Vehicle to Everything Blackbox Recorder

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***Abstract*—For the purpose of to provide regular upkeep and tracking for automobile companies, this endeavour installs an automobile "Black Box," which is a (Event Data Recorder). Important immediate occurrences, such as travel speed, time stamped latitude, geographic location, tilt detector, precision, and additionally, are recorded by the entire system. Transportation supervisors can examine tracked records as well as configure system duration via UP/DOWN key responses that include specified long-pressed behaviours as well as automatic logout, whereas a typical dashboard initial window shows the present date and time, speed of the automobile, and the most recent incident. The layout guarantees accurate data administration, scrolling acceptance for submissions, or constant occurrence recording throughout record navigation. To enable dependable collection and assessment, information retention adheres to an established document structure. Regular exporting onto a cloud-based system for unified vehicle control and preventative upkeep, including identifying ignition problems, reckless driving, and more, is made possible by the application's adaptability to a specific IoT design. In order to demonstrate a modular framework for secure, immediate automobile recording of events and operational management, a working model must be built and verified.**

***Index Terms*—Vehicle data tracking, Gyroscope values reading, Location tracking.**

I. INTRODUCTION

The idea of a "Black Box" has historically been connected to aerospace, as it records aircraft information as well as operator interactions, which makes it a vital instrument for aftermath evaluation. There's usefulness, nevertheless, goes far past immediate detection. comparable devices, also known to be EDRs or as "Accident Data Recorders", are becoming prevalent more and more in the automobile sector to track vehicle variables in actual time. Early repairs and managerial control are made possible via such integrated devices, which record remotely identified incidents like engine problems, gear changes, and speed irregularities.

The incorporation of a Black Box technology into automobiles provides a tactical remedy in the setting of contemporary transportation in cities, in which deadlines frequently result in careless driving and legal infractions. The platform may assist to reduce dangers, impose responsibility, and improve vehicle efficiency by constantly recording significant events and identifying dangerous behaviour, especially excessive speed or irregular gear changes. Additionally, it improves security and adherence by addressing fundamental routines brought on by time constraints or illicit use.

What is a black box in an automobile?

An automobile black box is an electronic tool set up in the automobile that keeps track of a few things, such as traffic incidents, acceleration, kilometres travelled, and collisions. The positioning can also be altered.

Vehicle Black Box Preferable

The automobile Black Box primarily monitors driving patterns and engine efficiency to improve driver safety measures. In the event of a problem, authorities have access to anything that has been documented [1]. A car black box device's main function is to provide an automotive tracking option which continuously captures video of how you drive. Such processes proved extremely helpful in supplying proof in court cases and submitting insurance claims. Black box gadgets are now a crucial component of every automobile safety framework, regardless of whether they serve the purpose to record a crash or deter burglary.

1.1 Problem Statement

"Vehicle to everything" is a model in which automobiles communicate not solely to one another additionally to the environment, people on foot, and ecosystems. Contemporary public transit systems were making adapting progress to promote interconnected and autonomous transit. spite of this development, the majority of current vehicle information loggers are merely capable of limited internal maintenance as well as post-accident evaluation; they are unable to gather information and interpret events throughout the larger V2X framework. Maintaining motorist security, transparency, and productivity in business is severely hampered by such discrepancy. Because there are currently none inter-entity interaction records, serious incidents like close-call crashes, roadway signal infringements, system malfunctions, and illegal manoeuvres frequently go unreported or have been incorrectly understood.

Additionally, automobile owners and governing agencies do not have safe, instant accessibility to unified incident information which might assist with criminal assessment, regulation monitoring, and strategic decisions.

A reliable V2X-equipped Black Box Recording device that records outside conversations with roadside assistance devices (RSUs), other automobiles (V2V), people walking (V2P), and wireless networks (V2N) in addition to inside automobile data like acceleration, gear changes, engine heat, as well as usage of fuel is required to overcome these obstacles. To provide clients in useful information for upkeep, security, and enforcement of regulations, the infrastructure has to offer time-tagged incident recording, safe entry management, and flexible information extraction procedures.

