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Smart Public Transport System Using Internet-Of-Things

Apsara .S
Dr. Ambedkar Institute of Technology, Bengaluru
apsara.apsara001@gmail.com

Rashmi G. A
Dr. Ambedkar Institute of Technology, Bengaluru
rashmi03ga@gmail.com

Mohan Kumar K .V
Dr. Ambedkar Institute of Technology, Bengaluru
mohankumari401mk@gmail.com

Anitha .L
Dr. Ambedkar Institute of Technology, Bengaluru
anitha512ga@gmail.com

Jyothi .B
Dr. Ambedkar Institute of Technology, Bengaluru
jyothi.basavaraj@dr-ait.org

Abstract: ***Efficient transportation could be an important issue to be considered in public transport system [PTS]. To make a city smart and digitalised this is a small contribution. Smart public transportation system [SPTS] using IOT shows that how IOT can be applied to PTS and present the navigational facilities for urban bus passengers. SPTS provides three novel information services for bus passengers: 1) Micro-navigation [MN] 2) Crowd-aware route recommendation [CARR] and 3) Bus arrival time estimation [BATE]. MN gives fine-grained information or guidance about passenger's bus journey by recognizing and tracking the bus a person boarded. CARR collects the crowd levels of different routes and predicts and suggests the best and less crowded routes to passengers. BATE collects bus locations and predicts the estimated arrival time to passenger's location with shared route details so that BATE will be more accurate. SPTS provides an efficient and reliable PTS which is simple, attractive and user-friendly.***

Keywords: Smart Public Transport System (SPTS), Internet-of-Things (IOT), Navigation System (NS), Micro Navigation (MN), Crowd-aware Route Recommendation (CARR), Bus Arrival Time Estimation (Bate), Smart And Digitalised, Traffic Congestion (Tc).

I. INTRODUCTION

The IOT is an ecosystem where connected physical objects are accessible through the internet. As countries in the world try to improve the standard of living of its citizens, it starts improving the infrastructure of the cities, towns, and villages. Improving the infrastructure of the cities will also include improving cities transportation facilities. Bus systems are backbones of PTS in cities. As cities continue to grow in size providing good transportation facilities is a major issue for its development. Bus transportation is a very convenient means of transportation as a result of which more people depend on buses. But nowadays the reliability on these PTS is being reduced due to many problems such as delay time, no proper location updates, traffic congestion etc. Extremely long waiting time at bus stops disappoints commuters and encourages them to take other means such as using their own vehicles etc. which in turn may lead to TC. An important task for growing cities is to provide effective PTS. To avoid all these problems SPTS using an IOT is intended to provide 1.crowd aware route recommendation [1] system which helps bus rider in taking different routes that are less crowded when the route in which the bus is traveling has traffic congestion. 2. Micro-navigation [1] which helps in providing fine-grained location updates for the passengers through a simple and attractive Graphical user interface(GUI).3.Bus arrival time estimation [2] which gives the information about at what time the bus arrives and at what distance it is to the passengers at the bus stop through a simple and user-friendly GUI.

II. LITERATURE SURVEY

The literature survey is an essential step in software development process. Once a programmer starts developing a project, he needs lots of support which can be obtained from other programmers, websites or books. SPTS using an IOT is the implementation of paper [1] and [2].

Paper[3] says that people living in the city dislike the use of public transport services for the reasons like feeling unsafe, problems with service provision, no direct routes, too much of people crowd and vehicle crowd, availability of private mode of transport, the frequency of buses etc. This leads to the complexity and hassle journey. Paper [4] done was to provide internet services to PTS. The WI Rover System (WRS) has been running on the buses since April 2010 providing Wifi hotspots for the use of passengers. On the survey, 17,567 unique client devices were connected to the WRS. This system provides design, management strategies for the network. This proves that people are towards the usage of network facilities. Paper [5] says that location-based services are done concentrating on mobile guides, transport support, assistive technology etc. The needs opportunities in each area are collected, evaluated and applications are represented based on the demand of public transit service. Those applications that overcome the technical and economic challenges are implemented for public use.

Paper [6] says that there was a research in Dublin city center having two objectives i.e., to examine the stress level and to determine comfort and reliability level of public transport services. This survey proved that stress was very high and comfort and reliability level decreased considerably. Hence to overcome this multinomial logic model was used to eradicate crowded and unreliable services.Paper [7] studies twelve cities in terms of energy usage and greenhouse gas emission [GGE]. Each city reviewed had increased energy usage, GGE, and private vehicle usage. Here author says that private vehicle usage is increasing since people do not compromise on comfort and reliability of public transit system.

Paper [8] says that there are a number of factors like traffic congestion, weather conditions etc. which affects the predetermined bus arrival schedule and hence results in increasing passenger waiting time. So there is a need for the system to predict the accurate bus arrival time and hence reduce the passenger waiting time. Paper [9] says that travel period reliability is a significant factor in PTS and conducted a study on measuring of reliability and standard travel times using bus data from Chicago area. Paper [10] concentrates on quality of service and reliability offered by public transit services. From data collected in a case study of automated vehicle location (AVL), it presents the Transit Capacity and Quality of Service Manual (TCQSM) method for level-of-service (LOS) estimation. Besides ease of use and simplicity, sometimes the system is inconsistent since the system does not consider delay amount, does not states the effects of early departures.

