IoT-Driven RFID: Redefining Gate Automation for Smart Security Solutions

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Abstract: The term "Internet of Things" (IoT) describes a network of linked devices that can share data and communicate with one another instantly. It is widely used in a variety of industries, including industrial automation, smart homes, healthcare, and transportation. But as IoT grows, security risks like illegal access and data breaches arise, necessitating robust security measures. Physical locks and keys are typically used to secure gates. However, these methods do not provide any further safety measures or alarms in case of unwanted entrance. On the other hand, by incorporating RFID (Radio Frequency Identification) technology to guarantee high levels of security and control, IoT-driven automation can completely transform this system. An IoT and RFID-based automated gate system marks the entrance, exit of authorized users, and rejects unauthorized attempts by sending out warnings in the event that an unregistered card is used. This provides an automated, safe, and full-proof system that enhances the security and control of restricted areas. The RFID-based system is a reliable replacement for common key-based systems since it reduces human error, boosts efficiency, and improves security.

Keywords: Internet of Things, RFID(Radio Frequency Identification), Industry 5.0, Smart Gate, Microcontrollers, Microprocessors, Sensors, Serial Communication.

I. Introduction

Previously, to ensure entry points in homes, offices, and other places, the principal object used has been the key to turn the door locks on and off. Even though it was effective then, that olden method does not have advantages such as anxiety for keys maybe it would be lost, chances of duplication and also opening the door by the key is quite cumbersome whereby at times it's pretty frustrating. They were reduced by the change of technology, hence the coming up with the innovative solution concepts like smart door locks which make use of digital technology to enhance security and access. Traditionally, doors are locked or unlocked by keys. However, as technology changed, key locks have been substituted by smart locks with individuals locking or unlocking them using smartphones, key cards, biometric identifications or even voice commands.[1]

Although with these developments, many of the conventional gates still lack security features and easily become a means of illegal entry with security lapses in case they are opened manually. This indicates the need to come up with a more reliable and smart means of ensuring security even while using gates. With IoT development coming into play, it comes as an acceptable solution to this challenge. IoT enables smooth connectivity between devices, which allows enhancing security protocols by introducing remote access control and real-time monitoring. Automated gate systems can

sense unwanted entries, alert others with alarms, or even manage access on their own due to the Internet of Things. This improves security around existing entryways and solves weaknesses related to human operations.[2]

These security problems are addressed by combining Internet of Things (IoT) technology with gate automation, which makes use of a network of linked sensors and electric parts. IoT-based Technologies allow the installation of automatic gates that can be remotely monitored and controlled, improving ease and security. IoT-based gate automation systems that use RFID technology can provide secure entry control, ensuring that only authorized individuals can pass through. Because of this addition, IoT gate automation is a novel solution for modern access control demands, as it not only simplifies gate operations but also significantly boosts security. [3]

A new way of doing things that will encourage people to collaborate with machines more effectively. Smart technology such as robots, AI, and IoT will be used to increase people's creativity and efficiency when building factories. Actually, while Industry 4.0 focused on giving machines the ability to conduct their work automatically, Industry 5.0 focusses on making products more personalized so that people can do their jobs more effectively. It also connects the equipment with faster internet (5G), and this technology promotes environmentally friendly concepts. The next phase enhances factories and ensures that technology does not work against people, but rather seamlessly integrates everything.[4]

1.1 RFID Technology

There are four basic elements that make up an RFID system, which include RFID tags, readers, antennae, and software. Readers scan through tags, and it could be active, semi-passive, or passive tags, though tag data is held and transmitted by the reader itself. These tags are inexpensive but require a shorter read distance because they derive power from the reader's signal, while the active tags have an internal source of power and can read at greater ranges. Semi-passive tags are highly effective because they combine the best from both worlds, using the reader signal for communication while bringing a battery to enhance performance even more. Antennas, however, provide connectivity between RFID tags and readers. Software controls data gathering, processing, and integration into the system, but to ensure efficiency and compatibility in gate automation systems, the protocols used for communication, including ISO/IEC 14443 and ISO/IEC 15693, provide a detailed outline of what tag-reader interaction is supposed to entail.

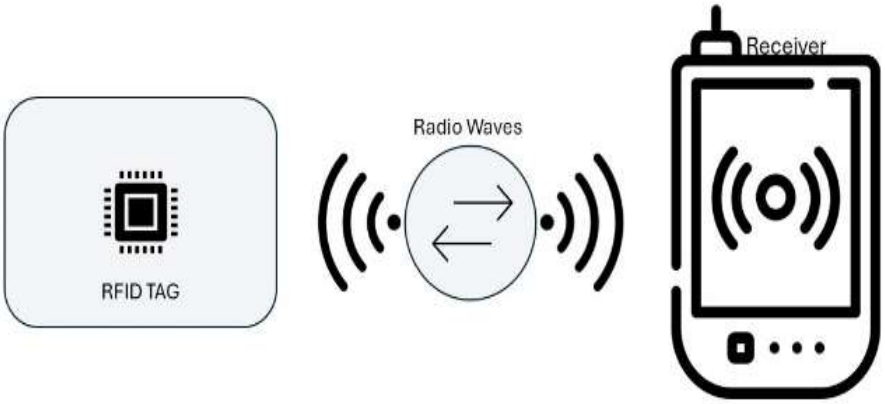

Fig 1: RFID Reader and Tag Operation

1.2 **Architecture**

The following diagram represents a gate automation system, centered at the microcontroller, containing the basic elements needed to control the access of secure gates. The CPU sends signals to a motor driver, which activates a DC motor turning on or off a gate, after it verifies that the RFID tag is authentic. These safety sensors are mounted in such a way that if it detects any obstacle while closing of gate stops at the same position, helping in avoiding the risk of accidents. The microcontrollers also activate a warning light and buzzer to provide loud and visual alerts for any system notifications or illegal access attempts. This design will ensure that the gate runs efficiently with levels of protection and safety that are integrated via the central control from the microcontroller. The overall functionality and reliability of the gate automation application will thus be enhanced.

