Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 05, May-2025

Vehicle Theft Real-Time Tracking System in Uganda

Anyango Esther Gorret, M.Tech,
Department of Computer Science and Engineering Aditya University, India

Kasichainula Vydehi, M.Tech (Ph.D),
Assistant Professor
Department of Computer Science and Engineering Aditya University, India.

Abstract
Vehicle theft is a growing concern in Uganda, leading to significant financial and emotional distress for vehicle owners. This paper was about the design and implementation of a vehicle tracking system aimed at enhancing vehicle security and recovery, real-time monitoring and law enforcement agency in the event of theft. The system leverages Internet of Things (IoT) devices for real-time location tracking and integrated with a web-based application to provide a seamless user experience. Users can report stolen vehicles, and law enforcement agencies can access the system to monitor the live location of vehicles using Moto cop GPS-enabled tracking devices which were connected to the battery terminal of the vehicles. The system utilized APIs for data communication between the tracking devices and the web-based application, ensuring real-time updates and efficient management of stolen vehicle cases. The Key technologies employed by the system included GPS, IoT sensors, cloud computing, and web development frameworks, ensuring theft detection notifications, route history, scalability and reliability. The system addressed the critical gap in vehicle security in Uganda by offering an innovative solution for tracking and recovering stolen vehicles the country. The system allowed vehicle owners and administrators to track the real-time location of vehicles through a user-friendly web interface. Not only recovering vehicles but also reducing on the terrorism, kidnapping, armed robberies, and other illegal operations which would have been done through the stollen vehicles and hence saving the lives of those who might have become victims.

Keywords: **Vehicle theft, Real-Time Location, Global Positioning System, IoT, Web-based**

INTRODUCTION

Vehicle tracking systems play a crucial role in enhancing fleet management efficiency and improving vehicle security. These systems are also vital for tracking stolen vehicles—a significant concern globally. According to recent statistics, thousands of vehicles are stolen every day, resulting in substantial financial losses for individuals, businesses, and entire nations. Beyond financial implications, vehicle theft disrupts daily routines and compromises personal safety (Keerthana R, 2023).

In Uganda, vehicle theft remains a persistent problem due to limited infrastructure for effective prevention and recovery. The old system of recovering vehicle were often slow and inefficient, which lead to low recovery rates or failure to recover the stolen vehicles. The absence of a centralized platform to report and track stolen vehicles further worsens the problem. However, the recent designed system was limited to central Urban area of the country. To address these challenges, this project proposes a comprehensive vehicle tracking system that leverages modern technologies to enhance both vehicle security and the recovery process.

The proposed solution includes a web application that allows users to report stolen vehicles and receive real-time updates on their status. Integrated IoT-based GPS tracking devices provide accurate location data, enabling real-time monitoring. The system utilizes an API-based communication framework to facilitate seamless data exchange between tracking devices, cloud servers, and the web application. This approach not only improves recovery efficiency but also centralizes vehicle theft management, making it accessible to both vehicle owners and law enforcement agencies.

The Global Positioning System (GPS), owned by the United States government, is a satellite-based service that provides users with positioning, navigation, and timing (PNT) data (GPS.gov, 2021). Internet of Things (IoT) refers to the digital interconnection of physical objects via unique identifiers, enabling them to automatically transmit data over a network without human intervention. This machine-to-machine (M2M) communication enhances automation and tracking capabilities (Maureira, 2011).

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 05, May-2025

This project also incorporates RESTful APIs (Representational State Transfer), which are essential for designing scalable and efficient web services. REST APIs focus on system resources and facilitate data transfer using a request-response communication model. One of the strengths of this architecture is the separation of concerns: for instance, clients interact with the server through responses without needing to understand server-side data handling, and vice versa. This modularity supports independent development and future upgrades.

The purpose of this project is to design a web-based system capable of monitoring and tracking stolen vehicles equipped with GPS devices, accessible anytime by authorized users.

