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Article

Electronic Tracking Device of Mass Public Transport Vehicle for Evaluating Driving Performance in Thailand

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Abstract. Thailand Mass Public Transport has a location tracking device along with a vehicle speed limiter attached to each public transport vehicle combined with Mass Public Transport Policy that aims to prevent dangers caused by improper driving behavior. These actions result in the troubles caused by inappropriate driving behavior decreasing drastically. However, risks from driving have more cases that the vehicle's position and speed cannot determine and analyze. Thus, this research aims to develop a data-collecting device that collects linear acceleration, angular velocity, and magnetic field while transmitting data to an online database. The collected data enables the creation of a three-dimensional simulation from ten different public transport vehicle routes. The two main goals of developing a data-collecting device are to maximize the data collection frequency and evaluate its effectiveness in a real environment while the public transport vehicle is on duty. From ten vehicle routes, the device was able to collect stable data at a frequency of 50 Hz, with a reliability rate of over 50%. However, the device encounters various problems from external factors and bus layout diversity while testing in real environments on the road, which have been solved and are ready for real usage and statistical data analysis in the future.

Keywords: Data collecting device, GPS tracking, public transport vehicle, road safety, road accident prevention.

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1. Introduction

Studies on reducing the risk of accidents and minimizing casualties have shown that vehicle safety technology is one effective solution that may reduce road accidents; by collecting, analyzing, and classifying systems or devices for enhancing vehicle safety [1].

In developing countries, an intelligent transportation system (ITS) is being implemented using the Internet of Things (IoT) to design the public transportation infrastructure. Effective monitoring and enforcement of ITS using IoT technology is critical to ensure its efficient implementation in countries like Colombia and Italy [2]. In Romania, a mass transportation system will be serviced by GPS. In cities with high-rise buildings or vehicles without GPS, the installation of ZigBee can improve location accuracy for mass transportation systems [3]. In India, a system has been created to track, schedule, and notify the services of the mass transportation system that will help increase access to quality mass transportation for people in the country. The Vehicle Tracking and Monitoring System [4] will provide medical assistance in the event of an accident by providing information about the accident site and the driver's position through an accident alert and ambulance tracking systems [5]. Both developed and developing countries have established tracking and monitoring systems for their public transport systems in order to create standards, quality, and safety for people. In Thailand, the Department of Land Transport is the administrator or regulatory agency which finds solutions for policies and practical measures [6]. A law requires public transport to have GPS equipped and linked to the transportation management center of the Department of Land Transport in the public and private sectors. There are only a few private companies that have installed GPS systems for buses to track, monitor and control the speed of buses, which are equipped with basic GPS only. After an accident, insufficient data accuracy hinders stakeholders from conducting a timely investigation or providing medical assistance.

The safety of vehicles used for public transportation is of critical importance. A vehicle tracking system must be developed to monitor the vehicle's real-time location and speed to ensure this safety. This will help track the route and assist in the event of a vehicle accident as soon as possible [7]. Storing data such as vehicle speed, driving hours, and car coordinates can be valuable resources for analyzing, predicting, preventing, and minimizing accidents involving public buses and trucks.

N. Rungsoi et al. have demonstrated that Auto Vehicle Location (AVL) systems can be utilized as a transport management tool to ensure optimal efficiency [8]. The real-time location data of a vehicle can be transmitted to a remote data center through the development and deployment of AVL systems, as shown by M. A. Elahi et al. [8], [9]. Y. Cu et al. offer a LiDAR system that can detect vehicle status, including lane identification and vehicle tracking. This system can enhance the efficiency of real-time vehicle tracking information for vehicle users [10]. C. Li et al. investigated a system for monitoring incidents that occur along the way to quickly locate the scene of an accident and transmit accident location information, resulting in more accurate detection of accidents [11].

However, there have also been frequent false alarms that can be caused by external factors or instrument inaccuracies. The speed, acceleration, and vehicle altitude data can provide details of the incident and significantly reduce false alarms [12]. Traffic accident situations in terms of data management to link data from various sources for quick inspection and control will help reduce the damage or death from road accidents.

