Journal of Cases on Information Technology
Volume 23 • Issue 2 • April-June 2021

434 MHz Environmentally Safe Monitoring Schema for Vehicular Network by AI-ML-IoT Technologies

Jeba Kumar R. J. S., Karunya Institute of Technology and Sciences, India
Roopa Jayasingh J., Karunya Institute of Technology and Sciences, India

ABSTRACT

Connected vehicular tracking schema operated in environmentally safe radio frequency of 434 MHz, artificial intelligence, and machine learning and IoT technology (CVT-AIML-IoT) is cost effective and secured tracking or device monitoring system. The prime benefit of the proposed CVT-AIML-IoT system is that it utilizes cloud internet of things (IoT) technology and active radio frequency identification over global positioning system (GPS), which is prone to attackers due to self-defenseless network architecture. The sliding side of GPS is observed; when the GPS module is switched-off, it can be hidden without any authorization. Hence, an uninterrupted observing secured system like CVT-AIML-IoT is a promising solution with dynamic vehicular PIN generation by AI-ML concept. CVT-AIML-IoT grids the traceable area based on the topographical dependency. Detection range gateway coupled with IoT transceiver module captures data from each tracking zone to the cloud for monitoring over Web UI support and mapped with time stamp. Hence, CVT-AIML-IoT assures vehicular monitoring in a lucrative approach.

KEYWORDS

Active Radio Frequency, Artificial Intelligence, Central Server, Connected Vehicular Tracking, Environmentally Safe, Hardware Security, Internet of Things, Machine Learning

1. INTRODUCTION

Ever since the originating era of digital civilization, threat to our belongings and information is increasing at alarming rate. Booming and well-established car lending organization like Taxify, Ola, Uber etc. and bank chest cash replenishing vehicle need a system, which provides additional Tracking Schema over the zone without implantation of Global Positioning System (GPS) for additional security which leads to a heavy load in security messages. To surge security, periodic monitoring of vehicles must be entrenched. Commercial and corporate risk demands 24x7 surveillance that even holds true for vehicular tracking. With escalation in modern sophisticated vehicular epoch, an exceedingly tracking tool is needed for clients who are in ardent need to avoid such problematical chaos of vehicular insecurity. According to Aalsalem et al. (2017) the substantial practice of monitoring the vehicle with layman-friendly dimension is greeted by current community. As discussed by Ogudo et al. (2019) notification at any topographical location can be witnessed by utilizing a webpage support which is accessible through a remote desktop or even in handy smartphone. As discussed by the following authors Khalaf et al. (2019), Adam et al. (2020), Khalaf et al. (2020) and Li et al. (2020), remote

DOI: 10.4018/JCIT.20210401.oa3

sensing of vehicular network is achieved effectively with the implementation of Artificial Intelligence and Machine learning (AI-ML) grid, which is connected in the form of Wireless Sensor Network (WSN). According to Salman et al. (2019), the implementation of intelligent WSN should be made long lasting with the stable functioning algorithm to increase the life span of node or inter node in the WSN and it should be made intelligent. The proposed CVT-AIML-IoT consist of Enhanced Wireless Sensor Network Module (EWSNM) with the combination of data communication module to confine the incoming signals which are frequently watched by connected vehicular in making practical and effective use of Active Radio Frequency ID Sensing and Internet of Things (IoT) Technology which is secured by the dynamic allocation of Artificial Intelligence and Machine learning algorithm for pin generation. As elucidated by Abdulsahib et al. (2018) IoT is integrated with cloud database for effective data processing for the monitored data gathered from the WSN network. Replica of data center of data is created in the cloud to maintain the fail-safe mechanism with the help of data mirroring implementation. CVT-AIML-IoT functions in the environmental safe frequency range of 434 MHz, which is an acceptable frequency range of short range communication. As utilized by the following researchers Adaramola et al. (2020) and Sanda et al. (2020) for the existing monitoring application with over exposure of GPS and GSM module for daily tracking purpose leads to memory related ailments due to its strong ionizing radiation which is emitted. In-order to validate the practicability of the proposed CVT-AIML-IoT, it is implemented on real time as a tracking model which functions in the human friendly operating frequency range of 434 Mhz. Vehicular identification entry processing, Zonal details mapping in accordance with topographical zones and time-stamping processing with entry date and time are made customized with the CVT-AIML-IoT Web User Interface (WUI) to establish the secure and robust way of tracking which is environmental safe due to its acceptable operating frequency.

2. LITERATURE SURVEY

S. L. Ting et al. (2012) intensively focused vehicular motion detection and analyzed their performance and operation by utilizing Passive RFID (P-RFID) tag, which is not achievable for real time implementation which demands higher range tracking. This system mainly focuses on short range vehicular tracking which is not capable for continuous on-road monitoring. Proximity distance dependency with P-RFID marks this system to be inappropriate for real time implementation. Hafeez et al. (2015) established the ongoing velocity capturing system but this system flips with the side of topographical coverage and the advanced concept like IoT which makes the system to be compatible. Low profile A-RFID is used for speed monitoring but not for zonal tracking. Pavithra et al. (2019) conferred the vehicular slot Tracking Schema with the aid of P-RFID which compromises the sensing ability. Utilized P-RFID has the maximum sensing range of three feet, which is not a decent solution of real time implementation. Displacement of P-RFID is the main hindrance with accurate RF capturing ability. The prime disadvantage of P-RFID is that it can be easily mimicked and there is always the security comprise related to a system which utilizes the P-RFID. Kumar et al. (2019) exhibited the Tracking Schema with the blend with satellite based navigation System devices. The sliding side of the mechanism is that the vehicular body becomes hidden from tracing view, if the GPS device is switched off. Fernando et al. (2020) established the monitoring schema with satellite based navigation and to describe the protocols for second generation tracking device, but this system flips with the remote sensing ability as it does not encompass IoT technology for the ease of connectivity.