Problem statement

Ugandan car or vehicle security system is still very low and this has been observed in different parts of the country where cars or vehicles have been stollen and never retrieved. some Agencies like Uganda Revenue Authority which would have enforced the policy on vehicle security for both individuals and government, have not done it yet while the very agencies collect revenue from those individual car/vehicle owners.

Uganda is one of the developing Country with a population of about 45.9 million people and has a challenge of motor vehicle theft each year.

According to Police 2023 annual crime report released on Wednesday, number vehicle theft cases were registered in the capital city of Uganda (Kampala Metropolitan Police); where North of the city registered the highest of 206, followed by the south registered 203, East registered 156 cases as well as the neighbouring city of Rwizi with 40 cases and Sezibwa with 41 cases (Odeng, 2024)

The Uganda Police try much as possible recover the stollen vehicles after individuals reporting to them about the theft however, only few vehicles may be recovered and this also takes a longer time to recover since is done manually by viewing the vehicle number plates.

The crimes on various vehicle thefts have not only left vehicles missing or stolen but, the thieves do steal vehicles to use them for terrorism, kidnapping, armed robberies, and other illegal operations. This has left many people/families with no private vehicles hence, limiting their movements and also struggle transporting their family members. It is therefore on the above background that the proposed project of vehicle real-time tracking system should be designed/built to detect the vehicle's location once stolen. This will be done by detecting the vehicle's location via GPS using the global system of mobile communications (GSM).

The Literatures Reviewed

According to study conducted by (Gorret, 2025) in Uganda, recommended a Web-based tracking system to enable stolen vehicles be monitored and tracked at any time by different agencies. This has been the basis to designing a Could-based system in vehicle theft tracking.

In the study by (Ahad Alotaibi, 2025), developed a system that had ability to track stolen vehicles or those involved in criminal activities in real-time can significantly enhance operational efficiency. To differ from the current system, it used licenced number plates in the tracking of stolen vehicles. The tracking brought about the expansion of collaboration with law enforcement agencies to enable real-time monitoring and faster response to violations.

Similarly, in the study conducted by (Patrick, (2024) in Rwanda indicated that the enhanced vehicle monitoring and theft prevention system improved the ability to detect and respond to theft incidents. However, to differ from this current system, used Radio Frequency Identification (RFID) in accessing the vehicle doors where by unauthorized persons have limited access. This was a preventive measure that applied in the monitoring of cases which would have occurred.

The study conducted in Bangladesh by (Hossain, 2023) revealed that the implementation of a comprehensive automated web-based monitoring approach was feasible and suitable for general indoor construction site, reducing on the insurance cost as well as loses. To differ from this current system, handles safety of vehicles. Here we see that vehicles are protected against theft which would have led to loses of resources.

System Overview and Architecture

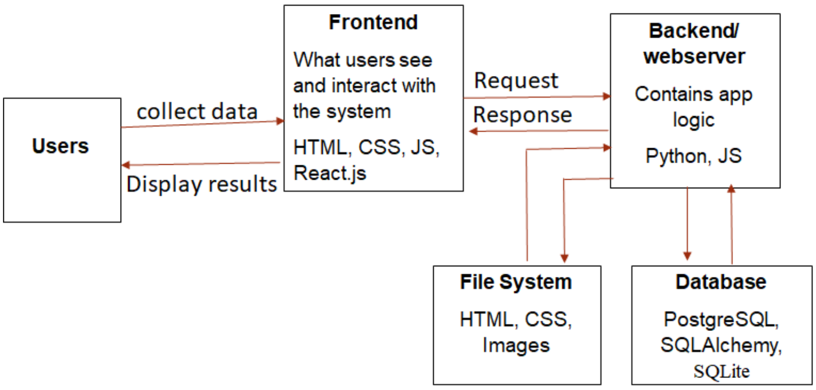
The proposed system comprises a web application that allows users to report stolen vehicles and view updates on their status. Integrated IoT-based GPS tracking devices provide real-time location data, enabling accurate tracking of vehicles. An API-based communication framework ensures seamless data flow between the tracking devices, cloud servers, and the web application. The system architecture is designed to ensure that specific parties have access only to relevant information. For example, a customer may not need to know about the storage part of the system