Designing an accident detection tool requires more equipment than GPS [13]. An intelligent bus management system architecture that utilizes intelligent tracking systems, cameras, door entry, alerts, and feedback can reduce the risk of injury and disability for public transport users in Thailand who are at risk due to frequent accidents [14].

In this study, the SafeSide© box is developed for tracking and recording data from large buses using electronic prototypes and forms the basis of this research. It is important to track and record data for statistical analysis and machine learning for both models and factors related to accidents to reduce the risk of accidents and to find ways to reduce losses caused by accidents. This is an issue that will enlighten Thailand's road safety. Moreover, the prototype focuses on large public buses, which cause high rates of fatalities per crash. The analysis results will inform the development of public health policy planning and road traffic legislation for large public buses, with the aim of improving road safety in Thailand.

2. Materials and Method

We designed a simple data collection device for large public buses with better data storage capabilities than the GPS device used in Thailand's large buses nowadays. It will be discussed a system design and a hardware design, respectively.

2.1. Architectural Design

Designing a data storage device must consider the device's limitation based on movement data frequency that must be at 50 Hz [15], and the device will be attached at a place that lacks consistent maintenance. The device must be durable throughout an entire system, easily installed, and operate in one-touch operation without difficulties in control system management [16]. By selecting from the control system capable of handling data, it was found that the control system that includes a microcontroller is the most appropriate [17].

Another essential part that affects the architectural design is the sensor system. Typically, the system only contains the GPS that collects the vehicle's position and speed. However, when studying the bus's motion analysis, we found that scalar data only provides information about the magnitude and not direction [18] and is insufficient to analyze or conclude the details of the vehicle's movement. The system requires the velocity profile of a vehicle, which includes direction and quantity. According to this information, the system can analyze the speed of the vehicle, moment equilibrium, and the effect of external forces. It can generate a time-dependent continuity equation under the conservation of momentum and energy conservation equation [19]. Therefore, the system requires inertial measurement unit (IMU) sensors and uses them in vector analysis according to the Laws of Motion [20].

The system-controlling software should be able to collect data at a frequency of 50 Hz and handle devices with very different frequencies in the system, i.e., GPS. It should update all data collected to the server immediately. Since data with 50 Hz frequency is vast - causing frequent system failure and data transmission to the server takes some time to complete. It should not interrupt the data collecting process to maintain the data collecting frequency as stable as possible all the time.

2.2. Data Management

Data handling at a frequency of 50 Hz is commonly used in microcontrollers. Still, this device handles data with multiple frequency ranges, and the efficiency of the microcontroller is not optimized for reading data alone. In addition, the device must also constantly transmit data to the server. Typically, microcontrollers work on a single task by following the commands from top to bottom repetitively, without splitting into multiple tasks, and have no processing core management. However, the complexity of data frequencies can significantly affect how the data is processed and used. Therefore, a dual-core processing system is used on the ESP32 microcontroller board to manage data with different frequencies, as shown in Table 1.

Table 1. Different frequencies of each data type.

Data	Frequency (Hz)
Imu	50
GPS	Inconsistent
Data payload	1
Data payload send	3
MQTT status	3

The system is divided into two sets of tasks to separate the operation by using dual-core processing, as shown in Fig. 1. CPU core 1 is responsible for reading and packaging data within the system. The data is IMU data with a frequency of 50 Hz, which will be read for 3 seconds and stored in a package that includes time and IMU data. When the system reads GPS data, it records it.

CPU core 2 manages the internet using the sim800 chip to connect to the internet via a sim card using cellular data and manages connections to the server using MQTT protocol to send and receive data between devices and the server. It also manages data packets in preparation for transmission. The system records IMU data with a frequency of 50 Hz for 3 seconds and stores it in a package including time and IMU data. Then, the system records GPS data and manages the internet connection using the sim800 chip in CPU core 2. The system transmits data to the server every 3 seconds using the MQTT protocol and clears the transmitted data when the transmission is successful. When the transmission is successful, the system will clear the transmitted data. The system can know the data status by using Quality of Service (QoS) in MQTT, which is set to 1 in the system. When the data is successfully sent, the server will respond back [21]. With this procedure, core 1 creates a new data package while core 2 transmits data to a server.

