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IoT-Driven Sophisticated Robot Leveraging RFID Identification

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Abstract. RFID is commonly applied to autonomously recognize motorists and cars for gateway authentication. The potential to authorize or refuse admittance depending on a vehicle's RFID identification number is an advantageous way in offering a higher quality of protection to a territory or structure. These precautions discourage unwanted transportation from using parking spaces and prohibit anyone from approaching a safe premises or property. RFID (Radio Frequency Identification) is thus ideal technology for safeguard automobile operations that involve exceptionally safe transportation entry at transportation hubs, maritime ports, and underground mines. It's also useful for quick and easy transport entry into garages, secured neighborhoods, employee parking spots and workplaces. With an IoT driven system, RFID technology will contribute a revolutionary change in the identification, control, communication, automation and surveillance system. In this research, we present an IOT-based transportation authentication mechanism using RFID signals. As a consequence, its counterpart identification, which currently occurs independently, could get transformed into mechanization. This procedure is going to be streamlined by the suggested system. The current accreditation procedure employs inductive chains installed in vehicles that retrieve the appropriate identity when they travel by means of the magnetism cycle.

Keywords. Internet of Things, RFID, authentication, automation, control, surveillance

1. Introduction

The amount of automobiles on highways has risen dramatically in recent years. Unluckily, the proprietor's encryption and vehicle recognition systems aren't evolving proportionately to fleet quantities. This has resulted in a massive automobile accreditation dilemma, particularly in metropolitan regions. Innovative internet driven advanced automobiles with RFID tags for identification are currently in high demand around this juncture. To create the IoT-driven advanced vehicle with RFID technology capabilities, the network employs a number of technological advances. RFID scanning device, Esp8266 wireless networking module, 4 channel relay module, DC motors, Microcontroller, and other electronics elements are included in the development of this

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framework. With the aim to execute the intended action, the microcontroller that controls it will be used to regulate all aspects of the system. Initially the individual uses an incorporated IoT technique to verify the car details on-demand [1]. The embedded device detects the advanced system attributes relating to the robot's performance powered by IoT before sending those values digitally by way of IoT technology via internet access [2]. IoT servers are utilized to centralize all of this data collection through RFID signals and provide the car administrator permission to use it in the safest possible manner [3-7].

2. Background

2.1. IoT System Communication with RFID

The Internet Interconnected Things (IoT) enables communication between people and intelligent devices like remote sensors and automated systems. In robotics' most unsolved obstacle is recognizing objects, however, technologies like radio frequency identification, also known as RFID, and quick response codes can help. In the present research, as a method for the Internet of Things, we suggest and put into practice a combined framework of automation, microcontrollers, and RFID technology. Our solution enables robots to communicate with additional Internet of Things gadgets and collect important data for undertaking various activities. RFID might have a significant influence to begin with.

Existing technologies and issues: Prior to the development of contemporary technology, there were several ways for designing and implementing portable robots, as well as numerous algorithms for guiding robots. Contrary with magnetic bar codes, reliable reading is possible without an obvious line of contact. We are employing RFID tags instead of barcodes since they are more expensive [8]. The most prevalent and well-liked navigation and identification methods advised by the latest state of science often fall into one of the subsequent groups: mapping-based method, dead-calculating method, landmarks method, visual method, and behavioural method.

3. Materials and Methodology

3.1. Conceptual Framework

Considering the advancement of methods of transportation currently, several developments have occurred. The majority of the research and studies concentrated on recognizing vehicles through automated processes, automotive surveillance employing cameras, and observing through RFID, NodeMCU, Microcontroller, and GSM connectivity. The notion of employing RFID for identification purposes is presented in this documentation. In other cases, sensor-integrated RFID systems, microcontrollers, a safety alarm with a built-in camera, and an intersection of RFID, Internet of Things, Microcontrollers, and GSM networks were utilized to inform the proprietor of the robot. This section contains briefly comprehensive explanations on the functioning of every appliance, mostly involving the microcontroller utilized. Figure 1 shows the functional schematic design of an IoT-Driven Robot with RFID Identification.