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 05, May-2025

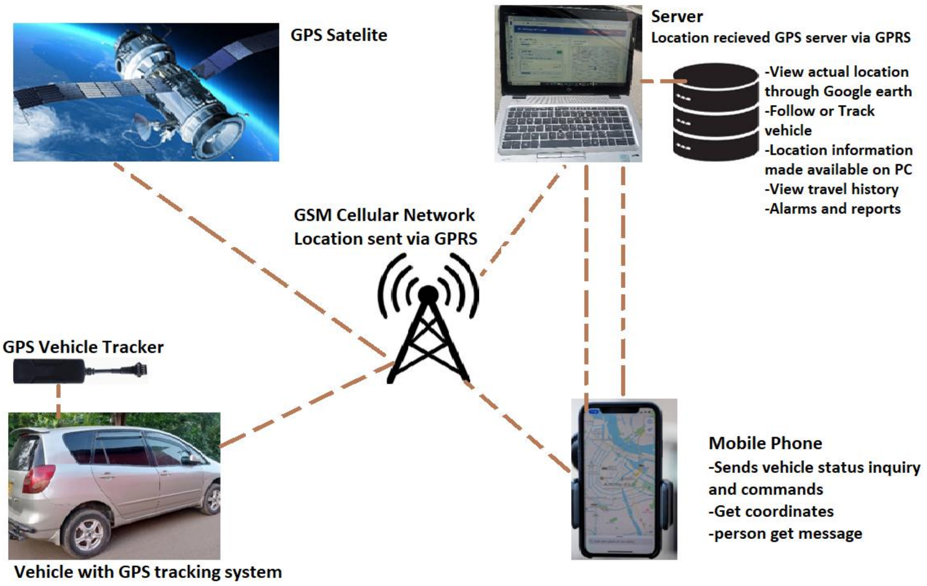
or how data is stored. Similarly, the server has no concern with the user interface, allowing for independent development and updating of server and client components.
This approach not only improves the efficiency of vehicle recovery but also provides a centralized platform for vehicle theft management, accessible to both vehicle owners and law enforcement agencies.

System Architecture diagram



The primary components of this Architecture include user interfaces (UI), client-side processing, server-side processing, and database management, all of which work together to deliver a functional web application. the Architecture works by managing and directing the flow of data between the client-side (front-end) and server-side (back-end) components, ensuring smooth communication and interaction for users.

Hardware design



(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 05, May-2025

GPS Satellites: Global Positioning System

- Orbit & Coverage: Approximately 30 GPS satellites orbit Earth at an altitude of about 20,200 km, forming a global navigation network.
- Signal Transmission: Each satellite broadcasts signals containing its location and the exact time the signal was sent.
- Receiver Function: Devices like smartphones and GPS trackers receive signals from at least four satellites to calculate their 3D position (latitude, longitude, and altitude) and correct any clock errors.

GSM Network: Mobile Communication Backbone

- Core Functions: GSM (Global System for Mobile Communications) facilitates SMS (text messaging), and mobile data services.
- Evolution: Initially a 2G network, GSM evolved to support mobile internet access through GPRS and EDGE, enabling email, browsing, and app usage on mobile devices.
- International Roaming: GSM enables international roaming, allowing users to use their phones abroad with another carrier’s network .
- SIM Card: The SIM card in this case, was used to transfer /send the information from the GPS to the user allowing users to switch devices without changing their number and securing communications.

GPS Tracker: Real-Time Location Monitoring

- Functionality: GPS trackers monitor and record the real-time location of vehicles, or objects using GPS signals.
- Data Transmission: These devices use cellular networks (GSM/4G), Wi-Fi, or satellite networks to send location data to a user's phone or computer.