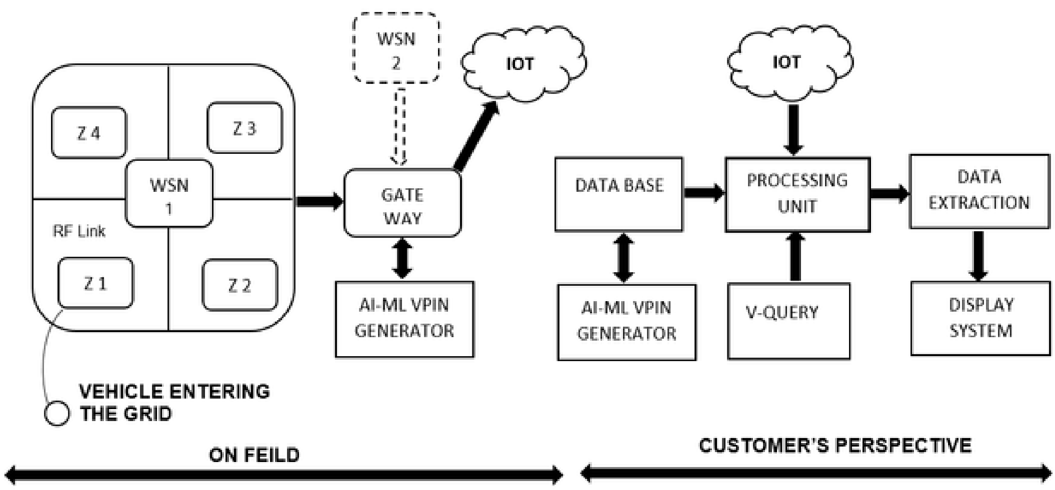
3. RESEARCH MOTIVATION

Vehicle and Information theft is the upsetting problem in modern era. Government owned banks and private banks usually depends on external or self-owned agency for refilling cash in ATM's (Automated Teller Machine). The dark side of this dependency is that intruders usually join hands with agency and attempt to steal the cash along its way while replenishing. Few vehicular vending company like Ola, Uber etc. which rents car for out-station for local and inter-state travel needs a security system in a reliable way. In general, these transportation network company uses GPS and GSM security oriented system for security purpose. The implementation of GPS and GSM devices faces unauthorized drive away issue while switching-off these devices makes them hidden from tracking zone. The usage of GPS and GSM devices are not advisable for human exposure long time due to its strong ionizing property. Hence this lending transportation system needs a prominent tracking methodology and hence this CVT-AIML-IoT will be most suitable solution to combat the security issue.

4. PROPOSED DETECTION SENSITIVITY ENHANCED CVT-AIML-IOT SCHEMA

The proposed CVT-AIML-IoT tracking solution system blends both Wireless Sensor Network technology and IoT technology. This system claims to be cost effective because of the system implementation with Active Radio Frequency Identification Tag instead of GSM and GPS system which is costlier technology. A-RFID always emits RF signals with the sync data associated date and it is made captured in webpage administrator page. Vehicular positional status and time stamp of the vehicle entry is also made reflected in the webpage for additional detailed tracking details. The

Figure 1. Detailed Block Diagram of CVT-AIML-IoT



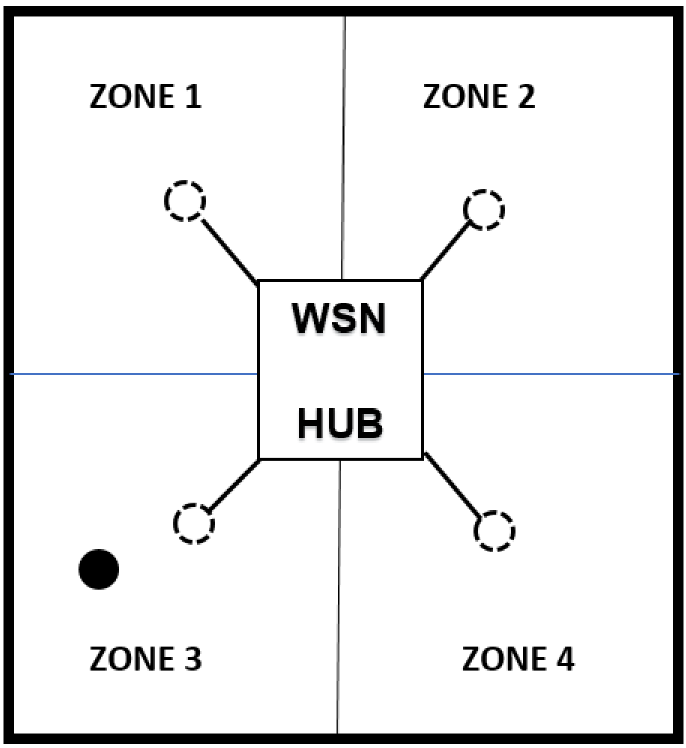
comprehensive system block diagram is as depicted in Figure 1.

Wi-Fi microchip ESP 8266is utilized in CVT-AIML-IoT system to move the observed data to IoT Cloud storage. Hereby a standard pattern for vital tracking data is followed as a combinational set of four bit binary numbers “0000 to 1111”, followed by unique dedicated bit for WSN number and Zone number. The binary coded data packet sample message is as follows “1010:1:1”. These on-field binary data are serially generated by the A-RFID module and pushed from each WSN hub to IoT cloud. Basic vehicle detailed who are registered under this CVT-AIML-IoT system is already loaded in the database and it is made synchronized with the harvested RFID binary data. Due to the range of coverage, primarily the zones are classified on the outline of the sector. Active Range Radio Frequency source equipment which are used to generate and transmit are movable throughout the sector, held on the vehicle. The Radio Frequency wireless radio frequency sensors aid as immobile.

