Development of Radio Frequency Identification (RFID) in the Campus Parking System based on Microcontroller

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Abstract. In a conventional parking system that is currently still widely used, vehicle owners must show the parking card or the receipt for the parking hours, so that the fee will be paid. In this experimental study, a parking system was developed by utilizing Radio Frequency Identification (RFID) technology based on a microcontroller control system. The use of this technology makes it possible to make a subscription parking system that is served automatically and flexibly by a parking lot. RFID has data information that can be used as a user's identity to enter the parking area. In this research, parking system design and implementation were made by simulating a miniature portal door system to enter and exit vehicles on campus using RFID cards/tags as subscription IDs. AT89C51 microcontroller is used as a system controller. By using this RFID technology, the parking subscription system becomes more flexible and faster.

1. Introduction

RFID has advantages over previous identification technologies, such as barcodes. Among them can read a data object of a certain size without going through direct contact (contactless) and does not have to be parallel to the object being read, besides being able to store information on the tag RFID according to its storage capacity. As a successor of barcodes, RFID can do automatic control for many things. RFID systems offer increased efficiency in inventory control, logistics and supply chain management. Meanwhile, usually in public places, people experience inconvenience in finding empty parking slots, even though it is a paid facility with a security guard. A system with a pair of infrared transmitters that communicates the status of the parking lot remotely, for example to a raspberry pi, can display an empty slot on the screen at the entrance of the parking lot so that users can find out the availability/unavailability of a parking space before entering the parking lot. Such a system will reduce the amount of time wasted by users in parking their vehicles. [1]

On campuses, various information technologies can be applied to optimize existing systems, such as the many uses of academic information systems, the use of voice over internet technology, and Radio Frequency Identification (RFID) technology. As an example of the application of an RFID system is in a parking lot of a building, where a vehicle owner is a person who works or often comes to the building, or that is applied on campuses. The big advantage on the university campus is reducing time wasted and increasing security. RFID technology can be used to collect vehicle
information in real-time in a parking lot through receipt of a vehicle ID from an RFID reader. It can be equipped with a website programmed to display and register user accounts, send and receive emails, and provide reports for the tracking process. RFID readers can be installed in parking lots around campus to collect data and monitor all vehicles entering and departing to arrange parking spaces. This system can classify user types according to predetermined hierarchies, where it will separate and provide vehicle parking slots according to the client's status. [2] [3] The parking door will only open if the vehicle owner shows his parking ID card at the parking location. If the ID card is not registered or the vehicle owner does not have it, the parking door will not open. To be able to enter the location, the vehicle owner must register as a user of the parking lot to obtain an RFID ID card for access to and out of the vehicle at the location of the parking lot. Thus, the manager must provide a parking card or ticket every day and type the police number of a vehicle that will use the parking service. This system is less effective if the owner of the vehicle is a person who frequently goes in and out of the parking location or the person/owner of the vehicle that works in that location. Under these conditions, it is necessary and is an urgency to change the conventional and semi-automatic parking system to be automated by using RFID. This research will contribute to providing an alternative implementation of the open and close automatic parking portal system using RFID technology with microprocessor control.

RFID technology is a technology that is expected to replace optical barcodes in the future. The advantages of RFID compared to conventional barcodes include RFID can do many-to-many communication which can be interpreted as many readers can read one tag, or one reader can read many tags, and use data transmission wirelessly compared to conventional barcodes that use optics. With its advantages, RFID systems promise prospects for various needs, one of which is for motorized parking systems. RFID technology has a major component called tags. With this tag, the data transmission process can be carried out between the transmitter and receiver pair. And the tip that comes in contact with the air media is a tag antenna that can be made from micro strip material. In [4] the design and realization of a parking monitoring system model are carried out with the parking area selection facility using RFID Technology. The software used in this system is designed using C# language. In this system, the process of taking data continuously uses the Atmega16 microcontroller as its main control component. Tests carried out in simulated miniature parking. The test results in the form of a parking system model can display the conditions of each parking area displayed on the display. Continuous data retrieval systems using RFID cards can replace operators. Light sensors (LED and LDR) will have logic 1 if a car passes by. Parking is a requirement that must be met for all public service settings. Parking management is needed to ensure the safety and comfort of users. Current parking systems are mostly manual through vehicle registration checks when the vehicle exits. Research [5] produced a parking management system using RFID. RFID technology uses radio waves to automatically identify people or objects using tags. The identification process is done by storing a serial number that identifies a person or object through a microchip mounted on a chip antenna which then sends identification data information to the reader and converts radio waves (analogue waves) into digital information and is forwarded to the computer so that it can be processed and used. Media used in the form of a parking sign card. With the construction of a parking system using RFID, it will change the manual parking system towards a computerized system that provides many facilities and controls that are more effective and efficient. So that it can make the existing parking system on campuses now can run better, safer and more comfortable. [5] [6] The purpose of this study is to realize a subscription parking system or a prepaid system on campus using an AT89C51 microcontroller-based RFID card. With it, the planned or offered solution is to build an electronic parking automation system that is more flexible to help the management of buildings or campus parking lots for students who routinely use parking lots. So that it will create efficiency and effectiveness of work both in terms of time and energy accurately.