- Applications:

  - Navigation & Route Guidance: Provides turn-by-turn directions and maps.
  - Fleet Management: Monitors vehicle locations, optimizes routes, and improves driver safety and efficiency.
  - Security & Theft Prevention: Helps recover stolen vehicles or equipment by tracking their location and travel history.

GPS Server: Centralized Data Processing

- Role: The GPS server acts as the central system that receives, stores, processes, and displays location data sent from GPS tracking devices.
- Data Handling: It organizes location data into useful information like routes taken, speed, stops, and time logs.
- Integration: Connects with map services (e.g., Google Maps, OpenStreetMap) to show real-time tracking and past routes on a dashboard.
- User Management: Supports multiple devices and user roles, allowing admins to assign users and monitor vehicle locations.
- API Integration: Facilitates integration with other systems, aiding law enforcement and insurance investigations.

Mobile Phones: Integral to Tracking Systems

- Functionality: Modern smartphones have built-in GPS chips and can act as GPS trackers.
- App Integration: Apps like MotoCop or MilliTrack can send GPS data to a central tracking server.
- Data Transmission: Phones use cellular data (GSM/4G/5G) to send location and sensor data to a GPS server or tracking platform, enabling real-time updates on a map.
- Sensor Utilization: Phone sensors (accelerometer, gyroscope) can track speed, idle time, and movement, enhancing tracking accuracy.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 05, May-2025

Finally, the integrated system of GPS satellites, GSM networks, GPS trackers, servers, and mobile phones provides a comprehensive solution for real-time location tracking and monitoring Software used in the system

The system used different software and their libraries in the development as follow;

Frontend; The Programming Languages which were used for the development are JavaScript, Hyper Text Marker up language (HTML), Cascading Style Sheet (CSS).

In this Frontend, HTML helped in defining the structure of the content and creating a web page and web applications. While CSS was used mainly for styling and controlling web page making them look attractive. Then, JavaScript made the content interactive where by incorporated valuable skills like object-oriented and imperative styles of programming.

Backend; the Programming Language which were used for the development are Python and JavaScript. Python was used in this Backend side for its simplicity as well as wide range of applications. While JavaScript was used because is an essential language for web development, enabling interactive web pages. JavaScript was useful for both front-end development and backend with Node. Backend also was linked to Database which was responsible for storing data and for this case was SQLite. SQLite which is lightweight database was used together with SQLAlchemy which is a python toolkit and the ORM was used. SQLite was used because of SQLite's file format being cross-platform and can easily move database files between 32-bit and 64-bit systems or between big-endian and little-endian architectures. Therefore, because of the flexibility SQLite has, made it a better choice to be used for application file formats.

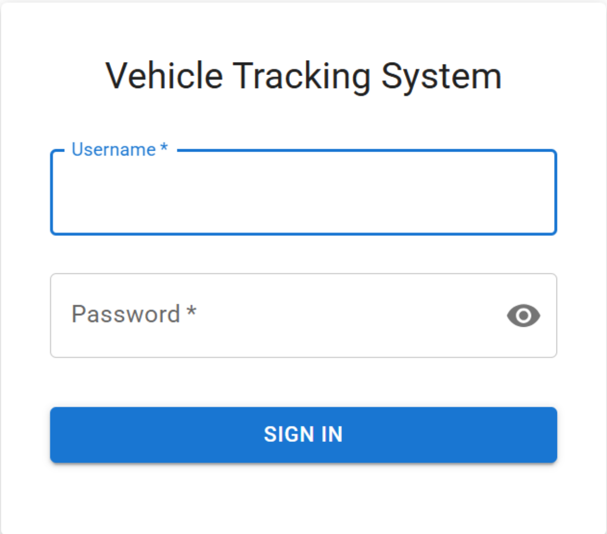
Application Programming Interface was incorporated to enable the User Interface communicate with the server. This API system facilitated communication and integration between backend, frontend and Internet of Things software components, allowing for efficient development, and the creation of interconnected applications and services. The communication process enables the display of vehicle location in real time including the name of the location/area where the vehicle could be.