1.2: Aim: An analog tilt sensor, and other detectors are used in this programming task to identify abrupt shifts in velocity which could signal an impending collision. It gathers information about the incident's duration, location (using GPS), as well as velocity.

1.3: Objectives:

- Information recording in records or CSV file formats.
- GPS component connection for monitoring your position.
- Sending and receiving SMS notifications in immediate form (through services such as Twilio, for example).
- Visualizing presentation with Python tools such as the Matplotlib library or Plotly.

II. LITERATURE SURVEY

[2] Unexpected events claim the lives of countless people. The document's objective remains to present automobile security measures which proactively warn drivers to exercise caution. In the present article, the authors employ web-based equipment to constantly track motorist conduct and automobile efficiency via detectors. In addition to pressing as well as alarm buttons, the automobile's black box gets data to a number of detectors, including breathing monitor, speed, while the proximity of nearby automobiles. Alerts are transmitted to important numbers while the motorist's alcohol intake exceeds the permitted threshold. In the case of a crash, the position of the automobile is tracked via cell phone signals and GPS to determine its position and the nearby law enforcement and healthcare facility are notified. The position of this device remains tracked in a centralized system provider thanks to IoT devices. The press and alarm buttons serve to notify the government to call for urgent assistance around-the-clock.

[3] The following article's primary goal is to create a Black Box technology model which may be put in any kind of automobile. In order to help crash detectives identify the origin of a crash, the technology is designed to track either the driving actions or the present condition for the vehicle in real-time. The equipment may offer essential data regarding what happened by using detectors and GPS technological advances. to gather data. to capture and retain information about velocity, brakes, controlling the accelerating, and other aspects of the automobile's behaviour before and at a collision.

It gives motorists immediate information on his or her automobile habits, including driving too fast or halting excessively, that may assist with avoid incidents in years to come. It additionally offers proof for legitimate and insurance-related complaints, that may be utilized to establish who is at blame and who is responsible over a crash. The automobile's velocity, rotating condition, and specific place can all be tracked using the automobile's black box. The one in question was built using a variety of detectors, including the Raspberry Pi laptop, video, noise, and alcoholic beverage detector components. The technique uses a particular method for gathering all travel information, much like the "black box" utilized by aircraft. Therefore, it possible for law enforcement to examine the information stored at any time.

[4] Intelligent automobiles require robust as well as dependable monitoring packages as well as warning technologies. The structure and functionality of an advanced tracking and notification device for automotive motor vehicle features are covered in this article. In order to accommodate the massive humanity, the number of cars has additionally rapidly increased. Unexpected events also increased as an outcome of that. All of the current preventative techniques are out-of-date and unchanging. Furthermore, there currently isn't a trustworthy collision identification technology. A tiny computer constantly monitors the operating variables in automobiles and archives the information records in a cloud server and a protected memories card. In addition to constantly recording the motor vehicle's characteristics, the technology continually glances for signs of unexpected car accidents.

Whenever a crash occurs, the detection device might make it easier for people to swiftly and legally analyze the scene and notify emergency personnel. Every time an unusual technical incident occurs, the software will modify the data. A vehicular black box collects data on driving prior to and afterwards following a collision. velocity, accelerating, brake usage, control, and airbag activation are among the information that was collected. In addition to improving roadways in order to lower fatalities, an automobile's black box device can help insurers using automobile accident inquiries, enhance crashes victims' treatment, as well as boost security for drivers. The experiments show that the suggested approach outperforms the traditional RFID, SVM, supervised neural network, and RNN-Based techniques in precision by 29.3103%, 22.70%, 18.103%, as well as 11.206%.

