AN INTERNET OF THINGS BASED VEHICLE PERMIT VERIFICATION SYSTEM WITH DIGITAL DEVICE FOR TIMBER TRANSPORTATION

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ABSTRACT

The vehicle permit system enables any person to obtain permission to transport timbers around Sri Lanka. The persons can apply for vehicle licenses/permits via the forest department and verify them by the police. It has been realized that the vehicle verification process is still done by stopping vehicles by local police officers. The process of applying for licenses/permits is still done by visiting the divisional forest office, and the records are maintained paper-based. This paper presents a novel concept for an Online real-time permit verification system for Sri Lanka, and there is no ongoing system or architecture to do this concept up to now. Two digital devices and a web portal were used for this concept to become a reality. Once devices are powered ON, complete permit verifications can be automatically recorded into the web portal. For example, if there is a police checkpoint with a checking device and a vehicle arriving towards the checkpoint that has a vehicle device powered ON, once the vehicle reaches a 50m radius area, it transmits a signal to the checkpoint device. With that signal, police officers can identify whether the arriving vehicle has a valid permit. Also, they can get a fully detailed view of the permit. The permit issuing and verification portal were hosted in a live environment and ready to receive signals from verification units in real-time. Further development of this system uses the blockchain concept to share and save details among vehicles.

KEYWORDS

digital device, internet of things, nodeMCU 8266, radiofrequency identification, permit verification

1. INTRODUCTION

In this century, every manual system is converting to online-based smart systems. It helps to gain faster and more accurate data handling, sharing, and verifications using IT services. In Sri Lanka, it can identify steps to start IT-based solutions in government agencies such as the health, education, agriculture, and banking sectors[1]. But the permitting/licensing and verification methods are not yet upgraded with a considerable percentage of online services. Many agencies issue digital cards for permits and verification, and no proper verification devices are used practically. Using online-based verification systems may increase efficiency with time and cost rather than handling manual document-based systems; considering the pandemic, there is a risk with handling paper-based manual document verification. Using an online system can reduce human resources for the verification process and helps maintain records using the blockchain concept. This study focused on solving major issues in manual paper-based permit verification systems.

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The forest departments in Sri Lanka are responsible for issuing permits/licenses for the timbers belonging to the group of prohibited species [2], and the Sri Lankan police department is responsible for identifying illegal timber transportation cases. But both departments use manual systems and are not linked with one another. For example, to transport timbers, an owner needs to get a permit from the forest department, and the verification process should be done by the police officer [3]. That verification process is based on paper-based manual verification and can not check with the original source of the forest department. Therefore, transporters must stop twice to three times for the permit checking process in their routing schedule. Using the proposed system with IoT digital devices helps to reduce permit verification time. Considering the current global pandemic, social distancing is an effective method to avoid spreading the virus. This study also aims to show how officers can check the license/permit documents of transport vehicles without using paper documentation. Using the digitized system for this process helps to avoid spreading viruses. Furthermore, some long-distance vehicles that carry timbers have to spend a minimum of twenty minutes verifying the documents with one checking spot. This system helps to reduce time as well as health assurance.

2. LITERATURE REVIEW

In order to get knowledge about verification systems and their technologies, a few publications were studied. According to our findings, the researchers developed systems to verify licenses, vehicles, and students' attendance. More researchers used Radio-frequency identification (RFID) technology with or without the Internet of Things (IoT) platform to implement their works. Here, the following publications were reviewed to identify the solution for the permit verification system.

Alen Samuel and Shoney Sebastian [3] designed an automated vehicle checking system for the motor vehicle department in India. This system introduced two radio frequency (RF) based devices. One RF device had an RFID tag fitted with the vehicle, and another RF device was placed nearby the road checking area. Using this RFID technology, the authors suggested an algorithm to automate the verification process of the vehicle documents like registration of certificates, echo tests, and insurance with the help of an IoT platform.

Uma Kandhikonda [4] proposed an IoT-based device to verify the vehicle's registration and authentication of the user license. This publication used an IoT platform to centralize vehicle and license details. RFID tags were attached to the vehicle, and an RF reader was used to detect the tags. For authentication purposes, a fingerprint module and sound alarm were used. To implement a prototype, all components are connected to an Arduino board.

Shoewu et al. [5] designed an RFID-based device to verify students' identification at the classroom entrances. This device was developed to gather students' attendance records for further analysis. The RFID tag can be included in the student ID. The RF readers were placed in the classroom; when an RF tag passes through its vicinity, the readers scan its existence, fetch its unique serial number, and send this code into the microcontroller, which matches the correct student.

