Design of Automatic Parking System of Lhokseumawe State Polytechnic Using RFID

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Abstract

The design of the barrier or portal system now in use predominantly relies on a manual mechanism; however, the automatic barrier door of the Lhokseumawe State Polytechnic aims to create a device that facilitates the opening and closing of the parking portal for users. This Portal system employs RFID (Radio Frequency identifying) cards as identifying tags for vehicles entering and exiting. This autonomous portal comprises several components, specifically an RFID (Radio Frequency Identification) Tag, an RFID Reader, a Servo Motor, an Arduino Uno, and a Buzzer. The servo motor is designed to elevate and lower the barrier door, while the buzzer is intended to detect vehicles entering and exiting via unregistered RFID (Radio Frequency Identification) tags.

Keywords

Barrier, RFID, ID CARD, Microcontroller

Introduction

The automatic parking barrier system utilizing Radio Frequency Identification (RFID) technology provides a contemporary resolution to these issues (A.K. Maini., 2007; A. Winoto, 2010; J. Oroh,, 2014). RFID technology facilitates the identification and tracking of items by radio waves, offering benefits in speed and efficiency (Mahadhir, 2008). The utilization of RFID facilitates the automatic entry and exit of cars, hence minimizing wait times and enhancing user comfort.

The parking system at the Lhokseumawe State Polytechnic is currently still conventional, where the parking area does not have clear rules for parking student or lecturer vehicles. So that every vehicle owner parks his motorbike in the wrong place which results in the parking lot being untidy and often losing parked vehicles. With these conditions, a system is needed that can overcome existing problems, one system that can be used is a parking system that can control the flow of vehicles entering and leaving and the location of vehicles to be parked based on the registration that has been done. Vehicles that will enter or exit must go through the gate/bar that has been equipped with a system that will automatically open or close the gate/bar and provide information on where the vehicle should be parked.

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This system can implement RFID tags and RFID readers as identification and detection tools. Alongside these technologies, additional implementations include infrared sensors for detecting vehicles entering or exiting and identifying vacant parking spaces, speakers for delivering auditory information regarding the designated parking area, and microcontrollers serving as the central processing units of the technology system. At now, individuals have successfully designed a manual control system that has evolved into an automated version, enhancing the security system's efficacy. For instance, while operating a toll gate, parking gate, and portal situated at a home entrance, which are typically opened manually. Security personnel must remain on standby around the clock to facilitate entry and leave through the door. A system is required to facilitate security officials by automating the opening and closing of doors, thereby alleviating their workload. In light of these issues, it is imperative to develop a system that employs Radio Frequency Identification (RFID) cards, which utilize radio waves for the identification process. In conventional RFID systems, transponders (tags) are affixed to an object. Everything possesses distinct information, including serial numbers and additional data (Andi Adriansyah dan Oka Hidyatama., 2013).

The tag transmits data to the RFID reader when it passes through the field that a compatible RFID reader creates, facilitating the object identification process. This procedure employs the RFID system as an identification mechanism affixed to the gate. This ID Tag Card is designed to grant access to the gate. The benefit of employing Radio Frequency Identification (RFID) lies in its role as a gate security mechanism, facilitating automatic gate operation for security personnel. The Radio Frequency Identification (RFID) key employs an ID tag card as an identification mechanism for gate access. This circuit regulates the servo to automatically open the gate through detection and authorization mechanisms. Consequently, a conclusive research project titled "Design and Construction of an Automatic Parking System at the Lhokseumawe State Polytechnic Utilizing RFID" was developed and executed.

Methodology

This study employs a design methodology that initiates with the development of a prototype for a housing portal scheme, which will subsequently be implemented. The output signal of the portal's functional description will be substituted with a lamp indicator that receives input from the relay coil, with the relay being governed by Arduino. Activate the relay upon validation of the detected Tag card transmitted by the Arduino to the VB program, which subsequently provides a confirmation signal back to the Arduino. The phases are as follows:

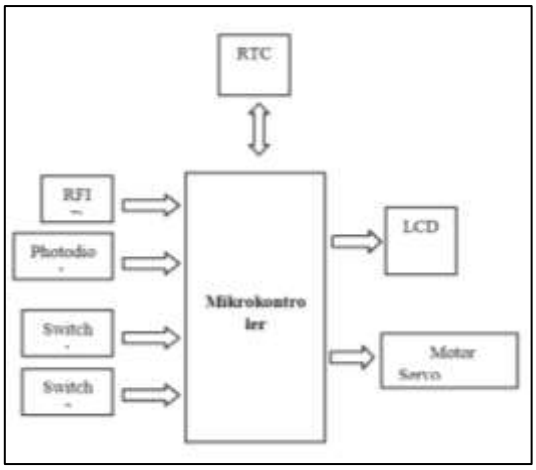

Figure 1. Circuit Block Diagram

The necessary components comprise an Arduino Mega Microcontroller, a 16x2 Character LCD, an MF S50 13.56 MHz RFID Tag, an MFRC522 RFID Reader (for prototyping), an AC to DC Power Supply (220 VAC to 24 VDC), Jumper Cables, a NYYHY 5x1 5 mm control cable, an Omron MY2N-D2 24V DC Relay, a 4 Channel 5V DC Relay, an Omron E3JK-DS30M1 Photo Sensor, a terminal connector block, a 150mm ripet rope, 4mm thick acrylic mica and a PC Unit Processor: dual-core 2.4 GHz; RAM: 4 GB; Hard Drive: 256 GB. Graphics Card: Integrated (Intel Processor). PC Enclosure: Standard Mini ITX. Display: 19 inches. Office Series Keyboard and Mouse Operating System: Windows 10 Home, 4x8 mm hollow iron.

The RFID Arduino-based portal access system is constructed utilizing several components, including a Mifare type RFID tag functioning at a frequency of 13.58 MHz, an Arduino Mega Board, an Arduino RFID Reader Module, a photosensor, a relay, Visual Basic software, an electric portal, and a computer unit. The system's operational process entails the Arduino Reader scanning the Tag card to retrieve the ID. Thereafter, the Arduino Mega board processes this ID and delivers it to the computer application through a serial connection. The ID data is compared to the database contents within the application. In the event of a mismatch, the portal stays secured; conversely, if a match is detected, the application records the data, presents the identification information, and instructs the Arduino board to engage the relay, thus unlocking the portal. The gateway will remain open while the photosensor detects an object; otherwise, it will close autonomously.

The block diagram in Figure 1 depicts the presence of sensors. The RFID Starter Kit sensor identifies tags attached to its surface and features a signal conditioning module that transforms input into digital data for relay to the microcontroller. The microcontroller functions as the central component of the system, serving as a control hub for many peripherals. This component is integrated with an RFID, photodiode, real-time clock (RTC), liquid crystal display (LCD), and servo motor.

a. RFID Module Interface Design

This system design employs an RFID Starter Kit sensor to detect the tag utilised for opening the gateway door. The RFID Starter Kit use serial data for interfacing with the microcontroller. Figure 2 depicts the interface circuit of the RFID Starter Kit ID-12. The RFID Starter Kit ID-12 module employs a serial port for data transmission, featuring three connectors: Vcc, Tx, and Gnd.

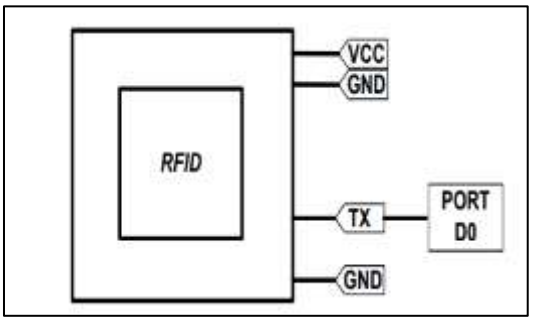

Figure 2. RFID Module Interface Design

b. Design of sensor and comparator circuit

The employed sensor is a photodiode that emits LED illumination. The photodiode's output will be directed to the (+) input of the LM324 comparator, where it will be compared to the reference voltage of the potentiometer. The comparator output, represented as a signal "0" (0V) and "1" (5V), will be transmitted to the microcontroller for processing.

c. Tag Capture and Recognition

At this stage, the RFID Starter Kit is linked to the computer to transfer Tag data into the software, which is subsequently synchronized using Code Vision AVR and transferred to the microcontroller. Tag recognition is executed by a real-time scanning technique. The application will scan the tag positioned on the RFID surface.

Figure 3. Tag recognition program

Results and Discussion

After completing the prior design, the system testing will be conducted. Each function of the circuit block undergoes testing. According to the block classification, testing is categorized into four components: power supply testing, sensor and comparator circuit test. Testing of sensor and comparator circuits RFID reader reading distance testing, along with over a Comprehensive Evaluation. Ting of sensor and comparator circuits. This test is performed to assess the precision of sensor readings and the responsiveness of the comparator to the sensor output. Evaluation of servo motor responsiveness. This test is performed to assess the servo motor's reaction across multiple vehicle samples. Testing the reading distance of RFID readers. Testing is performed to ascertain the maximum reading distance of the RFID Starter Kit tag. Overall Testing. This test is performed to assess the functionality of the overall system and its components.