In the dual-core system, both systems have separate operating loops. Therefore, there is no waiting time between systems, for example, connecting to the internet on CPU core 1 and reading IMU data on CPU core 2. It will continuously read values and handle data packets. Within each CPU core, task scheduler is used to manage the frequency precisely. The task scheduler of each control system is used to handle commands accurately, enabling the system to manage multiple frequencies consistently and not interfere with each other.

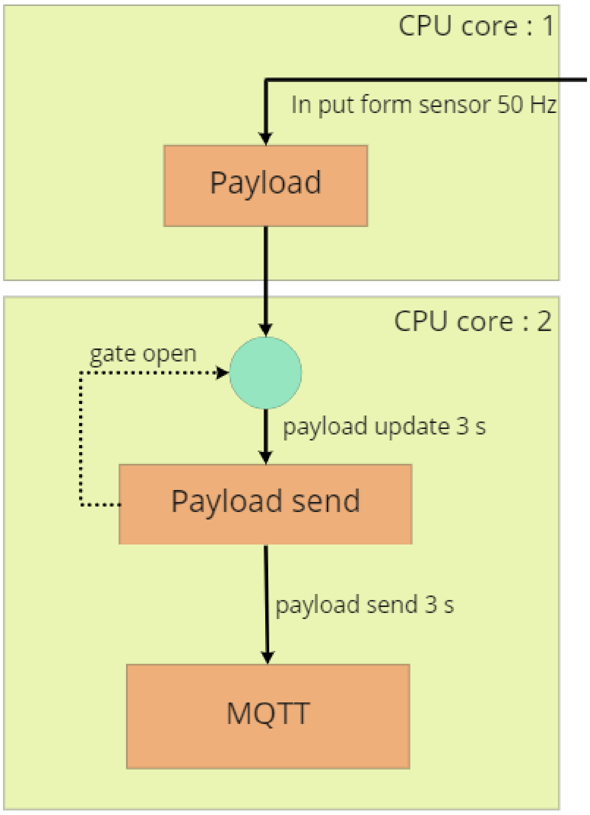

Fig. 1. Dual CORE's system flowchart.

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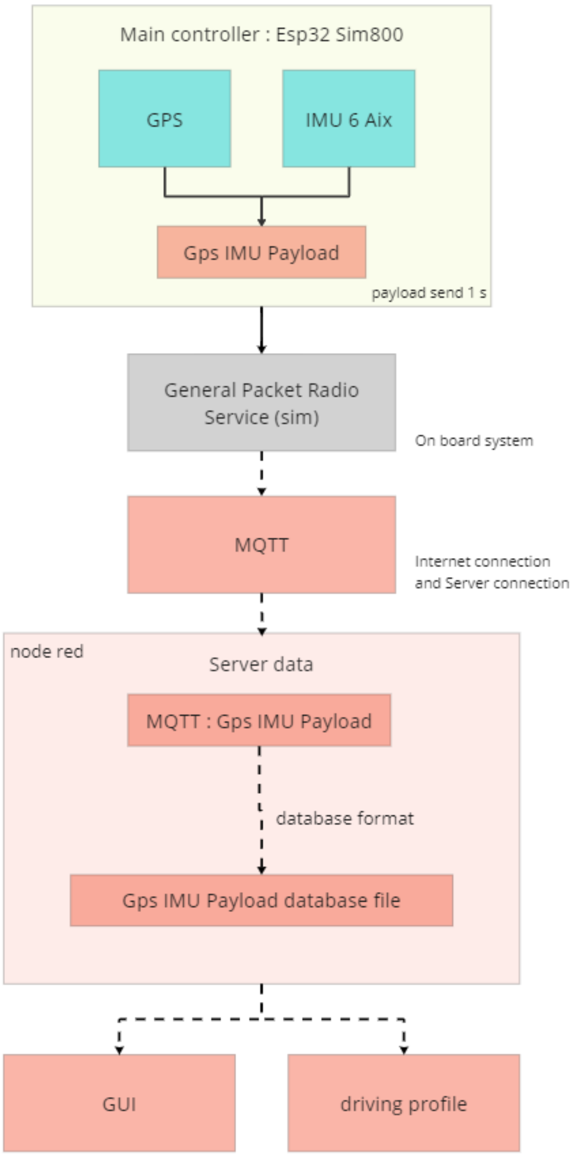