RESULTS

For communication protocol, Backend runs on http://127.0.0.1:5003 While Frontend runs on http://localhost:5173/ for the local host and then for network, it runs on http://192.168.0.236:5173/

Login page

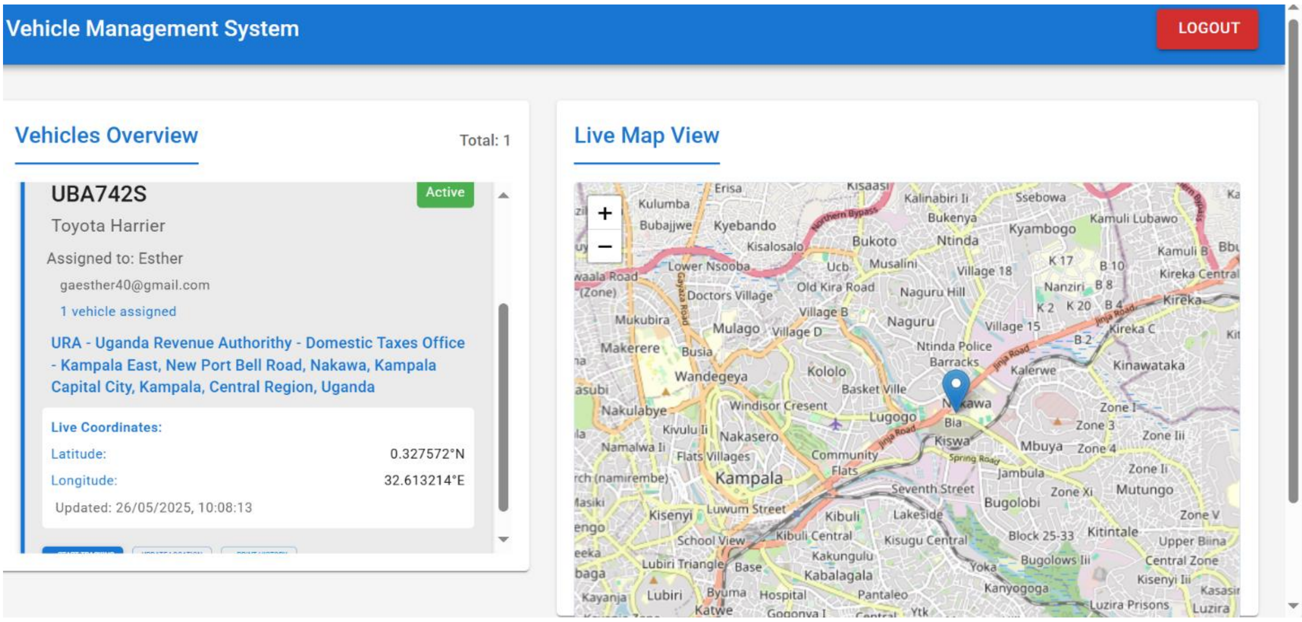
Both users (admin and client) are able to login using the same login page but with different credentials. This leads to the tracking page. The client signs in using the captured data which was entered in the system.