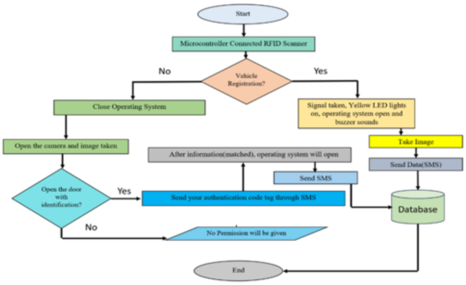

Figure 1. IoT-Driven Sophisticated Robot leveraging RFID Identification robot's system flowchart.

3.2. Wiring Diagram

RFID monitoring systems are primarily made up of a wireless transceiver that is attached to a scanning antenna and a collection of transmitting and receiving devices or tags that serve as instruments and record information. These RFID methods and their various detecting philosophies will be introduced in this work. The design's elements are connected according to the electrical schematic in figures 2 and 3 as guidance. The Arduino Uno microcontroller, which acts as the central nervous system and the forefront of all linked parts is the main piece of equipment utilized in the layout. In contrast, an RFID scanner acts as a controller in order to turn on every device, including the GSM module, which is the part that alerts the database of information, the servo mechanism which operates the entrance gate mechanism, the buzzer that sounds, and the lighting elements ensuring the permission signal(yes/no). It is only after an unidentified robot attempts to reach the area where the designated staff will use the ignition key does it is ready to explore or not.

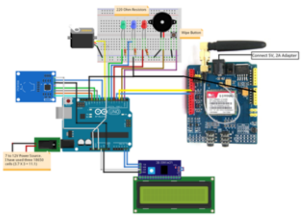

Figure 2. GSM and RFID Automated Fritzing Circuit Design.

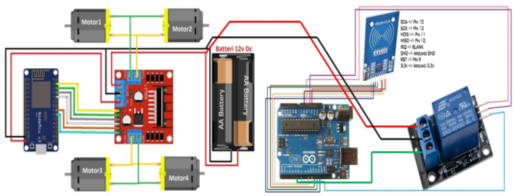

Figure 3. IoT Driven Sophisticated Automation with RFID.

3.3. System Development

The communication that occurs throughout the scanner and the tracking device can be compared to the signals produced by the radar receiver. You need to initially install the library as it does not constitute a part of the integrated development environment for Arduino. Click to Sketch > Include Libraries > Manage Libraries to set up the library. Allow Library Administrator to refresh the directory of registered library systems and obtain the archive index. In figure 4 and 5, we have checked our new UID tag.

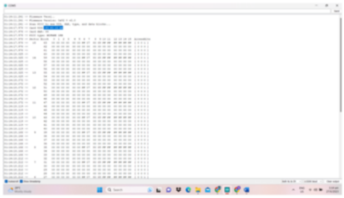

Figure 4. New RFID UID Tag= F3 F3 15 AA.

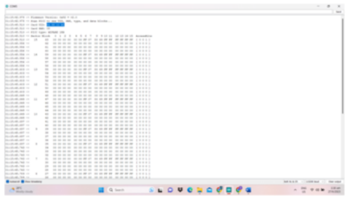

Figure 5. New RFID UID Tag= 8A 66 11 B1.

In our IoT-Driven Sophisticated Robot leveraging RFID Identification, we have given RFID UID= F3 F3 AA 15 and RFID UID= 8A 66 11 B1 for security identification checking permission through digital automation system through microcontroller [8-10]. In this endeavor, the ESP8266 microcontroller serves as the governing element. Any smart device with Android Operating System may do function remotely using a Graphical User Interface (GUI) that relies on onscreen correspondence functioning. An android-powered gadget is communicated by orders at the other end of the spectrum. Instructions are sent out to operate the robot in every direction at the point of intersection. Movements of four separate motors connected to an IoT-Driven microcontroller that regulates them. The smartphone app sends information in sequence, which is gathered by an IoT(NodeMCU) device interacting with the control system. Photos and video transmission will monitor from the cloud storage which is linked through an unique API address over internet which is briefly described in figure 6. Before starting the total operating system, we have to complete the RFID identification process.