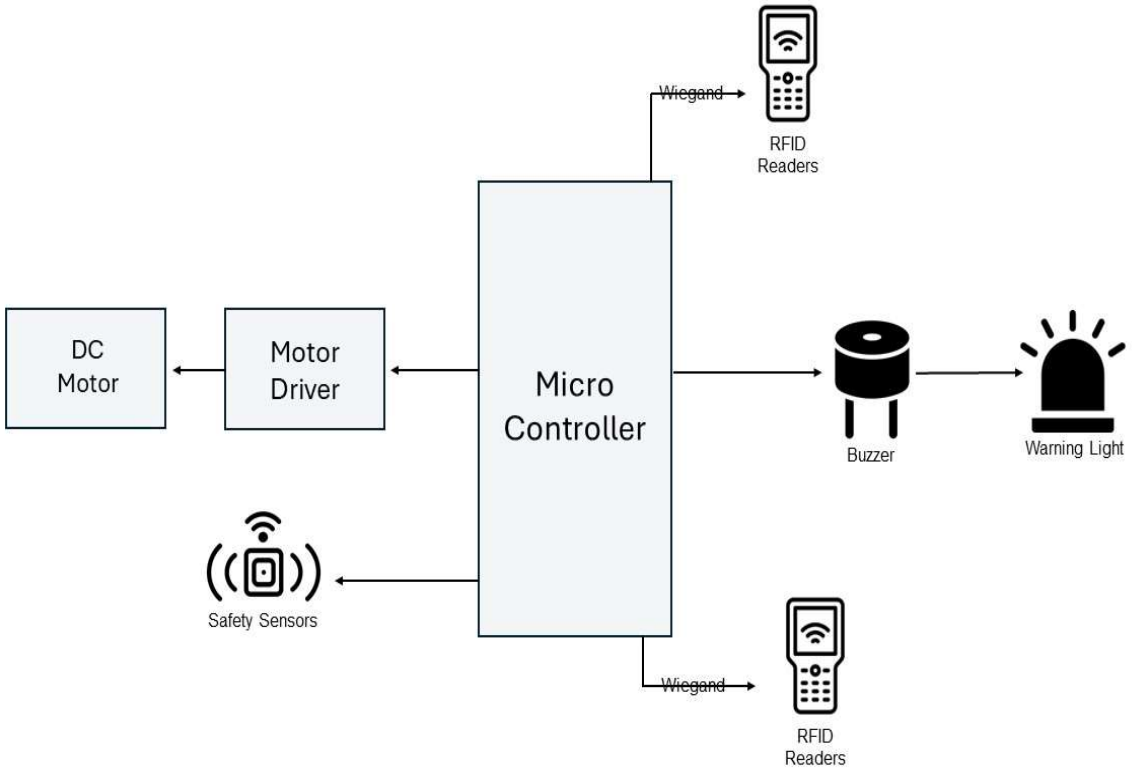

Fig 2: Block Diagram of Gate Automation

1.3 Controller

Controllers are essential to the efficient management of the gate's operations and integration of its many components in gate automation systems. These controllers are usually embedded systems with microprocessors or microcontrollers that run pre-programmed algorithms for biometric or RFID-based access control. They interpret data, oversee sensor inputs, and educate actuators to turn the gate mechanisms. Integrating advanced controllers with centralized security systems is made possible by their support of communication protocols for remote access and monitoring. These controllers improve the efficiency and dependability of gate automation with features including programmable logic,

adaptive response capabilities, and real-time processing, guaranteeing safe and easy access control in a range of applications.

