Vehicle Monitoring with Web-Based Applications Utilizing High-Precision Positioning

Taufan Zandy Andrian[1], Uke Kurniawan Usman[2]

School of Electrical Engineering, Telkom University

[1]taufanzandy@student.telkomuniversity.ac.id

[2]ukeusman@telkomuniversity.ac.id

***Abstract*— Motorized vehicles have facilitated various human activities in everyday life. As technology develops, various features in driving have been added to the vehicle itself. Starting with the aim of adding comfort, even to increase the safety in the use of vehicles. In the current digital era, the vehicle monitoring process has been widely applied, especially in a number of smart vehicles that are integrated with a monitoring system from various vendors. A web-based application or commonly known as webapp, designed by PT. Telkom Indonesia, Tbk. named IndiCar, is an example of a monitoring system, which can be applied to vehicles that are commonly used daily. This is in line with the main goal of IndiCar, which is the digitalization of public vehicles, into smart vehicles. The implementation of monitoring using the IndiCar webapp can make it easier for vehicle users, both in personal and institutional use, to track and diagnose a vehicle, regarding a number of factors such as precise location, track traveled, to the condition of various vehicle components, utilizing a number of sensors applied to the IndiCar system.**

***Keywords*— Monitoring System, Vehicles Digitalization, Web Application**

I. INTRODUCTION

Along with the development of technology, the world of telecommunications has also experienced developments. With a very wide range of telecommunications technology coverage, there are also developments in the application of technology and features in driving, vehicle monitoring is a feature that is widely developed today. New positioning, detection and tracking technology has projected and designed to take advantage of modern spaces (radio and satellite) Communications, Navigation and Surveillance solutions (CNS) and Services Improved traffic control, monitoring, and management of civilian and military mobile personal and assets [2]. One of the largest telecommunications companies in Indonesia is PT. Telkom Indonesia, Tbk. which is also engaged in the internet of things (IoT), participated in developing a monitoring system. This monitoring system is generally used to find out the position of a vehicle accurately. Deeper than just knowing the position, the monitoring process was also developed in order to be able to diagnose the condition of the vehicle that being tracked.

The advanced driving features are provided by a web-based application designed by PT. Telkom Indonesia, Tbk. which is called IndiCar. This web-based application or webapp has the main purpose of digitizing ordinary vehicles into smart vehicles, one of which is by applying further features in driving such as tracking the whereabouts of vehicles with precision, which can then be used as detection of normal movements and sudden movements of the vehicle, the detection can be developed further so that it can record the driving behavior of each vehicle and every rider.

One of the advantages of the IndiCar webapp is that there is a high-precision position feature that can track vehicle position with a high level of accuracy. This feature is supported by the application of the real-time kinematic method as a positioning system method used in the IndiCar system. The real-time kinematic method is one of the positioning system methods, which produces a high level of accuracy value using GNSS. The Multi-Constellation Global Navigation Satellite System "Multi-GNSS" has become the standard implementation for high-precision positioning and navigation applications. It is well known that code and phase measurement noise depends on the GNSS constellation [3]. The real-time kinematic method can produce accuracy values of up to 5 centimeters [1]. The positioning system device is then applied directly to the vehicle.

The positioning system device on the IndiCar system can also be used in the journey & geofencing feature, where this feature can record the journey that has been traveled by the vehicle, as well as alert the driver if the vehicle starts to enter or leave the predetermined driving area boundary. Route information as navigation in driving is also provided by this feature so that the use of time and fuel can be more efficient.

With the application of the positioning system method with a high level of accuracy, it is expected to meet the needs of users in tracking vehicles that are traveling accurately and precisely. When the accuracy of the positioning system can be improved, the tracking process can become more precise. By knowing the position of the vehicle accurately, the vehicle can be connected to various on-board diagnostic (OBD) sensors so that tracking not only knows the position of the vehicle, but also the condition of the vehicle, as well as driving behavior.