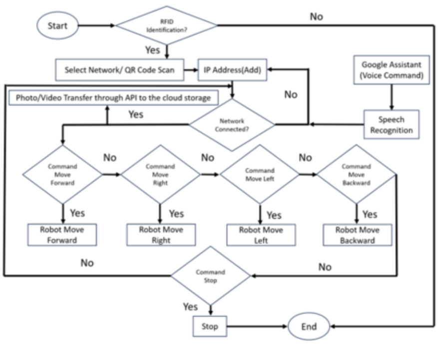

Figure 6. Robot's IoT-Driven, RFID Identification Flowchart Interface.

4. Result and Analysis

We will receive notifications from the IoT serial monitor regarding the Wi-Fi connection, Time, IP address information, camera observation tools, and robot monitoring functionality after uploading the firmware to the IoT microcontroller. We can automate, control, and use the system for surveillance via IoT with a real time update. Using IoT based AI thinking webcam, we can make video surveillance, image processing for object detection, Quick Response(QR) code scanning, and Human Identification processing. Figures 7 and 8 represent the camera observation and setup procedure.

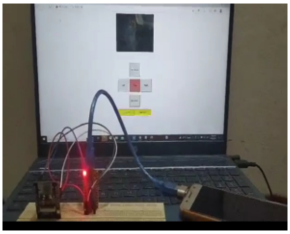

Figure 7. Camera Observation & Image Capture.

Figure 8. Wi-Fi, IP Address and Webcam Configuration.

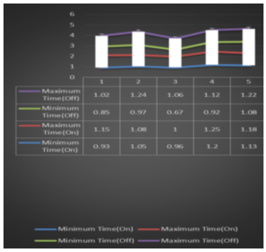

Figure 9. Graphical Representation of Robot's Time Interval Through RFID (Maximum and Minimum).

This inspection explained in table 1 determines if this robot is allowed to execute its operating system following registration in accordance with the RFID-based accessibility identification mechanism or not.

Table 1. RFID Card Checking(Access Authentication).

No	RFID(F3 F3 15 AA) Operating System(On)	RFID(8A 66 11 B1) Operating System(Off)	RFID(H8 B4 29 C2)
1	Access given	Access Given	Access (Not Given)
2	Access given	Access Given	Access(Not Given)
3	Access given	Access Given	Access (Not Given)
4	Access given	Access Given	Access (Not Given)
5	Access given	Access Given	Access (Not Given)

The structure of this system was created in two parts. IoT-Driven Sophisticated Robot's functioning after verification of registered user and before stopping the robot's operating system. In these two instances, we enhanced the robot's control, automation, and exploration systems more secure by using an RFID-based authentication mechanism. We calculated the maximum and lowest time intervals of the RFID access authentication system while the operating system is both on and off. The graph in figure 9 depicts the robot's maximum and shortest time intervals for switching its operating system on and off following RFID automatic identification.

Regarding all authorized automobiles, an informational infrastructure was included in the layout. With the incorporation of an RFID credentialing system that uses a servo motor as it's controlling procedure, a centered around the internet monitoring system is employed. Additionally, an integrated GSM module is present, which is utilized to send SMS notifications whether or not an RFID tag is found by the scanner. The identification of the vehicle's owner is accomplished by an ultrasonic sensor, and vehicle pictures are recorded by a digital camera. RFID based authentication and it's different sensor's status, database sms, and operating system status is briefly explained in the table 2.

Table 2. IoT-Driven Sophisticated Robot's Informational Infrastructure Data Analysis.