[5] The rise in collisions between vehicles has drawn attention towards the critical requirement for actions to enhance automobile security and provide precise crash analysis. In this paper, we describe an intelligent automobile black box that uses Internet of Things innovation to effectively gather and retrieve crucial information about crashes. This approach incorporates audio capture features that offer more information throughout significant events, whereas current applications possess concentrated on footage or photographic information. Essential automobile metrics, including acceleration, location, and braking strength, are gathered by the software using detectors. The information is then transmitted in real time over a trustworthy cloud-based server for quick retrieval and evaluation. The suggested tool facilitates thorough inquiries following a collision by giving stakeholders, including the police and insurance firms, helpful data. The development is a significant advancement in the realm of connected automobile security and incident management technologies, as well as initial evaluations demonstrate outstanding dependability in gathering information and conveyance.

[6] An RFID-based and wireless information tracking device for educational institution automobiles. The radio frequency identification (RFID) scanners which are installed within vehicles, near bus stops, and additionally at pickup sites at educational institution gates are now the basis of the entire system. A particular manager oversees the cloud-hosted platform records for handheld devices. The application is connected with a database hosted by MySQL which operates via the Heroku computing cloud-based system. Furthermore, the application offers an encrypted Java graphical user interface (GUI) allowing safe online communication between stakeholders regarding the path of the bus.

[7] In addition to a warning mechanism which may alert motorists about driving cautiously, the following article discusses methods for making cars less dangerous. and additionally offer It details ongoing connected device sensor-based driver behaviour and car efficiency tracking. The black box of the car receives feedback from a number of detectors, including speed, a Breathalyzer, and the proximity separating the car and a push and panic press. Whenever a motorist consumes more liquor than is permitted, notifications are sent to emergency numbers. In the wake of a crash, the two technologies are used to monitor the automobile's vicinity, and the law enforcement along with a nearby hospital receive the details. Internet of Things innovation's cloud-based solution continues to be utilized for monitoring where it is. Push and alarm buttons are used to alert staff to a need for urgent help around-the-clock.

[8] The primary objective regarding the undertaking is to create and implement electronic driving systems within a partially autonomous automobile. The goals have been to add black box features and improve the

driver-vehicle relationship. Analog signalling is converted into digital forms while shown upon a display panel by the device using an Arduino-powered data collection application. The CAN standard is used in inbuilt networks to facilitate interaction and ensure safe information transmission. Additionally, it gathers information about automobile circumstances that are managed through the primary controller, including acceleration and engine heat. It also has an ESP32 transmitter to feed a variety of uses and GPS for navigation. The system analyses crashes involving cars independently by combining several approaches inside one, with the goal of preventing harm to property or fatalities. It includes autonomous surveillance and recording capabilities, an intelligent screen, and safeguarding precautions to improve protection. In essence, it prioritizes customer satisfaction and avoiding crashes, turning a single regular car through an intelligent model.

III. METHODOLOGY

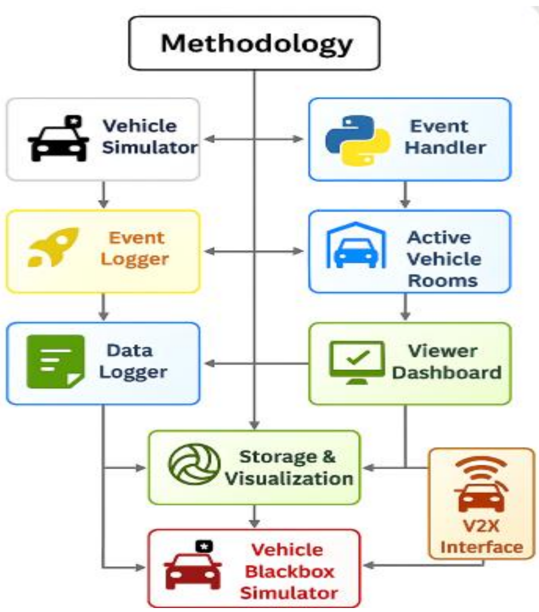


Figure 3.1: Working Methodology of Vehicle Blackbox

Automobile Simulation (Standard Display): This screen is intended to assist with testing or tracking the behaviour of automobiles within a connected setting.