2. Method
2.1. Steps
In this study the authors used an experimental research method, with steps:

▪ conducting a survey of relevant literature for the problem to be worked on
▪ identifying and defining the problem of
▪ formulating a hypothesis, based on a review of the library
▪ defining the basic notions and main variables
▪ Planning and executing experiments
▪ organizes the rough data available to facilitate further analysis, place it in a design that allows taking into account the expected effects of
▪ applying significant tests to determine the level of significance of the results
▪ making interpretations of the results of the testing, and discussion.

2.2. Tools and instruments
The tools as the main components are microcontroller downloader, microcontroller IC, RFID reader, an RFID card, while the measurement instruments used are millimetres.

2.2.1. Microcontroller downloader
The downloader of Microcontroller used in this study is the DT-HiQ Programmer brand from Innovative Electronics as a program input from the computer to the microcontroller IC. With specifications, it requires a 9-12 VDC power supply, 250 mA (minimum). RS-232 UART interface, DB9 connector. Data format 57600 bps, 8 data bits, no parity bits, 1 stop bit, no flow control. 40 pin DIP - 0.6 "socket, 20 pin DIP - 0.3" (with converter socket), 8 pin DIP - 0.3 "(with converter socket), and 32 pin DIP - 0.6" with converter). Intel HEX file format or BIN file.

2.2.2. Microcontroller IC
The IC used is AT89C51, this IC is used as an integrated device controller. The AT89C51 microcontroller has an 8 bit CPU. Boolean processor for 1-bit logic operations. Internal clock generator. Two 16-bit timers/counters. Full-duplex serial data communication channel. Two external interrupt channels. 32-way bidirectional I / O line 32 pieces. Program memory is separate from data memory. Internal Program Memory (MPI) in the form of Flash EPROM 4 Kbyte. 128 bytes Internal Data Memory (MDI). 64 Kbyte External Program Memory (MPE) Address. 64 Kbyte External Data Memory (MDE) Address.

2.2.3. RFID Reader
RFID reader used is type ID-12. Works at a low frequency of 125 KHz which matches the EM4001 tag. Tag reading can be done with a distance of about 1-15cm. This type of reader can accept ASCII, Wiegand26, and Magnetic ABA Track 2 data formats. Also, the type of encoding used is Manchester 64-bit, 64-modulus.

2.2.4. RFID cards
RFID cards are used passive blank cards with 125 KHz carrier frequency. Read range 8-14 cm. Dimension 86x54x1,9 mm. 64-bit data. Reader type gk 4001 / EM 4001.

2.3. Design and testing
In design, the writer divides the two stages of design including the design of hardware and software design. Where both are designed systematically from designing control systems, analysing, designing, coding. In hardware design, it is divided into several important parts, namely the RFID Reader block, Keypad Entry, LCD Display, Main Controller (AT89C51), and Power Supply. Then proceed with the merging of hardware and software to perfect the system that has been designed and by the expectations; and trial.
RFID Block Reader functions as a data read from RFID tags/cards. In the system built there is 1 RFID Reader that is used. RFID Reader ID 12 circuit block is a reader in the form of a ready-made module that only provides data pins and voltage sources (+ and -). For details, the RFID data configuration can be seen in the following table. RFID wiring or wiring module determination determines the work function of RFID ID-12. RFID ID-12 has several choice modes including ASCII Mode, Wiegand26 and Magnet Emulation. On the system that is made the chosen mode is ASCII. The reason for choosing this model is that it is easy to process RFID data.