Active Radio Frequency receivers that are positioned as per the RF identifying the frequency range. The topographical section is fragmented affording to border area in accord to A-RFID discovery range.

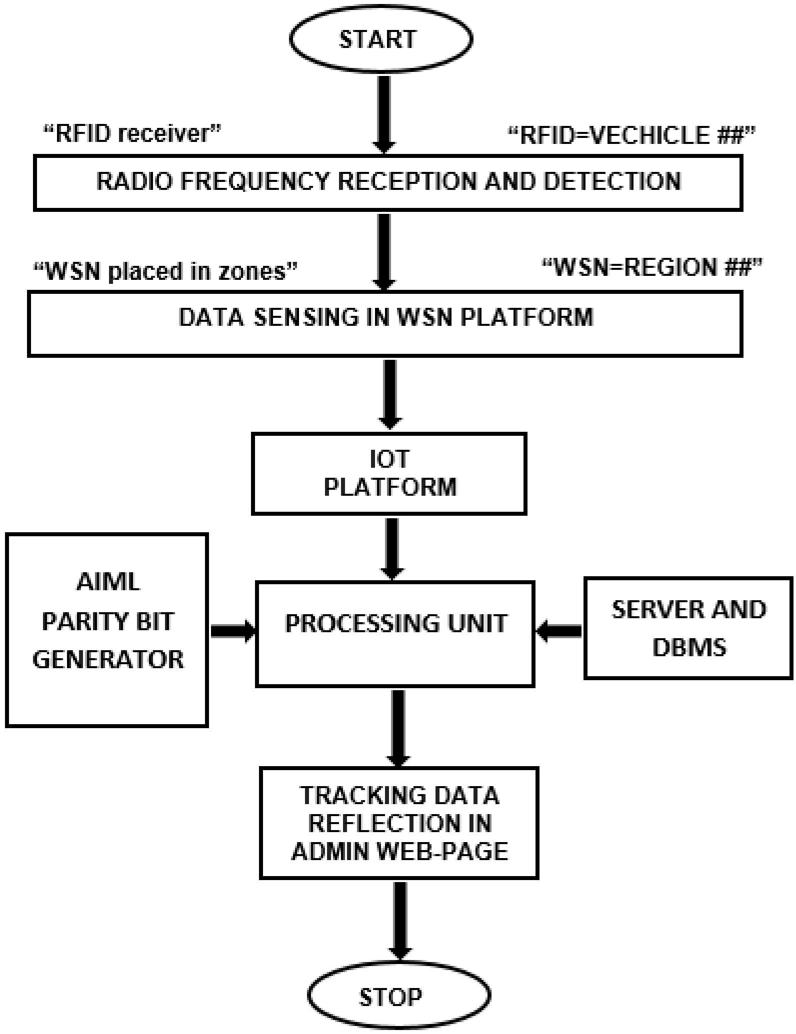
The immobile Active Radio Frequency module receivers are stowed. All these immobile A-RFID receivers along with A-RFID transmitter is connected to another zone in a wireless fashion to form an Enhanced Detection Range Wireless Sensor Network (E-WSN). Figure 2, depicts the grid schema of regional CVT-AIML-IoT, Dark spots in the figure shows that a vehicular peeping the region of E-WSN place with A-RFID Transmitter, Encircled light spots identifies the way sensor nodes are oriented with the receiver section of the E-WSN.

Figure 2. Zonal Grid Diagram of CVT-AIML-IoT



Detailed CVT-AIML-IoT functional flow diagram is as portrayed in Figure 3. The functional skeleton of the CVT-AIML-IoT system is classified as Hardware Processing section which is deployed on the field and the other is Software Processing which is deployed in server side with the integration with the customer tracking webpage support. The main responsibility of the hardware processing is to collect the transmitted data bits from the A-RFID transmitter and push it to the IoT cloud through ESP8266 wireless fidelity module through the WSN hub. The prime responsibility of the software section is to map the collected the RFID number with the already stored vehicular stored database which are subscribed to this CVT-AIML-IoT system. Dynamically generated customer requested query is peeped to the processing unit to have a monitoring contact with the connected vehicular. The backbone of the software section is that usage of Data-Base Management System (DBMS) which stores the history of registered vehicular which are registered under CVT-AIML-IoT system. Captured RFID number is matched with the vehicle number and hence the conclusion is made to finalize the topographical location of the vehicle associated with the zone in the webpage support.

Figure 3. Functional System of Work (SoW) of CVT-AIML-IoT



The Comparison between conventional GPS based monitoring vs. Proposed CVT-AIML-IoT system is differentiated clearly as in Table 1.

5. RESULTS AND DISCUSSION

The operating frequency of this proposed schema is in the range as allowed by Industrial Scientific Medical (ISM) frequency band of 434MHz. This operating 434 MHz RF frequency range is harmless to human and environment as it does not ionize the surrounding. CVT-AIML-IoT functions in the acceptable frequency range for human exposure and this this proposed system claim to be safer than strong GPS and GSM frequency. They are equipped to perform the role of Data Encoder. A-RFID module radiates RF signal as a synchronous code ranging from 0000 to 1111, i.e. 16 combinational binary inputs. These four-primary data Bit can be scaled suitably to multiple bit range by adding additional encoding bit which are readily made available on the presented HT12E module. Here the elasticity regarding CVT-AIML-IoT system for a medium to high scale system is achieved in a

Table 1. Comparison table for conventional GPS based vehicle monitoring Vs. Proposed CVT-AIML-IoT