3. METHODS

The research design of the proposed system has two major parts: hardware and software design. In hardware design, two digital device units were designed using microcontrollers, a 433Mhz RFID transmitter, receiver, RFID reader module, and RFID tags [6] for vehicle and spot verification. Software design included the programming code written in Arduino language and

uploaded in the microcontroller. A PHP language-based web portal was developed to handle timber license/permit registration and show vehicle verification status.
The mentioned components were interconnected with radio signals and one micro-controller device also had the capability to connect with the Thingspeak online platform and send data through the internet. In case the verification process started from both devices reaching the data transferable range, the vehicle device started sending the unique RFID card permit data attached to the device. Once the spot verification unit received that data from the incoming vehicle, that permitted data upload to the online platform. The last verification process was validating permit data with the forest department database.

Vehicle Unit

This unit consists of an Arduino UNO microcontroller, and a 433 MHz transmitter was placed inside the vehicle. The owner/driver had an issued license/permit card (RFID card) that should be inserted into the unit. Once the driver inserts the card into the unit, it transmits permit card data via radio frequency. According to the selected transmitter, the data is transmitted for a 50m radius. Figure 1 presents the vehicle unit.

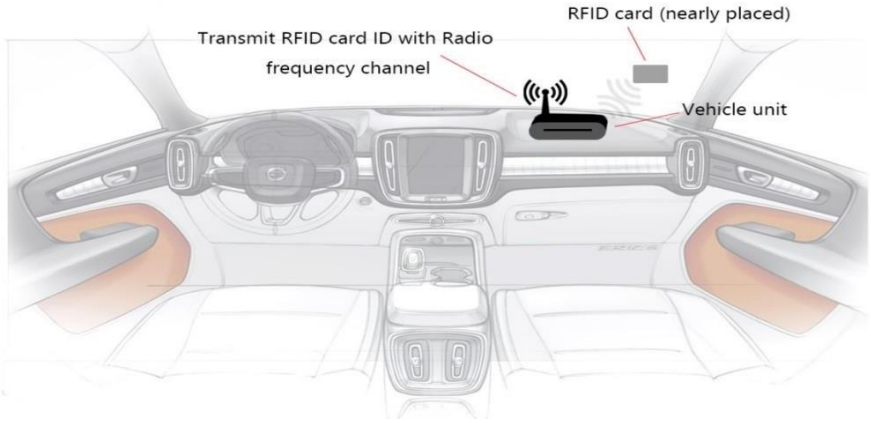

Figure. 1. Vehicle unit

Spot Verification Unit

This device used a 433 MHz receiver and a node MCU 8266 microcontroller. It is connected to Wi-Fi or a hotspot. When the device was powered on, it could receive RFID data sent from the vehicle device arriving at the checkpoint. If there was an activity feed with the vehicle device, the receiving RFID number was sent to the web portal. The checkpoint officer was able to check incoming vehicles' license/permit details. Figure 2 illustrates the spot verification unit.

Figure. 2. The spot verification unit

Web Portal

The sensor data (RFID number) was transmitted to the cloud-based Things peak Platform via a Wi-Fi or hotspot connection by the spot verification unit. The data was then retrieved using APIs for a PHP-based web portal. A MySQL database was used to store sensor data as well as information about licenses and permits. Figure. 3 provides the system architecture of the web portal. Spot checkers from the police department and authorized users from the forest department could use the login portal page to get into the system. It shows up in Figure 4.