Fig. 2. Overall system's flowchart.

From Fig. 2, when data comes in from MQTT to the server, the server will handle the data by separating the incoming data according to the package ID, which is the registration number of each bus. Then, the data packages will be divided into individual values, and the server will save them in separate files along with the time for real-time plotting during system testing.

In the dual-core system, both cores not only work separately, but they also both use task scheduler as frequency management within each process. They do not execute commands directly but manage the frequency precisely and use the task scheduler of each core to control the execution again.

2.3. Materials

The SafeSide© box set includes (1) GPS antenna, (2) Sensor Box, (3) USB Type-C, and (4) Sim card. Inside the sensor box, there are TTGO T8 V1.7 - ESP32 with 4MB PSRAM (Model), GY-521 6-DoF IMU(Sensor), and GY-NEO6MV2 Ublox (GPS Module) as shown in Fig. 3.

Fig. 3. List of components requires for data collecting device of SafeSide© Box.

Fig. 4. Assembled device of the SafeSide© box.

2.4. Installation Area and Procedure

The SafeSide© box is positioned at the front of the console, as depicted in Fig. 5 by the red arrows, to take advantage of the power supply and minimize any potential disruption from passengers. Additionally, it must be located within the driver's working area to facilitate routine monitoring of its performance. The installation processes are as follows: (1) clean the installed surface area and (2) orient the instrument horizontally as shown so that the instrument cover faces the front of the vehicle. (3) connect the USB to the vehicle's electrical system after installation. (4) after the power supply, the LED in box will flash and show the connection status in the completed system.

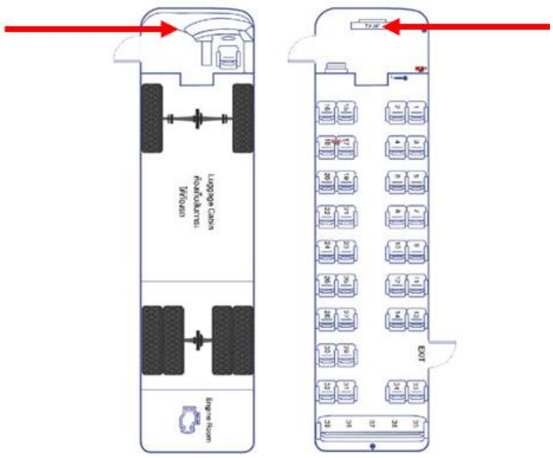

Fig. 5. The SafeSide© box's installation position on the bus (red arrows).

Fig. 6. An installation of the SafeSide© box on the bus

2.5. Field Experiment Design

The system will be tested in a laboratory and a real environment setting. In the laboratory, two tests will be conducted. The first test will compare the system's regular operation without dividing the processing core using Wi-Fi to access internet for data transmission to its regular operation with a sim card. The second test will compare the operation of the dual-core system using Wi-Fi to access Internet for data transmission to its operation using a sim card.

Concurrently testing two different pieces of equipment in a laboratory environment involves increasing the system response rate to calculate the actual system response rate, then comparing the rates to determine the fastest and most stable actual system response rate. Additionally, this process assesses the system's limitations and performance with high reliability and accuracy as data to evaluate the performance of the system in real environment conditions.

The dual-core system will be tested in a real environment using a sim card for data transmission, with a preset data response rate of 20 ms, which is the maximum response rate achieved in laboratory testing. The testing will be carried out over a period of three months on 10 buses, covering 17,317 kilometers, to gather system operation data and prove its stability.

