IoT-Based App for Commuter Travel Tracking System: A Review

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Abstract In this paper, the groundwork on commuter-based travel system is studied by considering the several existing techniques in this problem. In the present scenario, IoT plays an inevitable role in all emerging technologies because of the increasing usage of the internet. It aims at smart usage of human time in real-time applications. Transportation has become the essential factor of regular activities. Hence, this paper reviews all the system that can automatically measure the distance travelled by passengers on the bus and collect the distance travelled from the accounts of passengers. Several new systems could be implemented in the comfort zone of passengers only after a thorough review on literature. A few ideas of passenger's convenience like a method of charging tickets are by distance travelled is one of the most innovative ways. The usage of most secure smart card as the prepaid travel card, storing the amount in its internal memory, allowing users to easily board any bus in the area. The idea of incorporating the GPS receiver to calculate position and driving distance avoids relying on the vehicle's built-in distance of metres. To develop an effective system for IoT-based APP for commuter travel tracking system, this paper provides an exhaustive survey for real-time applications and compares the existing systems in various aspects guiding the future researchers.

Keywords Smart card reader · Commuter travelling system · Radio frequency identification tags · Global positioning system receiver

1 Introduction

Indoor and outdoor localization of objects and tracking of moving objects are required for many location-based services. Many technologies including infrared, wireless sensor networks (WSNs), Wi-Fi ultrasound and video camera, are used as the mechanism for localization and tracking in transportation. Several techniques are adopted

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for indoor and outdoor localization procedures. A few like GPS, RTPIS, RFID are most common. Radio Frequency Identification (RFID) is a significant technology for the purpose of tracking of objects using RF signals. IOT as an emerging technology could be adopted for building a comfortable App for passengers for commuter travel tracking system. This paper is organized as follows: Sect. 2 describes the related works on the commuter travelling system. Section 3 discusses the multiple comparisons of the several techniques with respect to overall review on literature according to its broadest methodologies, converging at RFID system with their implementation, limitations, and performance metric analysis. Section 4 converges the challenges with further scope for the researchers. Finally, Sect. 5 concludes the paper.

2 State of the Art

There exist several techniques in literature in the implementation of commuter travel tracking system. A few techniques or devices like GPS receiver, RFID Module, LCD Display are utilized in this. How so, each of the implementation has its own advantages and implementation difficulties in real-time scenario. The state of the art is presented as a selective study that supports the real-time implementation with zero practical difficulties.

A. Design of Real-Time Bus Monitoring and Passenger Information System:

Sinha et al. [1] proposed the main objectives of their research project as the following: RTPIS moving presentation on transportation stops anticipates season of appearance continually, electronic connection point for screen to manage space transportation gradually, to calculate transport plans and RTPIS, the end-user can use a portable application. However, some drawbacks like change in the expected time of arrival (ETA) due to Internet connectivity and security issues like attack by malicious agents.

B. Design of IoT-Based Intelligent Bus Positioning for Smart Campus:

Feng et al. [2] proposed the system that uses RFID technology for transportation. In addition, touch screens at bus stops can calculate the passengers count waiting for each bus, and electronic bus station loading can communicate information like the season in which each bus will appear. How so, a few limitations of the Zigbee wireless communication like reduction in accuracy for long-distance communication and the overall cost of project is not economical.

C. Passenger Assistant for Public Bus Commute using Smartphone:

Verma et al. [3] researched RTPIS shifting presentation on transport stops—predicted season of presence continually are the main objectives of this research study. Electronic transfer from control space to screen connection point, RTPIS, and transport plans can be calculated using a portable application for end-users. Some drawbacks are the speed breakers, and pots may not be detected by the system always and the requirement of Internet connectivity at all the time.

D.   UHF-RFID for Vehicle Localization in GPS-Less Environments:

Chen et al. [4] offered a brand new real-time vehicle localization strategy in GPS-less environments, which is based on UHF-RFID. They use a single antenna multi-frequency ranging system on a vehicle. The coordinates of the vehicle can then be determined using the tags reader distant factor. A few drawbacks are due to the presence of antennas which should take care of the system to prevent from damage. UHF-RFID tags cannot generate the omni-directional signal whose pace is independent of the reflecting surface.