Tracking page

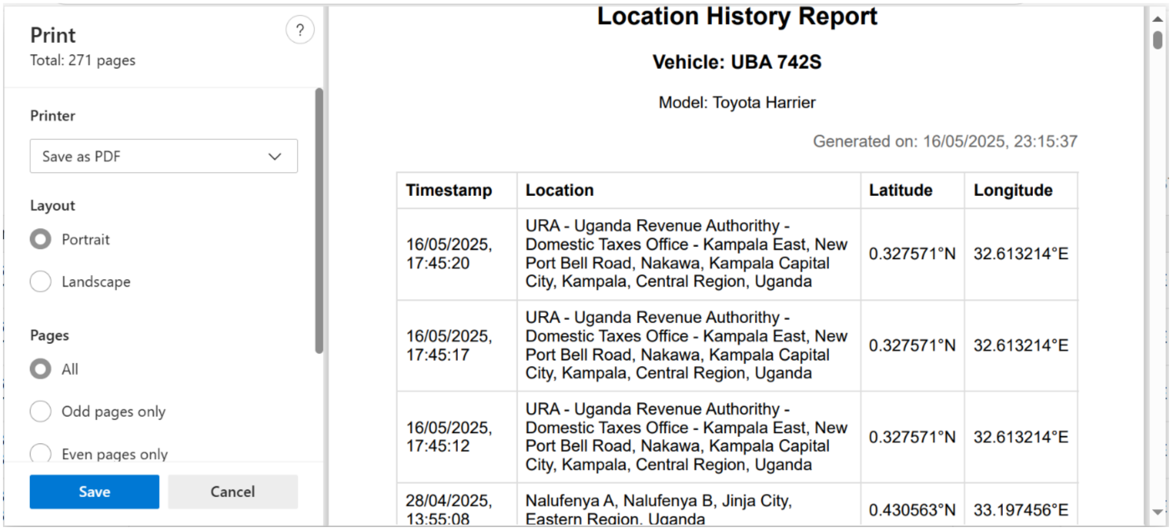
The tracking page displays according to your credential, as a client, you can only monitor and track the vehicle. Then for admin, can monitor, track, create users add vehicles and as well edit users. Vehicle overview panel enables the Admin/client to see the name of the location and current coordinates where the vehicle is including the time. Then, the live Map view panel helps the user/client vehicle real point and the surrounding areas.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)



Print page/ Location History Report

This is a page in the system which gives the history or record on where the vehicle had moved to so that you can trace for it. When the client click on print history, can get location of the vehicle in every 3 seconds including the name of the place and time where the vehicle was by then. Therefore, this page is very useful in allows the clients to view past routes taken by the vehicle and take action.



Location History Report

Vehicle: UBA 742S

Model: Toyota Harrier

Generated on: 16/05/2025, 23:15:37

Timestamp	Location	Latitude	Longitude
16/05/2025, 17:45:20	URA - Uganda Revenue Authority - Domestic Taxes Office - Kampala East, New Port Bell Road, Nakawa, Kampala Capital City, Kampala, Central Region, Uganda	0.327571°N	32.613214°E
16/05/2025, 17:45:17	URA - Uganda Revenue Authority - Domestic Taxes Office - Kampala East, New Port Bell Road, Nakawa, Kampala Capital City, Kampala, Central Region, Uganda	0.327571°N	32.613214°E
16/05/2025, 17:45:12	URA - Uganda Revenue Authority - Domestic Taxes Office - Kampala East, New Port Bell Road, Nakawa, Kampala Capital City, Kampala, Central Region, Uganda	0.327571°N	32.613214°E
28/04/2025, 13:55:08	Nalufenya A, Nalufenya B, Jinja City, Eastern Region, Uganda	0.430563°N	33.197456°E

CONCLUSION

The development of web-based vehicle theft real-time tracking system with GPS has proven to be a significant, powerful and effective solution for enhancing vehicle security. This system was done by integrating GPS technology with web platforms, where users gain real-time access to vehicle location, which enabled quick response in the event of theft. The system enhanced both personal and commercial vehicle management by offering features like live tracking, route history, and alerts.

However, the system is not without limitations. Its effectiveness depends heavily on the availability of GPS and internet signals, and it can be vulnerable to device tampering, GPS jamming, and network outages. Additionally, ongoing data and maintenance costs as well as potential cybersecurity risks which must be considered.

