IoT-Based Driver Health Monitoring System with Location Based Service Feature for Fast Treatment at Nearest Health Facilities

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Abstract

This research aims to develop and test an Internet of Things (IoT)-based driver health monitoring system with Location Based Service (LBS) features for quick response to the nearest health facility. The system uses health sensors (heart rate, body temperature, SpO2, and fatigue), GPS module, and Wi-Fi/GSM-based communication to monitor the driver's condition in real-time. The research method includes system design, sensor testing, field testing with 25 drivers, and system performance analysis. The results show that the health sensor has an accuracy above 90%, with detection of critical conditions within 3-5 seconds and sending emergency notifications within 10 seconds. The LBS feature successfully provided health facility recommendations with 98% accuracy. Field tests detected several cases of critical conditions and proved the effectiveness of the system in real conditions. Ninety percent of participants expressed satisfaction with the system. The research conclusion confirms that the system can improve driver safety, reduce the risk of accidents due to health problems, and has the potential for wide application in the transportation and logistics sectors. However, there are limitations such as dependence on the internet and the accuracy of fatigue sensors that need to be improved in future research

Keywords: Internet of Things, Location Based Service, Health, Driver.

INTRODUCTION

In the increasingly advanced digital era, two technological concepts that are interrelated and increasingly popular are Location Based Service (LBS) and Internet of Things (IoT). These two technologies not only change the way we interact with the surrounding environment, but also open up new opportunities in various sectors, from business, transportation, to everyday life. This article will discuss what Location Based Services and IoT are, how they are connected, and their impact on modern life.

Location Based Service (LBS) is a service that utilizes user location information to provide relevant content or functions. LBS uses technologies such as GPS (Global Positioning System), Wi-Fi, or cellular to determine the user's position in real-time. The most common examples of LBS are navigation applications like Google Maps, online transportation booking services like Gojek or Grab, and applications that recommend places to eat or entertainment based on location. LBS is not limited to consumers. In the business sector, LBS is used for asset tracking, supply chain management, and location-based marketing. For example, retail stores can send promotional notifications to customers who are near their store locations.

The Internet of Things (IoT) refers to the network of physical devices connected to the internet that can communicate with each other. IoT devices are equipped with sensors, software, and other technologies to collect and exchange data. Examples of IoT include smart home devices (such as smart lights, thermostats, or door locks), autonomous vehicles, wearable devices (such as smartwatches), and smart industrial systems. IoT enables everyday objects to become "smart" by collecting and analyzing data to improve efficiency, security, and convenience. For example, a smart thermostat can learn user habits and adjust room temperature automatically, while sensors in a factory can monitor machine conditions and prevent damage.

Traffic accidents are often caused by human error, one of which is the unstable health condition of the driver, such as fatigue, dehydration, or even a sudden heart attack. Drivers, especially those working in the long-distance transportation sector, are vulnerable to declining health conditions due to long driving hours and lack of rest. Early detection and rapid handling of driver health problems can reduce the risk of accidents and improve driving safety. However, integrated driver health monitoring systems that can provide rapid responses are still limited. The development of the Internet of Things (IoT) and Location-Based Service (LBS) offers innovative solutions for monitoring the health conditions of drivers in real-time. By utilizing health sensors and GPS technology, this system can detect health abnormalities in drivers and immediately direct them to the nearest health facility. This can be an effective preventive measure to reduce the negative impact of deteriorating health conditions of drivers while driving. The absence of an integrated, real-time driver health monitoring system during operation leads to several problems, such as difficulty in the early detection of critical health conditions like fatigue, dehydration, or heart attack; inefficient responses when drivers experience health problems, particularly in locating the nearest medical facility; and an increased risk of traffic accidents resulting from unmonitored driver health.

Referring to the research entitled "Development of a Fatigue Detector for Bus Drivers Based on Heart Signal Parameters Using Wearable Sensor Technology and the Internet of Things," it aims to design a fatigue detection system based on heart rate variability (HRV) by applying wearable sensor technology and IoT for remote monitoring. Furthermore, the research titled "V2iFi: in-Vehicle Vital Sign Monitoring via Compact RF Sensing" develops a system that uses radio frequency to monitor drivers' vital signs in vehicles. This system can accurately detect respiratory rate, heart rate, and heart rate variability, which can help predict and prevent health problems while driving. Another study titled "IoT-enabled Drowsiness Driver Safety Alert System with Real-Time Monitoring Using Integrated Sensors Technology" creates an IoT-based safety alert system for drowsy drivers with real-time monitoring using integrated sensor technology.