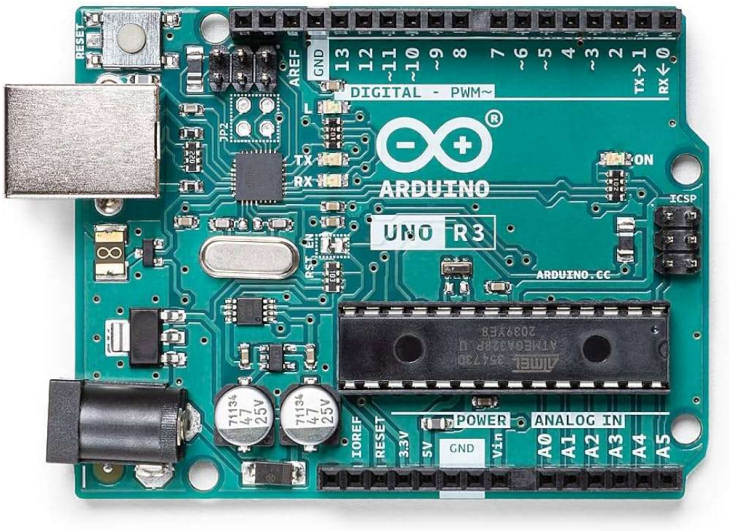

Fig 3: Microcontroller Arduino Uno

1.4 Processor

The Raspberry Pi 3 Model B is a versatile microprocessor used in gate automation systems for its compact size, affordability, and powerful processing capabilities. It is powered by a 1.2 GHz quad-core ARM Cortex-A53 CPU and can handle sophisticated tasks like RFID-based gate access control, real-time monitoring, and sensor and motor connection. Its built-in wireless LAN and Bluetooth support seamless connectivity, enabling remote control and automation. External components such as RFID readers, DC motors, and safety sensors can be easily integrated via the GPIO (General Purpose Input/Output) ports. This microprocessor's ability to run on open-source platforms makes it ideal for developing customizable and scalable gate automation solutions, enhancing security and operational efficiency in various settings.

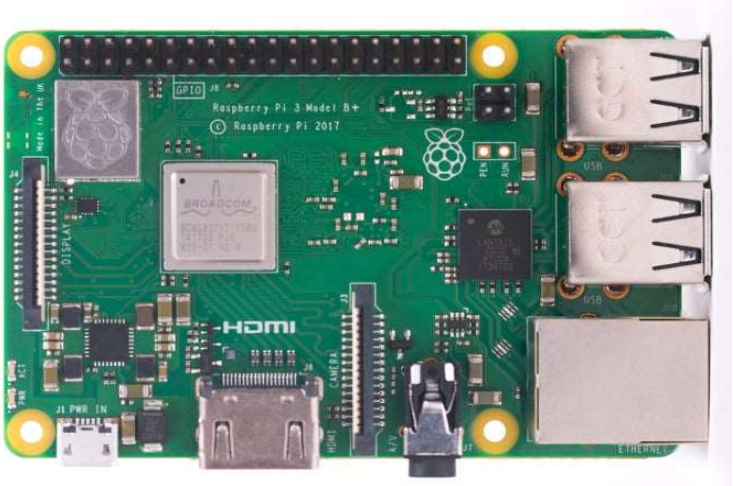

Fig 4: Microprocessor Raspberry Pi

1.5 Components used in this Research.

Gate automation systems are made up of both hardware and software groupings. A Raspberry Pi can serve as the central controller, managing communication protocols such as Wiegand, access control algorithms to validate RFID tags, and motor control to handle gate movement. It can communicate with safety sensors to avoid accidents by sensing obstacles and respond to defects or unauthorized entry with visual or aural notifications via a buzzer and warning light. The hardware also contains an RFID reader for access authentication and a motor driver to power the DC motor that moves the gate. Together, these components ensure that the system runs securely and efficiently.

Table 1: Components used in this research.

S.no	Software	Hardware
1.	Access Control Algorithms	Microprocessor
2.	VS Code	Microcontroller
3.	Communication Protocols	Safety Sensors
4.	Sensor Integration Code	RFID Readers
5.		DC Motor
6.		Motor Driver
7.		Buzzer
8.		Warning Light

II. Literature Review

In educational institutions, access control and traffic management at entry and exit points have typically been monitored by a team of military training instructors, students, or security officials. While traffic service workers work to reduce traffic during peak times, security officers constantly have an eye on both the entrance as well as exits. The risks of inadequately confirming visitors' identities, which can result in security breakdowns on college campuses, have been highlighted by previously reported instances in the media. Security personnel frequently become overburdened with the combined responsibilities of identity verification and traffic control, which results in lapses in attentiveness. This study presents a novel approach to campus gate control, utilizing RFID technology to efficiently verify identity and regulate vehicles. In order to efficiently verify identities and control vehicles, this research presents an innovative approach to campus gate control: RFID technology. and improve campus safety in general. [5]

The need for manual toll operated gates has been reduced because of the addition of RFID technology into toll systems, increasing efficiency and reliability. A tag (transponder), reader/writer, antenna, and computer host make up an RFID system. Active and passive tags are distinguished by their internal batteries, which enable longer read ranges, and by their reliance on the reader's electromagnetic signals, which reduces complication and enables shorter read ranges. Because passive RFID tags read one tag at a time, they reduce the usual ultra-high frequency (UHF) tag collision issues. Passive RFID tags are especially beneficial when operating at low frequencies (LF). Due to problems with time consumption, reflection, and power dependency, earlier technologies including Active RFID, Microwave Technology, Optical Camera Recognition, and GPS were shown to be inefficient. This approach overcomes these drawbacks by utilizing passive RFID, providing an affordable, low-maintenance solution with lower mistake rates and longer system lifetime.[6]

Over time, security measures have been improved in preventing unauthorized entry and enhancing security in all areas. It becomes challenging to track everyone's record of entering and leaving, having guards and volunteers at gate are not dependable. If the place becomes overcrowded then it is impossible to maintain the records and hence, will lead to mistakes and problems. There are more reliable options available as well, especially using new technology such as Sliding Gates along with automated systems like Remote Control Access, Gate Card Readers, Keypad access and Telephone entry. RFID (Radio Frequency Identification) has fast emerged as the technology, which automates opening and closing of access without any human involvement. RFID uses inductive coupling, a communication technique that uses electromagnetic waves to transfer data between the tag and reader, to identify authorized persons. As a non-contact, highly-recognition system that interfaces with present management systems, this technology is perfect for all kinds of public, commercial, and residential parking lots. RFID is one of the most advanced access control systems available today because of its secure, non-line-of-sight data transfer abilities.[7]