Despite these limitations, when properly maintained and secured, the system significantly improves the chances of recovering stolen vehicles and provides users with peace of mind. As technology continues to advance, future enhancements—like AI-based threat detection, satellite-independent tracking, and stronger data security—can make such systems even more reliable and indispensable.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

REAL-WORLD OF WORK AND POLICY INSPIRATION

According to (Nsimenta, 2024) in the news posted, indicated that the increasing incidence of vehicle-related crimes in Uganda, particularly motorcycle thefts, underscores the need for effective security solutions. As such, this system has ability to reduce on the theft by monitoring as well as tracking once stolen and one on the solution to curb the situation in the country. In Gulu, over 170 motorcycles were stolen in a year, leading to significant financial losses for riders. Similarly, in Mbarara, 182 motorcycles were stolen between January and June 2024, with only a fraction recovered. In addition, the number of vehicle theft cases registered in the capital city of Uganda (Kampala Metropolitan Police); where North of the city registered the highest of 206, followed by the south registered 203, East registered 156 cases as well as the neighbouring city of Rwizi with 40 cases and Sezibwa with 41 cases (Odeng, 2024)

These statistics highlight the vulnerability of vehicle owners, boda-boda operators and small logistics businesses to theft.

Therefore, integrating a vehicle tracking system with national databases can facilitate rapid response protocols and improve recovery rates of stolen vehicles or motorcycles. This integration is in line with Uganda's Vision 2040 and the Digital Uganda Vision, both of which emphasize the integration of ICT into national security and service delivery.

RECOMMENDATIONS FOR FUTURE WORK

Whereas the present system has proven successful in its objectives, there is significant scope for enhancement and further research as follow:

1. Mobile App Development: A cross-platform mobile application (built with React Native or Flutter) would improve user interaction, allow visual route mapping, and provide easier access to real-time alerts and history logs.
2. LoRa or NB-IoT Integration: For rural or cross-border applications, integrating LoRa (Long Range Radio) or NB-IoT (Narrowband IoT) would enable long-range communication without GSM dependency, enhancing coverage in off-grid environments.
3. AI & Machine Learning: The interested developer should incorporate Predictive Theft Detection by use of machine learning models to detect unusual behaviour like sudden movement during odd hours as well as the driver’s behaviour on the road.
4. RFID/Biometric Authentication: The integration of RFID tag validation or fingerprint-based ignition control could further enhance security and prevent unauthorized engine startups from gaining access to the Vehicle.

REFERENCES

Ahad Alotaibi, C. C. (2025). AI-driven UAV system for autonomous vehicle tracking and license plate recognition. Open Engineering, 15(1), 20240101.

Gorret, A. E. (2025). Design and Implementation of a GPS-GSM based Real-Time Vehicle Theft Tracking System for Urban Security in Uganda. International Journal of Innovative Science and Research Technology, 6.

GPS.Gov. (2021, February 22). Official U.S. From Government information about the Global Positioning System (GPS) and related topics: https://www.gps.gov/systems/gps/

Hossain, M. M. (2023). BIM-based smart safety monitoring system using a mobile app: a case study in an ongoing construction site. Construction Innovation., 552-576.

Keerthana R, A. R. (2023). Vehicle Theft Detection. ICONIC RESEARCH AND ENGINEERING JOURNALS.

Maureira, M. A. (2011). ThingSpeak–an API and Web Service for the Internet of Things. World Wide Web.

Nsimenta, B. (2024, December 9). Mbarara Boda Boda Riders Struggling with Insecurity. From Nile Post: https://nilepost.co.ug/news/231926/mbarara-boda-boda-riders-struggle-with-rising-insecurity?utm_source=chatgpt.com#

Odeng, M. (2024, February 25). stolen cars. From Newvision: https://www.newvision.co.ug

Patrick, T. K. ((2024). ENHANCED VEHICLE MONITORING AND THEFT PREVENTION SYSTEM. Kigali Independent University Repository Doctoral dissertation,.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)