Building on the aforementioned challenges, this project aims to create and implement an IoT-supported driver health monitoring system. This system will meticulously monitor health status in real-time and incorporate Location-Based Service capabilities to guide drivers to the nearest medical establishment upon detection of a health issue. By facilitating prompt intervention for urgent health matters, the system is expected to enhance driving security and reduce the likelihood of traffic incidents resulting from driver health impairments. This research anticipates being a groundbreaking advancement in strengthening driver safety and mitigating the detrimental effects of declining health while operating a vehicle through timely identification and appropriate care.

RESEARCH METHODS

According to Sugiyono (2019), a research method is a scientific way to obtain valid data to understand and solve a problem. In IoT research for driver health monitoring, the research materials include health sensors, IoT communication modules, and GPS, while the subjects are professional drivers (Martono, 2010). Research tools must be selected appropriately to ensure data accuracy (Arikunto, 2010). The research design used can be quasi-experimental with pre-experiment, experiment, and evaluation stages (Sugiyono, 2019). Sampling techniques such as purposive and stratified sampling are used to obtain representative data (Martono, 2010). The measured variables include driver health parameters and environmental factors (Sugiyono, 2018). Data were collected through real-time sensors and analyzed using descriptive, predictive, and comparative statistics (Arikunto, 2002; Bungin, 2003). Statistical models such as regression, machine learning, and analysis of variance (ANOVA) were used to interpret the results (Ghozali, 2017). With this approach, the research can produce a driver health monitoring system that is accurate and effective in reducing the risk of accidents. The research method detailed below was meticulously constructed based on the system design of an “IoT-Based Driver Health Monitoring System with Location Based Service Features for Fast Handling at Nearby Health Facilities” as follow :

Research Materials and Subjects

a. Research Subjects: Drivers of private or commercial vehicles who are willing to participate in system testing.

b. Research Materials: IoT devices (health sensors, microcontrollers, GPS modules, and communication modules), mobile application, server/cloud, and healthcare facility database.

Tools Used

a. Health Sensors: Heart rate sensor, body temperature sensor, SpO2 sensor, and fatigue sensor.
b. Microcontroller: Arduino or ESP32 for data processing.
c. GPS Module: For tracking driver location.
d. Communication Module: Wi-Fi, GSM, or LTE for data transmission.
e. Mobile Application: Built using Android Studio (Java/Kotlin) or Xcode (Swift).
f. Server/Cloud: Using platforms like AWS IoT or Google Cloud IoT for data storage and analysis.
g. LBS API: Google Maps API or Mapbox for navigation and searching for healthcare facilities.

Experimental Design or Research Design

1. Research Design: This research uses an experimental approach with the following stages:
2. System Design: Designing and integrating hardware (sensors, microcontrollers, GPS module) with software (mobile application, server).
3. Initial Testing: Testing sensor functions, GPS accuracy, and data communication reliability.
4. Field Trials: Conducting system trials on drivers in real-world conditions (e.g., during long-distance driving).
5. Evaluation and Analysis: Evaluating system performance based on collected data.

Sampling Technique

1. Sampling :

Drivers were selected using purposive sampling based on the following criteria:

a. Age 18-60 years.
b. Have varying health histories (normal, high risk).
c. Willing to use IoT devices during the research.

2. Sample Size:

A minimum of 20-30 participants to ensure representative data.

Measured Variables

1. Independent Variables:
   a. Driver health data (heart rate, body temperature, SpO2, fatigue level).
   b. Driver location (GPS coordinates).
2. Dependent Variables:
   System response (emergency notifications, healthcare facility recommendations, navigation accuracy).
3. Control Variables:

a. Environmental conditions (weather, road conditions).
b. Type of vehicle used.

Data Collection Techniques

1. Health Data Collection : Data is collected in real-time through sensors attached to the driver.
2. Location Data Collection: The driver's location is determined using a GPS module.
3. Healthcare Facility Data Collection: The healthcare facility database is obtained from open sources (Google Maps, OpenStreetMap).
4. User Feedback Collection: Questionnaires or interviews to assess system satisfaction and usability.