Access control systems have changed as a result of technological breakthroughs, moving from manual gates that required human involvement to complex, automated alternatives. At first, gates required continual human presence because they were operated manually. As technology developed, toll booth systems with operator-activated gate systems were created. These were followed by inventions that used infrared detectors to open gates for any moving vehicle automatically. The next big advancement in security and efficiency was systems that only permitted access to those who were authorized. The newest innovations are smartphone apps that operate gates, reducing manual labor and offering an intuitive user experience. Because security and usability were top priorities during design, even novice users could easily operate these systems. The dependability and efficiency of these systems are influenced by the integration of sensors, which are inexpensive and readily accessible. Given the circumstances, the one-time cost of this technology is less than the ongoing expenses of manual labor, providing a cost-effective, safe, and sustainable alternative.[8]

Malaysia's industrial landscape is changing quickly, making it necessary to continuously upgrade and improve performance systems in order to increase efficiency and output. In this environment, industrial control systems are essential. Electronic device design has gone through a revolution because of technologies like Arduino, a microcontroller board based on the Atmega328 that makes products more portable, affordable, and functional. The University Tun Hussein Onn Malaysia (UTHM) bachelor project, which attempts to create an automated garage door system employing RFID technology, an Arduino Uno, and ultrasonic motion detection sensors, is the subject of this literature study. A useful application of automation and security in domestic settings is provided by the RFID reader, which uses card information to regulate the garage door's opening and shutting. This project's usage of RFID highlights its affordability and influence on contemporary technology, corresponding with broader trends towards automation and remote control of devices to enhance sustainability and convenience in day-to-day living. [9]

Roy and Irawan believe that everyone desires a clean and safe house. According to Chowdhury, erecting a gate at the entrance to a neighborhood is vital for safety and satisfies the regulations outlined in Law No. 1 of 2011 on housing. According to Wei, modern neighborhoods usually include greater security features, such as cameras that constantly monitor the area, which raises the value of homes. Fatma Wati and Mainetti, using the Indonesian vocabulary, define gate portals as areas where people and vehicles enter and exit, allowing them to control who comes in. However, when these gates are not

used properly, problems can happen. Muhardi, Taweel, and Sohar discovered that at the Widya Graha housing complex, gates that were opened manually and not closely monitored by security officials allowed for threats like robbery and unwelcome access. Irawan, Mainetti, and Lin propose adopting an automatic gate system with RFID cards to address these concerns and make the community safer and more comfortable for everyone.[10]

Maintenance and restoration of infrastructure such as highways, roads, bridges, and tunnels are critical but expensive procedures that have typically been supported indirectly through fuel taxes or budget allocations. However, these techniques are inefficient because they charge taxpayers who may not use the services. Direct tolling, which collects payments from drivers utilizing the roadways, addresses this issue more evenly. Advances in wireless communication technology have aided the proliferation of RFID-based systems, which provide a secure and cost-effective alternative for automated toll collection. RFID technology, combined with the ubiquitous use of 2.4 GHz wireless networks, enables near-real-time replies, making it ideal for essential applications like electronic toll collection. Furthermore, GSM-based systems improve worldwide connectivity by enabling capabilities such as mobile communication for health monitoring through SMS. The implementation of Electronic Toll Gate Stations with RFID technology speeds toll collecting and improves traffic management, providing a more efficient alternative to older techniques.[11]

S.no.	Authors	Title	Objective	Technology
1.	Ononiwu G. Chiagozie, Okorafor G. Nwaji. [12]	Radio Frequency Identification (RFID) Based Attendance System with Automatic Door Unit	With the use of this new technology i.e. RFID cards, scanners and readers . The design wants to automate the system of marking the attendance. This system uses cards to register, track, and maintain people's IDs automatically, minimizing the need to do it manually.	Radio-frequency identification , RFID technology, radio waves
2.	Hendra Gunawan Eviz al Abdul Kadir [13]	Integration protocol student academic information to campus RFID gate pass system	This project aims to use specific technologies such as RFID and GSM to make areas secure. It doesn't allow illegal person to enter the restricted area also it gives warning on the unauthorized access making the process faster and easier to determine who should be permitted and whom not to enter by checking them in real time.	Logic Gates, RFID, IOT, Information & Communicati on Technologies . Sensors, Databases, Near Field Communicati on.
3.	K.Srinivasa Ravi, G.H.Varun, T.Vamsi, P.Pratyusha [14]	RFID Based Security System	This research involves an RFID-based security system that allows users by reading RFID cards and . It checks recorded data, controls door actions, and offers safe access through stepper motor automation.	RFID (Radio Frequency Identification), MAX 232 IC, Stepper Motor.