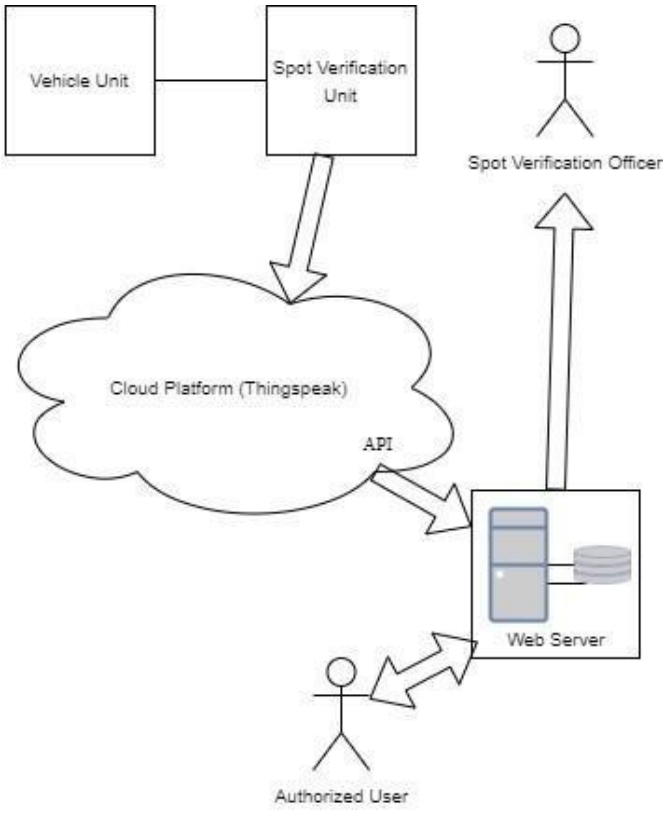

Figure 3. The system architecture of the web portal

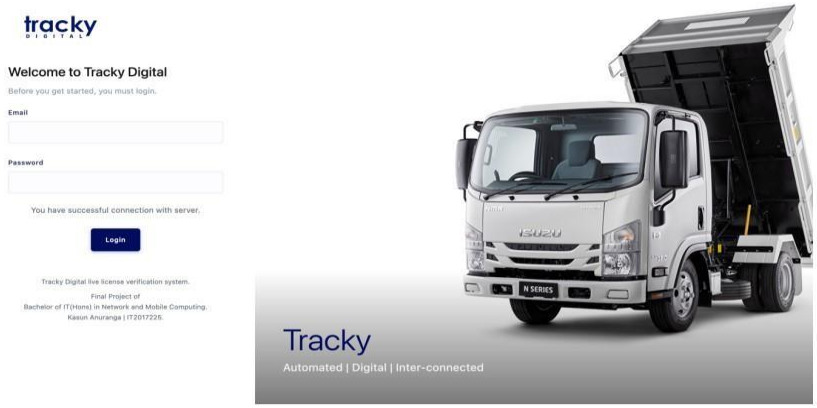

Figure 4. The system using the login portal page The function of each hardware and software requirement is explained in Table 1.

Table 1. Hardware and software requirements

No	Name	Function
	Hardware	
1	NodeMcu ESP8266	A controller of spot verification unit and to connect with IoT
2	Arduino UNO	A controller of vehicle unit
3	433 MHz Transmitter and Receiver	Send and receive RFID number
4	433 MHz Antena	Increase frequency range
5	RFID Reader Module	Read RFID number
6	RFID Tag Card	Store RFID number
7	Jumper Wires	Connect components
	Software	
8	Thingspeak	Store sensor data in cloud
9	Arduino IDE	Write and test programs for microcontrollers
10	XAMMP (Apache, MySQL, PHP)	Develop the web portal

Figure 5 shows the schematic diagrams. It displays the connection of the components to the microcontrollers that were used. Figure 6 shows the experimental setup for the vehicle and spot verification unit.

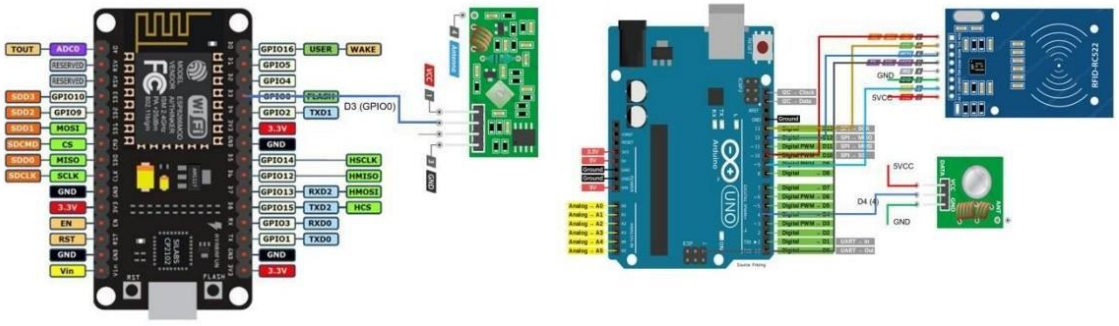

Figure 5. The schematic diagrams

Figure 6. The experimental setup

4. RESULTS

The proposed system has two parts: the hardware (the vehicle device and the spot verification units) and the software (the web portal). This section discusses the tests that were done on different parts and the overall performance of the system.