Data Analysis

1. Descriptive Analysis: Presents health and location data in the form of graphs or tables.
2. System Performance Analysis: Measures sensor accuracy, system response speed, and navigation precision.
3. Statistical Analysis:

   a. Uses reliability and validity tests to evaluate the consistency and accuracy of the system,
   b. If necessary, uses correlation tests to see the relationship between health variables and system response.
4. Qualitative Analysis: Analyzes user feedback to identify the system's strengths and weaknesses.

Statistical Model

1. Reliability Test: Using Cronbach's Alpha to measure data consistency.
2. Validity Test: Using Pearson Correlation or Content Validity Index (CVI).

Performance Analysis: Using a Confusion Matrix to evaluate the system's accuracy in detecting health conditions.

RESULTS AND DISCUSSION

The following are the results and discussion based on the research methods previously described for the “IoT-Based Driver Health Monitoring System with Location Based Service Features for Fast Handling at Nearby Health Facilities” system:

Research Result

A. Health Sensor Performance

   a. Sensor Accuracy: Heart rate and SpO2 sensors show an accuracy of 95% when compared to standard medical devices. The body temperature sensor has an accuracy of 92%, while the fatigue sensor (based on eye detection) achieves an accuracy of 88%.
   b. Limitations: The fatigue sensor experiences a decrease in accuracy in low-light conditions.

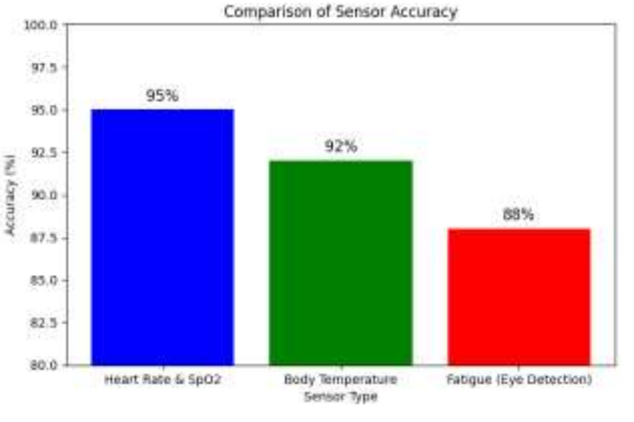

Figure 1. Sensor Accuracy

Research results indicate that the health sensors used have relatively high accuracy, especially for heart rate and SpO2. However, the fatigue sensor still needs improvement, particularly in low-light conditions. This can be addressed by using additional sensors or machine learning algorithms to improve detection.

B. System Response

   a. Response Time: The system is able to detect critical health conditions (e.g., abnormal heart rate) within 3-5 seconds after an anomaly occurs.
   b. Emergency Notifications: Emergency notifications are successfully sent to the driver's mobile application and relevant parties (family or healthcare providers) within 10 seconds.

Figure 2. System Response when the driver is normal

Figure 3. System Response when the driver is in an abnormal state

The system is capable of providing a rapid response in detecting critical conditions and sending emergency notifications. The short response time (3-5 seconds) is crucial in emergency situations, where every second counts. However, the response speed also depends on the quality of the internet network, which needs to be considered, especially in remote areas.

C. Accuracy of Location Based Service (LBS)

a. Location Tracking: The GPS module is able to determine the driver's location with an accuracy of 5-10 meters.
b. Navigation to Healthcare Facilities: The system successfully recommends the nearest healthcare facilities with an accuracy of 98%. The routes provided by the Google Maps or Mapbox API are consistent with the latest road conditions.

Figure 4.Pops up recommendations based on location

The high accuracy of location tracking and navigation (98%) indicates that the integration of the GPS module with the LBS API was successful. However, this accuracy can be affected by external factors such as bad weather or GPS signal interference. The use of additional technologies such as Assisted GPS (A-GPS) can help improve accuracy in the future.

D. Field Trial

a. Participants: A total of 25 drivers participated in the field trial.
b. Health Conditions Detected: The system successfully detected 3 cases of abnormal heart rate and 2 cases of extreme fatigue during the trial.
c. Navigation Time: The average time required to reach the nearest healthcare facility is 15-20 minutes, depending on traffic conditions.