4.	P.M. Akshay, K. Murugesh, Yashketan Patra [15]	IoT based Automated Paid Parking Using Electromagnetic RFID Tag	As a result, the objective of the project is to develop an off-street parking solution that searches, monitors, and conducts payment transactions in order to improve parking efficiency and reduce human interface—with the ultimate goal of eliminating waiting time.	RFID, IOT, Paid Parking, Payment Gateway.
5.	Sabbir Ahmed, Tamkin Mahmud Tan, Anna Mary Mondol, Zawad Alam, Noshin Nawal, Jia Uddin [16]	Automated Toll Collection System Based on RFID Sensor	The goal is to design and implement an RFID-based automated toll collection system in Bangladesh to reduce traffic jams, enhance transparency, and support digitization by eliminating cash transactions and improving efficiency.	RFID Technology, Circuit Board, Optical Character Recognition, Integrated Development Environment, Digital Collect
6.	M. Lawrance, C. Gobiya, V. Gowsalya, R. Masi, R. Priyanka [17]	Autonomous Flood Gate Control using Arduino UNO with GSM Technology	The project offers a self-sustaining flood gate system that uses Arduino UNO and GSM technology to manage gate operations based on water levels, controlling the pumps and gates to save water and reduce the need for human oversight.	Arduino Uno, GSM, DC Motor, Sensors
7.	J. Vales-Alonso, P. López-Matencio, J. J. Alcaraz [18]	A machine learning approach to improve UHF RFID gate operation.	The goal is to improve the performance of a UHF RFID gate system by reducing operation time and inventory errors, improving antenna selection, and creating a predictive model for item recognition with ANNs	RFID, machine learning, supervised learning, online operation
8.	P Anuradha, Rajeshwarrao Arabelli, K Rajkumar and J Ravichander [19]	Microcontroller Based Bi-directional Vehicle Counter and Automatic Gate Controlling System	The goal of the project is to enhance security by utilizing RFID and GSM technology. It stops unauthorized people from accessing various areas, notifies authorities about hacking attempts, and speeds up the process with real-time checks and confirmations.	Microcontroller, Arduino Uno, RFID, Tag, GSM

9.	N. Prabhakaran, V .Srivaishnavi, V. Srinaya, T. Preethi, S. Aishwarya, M. Dinesh [20]	Automatic gate control for highly secure organization using RFID and GSM Technology	The presented concept integrates RFID and GSM to create a protected system. Which bolsters security through illegal access to locations. Also, it will alert the responsible person in case of an alert or warning.	RFID (Radio Frequency Identification), GSM (Global System for Mobile Communicati ons)
10.	Md. Armanul Haque, Md. Shahid Iqbal Md. Monirul Kabir [21]	An Automated Toll Plaza System Using RFID and GSM Module: Perspective of Bangladesh	The main difficulty with Bangladesh's toll collection systems is the way they act, which results in long waiting time, long queues, and traffic jams. The limited use of RFID tags causes problems with vehicle registration and delays.	Microcontrol lers , Receivers, Logic gates, GSM Module, Servo Motor, RFID Reader, Serial Communicati on
11.	Bashir Salah [22]	Design, simulation, and performance-evaluation-based validation of a novel RFID-based automatic parking system.	These days, there are more cars on the road in urban areas. It resulted in lengthy traffic bottlenecks and hours of queue waiting. RFID technology is advised to be used to prevent these issues.	RFID (Radio Frequency Identification)
12.	M. Abinaya1, Vidya, Thenmozhi [23]	Automation of Railway Gate using Internet of Things (IoT)	Due to antiquated manual gates that frequently cause accidents, railway systems have safety concerns at level crossings. Improved safety and accident prevention require sophisticated, automated IoT systems.	IoT (Internet of Things), RFID, Magnetic Sensors, IR Sensors, Microcontrol ler (ATmega 16A, 8052)
13.	D.Leela, Krishna Sai, S.Santhi, D.S.P.Manohar , N.Sai Kalyan, K.Kameswari,	IOT Based RFID Gate Automation System	Automatic toll systems that use RFID successfully reduce traffic congestion in metropolitan areas by eliminating manual toll collection, improving transportation efficiency and contributing positively to a country's economic and social mobility.	RFID (Radio Frequency Identification), Automatic Toll Systems

	P.Gopala Reddy [24]			
14.	S. Emakpor, E. Esekhaigbe [25]	Development of an RFID-based security door system.	Even in secure locations, traditional methods like keys and passwords are easily compromised, leading to unauthorized access and crimes, highlighting the need for more reliable technologies like RFID for authentication.	RFID (Radio Frequency Identification)
15.	Faizan Rashid, Ghulam Abbas [26]	RFID Based Toll Booth Management System using Internet of Things	The literature proposes an automated toll system employing IoT and RFID technologies to speed toll collection and reduce congestion in order to address inefficiencies at toll plazas, such as long lines and manual labor.	Automation, RFID, Internet of Things, Android Application
16.	AFM Fazilah, M Jusoh, A Zakaria , T Sabapathy, M F Ibrahim, H A Rahim, M M Azizan, M Z Zakaria, N F M Nasir, M A M Albreem And R B Ahmad [27]	Smart Gateless System using RFID Technology in Universiti Malaysia Perlis.	On campuses, manual vehicle control and parking management lead to inefficiencies and traffic jams. By using RFID technology, traffic flow can be enhanced, manual labor can be decreased, and access control can be automated.	RFID (Radio Frequency Identification), Radio Frequency Spectrum, Microchip Technology, Silicon Chip.
19.	Sujita B. Dabekar, Sandhyarani A. Lahade, Manasi S. Lunge, Prof. Deepali Yewale [28]	IOT Based Smart Door Locked System Using Node MCU	The increasing global focus on security emphasizes safeguarding lives and property, leading to the development of an internet-connected door lock system that enhances home security through remote control and automation.	Home Automation, Internet Connectivity, Open-Source Software
17.	S. Chandrappa, M.S. Guruprasad, H. N. Naveen Kumar, K. Raju & D. K. Santhosh Kumar [29]	An IOT-Based Automotive and Intelligent Toll Gate Using RFID.	An automated toll collection system uses RFID technology along with a Raspberry Pi to help reduce fuel consumption, minimize wait times, and cut down on toll operation costs at toll booths.	RFID Technology (Radio Frequency Identification), Automated Toll Collection