Differential Paradigm	Conventional GPS based Vehicular Monitoring	Proposed CVT-AIML-IoT based Vehicular Monitoring
Architectural Enhancement	Automobile tracking system is accomplished based on GPS module incorporation to a network directly.	Connected Automobile tracking schema is trained with smart Integration of A-RFID and Enhanced Detection Range Wireless Sensor Network (E-WSN) coupled to IoT technology with secured dynamic pin generation by AI-ML, to empower most excellent data abstraction and competent data handling.
Bandwidth Efficiency	GPS based monitoring demands massive bandwidth, as it is only dependent on software level estimation.	CVT-AIML-IoT schema require minimal bandwidth. Equal weighted Balance of computational responsibility is shared by both hardware and software functional schema.
Scalability	GPS based tracking schema is not scalable.	CVT-AIML-IoT system can be expanded or contracted in size, since the codes are again used as recognized ones and restructured based on demand.
System Security	GPS based monitoring is viable to hacking and other software attacks.	CVT-AIML-IoT oriented tracking schema is immune to both software and hardware hacking. Additional Parity Codes are added to end of the written codes before the exclusive A-RFID number for the purpose of achieving data protection purpose with the application of Artificial Intelligence and Machine Learning (AI-ML).

cost-effective approach is a benefit to countless Micro, miniature and standard Lending Enterprise and its multi-purpose vehicle observing purposes. A-RFID module operates in the voltage range of 2.4 to 12 volts. Devoted three binary bit combinational encryption is being prepared undeviating in mutually for equipment used to transmit and receive. Unit of both A-RFID in which an equipment used to transmit and receive, synchronous code. Figure 4, depicts A-RFID Transmitting set of standard paths which operates in the environmental safe ISM band i.e. 434MHz, which is implanted on the registered mobile Vehicular units.

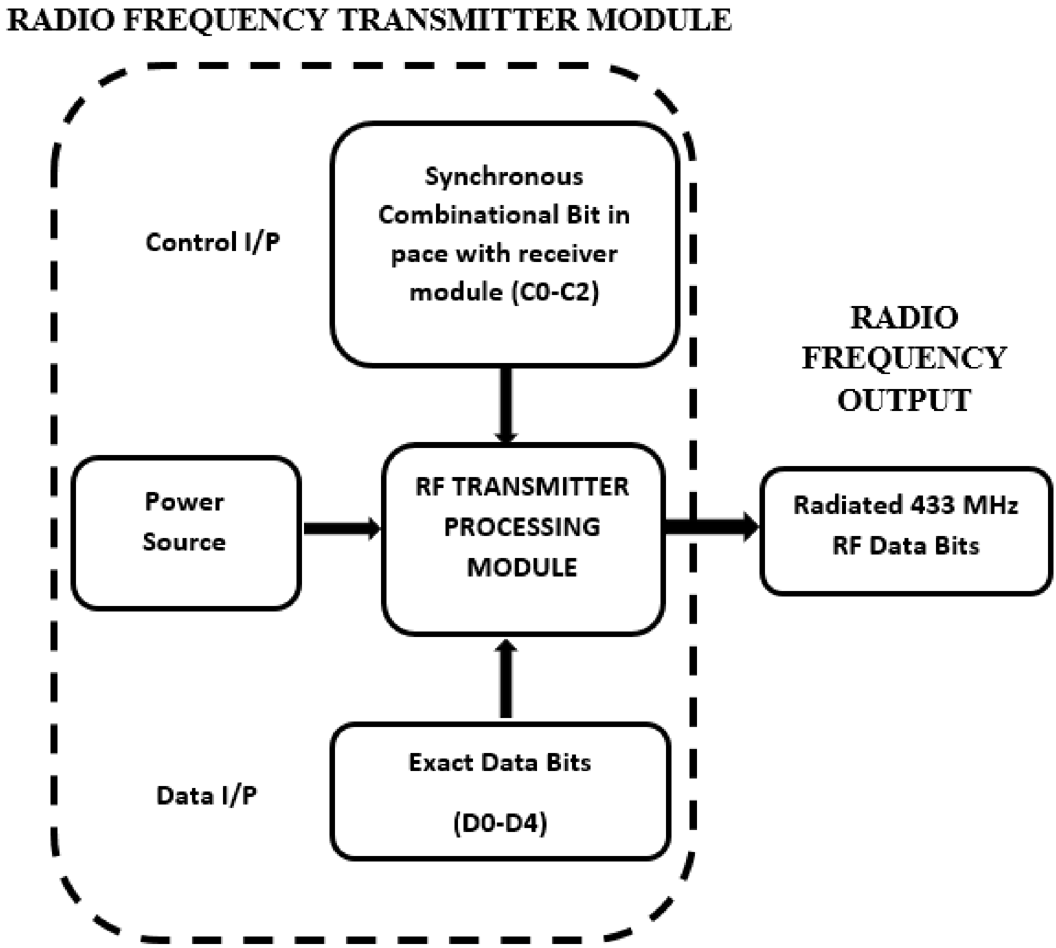
In synchronous to encoding unit housed in the vehicular unit, 4 binary bit data decoder module which acts as Active RFID receiver element in CVT-AIML-IoT schema. Figure 5, depicts the A-RFID receiver section which is positioned taking place the WSN Hub clubbed by means of Internet of Things, an equipment to transmit and receive a set of standard parts, to thrust a gathered fact from WSN hub towards Internet of Things cloud for the phase of next level of computation for tracking purpose.