- Vehicle ID Section: This is where customers can input the automobile's specific identification number.
- Set & Join a Room Option: Depending on what ID was provided, this switch probably links the automobile to a virtual environment.
- The Start Option: This option starts the information exchange or simulated process.
- Stop Option: This option stops the information process or modeling.
- Time frame (ms) Field: The period of time span in ms across simulation changes or information packets, represented by a numerical parameter via an initial value of 200.

Figure 3.1 shows the working flow of vehicle black box recorder.

The software functions similarly to a web browser whenever it’s in functioning State, allowing us to enter the automobile’s serial number over monitoring. It will display the most recent incident, the date and time, as well as the speed of the automobile.

Viewer Dashboard:

This web-based communication display is intended for continuous automobile monitoring. The “Join” and “Leave” options allow viewers to sign up to a particular Vehicle ID’s streaming data. The automobile’s latest tracking location is displayed in the center of the display.

Active Vehicle Rooms: an interface called “Active Vehicle Rooms (Live)” that is utilized to keep an eye on controlling and monitoring cars that are presently transmitting information through telemetry. For every operational automobile, the table shows important information such as:

- Vehicle ID (ts13ee7600): the automobile’s specific identification number.
- Clients (1): Shows how this automobile’s information flow is presently linked to a single person or system administrator.
- Last seen (UTC) (2025-10-16T03:33:18.956403Z): the bike’s latest information time stamped.
- Actions: The “Open Viewer,” “Download Log,” and “Copy ID” controls let individuals inspect the bike’s live information, access its communication records, or record its unique number for later use.

All the parameter values are recorded for vehicle id ts13ee7600 as shown in below table 3.1.

Table 3.1: Vehicle parameters tracked for vehicle id “ts13ee7600”

Timestamp (UTC)	Seq	Latitude	Longitude	Speed (m/s)	Heading (°)	Accel X (m/s²)	Gyro Z (°/s)	GPS Accuracy (m)
2025-11-14T04:33:08.588Z	1	37.7749	-122.419	0.21	-28.30606158	1	-2.43	4.706272733
2025-11-14T04:33:08.789Z	2	37.7749	-122.419	0.41	-55.71043534	1	1.32	7.507414191
2025-11-14T04:33:08.988Z	3	37.7749	-122.419	0.61	-82.23293879	1	0.67	3.623126835
2025-11-14T04:33:09.185Z	4	37.7749	-122.419	0.80	-105.8409305	1	0.80	4.916381108
2025-11-14T04:33:09.390Z	5	37.7749	-122.419	1.01	-128.4745046	1	2.13	5.227910447
2025-11-14T04:33:09.588Z	6	37.7749	-122.419	1.21	-146.3597288	1	-1.34	6.695484489
2025-11-14T04:33:09.787Z	7	37.7749	-122.419	1.40	-159.2880973	1	1.81	6.283881364
2025-11-14T04:33:09.989Z	8	37.7749	-122.419	1.61	-168.0944159	1	1.49	6.616052141
2025-11-14T04:33:10.189Z	9	37.7749	-122.419	1.81	-171.0918709	1	-1.29	5.708798351