E.   A passive UHF-RFID for the Indoor Autonomous vehicle:

Digiampaolo and Martinelli [5] proposed the global localization challenge for a mobile robot that can detect the availability of passive RFID tags placed at known positions of the environment's ceiling when moving beneath them was the focus of this article. As a result, a successful localization method based on Kalman filtering to combine RFID readings with odometry data is developed. A few limitations like the cost of the project, requirement of a large detection range (two metres or more) resulting in electromagnetic interference with environment.

F.   An Embedded Sensing Network Integrated Monitoring System for Pavement and
     Traffic:

Xue et al. [6] proposed a prototype to monitor pavement conditions and collect traffic data using the embedded sensing network. The system's two monitoring patterns namely regular monitoring and periodic testing are performed, and the data processing techniques used in each pattern. Few challenges like autonomous, low-cost, and self-powered sensors can be added up in order to minimize the cost along with various environmental and loading conditions.

G.   Bumping: Smart phones-based Inertial Navigation Method for Indoor Vehicles:

Tan et al. [7] studied and introduced Bumping, a Bump-Aided Inertial Navigation technique that greatly reduces the two issues. The Bump Matching algorithm, which is at the heart of this technique, uses the position data of the nearby speed bumps to generate helpful references for the INS. The suggested approach uses almost little extra energy and can be easily implemented without the need for infrastructure. Real trials were carried out in parking garages with trees that had various environmental parameters. A smart phone-based Inertial Navigation System (INS) has two significant issues. At first, it's susceptible to mistakes that can develop and add up very quickly over time, potentially making navigation useless. Secondly, since a smart phone can only learn its acceleration, it is difficult for it to infer its initial position and velocity, which form the basis for calculating distant metric, without human input or outside references.

H.   GPS Localization Accuracy Classification:

Drawil et al. [8] proposed a Context-Based Approach, a method for estimating localization accuracy includes two steps in this technique. The effectiveness of the suggested approach for categorizing GPS localization accuracy under various measurement settings is shown by real-world comparing studies. Although localization techniques have lately begun to show a noticeable improvement in their localization performance, the measurement conditions in their surroundings still have a considerable impact. Because the measuring process is incongruent, the effect of the measurement conditions on the localization accuracy is in fact an ill-defined problem in and of itself.

I.   Error-Cognitive Vehicle Localization in GPS-Less Environments:

Qin et al. [9] researched to attain great location precision; however, high tag density and a high cost are necessary. As a result, it frequently serves as an extra upgrade to GPS and servers. To provide a low-cost, low-density RFID infrastructure in addition to the already presented prototype RFID-based location system.

J.   J. RFID-based localization and tracking technologies:

Ni et al. [10] proposed an implementation of RFID-based travel tracking system. These technologies include tag-based (such as LANDMARK), reader-based (such as reverse RFID), transceiver free, and hybrid techniques. To locate the target objects, these systems primarily rely on information about radio signal strength or RSS change that is easily accessible. Although RSS may be cost-effective, multipath and interference are the limitations.

K.   Urban Eye—An Outdoor Localization for Public Transport:

Verma et al. [11] created Urban Eye, a route navigation and travel time estimation system for city commuters that are energy-efficient outside. The existing algorithm for localization and navigation shows poor performance when used on public buses in the cities, which is the primary motivation for this work. They develop a device with considerably less power consumption than GPS that just uses inertial sensors.

3   Comparative Analysis

From the thorough study of the literature, we created a diagrammatic representation of different aspects of the commuter travel tracking system. The implementation scenario of the papers is divided into several aspects based on the methodology it follows. Figure 1 consolidates the analysis of entire review of commuter travel tracking system.