Once the vehicle device and spot verification unit were powered on with active broadcasting data (the vehicle had reached a 50-meter area),

Firstly, the hardware part was tested. Then, the output appears on the Arduino IDE serial monitors as Figure 7. It depicts data transmission (e.g., RFID tag: 39455552) from the vehicle device and data reception into the spot verification unit.

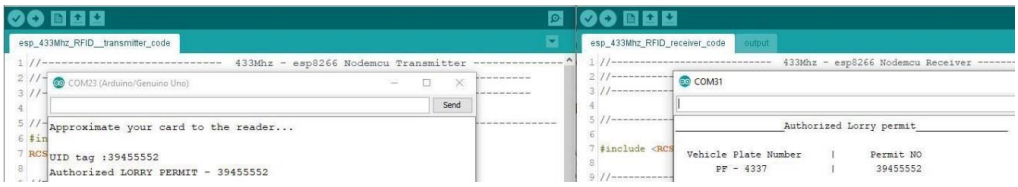

Figure 7. Arduino IDE serial monitors with transmitting and receiving data

Secondly, the entire system, including the connectivity of the web portal, was tested. The spot verification officer can log in to the system dashboard, and the following results of the incoming active feed are shown in Figure 8 (e.g., RFID tag: 60435711).

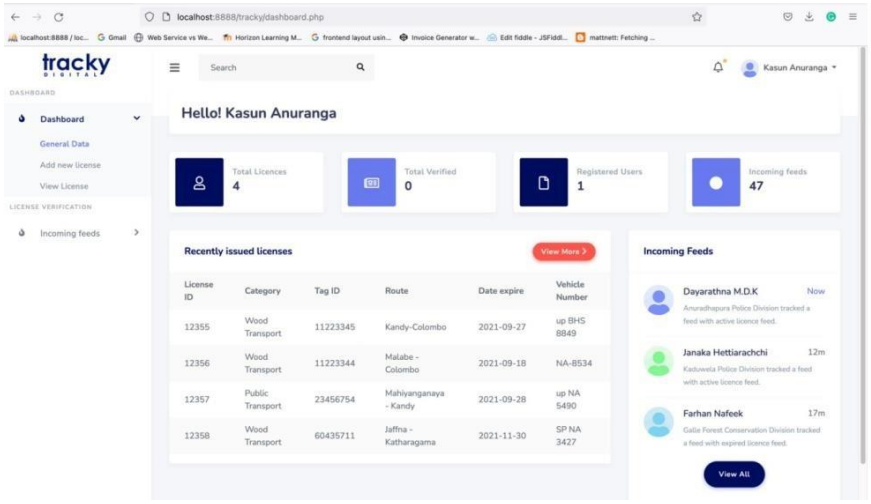

Figure 8. Incoming active license feed

Furthermore, Figure 9 illustrates that authorized users can log in to the system dashboard and manage the license/permit registrations and check feeds.

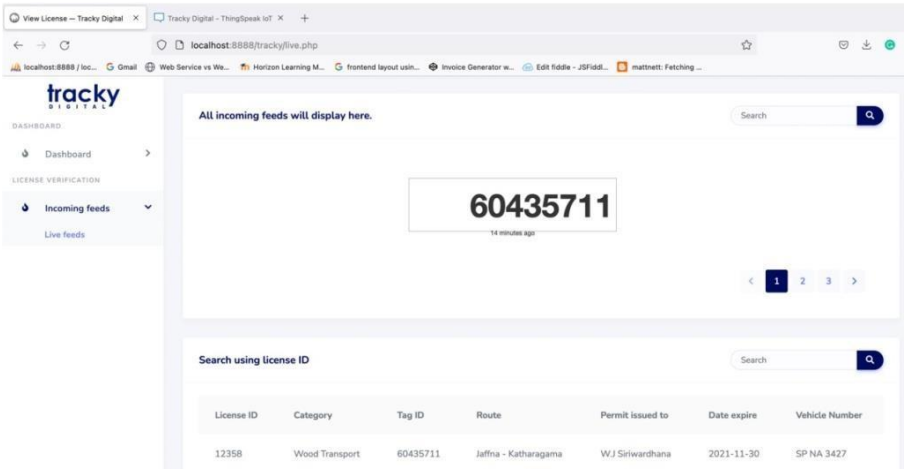

Figure 9. Dashboard of web portal

Finally, the following performance testing scenarios were performed on the IoT framework:

- Device-to-device communication (Vehicle device to Spot verification process)
- Device-to-server communication (Spot verification device to Thingspeak)
- Server-to-server communication (Thingspeak to web portal)
- Network bandwidth, latency, and packet loss