				System, Prepaid Card System, Servo Motor.
18.	Ayush Dongardive, Prapti Dongaonkar, Aman Donewar, Vanshika Dongare, Manav Dongare, Sanjivani Adsul [30]	Dam Automation Using IOT	This study offers an IoT-enabled, automated system for controlling dam gates that uses Arduino, ultrasonic sensors, and water level sensors.	IoT (Internet of Things), Arduino UNO, ESP8266 (NODEMCU), Sensors

III. Methodology

The design and implementation of an automated gate access control system based on RFID and the Internet of Things with the goal of improving security in limited areas are the method for this research study. Microcontrollers, RFID readers, safety sensors, DC motors, motor drivers, buzzers, and the growing global focus on security focuses preserving lives and property, causing the creation of an internet-connected door lock system that improves home security via remote control and automation. Warning lights are all integrated into the system design. The microcontroller checks the authorization state of an RFID tag after it has been scanned. The microprocessor instructs the motor driver to run the DC motor, opening the gate and documenting the enter or exit event, if it is authorized. When an unauthorized attempt is made, the system logs the attempt and sounds an alert with a buzzer and warning light. By offering real-time monitoring and reaction, this approach integrates RFID technology with IoT connectivity to automate gate operations, minimize human intervention, and strengthen security. Multiple scenarios including both authorized and unauthorized tags are used to verify the system's robustness, guaranteeing its efficacy and dependability in a range of operational conditions.

IV. Algorithm

Step 1: Start (Initialize the system)

Step 2: Turn on the RFID reader and configure it to look for RFID tags.

Step 3: Scan RFID Tag (Scan continuously for RFID tags provided at the gate.)

Step 4: Check Tag Status (If an RFID tag is found, verify its status against the authorized database.)

Step 5: Decision Authorized Tag
(If the tag is authorized:
Continue to the next step.

If the tag is unauthorized)
Go to Step 8

Step 6: Access Granted (Allow access to the authorized user.)

Step 7: Open Gate (Cause the gate mechanism to open.

Step 8: Log Entry/Exit (Log the event in the system database, including the time, tag ID, and access type (entry/exit).)

Step 9: Close Gate (Once the vehicle or person has passed, close the gate after a certain amount of time.)

Step 10: Unauthorized Attempt Detected (If the RFID tag is unauthorized, initiate security protocols.)

Step 11: Trigger Alert (Activate security alerts such as a buzzer or warning light to notify of an unauthorized attempt.)

Step13: Log Unauthorized Attempt (Record the unauthorized access attempt details, including the time, tag ID, and alert triggered.)

Step 14: End (In response to certain system directives, the process might either end itself or keep checking for new scans.)

The RFID-based gate automation system is expected to automate gate operations and make easier access control. The DC motor, which runs at 12V, is activated by the microcontroller upon detection of an approved RFID tag, allowing the gate to open or close. Safety sensors continuously scan the gate's path for any obstructions as it advances, assuring safe operation by stopping or reversing the gate as needed. When the gate moves, a warning light and buzzer combine to inform users, offering both visual and audible warnings. A ground block is strategically placed in the center of the gate to provide stability and smooth operation. This connection provides a secure, efficient, and user-friendly solution for managing automated gate systems in a variety of environments.

Following are the parts of the Gate Automation(Fig 5)

1. DC Motor based gate
2. Microcontroller and other peripherals
3. Warning indication (Light & Buzzer)
4. Safety Sensors
5. Ground Block
6. Access Control