Experiment No	RFID Tag	Authentication	Status (Buzzer)	LED Light	Operating System (Status)	Image (Taken)?	Database (GSM SMS)
1	F3 F3 15 AA	Yes	Sound	Light On	On	Yes	Msg Sent
2	8A 66 11 B1	Yes	Sound	Light On	On	Yes	Msg Sent
3	H8 B4 29 C2	No	No Sound	Light	Off	Yes	Msg Sent

				Off			
4	6C 45 23 D1	No	No Sound	Light Off	Off	Yes	Msg Sent
5	E1 E1 45 DD	No	No Sound	Light Off	Off	Yes	Msg Sent

The robot's control constituted the simplest technical part of the entire robotic setup. This was quite simple to achieve attributable to the simple nature of the motor programming language. This software simply required taking into consideration 5 distinct alternatives using three separate incoming signals. The visualization below in figure 10 depicts the signal inputs along with what these commands are transformed into the IoT microcontroller to automate the 4 individual motor automation.

A sophisticsated device based program regulates our robot's management interface. The robot may be controlled using a variety of conditions. The voice assistant control system, IoT automated control system, and stable system may all be used to operate the robot. After RFID-based identification, we will be permitted to manage the robot from faraway perspectives by observing the live streaming camera position view technology. We can move forward, move backward, move right, move left and stop the robot by using IoT controlled system. In the online connected framework, we can see live video footage and capture image by using IoT based automation system which is illustrated in figure 11. We can observe, monitor and make data analysis of every content utilizing the internet connected methodology [11]. The architecture have remotely controlled PWM controller. By using this PWM controller, By rapidly switching on and switching off the electricity, it enables us to change the median value of the electric voltage that is being sent to the electrical equipment.

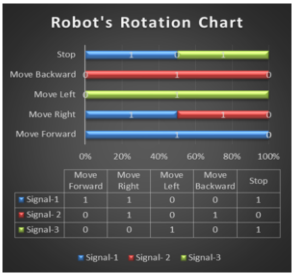

Figure 10. IoT-Driven Sophisticated Robot's Linear and Circular Rotation System Signal Variance Graphical Chart.

Figure 11. IoT-Driven Sophisticated Robot's Wireless Communication Architecture.

Smart imagining webcams based on artificial intelligence will keep trying to analyse images and recognize objects. Live streaming photos will be transformed here to "MJPG" files after the processing of images and classification of objects, and the identified data is going to arrive in the IoT-Driven Sophisticated Robot's automated system via individual image transmitting rate. Figure 12 represents the exact scenario.

The final prototype version of the IoT-Driven Robot Leveraging RFID Identification has been demonstrated in figure 13 after combining microcontroller, IoT, RFID, Smart Imaging Webcam, and other sensors.

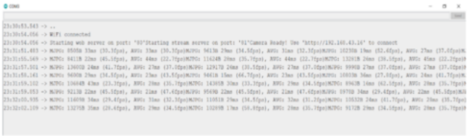

Figure 12. Smart Imaging Webcam Based Image Transmission System.

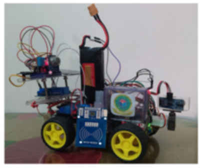

Figure 13. Prototype Version of IoT-Driven Sophisticated Robot leveraging RFID Identification.

5. Conclusion

In order to ensure adequate observation in the robot's digital operating system, this experiment demonstrated a sophisticated robot operated through the Internet of Things that uses RFID tags placed on items throughout the structure to interpret the data you supply. The construction of the experimental technology needed knowledge of data generation computation, commanding the mobile robot with a combination of data, and embedding the RFID system within the robot's mobile configuration. The results of the real-life tests showed that at some point in the near future, reaffirmed orienting tasks may be delegated to a moving robot. In order to make a contribution to electronic wireless oversight, automation, GSM-based position tracking & notification system, real-time image and camera observation, and economical and time-effectiveness of the process, the robot might offer pertinent details to specified persons utilizing RFID.

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