   This shows three different scenarios RTPIS [1] (Real-Time Passenger Information System), RFID [3, 12] (Radio Frequency Identification) and outdoor localization [6–8, 11]. RTPIS has two sub-types: General RTPIS and RTPIS using smart phone. The
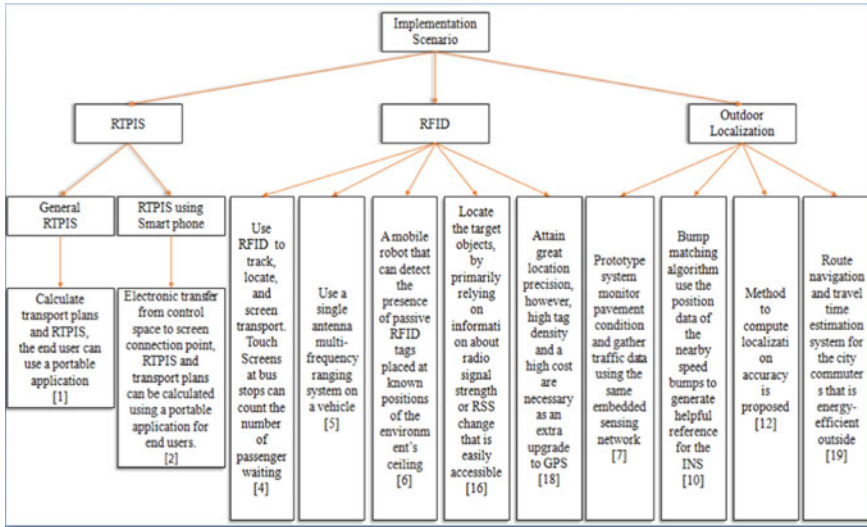
Fig. 1 Comparison on various techniques for commuter travel tracking system

five different techniques under RFID [2, 4, 5, 9, 10] are analysed by their methodology briefly, and some drawbacks are identified. The outdoor localization is also analysed effectively. The cost-effective solution for commuter travel tracking system is highly supported by RFID which can be applied practically in real life usage [13–18]. Table 1 converges the in-depth analysis on RFID-based techniques.

However, the final part of implementation is highly important to measure the performance. Table 2 depicts the comparison of implementation techniques along with the metric, i.e. analysed to measure the performance of the commuter travel tracking system using RFID.

4 Challenges and Future Scope

This paper reviews the entire commuter travel tracking system with the objective of developing a successful real-time cost-effective solution that alters the paper ticketing system using RFID technique as the background system. This analysis on literature is to create a mobile application that will allow users to track their travel positions, as well as their payment of the fare for the distance they cover. Figure 2 depicts that the draft of one of the efficient systems is the progressive work of the authors.

The GPS, RFID reader, and RFID cards, measure the distance metric from the board on point of the passenger; the RFID reader will begin tracking their whereabouts and recording their boarding and alighting times. This proposed cost-effective RFID system utilizes MSP430g2553 with salient features of inbuilt watchdog Timer, UART, LCD control and mainly suits for low power application.

Table 1 Comparison on methodology and drawbacks for RFID-based techniques

Literature	RFID-based methodology	Limitations
[2]	Transportation is tracked, located, and screened by the system using RFID technology. The number of people waiting for each bus can be counted via touch screens at bus stops, and computerized bus station loading systems can share details like the season in which each bus will arrive	Zigbee wireless communication may not be accurate in long-distance communication cases, and the project's overall cost is high
[4]	Usage of single antenna multi-frequency ranging device. The reconstructed distances between the tags and reader can then be used to get the coordinates of the vehicle	The omni-directional signal, whose speed is independent of the reflecting surface, cannot be produced by UHF-RFID tags
[5]	Identify passive RFID tags when moving beneath known locations on an environment's ceiling. The combination of RFID readings and odometry data allows us to create a viable localization approach based on Kalman filtering	The expense of the project is one of its drawbacks. Requires a wide detection range (two metres or more), which could lead to erratic detections due to electromagnetic interference from the surroundings
[10]	These technologies include transceiver-free, reader-based, tag-based (like LANDMARK), tag-based (like reverse RFID), and hybrid approaches. These systems largely rely on readily available information regarding radio signal strength or RSS change to locate the target objects	Despite the potential cost-effectiveness of RSS, multipath and interference pose challenges
[9]	High tag density and a high cost are required in order to achieve high location precision, though. Therefore, it frequently functions as an additional upgrade to servers and GPS	The exact necessity for a low density and low-cost RFID infrastructure

Finally, when they exit the bus, the base fare for the passenger they just travelled will be deducted. The passenger will be able to see the details of the tickets that are charged. This will enable us to eliminate the paper ticketing system and serves as a cost-effective real-time implementation of commuter travel tracking system.