To know about the real-time frequency distribution around the chosen short-range Ultra High Frequency band i.e. 434MHz. Implementation analysis have been done in both day and night time to study the prevalent turbulence discovery of effectiveness of the A-RFID capturing efficiency. Power Ratio (PR) as elucidated in Equation 1, is the effective method to measure the antennas ability to abate the interference effect:

$$Power\ Ratio(PR) = \frac{Undesired\ Power}{Desired\ Power} \tag{1}$$

It is evident from the Relative Signal Power or Relative Power (RP)calculated by using derivative Equation 2., depends on Transmitting Power (TP), Transmitting Gain (TG), Receiving Gain (RG), Signal Wavelength (λ) and Antenna Separation Distance (R). Compact real-time frequency spectrum analyzer is built using Register-Transfer Level Software Defined Radio i.e. RTL-SDR, using Mat-lab and Simulink. From depicted RTL-SDR frequency sweep output Figure 6, it is evident from the real-time frequency sweep analysis during the daytime with RTL-SDR, frequent turbulence in the Power

Figure 4. A-RFID Transmitter module (434 MHz) implanted on the Vehicular



Ratio (dBm) vs Frequency (MHz) around the desired central frequency is observed. The turbulent variation doesn't cross the central maxima at 434 MHz, hence A-RFID in CVT-AIML-IoT schema captures and delivers the desired radio frequency identification messages exactly even during day time. Relative Power of the A-RFID evidently at its peak in 230 Watts:

$$Relative\ \ Power(RP) = \frac{TP * TG * RG}{\left(4\pi R\right)^{2}} \tag{2}$$

In-order to analyze the turbulent variation of frequency distribution during night time around the central operating frequency of 434 MHz, is studied effectively for CVT-AIML-IoT schema. Figure 7, depicts the Frequency Sweep around the operating frequency during night time. It is evident from the graph that the variation around the operating frequency is less during the night times and during the day time. In both the cases the central peak remains the same at 434 MHz with the relative power of 230 Watts. The turbulent variation in either side of the operating frequency is minimal in both day and night times, hence the CVT-AIML-IoT schema remains stable and functional round the clock.

Figure 5. A-RFID Receiver module (434 MHz) positioned on WSN Hub furnished amid Internet of Things Transceiver Unit

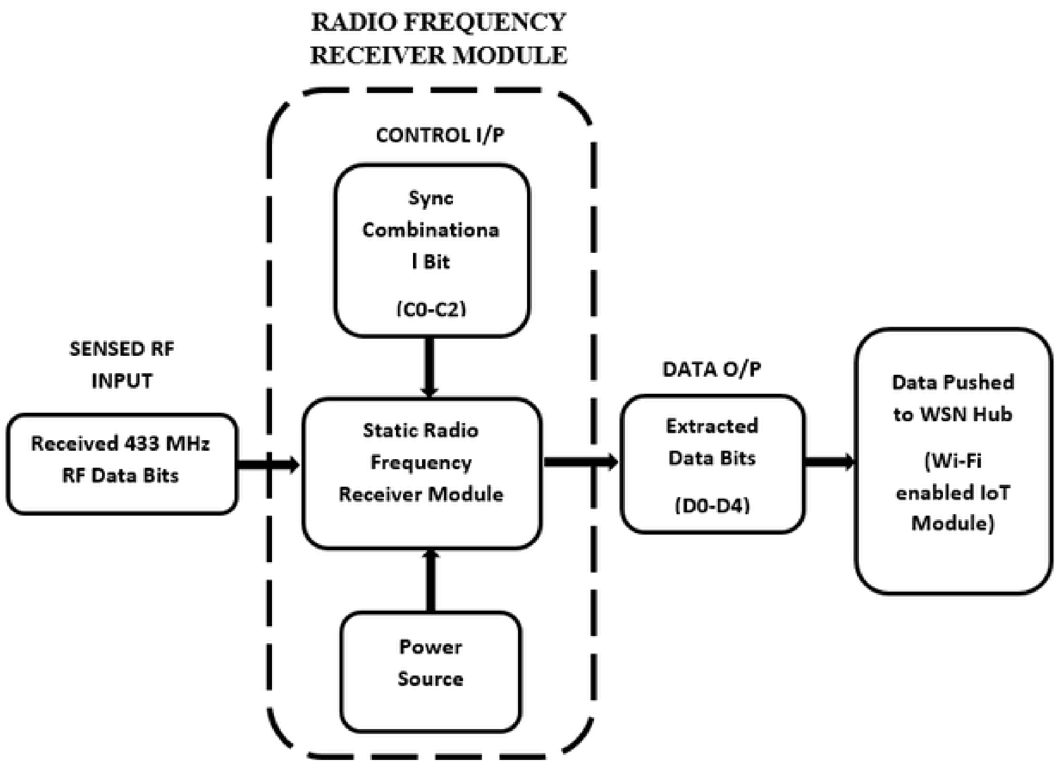


Figure 6. Frequency Sweep around the desired central frequency of 434 MHz detected at Day-Time