The OBD sensor device is used to meet the needs of the engine monitoring for compatible car feature, where the sensor makes it easy to record engine work data including RPM, fuel level, temperature, speed, odometer, and various other data during the trip. Supported by the development of communication technology such as android-based smartphones that can be used as communication tools and controllers of electronic devices [4], this feature allows users to monitor the condition of the vehicle through the gadgets used such as smartphones, tablets and laptops. This can certainly increase safety, comfort, and productivity in driving.

II. Methods

A. Monitoring

In the vehicle monitoring process, the main component used is the positioning system device, where the device is the main object being tracked. The positioning system method used is real-time kinematic, where the method works by utilizing the Global Navigation Satellite System (GNSS) as the main system for positioning data source providers. Where GNSS is the most common technique used to determine the position of an object [5].

B. Tracking System Design

The positioning system device on the provider side is a GNSS receiver that acts as a base station, which is a device with a fix location that provides correction data to increase the accuracy value of the positioning system, while the positioning system device on the user's side is a GNSS receiver device with a role as a rover , where this device becomes a mobile device whose whereabouts are tracked.

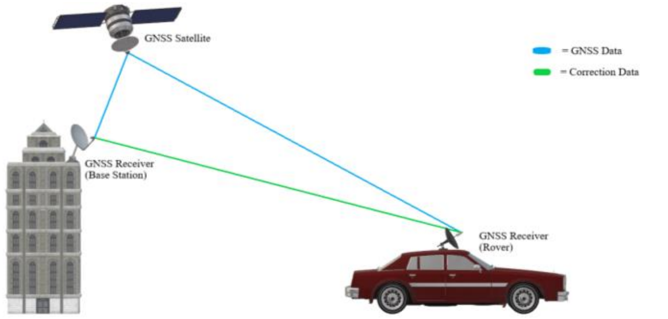

Fig. 1 Illustration of the application of the positioning system device

Figure 1 explains how the real-time kinematic method works starting from the GNSS satellite which sends GNSS data on both GNSS receivers, both base stations and rovers. The GNSS data received by the base station is then used as correction data, namely a comparison of the distance between the base station and the rover, then the correction data is sent to the rover via an internet connection, the correction data will then increase the accuracy value from the positioning system to the centimeter level, and become a differentiator between the real-time kinematic method and a number of other positioning system methods. This way of working is the main reference in the implementation of the tracking system on the IndiCar webapp.

C. Application of Real-Time Kinematic Method

In the practice of using real-time kinematic methods to obtain high-precision position features in the IndiCar system, the transmission of correction data requires additional devices so that the correction data can be transmitted and received properly, so that the accuracy value can be improved and produce precise values. Correction data obtained from the base station, transmitted to the rover using radio communication [6].

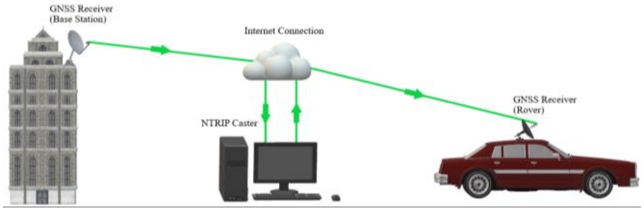

Fig. 2 Correction data delivery support devices

The additional device used in the transmission of correction data in the use of the real-time kinematic method is a caster of networked transported of RTCM via internet protocol or NTRIP caster. NTRIP caster is a device that acts as a bridge between the GNSS receiver which acts as a base station and a rover, to receive, process, and transmit correction data from the base station to the rover with the aim of increasing the accuracy value of the real-time kinematic method.

D. Rover Device System

The positioning system device applied to the user side is a GNSS receiver with a role as a rover. In research on the use of the IndiCar system in vehicles that are commonly used daily, it is necessary to design an adequate rover device system for the implementation of the real-time kinematic method.