3. Results

A prototype of a data-collecting device was developed by designing a circuit and applying the sensor to the main processing unit. Because adding the installation of an IMU sensor to record linear acceleration, angular velocity, and magnetic field data resulted in more accurate and comprehensive measurements, as shown in Table 2.

Table 2. Criteria for measuring each type of data when adding an IMU to the system.

Data Type	High reliability data	Low reliability data
GPS	Data have a stable frequency after taking latitude and longitude to calculate the distance and related to speed and time.	Data have an unstable and low frequency after taking the latitude and longitude to calculate the distance but have no relation to the velocity.
GPS and IMU	Data from the IMU and GPS are related to elapsed time and are consistently related.	Data from the IMU and GPS are related to elapsed time but have no relation between each other.

Then, when comparing the signal, it was found that the frequency of GPS is low and contains high uncertainty. However, when looking at the frequency of GPS + IMU, it was found that it could operate at higher frequencies and able to maintain the system's stability.

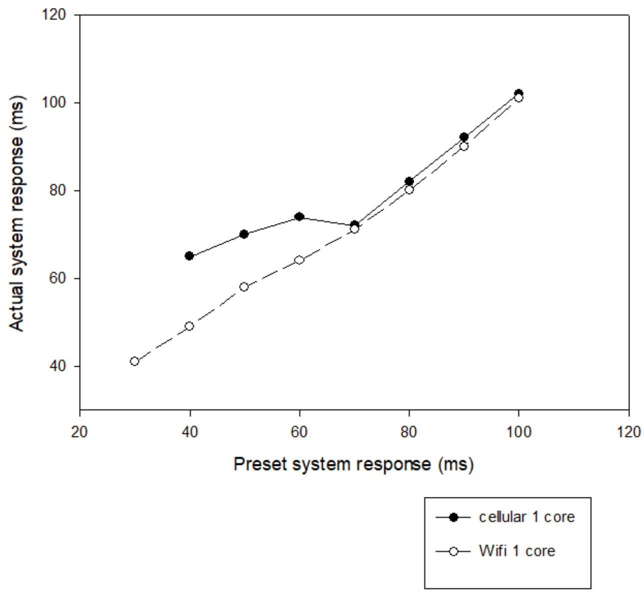

Fig. 7. Comparing actual system response rate between via wi-fi and via cellular in 1 core.

From Fig. 7, when using Wi-Fi to determine an actual system response rate, the device can reach a maximum system response rate of 30 ms. Attempts to increase the

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system response rate beyond this caused the device to restart. Dual-core testing via Wi-Fi increased the actual system response rate up to 3 times, with a maximum system response rate of 10 ms, as shown in Fig. 8. However, when operating using cellular instead of Wi-Fi, the system response rate cannot reach 20 ms.

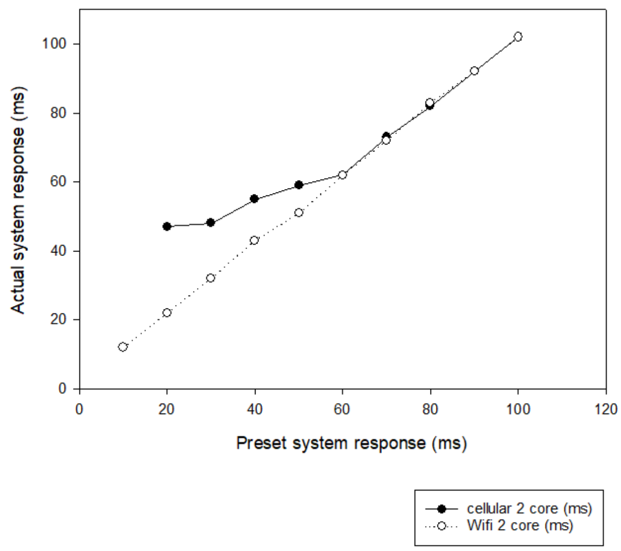

Fig. 8. Comparing actual system response rate between via wi-fi and via cellular in 2 cores.