Sensor and comparator circuit testing This test is performed to assess the precision of sensor readings and the responsiveness of the comparator to the sensor output. Testing of comparator inputs. This test seeks to ascertain the voltage value at the comparator input. When the sensor is subjected to illumination and when it is not. Figure 3 illustrates the Tag recognition program, while Table 1 displays the corresponding results. Testing of comparator output. This test seeks to ascertain the voltage level at the comparator output when the photodiode is both active and inactive.

Table. 1 Comparator Input Measurement Results

Input	Voltage	Condition
1	0.14	when hit by laser
	4.89	not hit by laser
2	0.13	when hit by laser
	4.89	not hit by laser
3	0.15	when hit by laser
	4.87	not hit by laser

This test was performed using a sample of five tags, each designated for use by vehicles positioned at a distance of 8.5 cm to 9.5 cm from the RFID Starter Kit. This test seeks to assess the sensitivity level of the RFID tag. The outcomes of the RFID sensor reading distance assessment are displayed in Table 2.

Tabel 2. RFID Sensor Reading Distance Measurement Results

	Distance /cm										
No. Tag	8.5	8.6	8.7	8.8	8.9	9	9.1	9.2	9.3	9.4	9.5
1	√	√	√	X	X	X	X	X	X	X	X
2	√	√	√	√	√	X	X	X	X	X	X
3	√	√	√	X	X	X	X	X	X	X	X
4	√	√	√	√	X	X	X	X	X	X	X
5	√	√	√	√	√	√	√	X	X	X	X

This test delineates the comprehensive functionality of the tool, namely through the following six steps: Tag/ID card status: registered or unregistered. Prior to the vehicle's entry via the portal door, it is imperative that the vehicle possesses a registered Tag/ID card. Upon the display of the message "ALREADY REGISTERED PLEASE LOG IN" on the LCD screen, position the Tag/ID card near the RFID Reader. If the information is recorded and corresponds, the portal door will open, and the LCD will indicate the vehicle's entry time and date. Figure 4 illustrates the ID card exam. If there is no match, the portal door will remain closed, and a notification will indicate that the ID is invalid. The Tag/ID card test is illustrated in Figure 4.

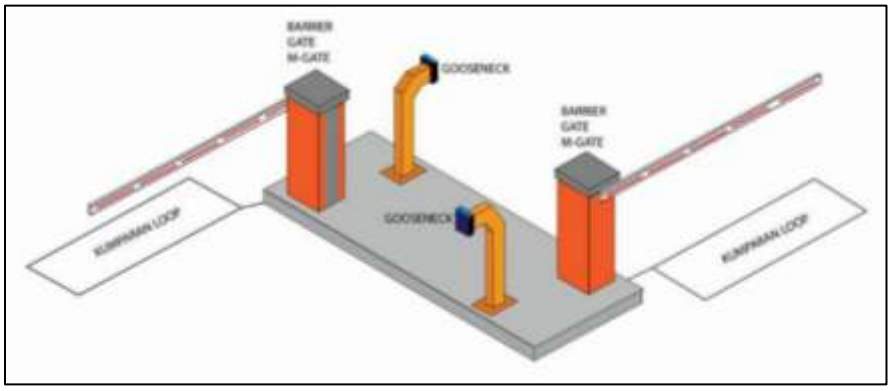

Figure 4. Tag/ID Card Testing

The purpose of testing RFID cards is to ascertain whether the RFID scanner can identify if the scanned card is registered. The RFID card is tested with a serial monitor on the PC. Figure 5 shows the serial monitor view of registered RFID cards and Figure 6 shows the serial monitor display RFID card not registered.

