition since there are only limited space near the parking gate.

4. Conclusion

Automatic parking system using RFID is designed and perform well for real application. Ideally the DL-910 could read up to 12.5 meters, but in real condition, the reading capability was decreased only to 3 meters. The durability of 5 tags tested was quite good for distance less than 3 meters.

Acknowledgment

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DISCRETE WAVELET TRANSFORM – k-NEAREST NEIGHBORS METHOD FOR SPEAKER RECOGNITION

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ABSTRACT

A Speaker recognition system was created in this research by using discrete wavelet transform (DWT) and *k-Nearest Neighbor (k-NN). Evaluation of this research is using 45 data training database which represents 9 types of sound identity (3 speaker identities and 3 text identities). In summary, this system works by using the data sample of sound through the cutting stage, DWT, Dynamic Time Wrapping (DTW), and k-NN algorithm. The average success of this system in recognizing the sample of this speaker and text identity sound in the database is 98.33% with the average time recognition is 59.03 seconds. This result is achieved through level-2 wavelet decomposition and the usage of approximation coefficients (cA) along with detail coefficients (cD). The average success of this system in recognizing the sample of sound which the speaker and text identity is not available in the database is 72.33%.*

Keywords

Speaker Recognition, Discrete Wavelet Transform, k-Nearest Neighbors

1. INTRODUCTION

Speaker recognition was a digital signal processing technique for recognize, identification or speaker verification (speaker). Function of speaker recognition was classic example of problem in pattern recognition, which in general is useful to found kind of pattern from data got by the censor. Training process is needed for all of pattern recognition problem. For example in s*peaker authentication system*, user voice need to register. During that process, the system is "learn" the user voice that want to recognize. Speaker recognition can be text dependent or text independent. The word "text" in this context is a words is spoken by user [1]. In "*Speech Recognition for Controlling Movement of the Wheelchair*" using *Linear Predictive Coding* (*LPC*) and *Euclidean Squared Distance*, the maximum sucessful percentage that can be achieved is 78.57 % [2]. In this paper a speaker recognition system is developed by using Discrete Wavelet Transform (DWT) and k-Nearest Neighbors (k-NN). Evaluation of this system is using 45 data training database which represents 9 types of sound identity (3 speaker identities and 3 text identities).

2. THEORY

2.1 Discrete Wavelet Transform

Discrete Wavelet Transform (DWT) work by doing wavelet transform in discrete signal. The basic principle of *discrete wavelet transform* is how to get the representation of time and scale from a signal that using digital filter technique and sub-sampling operation or down-sampling operation. The signal first must be process in high pass filter and low pass filter, and then half of the output signal will be taken as sample with down-sampling operation. This process called the decomposition process one degree. The output from low-pass filter will be used as the input of the next decomposition process. This process will be repeated until the decomposition level that desire. Union of the signal output from high-pass filter and one output from the last low-pass filter is called wavelet coefficient, which contain the signal information in the form compressed signal. The explantion of two that process can be explain at Figure 1. Couple of *high-pass filter* and *low-pass filter* that used must be in the form *quadrature mirror filter* (QMF), which fulfill this equation:

$$h[n] = (-1)^n g[L+1-n] \qquad (1)$$

with $h[n]$ is *high-pass filter*, $g[n]$ is *low-pass filter* and L is length of *filter* [3].