![Figure 1. RFID module (ID-12)](image1)

![Figure 2. RFID layout](image2)

RFID data reading is done by reading the '02H' header when the data is first received by the main processor. The following is a piece of the program to read RFID data received by Reader RFID ID-12.

The Main Control Block is the main processing circuit of the entire work on the system created. The Main Controller uses IC AT89C51 as a data processing system that enters the RFID ID Reader ID12 circuit, organizes the memory organization for storing customer number data and drives the mechanical portal. The main controller circuit uses a single component Microcontroller AT89C51. Port functions are used optimally in this design. The main controller circuit functions as the receiver of input data from the input signal detector and processes the incoming data determines the operation of the input-output control and then sends these signals to each output pins.
In software design, a software design that will support hardware is discussed. Software design is discussed using a flow chart. The functional specifications of the software designed must be determined through the program’s input and output functions. Through the hardware description, it can be seen that the input data must be understood and will be processed by the program that is the data coming from the RFID Reader input circuit. The software created includes 2 main parts, namely sub-programs that function as data settings (telephone number entry, RFID records, and other supporting function settings). And the second is the main program of the system created.

The initialization process is giving initial values to registers that handle serial communication. What is regulated is the communication speed regulation of 9600 bps by setting SCON and TH1 registers. This must be done first because the system will read the status data at the RX serial data legs of Port 3.0 and TX pins on Port 3.1 pins. If not set, then all incoming data will never be processed by the microcontroller. Serial initialization is adjusted to the RFID device used (ID-12), which is by paying attention to the baud rate. The recommended Baud rate for RFID Reader ID-12 is 9600 bps.

2.4. Data collection and analysis techniques
In the data collection phase, several methods are carried out, namely by observation, interviews, literature studies and certain bibliographies. Stages of data analysis are performed to find out and understand the system to be made, as well as data collection needed for the implementation of hardware and software design. In the system analysis re-evaluating all stages of the research conducted and analyzing the results achieved, which were targeted in this study. This stage is expected to make it easier to conclude.

3. Result and Discussions

This system testing is a hardware and testing software where 1 test uses 3 cards, where each card has 5 pulses. And also testing the opening and closing time of the portal. The results of system testing using 5 tests can be seen in the test results table below:

| Pulse | CARD No: 000112953101715419 | CARD No: 000111697101702859 | CARD No: 000112865601714544 |
|-------|----------------------------|----------------------------|----------------------------|
| #1    | Ok                         | Ok                         | Ok                         |
| #2    | Ok                         | Ok                         | Ok                         |
| #3    | Ok                         | Ok                         | Ok                         |
| #4    | Ok                         | Ok                         | Ok                         |
| #5    | Ok                         | Ok                         | Ok                         |

Results system testing to determine the average time to open and close the portal using 3 cards.

| Card Portal | open (s) | close (s) | open (s) | close (s) |
|-------------|----------|-----------|----------|-----------|
| #1          | 1.04     | 0.67      | 1.12     | 0.87      |
| #2          | 1.26     | 0.92      | 1.07     | 0.94      |
| #3          | 1.38     | 0.77      | 1.08     | 0.82      |
| #4          | 1.28     | 0.93      | 1.10     | 0.96      |
| #5          | 1.31     | 0.80      | 1.05     | 0.84      |
| Time average (s) | 1.25 | 0.81 | 1.08 | 0.89 |

Wherefrom the system test data using 3 RFID cards we can get the longest average value of vehicles passing through the portal on each vehicle that wants to enter and exit the parking lot. So we can know the flexibility and automation of this system.

The longest average time through the portal =
= (average time of the inbound portal) + (average time-out portal)
= (1.25 + 0.81) + (1.08 + 0.89)
= 4.03 seconds

Accuracy in the installation of the control circuit installation is needed so that it does not experience difficulties, especially in testing the control circuits that exist in the simulator. Two RFID readers can be used so that the entrance and exit do not have to be next to each other. Inputting customer data must be when the parking system is not serving customers, and the placement of components for simulation can be arranged more aesthetically.
4. Conclusion
Testing on the system has been carried out and it can be analysed that the results of the simulation design of an automatic subscription parking system using an AT89C51 microcontroller-based RFID can work well. Based on the test results and the data, the development of the parking system with RFID allows the parking subscription system to become more flexible and faster.

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