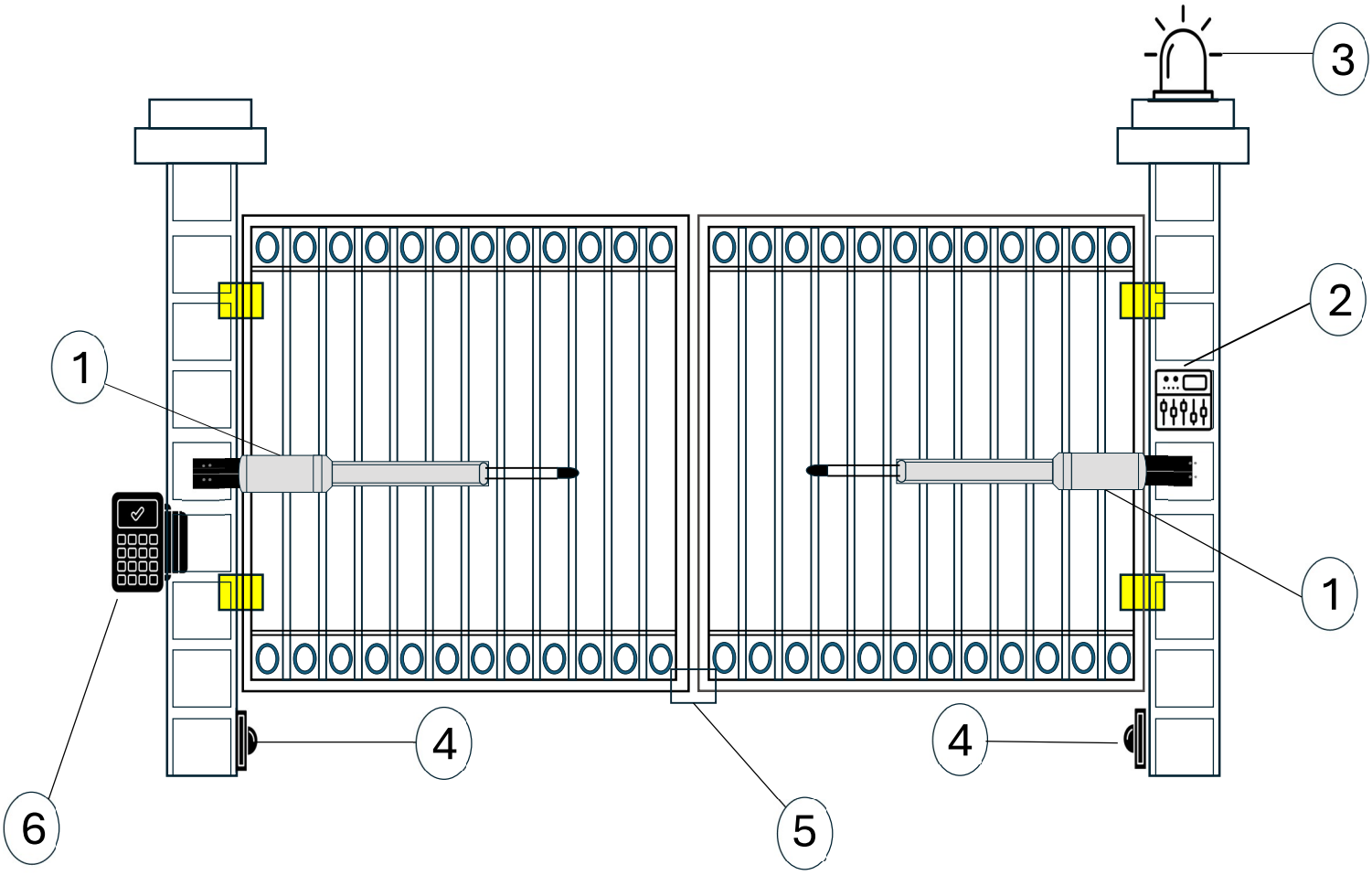

Fig 5: Proposed Gate Automation Implementation

V. Results

Table 2 shows the various situations based on vehicle identification and tag status that are presented in a gate automation system that uses RFID tags for decision-making. Every car receives an RFID tag that tells whether it is operable or not. The tags are divided as allowed or unauthorized tags. This approach ensures that only vehicles with verified and authorized tags are allowed entry, maintaining the integrity and safety of the restricted area. It also quickly detects and prevents any unauthorized entries. Which further decides who is legally permitted to enter. The gate automatically opens for approved vehicles with active tags, improving access control efficiency and security. On the other hand, cars with invalid or inactive tags cause system alarms that block access and turn on buzzers or warning lights as needed. This method preserves the integrity and safety of the controlled area by guaranteeing that only cars with validated and approved tags are allowed entry, and it quickly detects and blocks any unauthorized entrance attempts. This system, which incorporates RFID technology for exact, automated gate management, is an excellent example of an IoT-based security solution.

Table 2: RFID Based Entries Summary

Vehicle ID	RFID Tag Status	Authorization Level	Access Granted	Access Denied	Action Taken
V-101	Active	Authorized	✓		Gate Opened
V-102	Active	Authorized	✓		Gate Opened
V-103	Inactive	Unauthorized		✓	Alert Triggered
V-104	Active	Unauthorized		✓	Denied and alerted
V-105	Active	Authorized	✓		Gate Opened
V-106	Active	Unauthorized		✓	Warning Light Activated
V-107	Inactive	Unauthorized		✓	System Alerted

VI. **Graphical representation of visitor's count**

The variation in visitor counts overtime from 5 AM to 11 AM is depicted in Fig. 6's line chart. The data indicates that visitor arrivals follow a cyclical pattern, with a discernible uptick beginning at five in the morning. There are fifteen visitors at first, and that number steadily increases to 86 at seven in the morning. But at 8 AM, the figure drops to 56, and at 9 AM and 10 AM, it drops even more to 46 and 28. It's interesting to note that there is a noticeable spike in visitors at about 11 AM, with a high count of 108. This pattern indicates that the number of visitors is not evenly distributed throughout the course of the observation period. It also shows different peaks and troughs that indicate different arrival behavior's that may be impacted by outside variables like events, opening hours, or other time-sensitive activities.