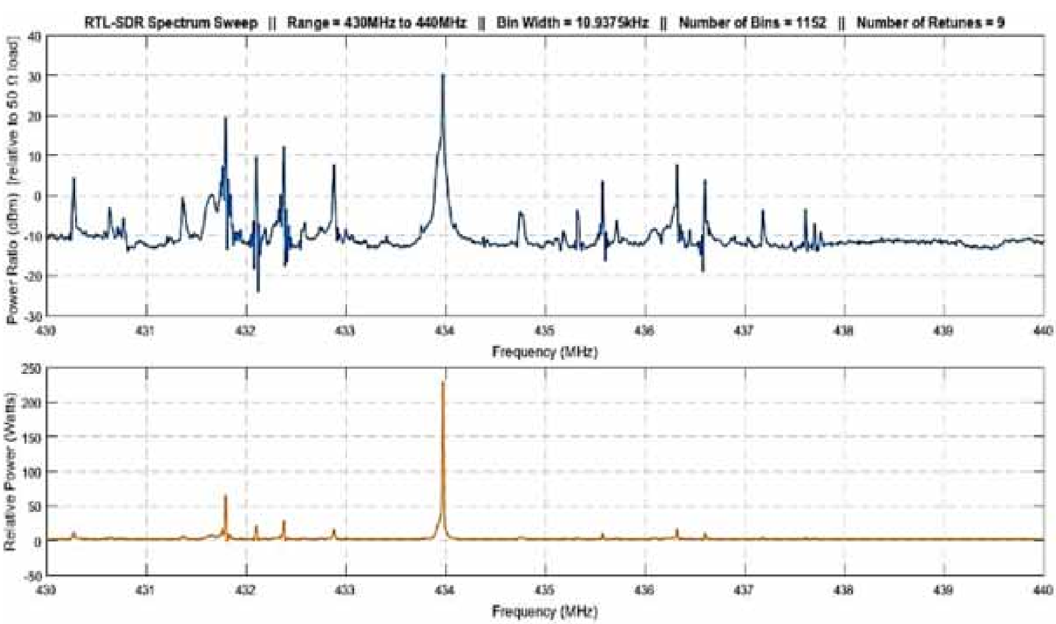
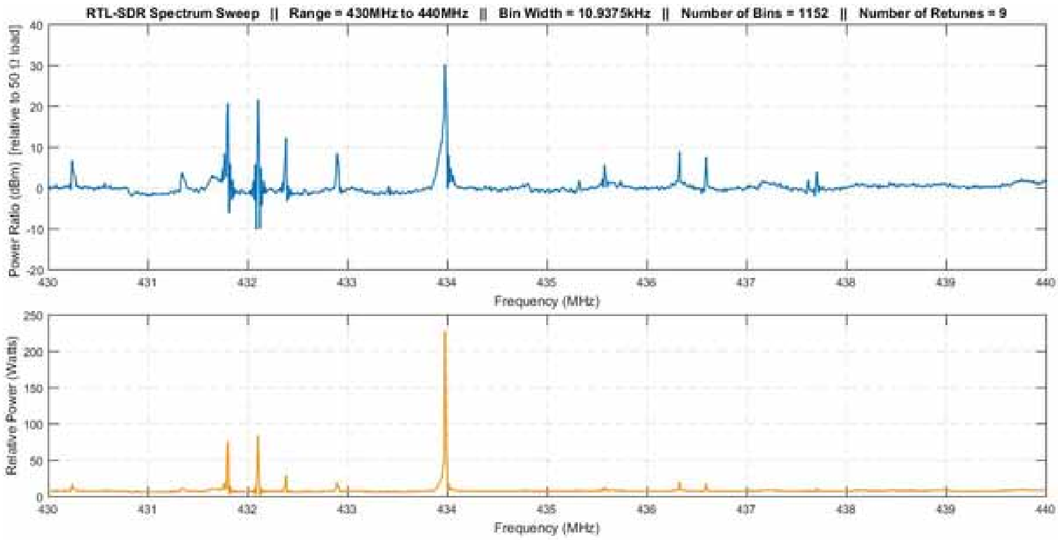


Figure 7. Frequency Sweep around the desired central frequency of 434 MHz detected at Night-Time



Central server is made designated to connect the WSN central node to the common junction. In CVT-RF-AIML-IoT, system Raspberry Pi 3 equipped with inbuilt Wi-Fi capability, perform as the Central Server which connects entire WSN nodes. Figure 8, depicts the server arrangement.

The central server gathers the binary data as distinct sequential bits along with region-ID. Putty terminal in the central server acts as bridge between the secure shell and serial ports. The terminal screenshot of the gathered data depicted in Figure 9, Putty platform which is linked via Secure Shell

Figure 8. Wi-Fi enabled Central Server (CS) Schema

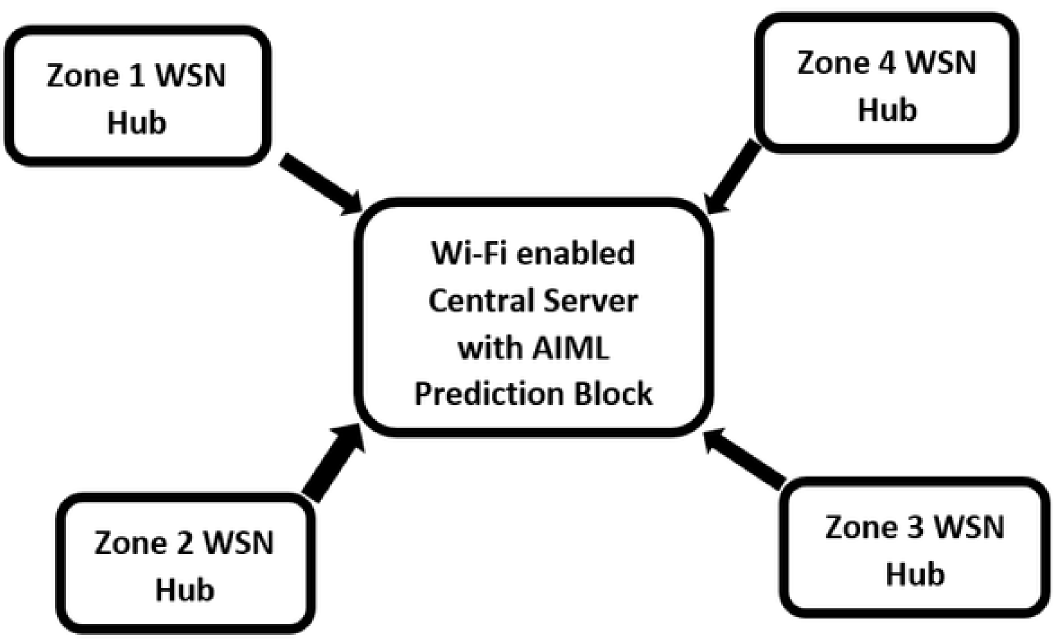
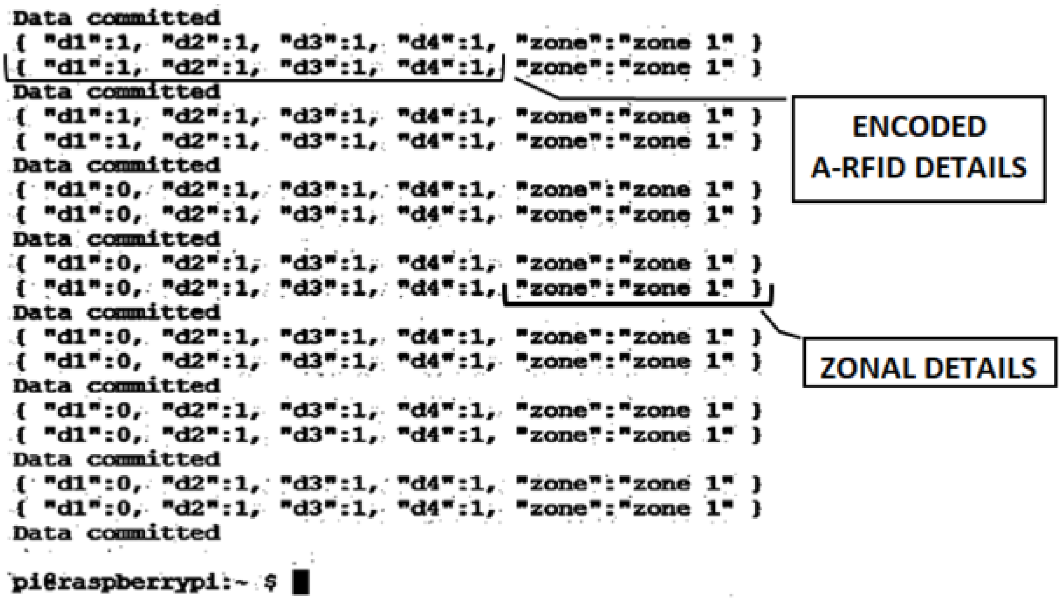