In terms of actual system response rate, after the device is adjusted to operate at 20ms over cellular using dual-core. Increasing the system response rate in a cellular device with a dual-core has been found to slow the system response rate for a certain amount. When compared with the device that uses Wi-Fi with dual-core, it shows that the actual system response rate matches the preset ones. This problem may cause by serial limitation since data collecting and data transmitting using cellular are both using Serial communication [22]. The device's long-term stability has been tested to confirm that the device could operate at 20ms by evaluating the performance of field equipment in Thailand. Collecting data from ten routes for three months counted as more than 10,000 kilometres. It was found that the average system response rate of the device that has been adjusted to operate at 20ms is around 47ms, which is not a desirable response rate. But the device's stability cannot be determined by the average system response rate. After the observation, it showed that the actual system response rate at 20ms is more than 50% of the overall system response rate in every route. The rest of the actual system response rate cannot reach 20ms because of the inconsistency of GPS data. Updating GPS data takes a few seconds and is collected in the same core as the IMU data, which can cause a decrease in overall system response rate. This process pulls down the overall actual system response rate. An actual system response rate can still determine the vehicle's position, as the only varying factor is the data inconsistency.

Table 3. Vehicle Path that the SafeSide© box has attached. (All places are in Thailand.)

Path	Origin (Province)	Destination (Province)	Regional area (Origin)	Regional area (Destination)
1	Nakhon Ratchasima	Chiang Mai	Eastern	Northern
2	Nakhon Ratchasima	Chiang Mai	Eastern	Northern
3	Nakhon Ratchasima	Chiang Rai	Eastern	Northern
4	Nakhon Ratchasima	Chiang Rai	Eastern	Northern
5	Nakhon Ratchasima	Chiang Rai	Eastern	Northern
6	Nakhon Ratchasima	Chiang Mai	Eastern	Northern
7	Bangkok	Tak	Central	Western
8	Bangkok	Sukhothai	Central	Central
9	Bangkok	Si Sa Ket	Central	Eastern
10	Bangkok	Sukhothai	Central	Central

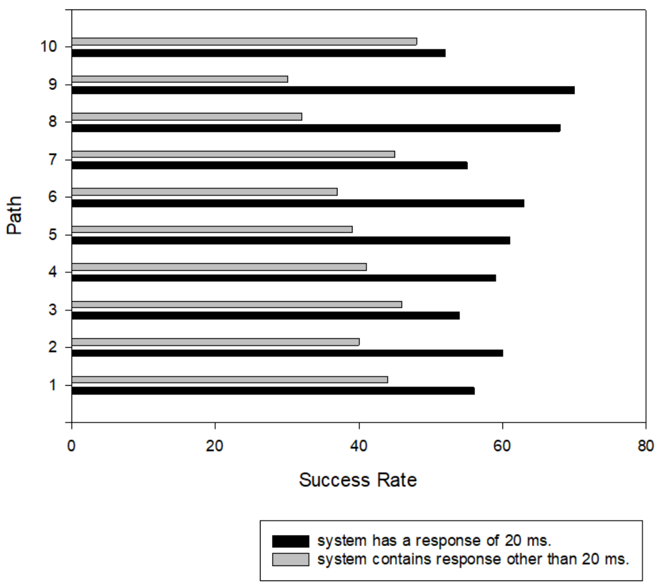

Fig. 9. Success rate of actual system response rate on each path.

According to Fig. 9, the device's actual system response rate is 20ms, with stability above 50% for all tested routes, indicating that it can be used reliably throughout Thailand. Table 3 lists the origin and destination of each path. System response rate other than 20ms are distributed in the range of 20 to 79ms, and the distribution of the system response rate are summarized in Fig. 10.