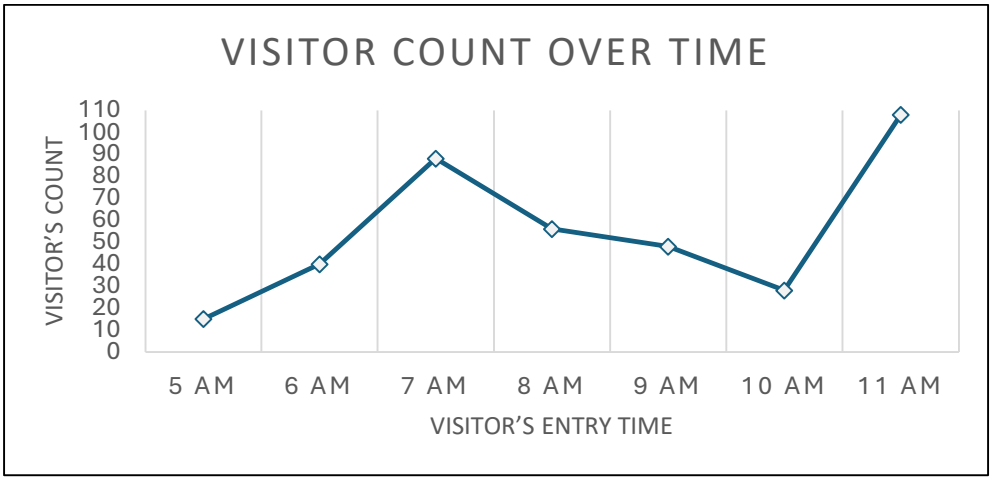

Fig 6: Graphical representation of visitor's count over time

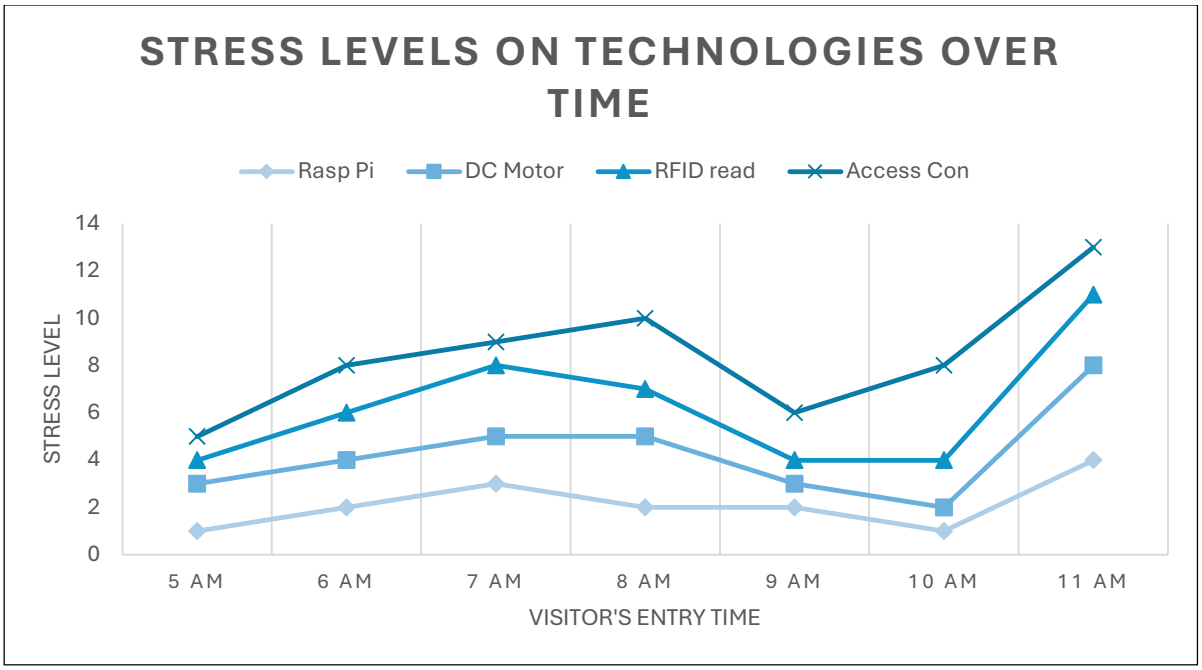

Fig 7: Line Chart Showing the Visitor count over time.

This chart shows how different technologies (like Raspberry Pi, DC Motors, RFID readers, and Access Control) are **"stressed"** at different times of the day when more people enter.

- The **X-axis** (horizontal line) shows time, starting from 5 AM to 11 AM, showing when visitors enter.
- The **Y-axis** (vertical line) The "stress level" of each technology is displayed, which indicates how hard they work when visitors arrive. The higher the stress level, the more technology is used.
  Each line represents a different technology:
- **Raspberry Pi** (light blue): This line remains quite low, indicating that the Raspberry Pi is not working too hard during the day.
- **DC Motor** (medium blue): The stress of this technology rises between 6 and 7 a.m., then falls after 8 a.m. and rises again around 11 a.m.
- **RFID readers** (dark blue): These readers follow similar patterns, working hardest at 7 and 11 a.m., but less in the middle of the day.
- **Access Control** (darkest blue): This line shows how visitor access control systems are stressed, with big jumps at 7 AM and 11 AM.

VII. Conclusion & Future Scope

To summarize, the RFID-based gate automation system powered by IoT has great potential for future development. Integrating AI and machine learning could improve gate operations, resulting in shorter wait times and lower energy use. The implementation of 5G technology will enable speedier, real-time data transfer for remote monitoring. Blockchain technology has the potential to increase security by ensuring unchanging access control. Biometric authentication, such as facial recognition and voice commands, may improve user experience. The system's sustainability can be improved by including renewable energy sources, such as solar electricity. The integration of safety sensors and motion

detection provides real-time obstacle identification, which improves safety. Overall, this breakthrough promises to enhance security, efficiency, and convenience in industrial, commercial, and residential applications.

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