Based on the above scenarios, the following goals were used to test performance test cases:

Table 2. Time taken to scan and send permit card data from vehicle device

Test Conditions	Output specification	Optimal
The time taken to fetch RFID data to a microcontroller—Vehicle vehicle unit	The time taken to fetch data from an RFID card using an RFID sensor is less than 50 ms.	True
The time taken to send RFID data to the spot verification unit receiver. (without a signal booster antenna).	The time taken to send data through the radiofrequency channel to the spot verification unit is less than 50 ms. (without signal booster antenna. – Test environment 2m distance)	True

Table 3. Time taken to get transmitter data using a receiver and send it to Thingspeak

Test Conditions	Output specification	Optimal
The time taken to get transmitter data.	The time taken to get data from the 433 MHz transmitter is less than 10 seconds.	True
The time taken to send RFID data to Thingspeak's server.	The time taken to fetch from the receiver and send to the Thingspeak server is less than 5 seconds.	True

Table 4. Time taken to send Thingspeak server data to web portal

Test Conditions	Output specification	Optimal
The time taken to send Thingspeak server data to the web portal.	The time taken to send data from the Thingspeak server to the web portal is less than 5 seconds.	True

Table 5. Time taken to fetch data from Thingspeak API and display License data

Test Conditions	Output specification	Optimal
It took a while to get data from the API and check it against the license table in the database.	It takes less than 10 seconds to get data from the API and check it against the database's issued license table.	True

5. DISCUSSION

Based on the results, both the vehicle device and the spot verification unit can check a vehicle's permit from up to 50 meters away. The web portal shows incoming feeds that officers can use to check the details of a vehicle on the spot. Lastly, the performance test shows how quickly the verification process works when hardware and software parts talk to each other. The most important thing that this research has given us is the ability to write the functional codes that allow the microcontrollers and web portals to talk to each other. This system can speed up the verification process while keeping government workers and the public safe and reducing health risks [6].

There are some limitations related to the system. This experiment is done in a testing environment. It has been suggested that testing could be done on the side of the road, where there is real traffic. The Internet facility is a significant factor. Therefore, the verification devices must be installed within the Internet coverage area. Also, government officers and the general public need training to use this system.

6. CONCLUSION

In this study, an IoT platform, microcontrollers, and RFID technologies were used to design and build a vehicle permit verification system for transporting wood. It is a new way to scan vehicle permit data. This system is made up of digital device units that are cheap and use little energy, so they can work all the time. In Sri Lanka, there is no digitalized verification system for this field. This system enables smart technology to be used for permit verification. The verification process can be completed quickly and without stopping vehicles. Also, it helps protect government workers and citizens by allowing them to work at a distance during a pandemic.

Many future improvements include

- Verify all license types related to driving, such as driving licenses, revenue licenses, and insurance details.
- Use signal booster antenna to increase distance range.
- Connecting GPS to the vehicle unit will help track the vehicle.
- Check the integrity of verification reports by using blockchain technology.

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REFERENCES

[1] S. Rainford, "e-Sri Lanka: An Integrated Approach to eGovernment Case Study", Unapcict.org, 2006. [Online]. Available: https://www.unapcict.org [Accessed: 23- Jun- 2022].

[2] "The Government Information Center", Gic.gov.lk, 2022. [Online]. Available: https://gic.gov.lk/gic/index.php/en/component/info/?id=1159&catid=70&task=info. [Accessed: 26Jun- 2022].

[3] A. Samuel and S. Sebastian, "An algorithm for IoT based vehicle verification system using RFID", *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 9, no. 5, p. 3751, 2019. Available: 10.11591/ijece.v9i5.pp3751-3758 [Accessed 23 June 2022].

[4] U. Kandhikonda, "IoT Based Vehicle and License Authentication Device", *SSRN Electronic Journal*, 2021. Available: 10.2139/ssrn.3904851 [Accessed 02 July 2022].

[5] P. Engr O Shoewu, "Design and Implementation of an Rfid Based Automated Students Attendance System R BASAS", Academia.edu, 2022. [Online]. Available: https://www.academia.edu/en/15362853/Design_and_Implementation_of_an_Rfid_Based_Automated_Students_Attendance_System_R_BASAS. [Accessed: 31- July- 2022].

[6] Prema.S, Mohamed Riyas Deen V.S., Murali Krishna V.P., Praveen.S, "Vehicle And License Authentication Using FingerPrint", *2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS 2019).*