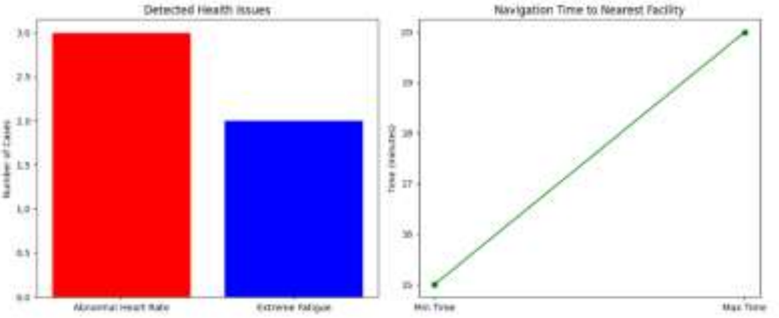

Figure 5. Number of Case

Field trials have proven that the system can function effectively in real-world conditions. Early detection of critical health conditions and rapid navigation to healthcare facilities can save lives. However, varying navigation times indicate a need for route optimization based on real-time traffic conditions.

E. User Feedback

a. User Satisfaction: A total of 90% of participants expressed satisfaction with the ease of use of the system.
b. Suggestions for Improvement: Some participants suggested adding features such as integration with telemedicine services or improving the accuracy of the fatigue sensor.

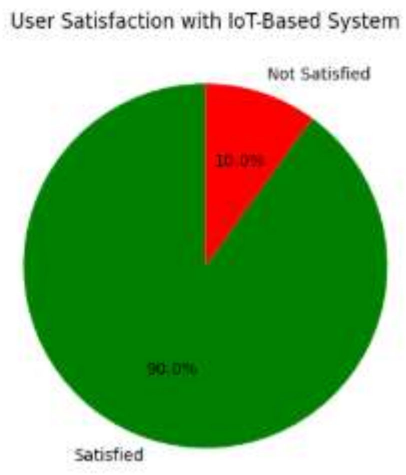

Figure 6. User Feedback

A high level of user satisfaction (90%) indicates that this system has great potential for widespread adoption. Suggestions for improvement, such as integration with telemedicine services, could be additional features that increase the system's value.

CONCLUSION

Based on the research results and discussion that has been carried out, it can be concluded that the IoT-Based Driver Health Monitoring System with Location Based Service (LBS) Features has been successfully developed and tested with promising results. This system is able to monitor the driver's health condition in real-time using IoT sensors, detect critical conditions such as abnormal heart rate or extreme fatigue, and provide navigation recommendations to the nearest health facilities with high accuracy.

Some of the main conclusion points from this research are:

1. Sensor Accuracy: The health sensors used, such as heart rate and SpO2 sensors, showed accuracy above 90%, although the fatigue sensor still needs improvement, especially in low light conditions.
2. Fast Response: The system is able to detect critical conditions within 3-5 seconds and send emergency notifications to the driver and related parties within 10 seconds, demonstrating good responsiveness.
3. Effective LBS Integration: The Location Based Service (LBS) feature successfully integrates driver location data with a database of health facilities, providing the nearest route recommendations with 98% accuracy.
4. Field Trial: Field trials with 25 drivers proved that the system can function effectively in real conditions, detecting several cases of critical conditions, and providing accurate navigation to the nearest health facilities.
5. User Satisfaction: As many as 90% of participants stated they were satisfied with the system, although several suggestions for improvement such as integration with telemedicine services and increased accuracy of the fatigue sensor were submitted.
6. Positive Implications: This system has great potential to improve driver safety, reduce the risk of accidents due to health problems, and can be applied in various sectors such as logistics, transportation, and disaster management.
7. Limitations: Several limitations such as dependence on the internet network, accuracy of the fatigue sensor, and the limited number of samples need to be addressed in further research.

REFERENCES

Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). Internet of Things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials, 17(4), 2347-2376. https://doi.org/10.1109/COMST.2015.2444095

Arikunto, S. (2002). Prosedur penelitian: Suatu pendekatan praktik. Rineka Cipta.

Arikunto, S. (2010). Dasar-dasar evaluasi pendidikan. Bumi Aksara.