Fig. 3 Components of the rover device on the IndiCar system

Figure 3 shows a number of components used in the design of the rover device, which will then be applied to the IndiCar system to meet the needs of high-precision position and journey & geofencing features. The device consists of a GNSS receiver as the main component that receives GNSS data, and becomes a tracked object, a Raspberry Pi as a data processor from GNSS data received by the GNSS receiver, and also a connector to connect the GNSS receiver device with the Raspberry Pi.

Once the rover device has been designed and can be used, it is then applied directly to the vehicle on-board. The application of the positioning system device on the IndiCar system can also be equipped with various OBD sensors, so that other further features such as diagnosing vehicle conditions during the trip can be used, and the IndiCar system can work according to user needs in increasing comfort, security, and productivity in driving.

III. RESULTS AND DISCUSSION

With the implementation of various devices in meeting the needs of advanced features in the IndiCar system, the IndiCar webapp can be used in monitoring vehicles. In the first use of the IndiCar webapp, the IndiCar system was tested using sample data from the RTKLIB application, where the RTKLIB application is one of the software that plays a role in processing GNSS data received by the GNSS receiver device.

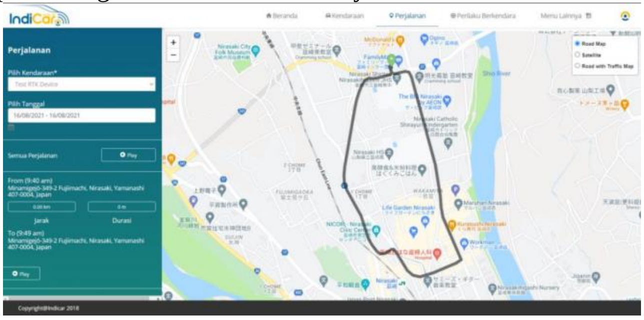

Fig. 4 IndiCar system testing with RTKLIB sample data [7]

Figure 4 shows the tracking form of the path traveled by the rover device, where the tracked rover device is sample data from the travel recording of a rover in Nirasaki, Japan. Testing proves that the IndiCar webapp can display tracking results from sample data, with accuracy corresponding to the original form of the sample data itself. As in previous studies that resulted in the accuracy of the positioning system method used at 20 cm [8]. The sample data from the RTKLIB application has the original form as shown in the following figure:

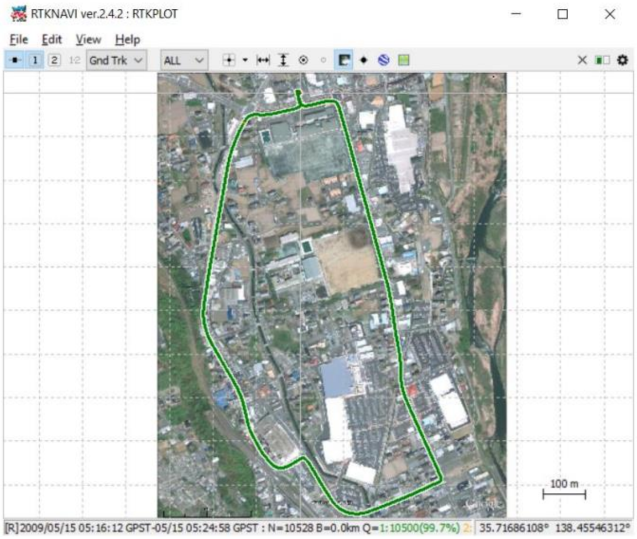

Fig. 5 View of sample data from RTKLIB applications [9]

In accordance with the display of sample data provided by the RTKLIB application in Figure 5, with the display on the IndiCar webapp, the next stage is testing the IndiCar system using a positioning system device that will be applied to vehicles which will then be tracked and monitored using the IndiCar web-based application.