Table 3.2: Vehicle parameters tracked for vehicle ID KA32449444

Timestamp (UTC)	Seq	Latitude	Longitude	Speed (m/s)	Heading (°)	Accel X (m/s²)	Gyro Z (°/s)	GPS Accuracy (m)
2025-10-03T04:38:34.940Z	1	37.7749	-122.419	0.20	23.2789749	1	-1.02	5.775573482
2025-10-03T04:38:35.139Z	2	37.7749	-122.419	0.40	41.60006787	1	0.11	3.653969448
2025-10-03T04:38:35.340Z	3	37.7749	-122.419	0.60	65.33116319	1	1.84	3.71395517
2025-10-03T04:38:35.544Z	4	37.7749	-122.419	0.80	88.98337065	1	-1.02	7.988993462
2025-10-03T04:38:35.747Z	5	37.7749	-122.419	1.00	109.2990328	1	-0.96	5.054967318
2025-10-03T04:38:35.939Z	6	37.77491	-122.419	1.20	125.1381077	1	0.19	4.186934358
2025-10-03T04:38:36.138Z	7	37.7749	-122.419	1.40	139.6215789	1	2.46	4.751570837
2025-10-03T04:38:36.340Z	8	37.7749	-122.419	1.60	150.2245999	1	-0.93	6.795499077
2025-10-03T04:38:36.540Z	9	37.7749	-122.419	1.80	156.1368247	1	0.71	4.620695558

Table 3.2 shows the data tracked for another vehicle id KA32449444. The values are generated in a .CSV file format in the simulation window itself.

IV. IMPLEMENTATION AND RESULTS

Our project successfully implements a vehicle Blackbox simulator. Any person with authentication credentials can track the vehicle using vehicle number be it a bike or car.

Figure 4.1 a dashboard screen gives option to feed a vehicle ID and join the tracking process. The vehicle will be monitored for a provided value of intervals.

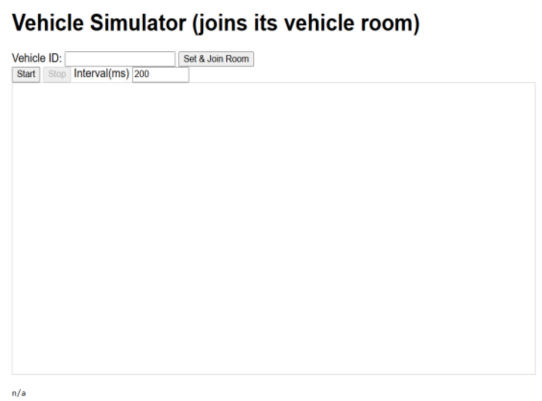


Figure 4.1: Dashboard screen for vehicle simulator

As soon as the vehicle id is provided the system starts to display various parameter values of the vehicle under surveillance like timestamp, vehicle speed, accuracy, acceleration and others as shown in figure 4.2.

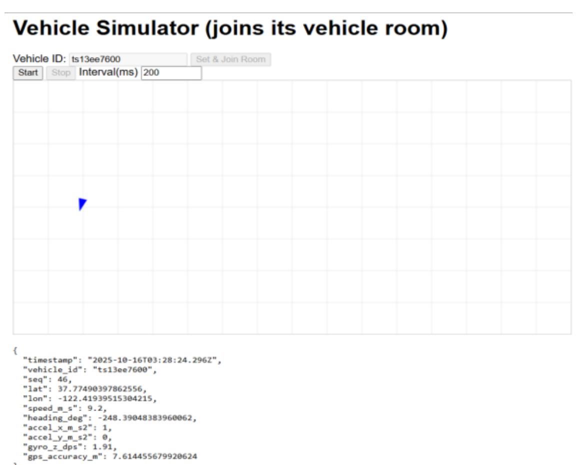


Figure 4.2: A view of vehicle room when a vehicle is joined.

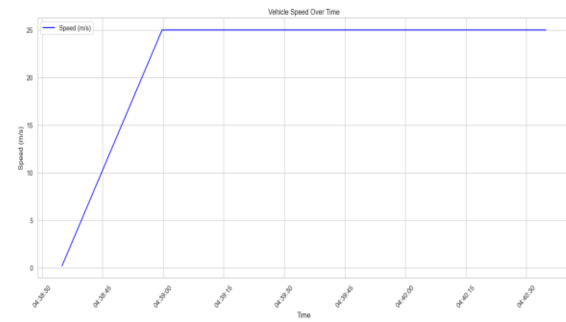


Figure 4.3: Plot of vehicle speed with respect to time(ts13ee7600)

As seen in the graphical representation shown in figure 4.3 the vehicle speed increases from zero to a constant value and remains constant thereafter.