In this perspective, the authors are at the exit phase of developing a system as shown in a process flow model as depicted in Fig. 3. It sends the details regarding distance, time, date, and the fare price to the web applications so that the passenger can track the information about the journey.

Table 2 Comparison on implementation and performance metrics for RFID-based techniques

| Literature	Implementation	Performance metrics
[2]	Integrate RFID technology with Zigbee wireless technology	Taking bus of certain examples on road, the effective calculation of dispatching time was measured
[4]	A combination of UHF and RFID technique	Time consumption and computational complexity (Road Test)
[5]	Localization procedure based on Kalman filter is used and is fused with RFID tags with odometry data	Average position error
[10]	Combines the RSS technique along with challenges in multipath and interference	Cost-effective
[9]	Correction based scheme to systematically cognize and correct localization error	Accurate vehicle localization
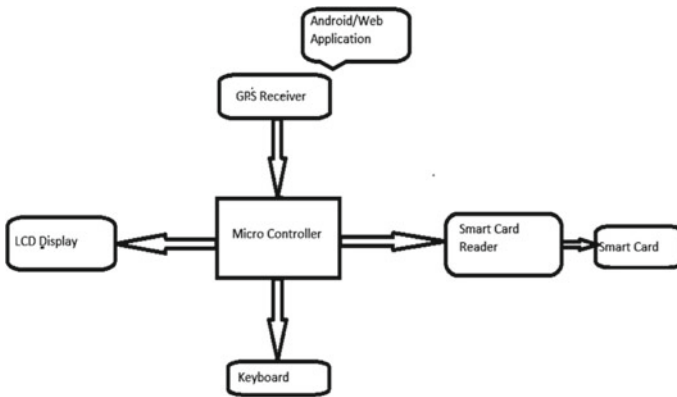
Fig. 2 Proposed cost-effective RFID-based commuter travel tracking system

5 Conclusion

This paper provides an exhaustive review on the existing commuter-based travel system with their preliminaries, state of the art along with the performance comparison to identify a cost-effective solution. In implementation perspective, the practical difficulties of replacing the paper ticketing system by this commuter-based App should be successfully rectified. Implementation of effective IOT App for this problem is still under the progress. The implementation of the efficient low cost IOT-based App for commuter travel tracking system using RFID is the progressive work by the authors.
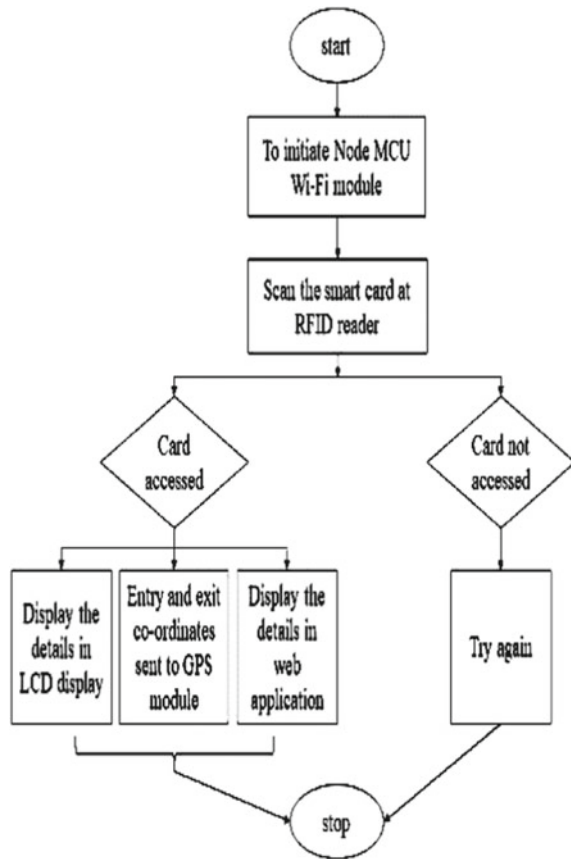
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