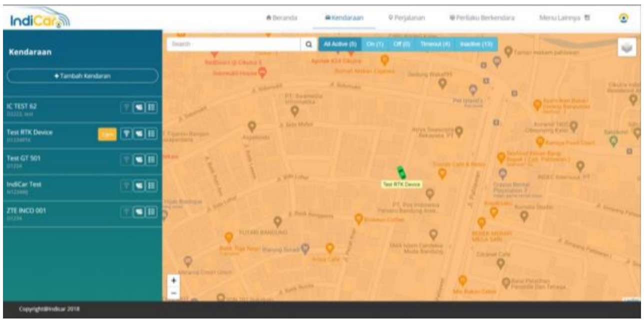

Fig. 6 Vehicle positioning display on the IndiCar webapp [7]

In Figure 6, it is shown that the IndiCar web-based application can display the position of the vehicle being tracked according to the actual position. This is supported by the high-precision position feature in the IndiCar system which utilizes accuracy values from the real-time kinematic method up to the centimeter level. The accuracy of the positioning system method used is then tested in the tracking process where the IndiCar webapp monitors the path traveled by the rover device. Tracking is a technology to find out the position of objects [10]. The tracking process carried out by the IndiCar system can be shown in the following image:

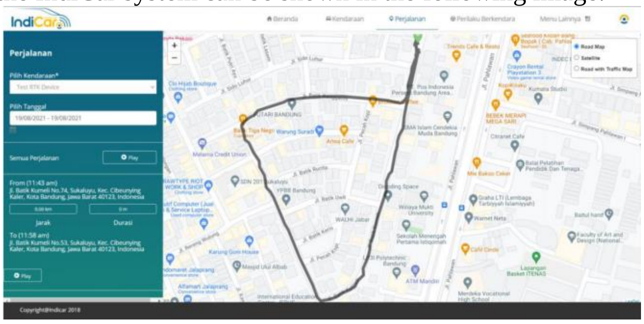

Fig. 7 Vehicle tracking display on the IndiCar webapp [7]

As shown in Figure 7, where the implementation of the use of real-time kinematic methods in the tracking process results in a number of different track forms. In some track images, you can see a stable path shape according to the movement of the rover device. These results are obtained when the real-time kinematic method in the IndiCar system works optimally and produces precise accuracy values. However, in some other track images, there is a bumpy and unstable track shape. These inappropriate results are produced when the positioning system method applied to the IndiCar system works less optimally. Under these conditions, the positioning system method produces an accuracy of about 5 meters [11].

The stability of the track shape produced by the IndiCar system is determined by the performance of the positioning system device applied, where the performance of the device can be influenced by various factors such as the open surrounding environment [12]. Several other factors such as the quality of the internet connection, and other factors also affect system performance. The tracking results obtained using the IndiCar system can be used in proving the high-precision tracking feature and also the implementation of the journey & geofencing feature provided by the IndiCar web-based application.

After the tracking process is carried out, the feature regarding the detection of driving behavior in the vehicle being tracked can be tested. Using different vehicles, the Web-based application IndiCar uses a fairly similar system in tracking such vehicles. A view of the monitoring process regarding the detection of driving behavior can be shown in the following figure:

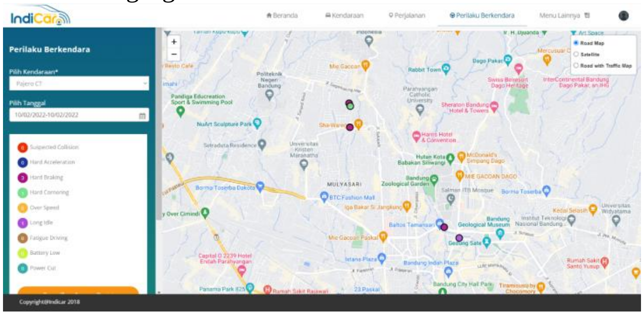

Fig. 8 Display of driving behavior detection on the IndiCar webapp [7]

In Figure 8, it is shown that the tracked vehicle experienced several driving situations in a number of areas, such as hard breaking conditions at 3 location points, hard cornering at 1 location point, and long idle at 1 location point. The display is enough to show that the driving behavior detection feature on the IndiCar system can work properly.