Figure 9. Data Flow Schema from WSN through SSL Putty Window



(SSH) and serial port. It can be concluded central server datagram packets that data bits of d1 to d4 bits followed by the zone number are gathered in the unique manner and hence the probability of data over lap is brought to the minimal extent.

Practically received data during actual time implementation in the IoT server to registered vehicular database as depicted in Figure10 with time parameter, stamping device for time and encoded characters. Arbitrary Parity bit is affixed ahead of every data bits (d1-d4) for security purpose to overcome the information hack. This CVT-AIML-IoT provides dual protection in terms of both Hardware Security (HS) and Software Security (SS) i.e. HS in-terms of four-bit encoder before transmitting from A-RFID Module and SS in-terms of additional random parity bit generated by the Artificial Intelligence and Machine Learning (AI-ML) unit by generating unique bit synchronous with the transceiver and receiver module before individual set of encoded bits which makes it immune.

IoT support connected vehicle login web-page is created HTML code. Exclusive report is formed for each one of the client by furnishing them distinctive user name and password as portrayed in the Figure11. This ability of access action mechanism is boon to deliver protection from unauthorized individual screening the tracking.

Monitoring Administrator Webpage (MAW) contain numerous functionality like data Importing functionality from IoT Server i.e. from server, List of Registered Vehicle customer, “Delete” option to remove the obsolete vehicular details from database, Tracking tab with A-RFID identification and capability to refresh and capture updated zonal values with the A-RFID existence. These schema with a purpose are as depicted in the admin webpage of Figure12. Figure13, which portrays the dynamically queried outcome of the vehicular with tagged A-RFID figure is “0010”, which is associated with outcomes as efficaciously made shown as CVT-AIML-IoT Web based User Interface (WUI).

6. CONCLUSION

Connected Vehicular Tracking Schema powered by Radio Frequency, Artificial Intelligence-Machine Learning and IoT technology (CVT-AIML-IoT), is a practical solution for connected vehicular tracking while comparing to the conventional usage of Global Positioning System (GPS) and Global System

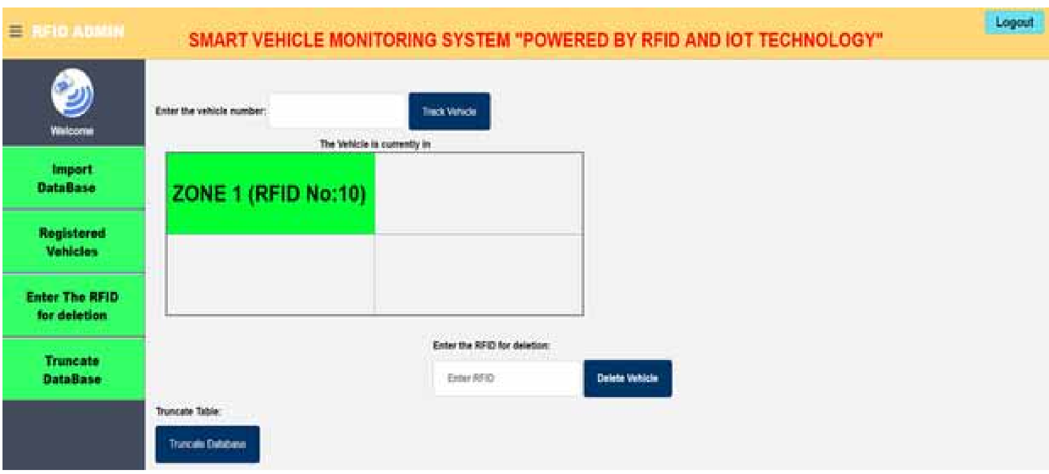
Figure 10. Realtime received data from IoT domain to database server of AI-ML Block

id	time	date	d1	d2	d3	d4	zone
1	02:33:25	2017-03-22	31	31	30	30	zone 1
2	02:33:26	2017-03-22	31	31	30	30	zone 1
3	02:33:26	2017-03-22	31	31	30	30	zone 1
4	02:33:27	2017-03-22	31	31	30	30	zone 1
5	02:33:27	2017-03-22	31	31	30	30	zone 1
6	02:33:28	2017-03-22	31	31	30	30	zone 1
7	02:33:28	2017-03-22	31	31	30	30	zone 1
8	02:33:29	2017-03-22	31	31	30	30	zone 1
9	02:33:29	2017-03-22	31	31	30	30	zone 1
10	02:33:30	2017-03-22	31	31	30	30	zone 1
11	02:33:30	2017-03-22	31	31	30	30	zone 1
12	02:33:31	2017-03-22	31	31	30	30	zone 1
13	02:33:31	2017-03-22	31	31	30	30	zone 1
14	02:33:32	2017-03-22	31	31	30	30	zone 1