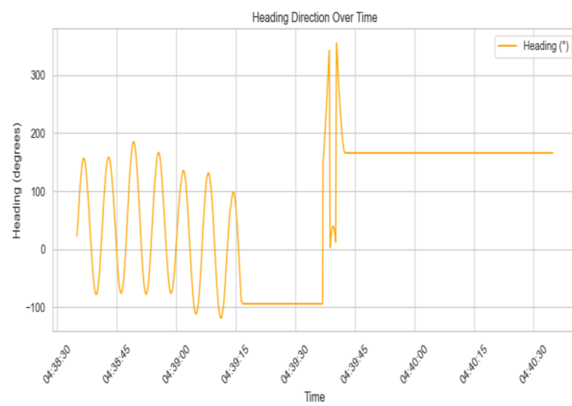


Figure 4.4: Direction of the vehicle(ts13ee7600)

Direction angles of the vehicle let us predict that vehicle is moving around the lanes as the heading degrees keep on changing for good amount of time as shown in figure 4.4.

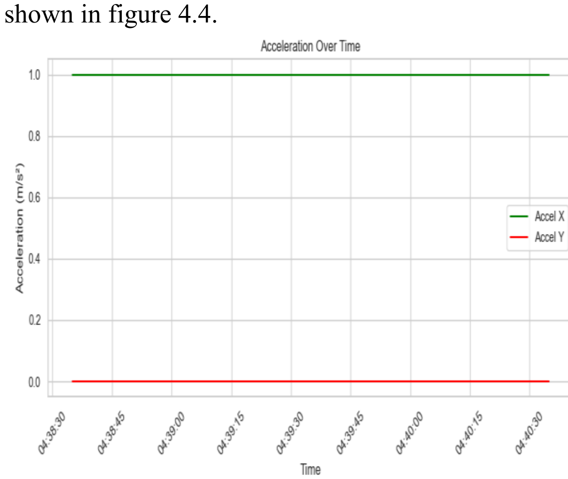


Figure 4.5: Acceleration of the vehicle(ts13ee7600)

Figure 4.5 shows two acceleration values recorded for the vehicle, acceleration x which is "zero" and acceleration y which is "one."

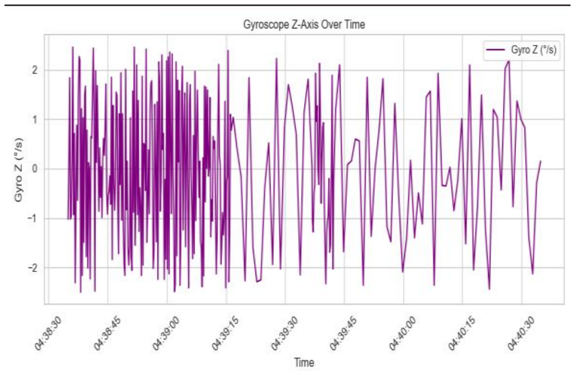


Figure 4.6: Gyroscope values(ts13ee7600)

Z-axis of gyroscope with respect to time is shown in figure 4.6 for vehicle id ts13ee7600. Very random and continuous changes can be clearly observed here.

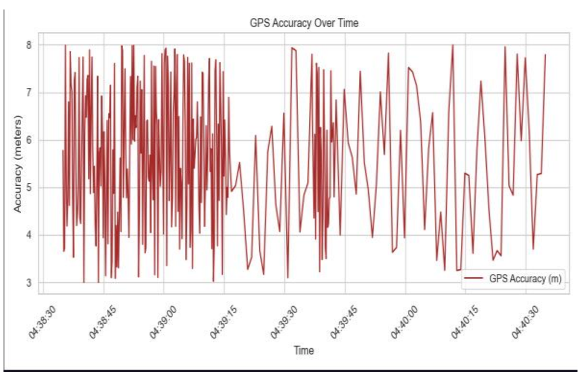


Figure 4.7: GPS location(ts13ee7600)

An important parameter to monitor and track the vehicle's well being is to track the location. This can be efficiently achieved by the approach as seen in figure 4.7.