IV. CONCLUSIONS

The IndiCar web-based application can monitor the vehicles that are tracked using the features provided quite well. By utilizing one of the positioning system methods, namely real-time kinematic which produces accuracy values up to the centimeter level, the main feature on the IndiCar webapp is that high-precision position can be applied to vehicles that are commonly used daily.

The high-precision position feature used can make it easier for users to know the true existence of the vehicle being tracked, and allow other features such as journey & geofencing to be applied in monitoring the tracked vehicle.

The performance of the positioning system device used in the IndiCar system can be improved by improving a number of factors, one of which is using an internet connection with better quality or using cellular communication technology that has a higher capacity, speed, and stability than the mobile hotspot feature from smartphones with 4G technology used in receiving correction data from base station to the rover.

With the limitations of the devices used by the authors, further research using OBD sensors is needed to prove that the vehicle's condition detection feature during travel on the IndiCar system can work according to user needs. A number of advanced features of the IndiCar webapp can also be researched more deeply to complement the research that the author conducted, in order to meet the needs of vehicle monitoring system users and develop telecommunications technology in driving optimally.

REFERENCES

[1] S. Alissa, M. Håkansson, P. Henkel, U. Mittmann, J. Hüffmeier, and R. Rylander, "Low bandwidth network-rtk correction dissemination for high accuracy maritime navigation," TransNav, vol. 15, no. 1, 2021, doi: 10.12716/1001.15.01.17.

[2] Ilcev S.D., "Architecture of Positioning and Tracking Solutions for Maritime Applications." TransNav, vol.16, No. 3, doi:10.12716/1001.16.03.09, pp. 481-489, 2022

[3] Džunda M., Dzurovčin P.: Influence of Mutual Position of Communication Network Users on Accuracy of Positioning by Telemetry Method. TransNav, vol. 15, No. 2, doi:10.12716/1001.15.02.04, pp. 299-305, 2021

[4] D. Eka Putri, "Microcontroller and Android-Based Motor Vehicle Safety Monitoring System," 2020.

[5] J. Lee, J. H. Kwon, and Y. Lee, "Analyzing Precision and Efficiency of Global Navigation Satellite System-Derived Height Determination for Coastal and Island Areas," Applied Sciences, vol. 11, no. 11, Jun. 2021, doi: 10.3390/app11115310.

[6] T. Baybura, İ. Tiryakioğlu, M. A. Uğur, H. İ. Solak, and Ş. Şafak, "Examining the Accuracy of Network RTK and Long Base RTK Methods with Repetitive Measurements," J Sens, vol. 2019, 2019, doi: 10.1155/2019/3572605.

[7] PT. Telkom Indonesia, "https://indicar-portal-v3-dev.vsan-apps.playcourt.id/."

[8] H. Keshavarzi, C. Lee, M. Johnson, D. Abbott, W. Ni, and D. L. M. Campbell, "Validation of real-time kinematic (RTK) devices on sheep to detect grazing movement leaders and social networks in merino ewes," Sensors (Switzerland), vol. 21, no. 3, pp. 1–19, Feb. 2021, doi: 10.3390/s21030924.

[9] T. Takasu, "http://rtklib.com/," 2007.

[10] M. Ridha Fahlivi, "Tracking Position System Based on GPS Coordinate Points Using Smartphones," Infomedia Journal, vol. 2, no. 1, 2017.

[11] R. Santerre, L. Pan, C. Cai, and J. Zhu, "Single Point Positioning Using GPS, GLONASS and BeiDou Satellites," Positioning, vol. 05, no. 04, 2014, doi: 10.4236/post.2014.54013.

[12] Fajriyanto, "Comparative Study of GPS Usage of Real Time Kinematic (RTK) Method with Total Station (TS) for Horizontal Positioning," 2009.