Figure 11. Administrator User Login Page of CVT-AIML-IoT

Figure 12. Admin Monitoring Page of CVT-AIML-IoT Schema

Figure 13. Tracking Page details as gridded zone in CVT-AIML-IoT layout



for Mobile Communication (GSM) implemented Tracking Schema. Interactive webpage support for specific vehicular tracking ability is a boon to detailly track vehicular over the wide topographical view. Monitoring Webpage is proficient to be dynamically reflecting the accurate zonal location which is internally linked to the registered vehicular database. Flexibility of CVT-AIML-IoT scaling to support micro to macro customer base. The paradigm of identification code reusability enables the system to be extended to wider spectrum. The implementation of Artificial Intelligence-Machine Learning(AI-ML) ensures the generated Vehicular Personal Identification Number (VPIN) to be dynamic and made synchronous to the system. Hence it ensures the safe journey of currency-chest vehicle to replenish the cash to the Automated Teller Machine (ATM) and the safe ambulance application which demands secured transportation. This system is also the major relief to vehicle lending enterprises to lower their cargo insecurity from unauthorized drive away issues by attackers and in-between intruders. The implementation of this schema streamlines the vehicle to follow the enterprise designated route covered under the traceable grid and even if there is deviation in the route it can be easily monitored by self-proclaiming safety system implemented. Hence CVT-AIML-IoT is cost-efficient solution for connected vehicular monitoring as a brain child application of advanced technology.

REFERENCES

Aalsalem, M. Y., & Khan, W. Z. (2017, February). CampusSense—A smart vehicle parking monitoring and management system using ANPR cameras and android phones. In *2017 19th International Conference on Advanced Communication Technology (ICACT)* (pp. 809-815). IEEE.

Abdulsahib, G. M., & Khalaf, O. I. (2018). Comparison and evaluation of cloud processing models in cloud-based networks. *International Journal of Simulation-Systems, Science & Technology, 19*(5).

Adam, M. S., Anisi, M. H., & Ali, I. (2020). Object tracking sensor networks in smart cities: Taxonomy, architecture, applications, research challenges and future directions. *Future Generation Computer Systems*, *107*, 909–923. doi:10.1016/j.future.2017.12.011

Adaramola, B. A., Salau, A. O., Adetunji, F. O., Fadodun, O. G., & Ogundipe, A. T. (2020, January). Development and Performance Analysis of a GPS-GSM Guided System for Vehicle Tracking. In *2020 International Conference on Computation, Automation and Knowledge Management (ICCAKM)* (pp. 286-290). IEEE.

Fernando, W. U. K., Samarakkody, R. M., & Halgamuge, M. N. (2020). Smart Transportation Tracking Systems Based on the Internet of Things Vision. In *Connected Vehicles in the Internet of Things* (pp. 143–166). Springer.

Hafeez, F., Shammrani, M. A., & Shammary, O. A. (2015). Smart Vehicles Speed Monitoring System Using RFID. *International Journal of Advanced Research in Electrical*, *Electronics and Instrumentation Engineering*, *4*(4), 1860–1864.

Khalaf, O. I., Abdulsahib, G. M., & Sabbar, B. M. (2020). Optimization of Wireless Sensor Network Coverage using the Bee Algorithm. *Journal of Information Science and Engineering*, *36*(2), 377–386.

Khalaf, O. I., & Sabbar, B. M. (2019). An overview on wireless sensor networks and finding optimal location of nodes. *Periodicals of Engineering and Natural Sciences*, *7*(3), 1096–1101. doi:10.21533/pen.v7i3.645

Kumar, G. A., Arun, B., & Divya, S. (2019, April). A Proficient Model for Vehicular Tracking Using GPS Tracking System. In *2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI)* (pp. 136-141). IEEE.

Li, J., Xing, Z., Zhang, W., Lin, Y., & Shu, F. (2020). Vehicle Tracking in Wireless Sensor Networks via Deep Reinforcement Learning. *IEEE Sensors Letters*, *4*(3), 1–4. doi:10.1109/LSENS.2020.2976133

Ogudo, K. A., Muwawa Jean Nestor, D., Ibrahim Khalaf, O., & Daei Kasmaei, H. (2019). A device performance and data analytics concept for smartphones' IoT services and machine-type communication in cellular networks. *Symmetry*, *11*(4), 593. doi:10.3390/sym11040593

Pavithra, B., Suchitra, S., Subbulakshmi, P., & Faustina, J. M. (2019, June). RFID based Smart Automatic Vehicle Management System for Healthcare Applications. In *2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA)* (pp. 390-394). IEEE.

Salman, A. D., Khalaf, O. I., & Abdulsahib, G. M. (2019). An adaptive intelligent alarm system for wireless sensor network. *Indonesian Journal of Electrical Engineering and Computer Science*, *15*(1), 142–147. doi:10.11591/ijeecs.v15.i1.pp142-147

Sanda, P. K., Barui, S., & Das, D. (2020). SMS Enabled Smart Vehicle Tracking Using GPS and GSM Technologies: A Cost-Effective Approach. In *Smart Systems and IoT: Innovations in Computing* (pp. 51–61). Springer.

Ting, S. L., Wang, L. X., & Ip, W. H. (2012). A study on RFID adoption for vehicle tracking in container terminal. *Journal of Industrial Engineering and Management*, *5*(1), 22–52.