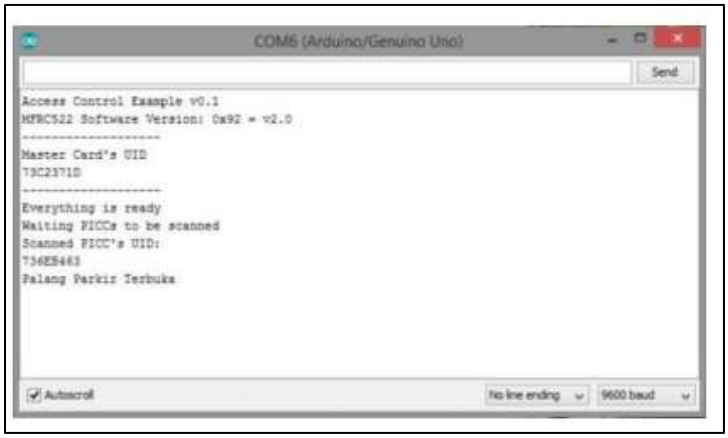

Figure 5. Serial Monitor View of Registered RFID Cards

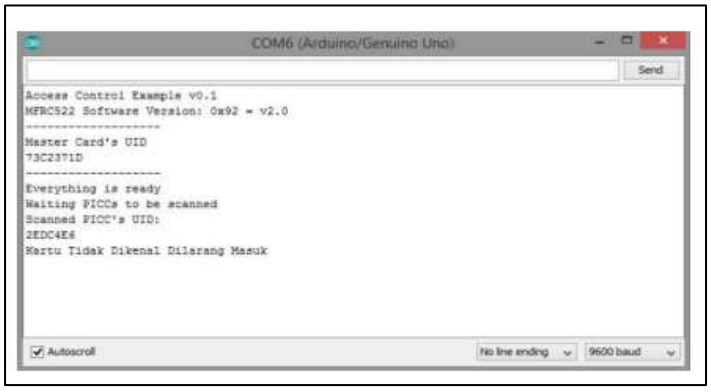

Figure 6. Serial Monitor Display RFID Card Not Registered

Tabel 3. Test Results on RFID Cards

Input Test	Input Card RFID	Condition LCD	Servo Motor Condition	Serial Monitor
To 1	Registered (736EB46 3)	Providing information about parking slot locations	Servo motor rotates 650	736EB463 (open parking barrier)
To 2	Not Registered (2EDC4E 6)	Displaying the text “PNL Access”	Servo motor rotates 00	2EDC4E6 Unknown card prohibited entry

Table 3 illustrates the outcomes of the RFID card test, indicating that the servo motor will activate upon the registration of the RFID card. Subsequently, the LCD will exhibit the location of the available parking slot, while the serial monitor will present the registered card UID and display the message "Open Parking Barrier." When the RFID card is unregistered, the servo motor will remain closed, the LCD will show "PNL Access," and the serial monitor will display the unregistered card ID along with the message "Unknown Cards Are Prohibited from Entering."
RFID Reader Testing.

The reaction of the RFID Reader to the tag is evaluated during testing. Testing involves measuring the distance between the Reader and the RFID tag intended for detection. Figure 7 illustrates that RFID testing is conducted by positioning the RFID tag near the reader to evaluate the efficacy of the RFID reading. Figure 8 shows the RFID data input testing and Figure 9 shows the RFID Registration and Data Input

Figure 7. RFID Reader Testing Using Tags

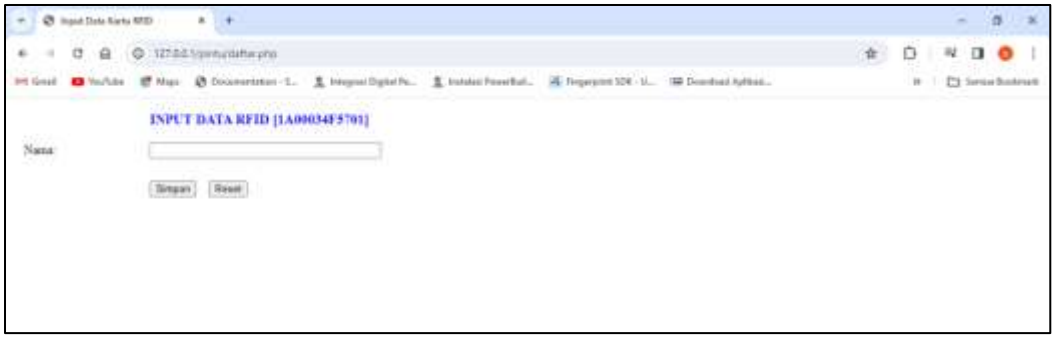

Figure 8. RFID Data Input Testing

Figure 9. RFID Registration and Data Input

Conclusion

The research findings indicate that an automatic parking system capable of identifying drivers and vehicles has been successfully designed and implemented using the Intel Galileo Gen2 microcontroller, an Intel RealSense camera for driver detection, and RFID technology for vehicle identification. The entire system is interconnected, such that any disturbance or malfunction in one component will impede the proper functioning of the parking system. This study seeks to ascertain the identities of drivers and cars entering and exiting the parking area of the Lhokseumawe State Polytechnic Administration Headquarters Building. The Intel Real sense camera test findings indicate that the gadget performs effectively, with a minimal mistake rate. The RFID testing can detect cards on drivers utilizing RFID, and the results of the RFID Reader test indicate that the device functions effectively, exhibiting a minimal mistake rate. The RFID reader test can detect

RFID tags at 10 cm. The parking barrier for exit or entry will activate if the driver's and vehicle's identities are registered in the parking system. Consequently, the identities of the driver and vehicle are accurately recorded in the parking area entry and exit register.

Acknowledgements

The 2023 Dipa Fund research at Lhokseumawe State Polytechnic has been completed, with the help of the research implementation team. The system uses registered RFID cards to open parking areas, with full areas showing "Parking FULL" and unregistered ones showing "Access successful." The research was assisted by the Director and the P3M Center for Research and Community Service.

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