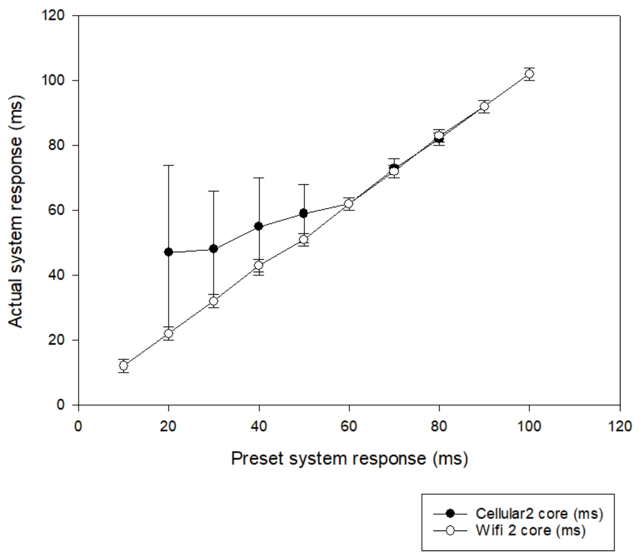

Fig. 10. Comparing actual system response rate distribution between via wi-fi and via cellular.

Figure 10 illustrates that increasing the system response rate results in a wider range of actual system response rate distribution. Inconsistencies in GPS data updating, and network instability may cause depletion of the actual system response rate. The actual system response rate drastically slow when transmitting data while receiving GPS data, and these inconsistencies result in the actual system response rate being lower than the preset one.

4. Discussion

After conducting on-site installations, it was discovered that the electrical systems of each vehicle have vastly different management methods, resulting in interference among the various components and making it difficult to resolve with a single solution. Moreover, some drivers' car starting methods cause electrical surges, which damage the equipment. We mitigated this problem by supplying power to the devices through an adapter separate from the vehicle's electrical system to prevent this. Furthermore, each vehicle's installation position cannot be identical due to changes in the structural design of the front of each vehicle or the installation of other tools. As a result, the IMU sensor readings differ. In addition, the variations in the electrical systems of each vehicle due to differences in starting mechanisms can result in equipment malfunction and operational disruptions. However, the bus servicing for the southern region of Thailand were not set up these devices, as this region has small numbers of bus transport. Lastly, the installation location should be far from passengers' contact since there is a risk of collision with the equipment, which could cause damage and interfere with the data.

Despite encountering several issues during its development, the device has been successfully developed for deployment in the real environment on road and for future statistical analysis of mass public transportation's information.

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References

[1] Ľ. Moravčík and M. Jaśkiewicz, "Integrated intelligent safety systems," *Perners Contacts*, vol. 11, no. 2, pp. 55–73, Jul. 2016.

[2] R. S. Cabrera and A. P. de la Cruz, "Public transport vehicle tracking service for intermediate cities of developing countries, based on ITS architecture using Internet of things (IoT)," in *2018 21st International Conference on Intelligent Transportation Systems (ITSC)*, Nov. 2018, pp. 2784–2789, doi: 10.1109/ITSC.2018.8569906.

[3] V. Iordache, A. Gheorghiu, M. Minea, and A. Cormos, *Field Testing of Bluetooth and ZigBee Technologies for Vehicle-to-Infrastructure Applications*. 2017. doi: 10.1109/TELSKS.2017.8246274.

[4] A. Deebika Shree, J. Anusuya, and S. Malathy, "Real time bus tracking and location updation system," in *2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS)*, Mar. 2019, pp. 242–245. doi: 10.1109/ICACCS.2019.8728353.

[5] R. Sasipriya, M. Leon, and S. Priya, "Social media usage of high school student during covid-19 pandemic," vol. 12, pp. 774–776, Jan. 2021.

[6] K. Chaikittiphorn and U. Pavakanun, "Developing the bus service of Bangkok Mass Transit Authority (BMTA)," *Thai J. Public Adm.*, vol. 14, no. 1, pp. 155–180, Jun. 2016.

[7] P. Jyothi and G. Harish, "Design and implementation of real time vehicle monitoring, tracking and controlling system," in *2016 International Conference on Communication and Electronics Systems (ICCES)*, Oct. 2016, pp. 1–4, doi: 10.1109/CESYS.2016.7889814.