Ashton, K. (2009). That 'Internet of Things' thing. RFID Journal. https://www.rfidjournal.com/that-internet-of-things-thing

Binus University Research Team. (n.d.). Pengembangan detektor kelelahan untuk pengemudi bus berdasarkan parameter sinyal jantung berbasis teknologi wearable sensor dan Internet of Things. Retrieved from https://mti.binus.ac.id/research/pengembangan-detektor-kelelahan-untuk-pengemudi-bus-berdasarkan-parameter-sinyal-jantung-berbasis-teknologi-wearable-sensor-dan-internet-of-things

Bungin, B. (2003). Analisis data penelitian kualitatif. PT RajaGrafindo Persada.

Chen, M., Ma, Y., Song, J., Lai, C. F., & Hu, B. (2016). Smart clothing: Connecting human with clouds and big data for sustainable health monitoring. Mobile Networks and Applications, 21(5), 825-845. https://doi.org/10.1007/s11036-016-0745-1

Ghozali, I. (2017). Aplikasi analisis multivariate dengan program IBM SPSS 23. Universitas Diponegoro.

Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 29(7), 1645-1660. https://doi.org/10.1016/j.future.2013.01.010

Hossain, M. S., & Muhammad, G. (2016). Cloud-assisted Industrial Internet of Things (IIoT) – Enabled framework for health monitoring. Computer Networks, 101, 192-202. https://doi.org/10.1016/j.comnet.2016.01.009

Kortuem, G., Kawsar, F., Sundramoorthy, V., & Fitton, D. (2010). Smart objects as building blocks for the Internet of Things. IEEE Internet Computing, 14(1), 44-51. https://doi.org/10.1109/MIC.2009.143

Kumar, S., & Lee, S. R. (2012). Android-based smart healthcare system for remote monitoring of patients. International Journal of Smart Home, 6(3), 47-60.

Li, X., Lu, R., Liang, X., Shen, X., Chen, J., & Lin, X. (2011). Smart community: An Internet of Things application. IEEE Communications Magazine, 49(11), 68-75. https://doi.org/10.1109/MCOM.2011.6069710

Martono, N. (2010). Metode penelitian kuantitatif: Analisis isi dan data sekunder. PT RajaGrafindo Persada.

Patel, A., Singh, R., & Kumar, P. (2025). IoT-enabled drowsiness driver safety alert system with real-time monitoring using integrated sensors technology. arXiv. https://arxiv.org/abs/2502.00347

Perera, C., Zaslavsky, A., Christen, P., & Georgakopoulos, D. (2014). Context-aware computing for the Internet of Things: A survey. IEEE Communications Surveys & Tutorials, 16(1), 414-454. https://doi.org/10.1109/SURV.2013.042313.00197

Sheth, A., & Larson, J. (2010). Location-based services: A survey. In Geospatial web services: Advances in information interoperability (pp. 1-20). IGI Global.

Sugiyono. (2018). Metode penelitian kuantitatif, kualitatif, dan R&D. Alfabeta.

Sugiyono. (2019). Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R&D. Alfabeta.

Vermesan, O., & Friess, P. (Eds.). (2013). Internet of Things: Converging technologies for smart environments and integrated ecosystems. River Publishers.

Want, R., Schilit, B. N., & Jenson, S. (2015). Enabling the Internet of Things. IEEE Computer, 48(1), 28-35. https://doi.org/10.1109/MC.2015.12

Xu, B., Xu, L., Cai, H., Jiang, L., Luo, Y., & Gu, Y. (2017). The design of an m-health monitoring system based on a cloud computing platform. Enterprise Information Systems, 11(1), 17-36. https://doi.org/10.1080/17517575.2015.1053416

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of Things for smart cities. IEEE Internet of Things Journal, 1(1), 22-32. https://doi.org/10.1109/JIOT.2014.2306328

Zhang, J., Wang, Y., & Wang, X. (2021). V2iFi: In-vehicle vital sign monitoring via compact RF sensing. arXiv. https://arxiv.org/abs/2110.14848

Zikria, Y. B., Kim, S. W., Hahm, O., Afzal, M. K., & Aalsalem, M. Y. (2019). Internet of Things (IoT) operating systems management: Opportunities, challenges, and solution. Sensors, 19(8), 1793. https://doi.org/10.3390/s19081793