Figure 4.8: Vehicle room for vehicle id ka32449444

Another vehicle id tracked during my project working was ka32449444. Figure 4.8 shows the vehicle under tracking.

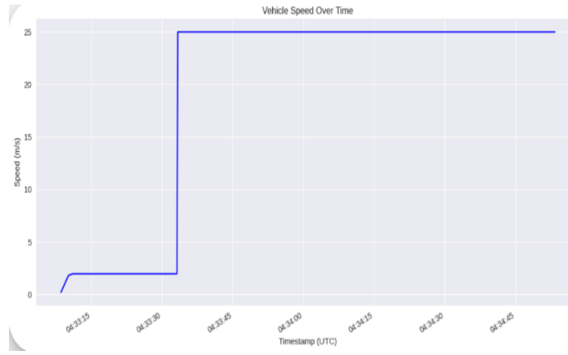


Figure 4.9: Monitoring speed of vehicle id(ka32449444)

The plot in figure 4.9 explains the speed at which the vehicle is moving in a specific direction. Speed increased from zero to a small value then remained constant and next a sharp increase in speed can be seen.

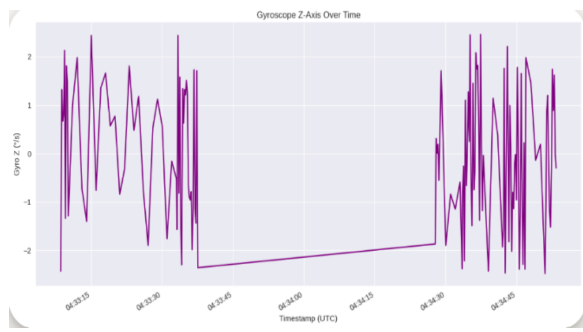


Figure 4.10: Gyroscope values for ka32449444

In contrast with the first vehicle id gyroscope values for second vehicle is slightly clear in prediction as shown by figure 4.10.

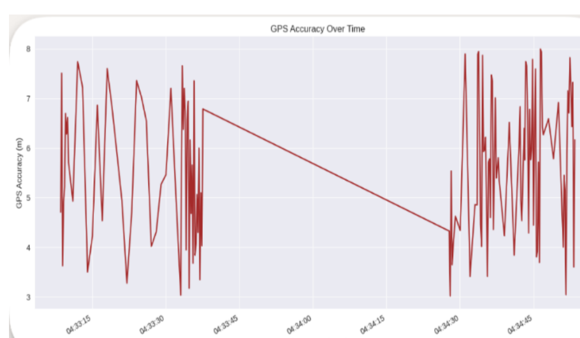
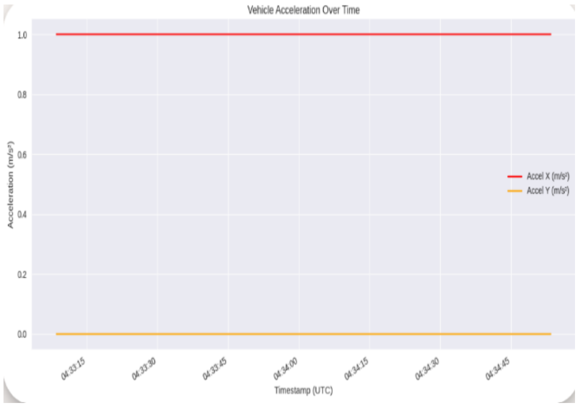


Figure 4.11: GPS tracking of vehicle id 2(ka32449444)

More clear location accuracy for second vehicle is achieved in figure 4.11.



4.12: Acceleration with respect to time for ka32449444

Figure 4.13: Directions of vehicle ka32449444

Two acceleration values are maintained in plot of figure 4.12.
The tracking of direction is very finely depicted in figure 4.13 showing a good driving behavior.

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