[8] N. Rungsoi, P. Woraphatthirakul, and W. Rungsoi, "Guidelines for solving public transportation services of The Department of Land Transport," *J. MCU Nakhondhat*, vol. 7, no. 9, pp. 163–174, Sep. 2020.

[9] M. A. Elahi, Y. A. Malkani, and M. Fraz, "Design and implementation of real time vehicle tracking system," in *2009 2nd International Conference on Computer, Control and Communication*, Feb. 2009, pp. 1–5, doi: 10.1109/IC4.2009.4909264.

[10] Y. Cui, H. Xu, J. Wu, Y. Sun, and J. Zhao, "Automatic vehicle tracking with roadside LiDAR data for the connected-vehicles system," *IEEE Intell.*

Syst., vol. 34, no. 3, pp. 44–51, Jun. 2019, doi: 10.1109/MIS.2019.2918115.

[11] C.-Z. Li, R.-F. Hu, and H.-W. Ye, "Method of freeway incident detection using wireless positioning," in *2008 IEEE International Conference on Automation and Logistics*, Sep. 2008, pp. 2801–2804, doi: 10.1109/ICAL.2008.4636651.

[12] M. Amin, *GPS and Map Matching Based Vehicle Accident Detection System*. 2013.

[13] S. Pudpong, P. Soontompipit, J. Sillabutra, and P. Satitvipawee, "Design data model and develop web application for road traffic injury in Thailand," in *2018 International Electrical Engineering Congress (iEECON)*, Mar. 2018, pp. 1–4, doi: 10.1109/IEECON.2018.8712311.

[14] S. Sangkhapan, P. Wannapiroon, and P. Nilsook, *Development of Smart Bus Management System Using NB-IoT*. 2021, p. 156. doi: 10.1109/ICCCI51764.2021.9486773.

[15] N. Twomey *et al.*, "A comprehensive study of activity recognition using accelerometers," *Informatics*, vol. 5, no. 2, 2018, doi: 10.3390/informatics5020027.

[16] J. Issa, R. Olszewski, and M. Dyszkiewicz-Konwińska, "The effectiveness of semi-automated and fully automatic segmentation for inferior alveolar canal localization on CBCT scans: A systematic review," *Int. J. Environ. Res. Public. Health*, vol. 19, no. 1, 2022, doi: 10.3390/ijerph19010560.

[17] A. S. Ali, Z. Zanzinger, D. Debose, and B. Stephens, "Open Source Building Science Sensors (OSBSS): A low-cost Arduino-based platform for long-term indoor environmental data collection," *Build. Environ.*, vol. 100, pp. 114–126, May 2016, doi: 10.1016/j.buildenv.2016.02.010.

[18] J. Kolecki, "An Introduction to Tensors for Students of Physics and Engineering," Glenn Research Center, Cleveland, Ohio, NASA/TM—2002-211716, Oct. 2002.

[19] Y. Zhao, "GPS/IMU integrated system for land vehicle navigation based on MEMS," Licentiate thesis, monograph, KTH Royal Institute of Technology, Stockholm, 2011. [Online]. Available: http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-42167

[20] C. Yu, T.-Y. Huang, and H.-P. Ma, "Motion analysis of football kick based on an IMU sensor," *Sensors*, vol. 22, no. 16, 2022, doi: 10.3390/s22166244.

[21] S. Lee, H. Kim, D.-K. Hong, and H. Ju, "Correlation analysis of MQTT loss and delay according to QoS level," in *The International Conference on Information Networking 2013 (ICOIN)*, Jan. 2013, pp. 714–717, doi: 10.1109/ICOIN.2013.6496715.

[22] D. M. satyavathi and A. Gera, "Implementation of BIST Technique in UART serial communication," *IOSR J. VLSI Signal Process.*, vol. 4, pp. 21–29, Jan. 2014, doi: 10.9790/4200-04522129.

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