As cities continue to grow in size and population, the challenges faced in PTS are

The public transport like bus, car etc. networks are dense, complex and difficult to navigate. In contrast to private modes of transport the existing modes of transport offer only a low level of comfort and convenience. The bus journey lacks the contextual information about the arrival time, departure time, crowd alert, and micro information about the progress of the journey. The public mode of transport does not have the novel information about the crowd or traffic jam as in private mode of transport example: Ola cabs. Time is the precious thing but the fine information about the arrival, delay and approach time of the bus is not provided in the existing PTS.

The existing public transit service does not have an idea of reducing the traffic congestion or contextual grained information about the journey progress. Hence this leads to the high energy consumption (waiting in traffic) and air pollution. Foremost problem foiling many people from selecting bus service for traveling is its randomness. The current system lacks the quick and accurate updates about the traffic congestion, road constructions, special events or bad weather blocking our journey progress. Tracking Vehicles and notifying riders about estimated times of arrival is a challenging task due to operational delays. The existing system fails to make a city as a smart city as there are no digital technologies and interfaces in our PTS. To make a journey/trip happy the passengers must be provided with timely updates.

Advantages of existing PTS

- Voice out messages provided in some buses for alerting the passengers about next steps.

Disadvantages of existing PTS

- Lacks real-time passenger information
- Lacks Automatic Vehicle location
- Lacks service alerts
- Lacks crowd aware and route recommendation system
- Lacks bus arrival notification systems
- Lacks MN system

III. ARCHITECTURAL OVERVIEW

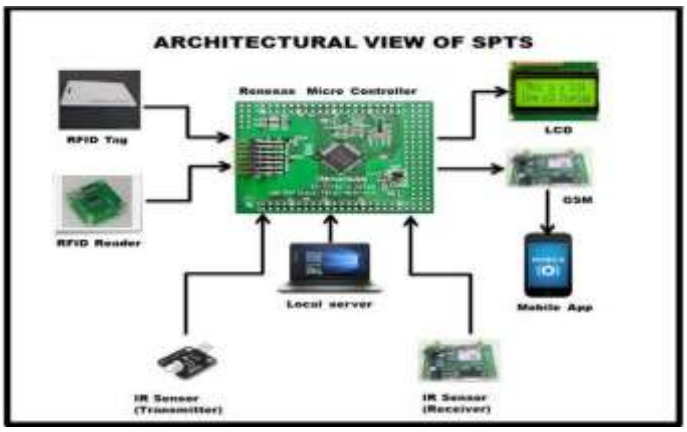

Figure 1: Architecture Diagram of Smart Public Transport System

The SPTS presents a solution to the main problems faced by the passengers as well as the drivers who use PTS as a means of transportation. The main reason for the discomfort and inconvenience in the bus as public means is unpredictable bus schedules. Hence this can be solved through „Real-time bus arrival time prediction" process. The SPTS provides an intelligent real-time alarming system that gives information about the traffic congestion/crowd and suggests the best and less crowded routes. This can be achieved through CARR process. The SPTS is an eco-friendly system through CARR. This process reduces the energy consumption of both human and vehicle getting stuck in traffic and reduces air pollution. For a journey to unknown or known places through public means, one must be aware of the things and stops or routes that come across. Such an assistance of providing the fine grained information about the progress of the journey is achieved through MN in the SPTS.

Advantages of SPTS

- Fine-Grained information through bus journey
- Bus arrival time prediction for passengers.
- The suggestion of best and less crowded routes for riders.
- Real-time information through the android app and LCD displays.
- Smart way of tracking vehicles, providing information to passengers and riders is through IoT.
- Embedding smart technology to real-life.
- Providing comfort and convenience in the journey.
- The relationship between digital and physical components gives good travel experience.

Disadvantages of SPTS

- The CARR module gives only the crowd updates but it does give the information about crowd extent levels.
- In this paper RFID tags and reader are used for BATE and MN. But it is better to use GPS and other sensors for real-time applications.

IV. SYSTEM REQUIREMENTS SPECIFICATION

Software Requirements

- Cube Suite + [CS+] : CS+ is a software used to write the code
- Renesas Flash Programmer: Software package used to program the on-chip flash memory of Renesas microcontrollers [RM].
- Eclipse Kepler: IDE used for programming.
- Embedded C: Contains a set of language extensions for the C programming Language.
- MySQL: is an open-source RDBMS (Relational Database Management System).

Hardware Requirements

- LCD: Liquid Crystal Display
- GSM: Global System for Mobile
- RFID: Radio Frequency Identification [RFID Reader & RFID tag]
- RENESAS RL78 MICROCONTROLLER
- IR SENSORS: Infrared Sensor
- UART: Universal Asynchronous

Receiver/Transmitter.

V. IMPLEMENTATION

RM is the main component. All the other components are connected to the microcontroller as shown in the figure. The other components used are RFID reader, RFID tags, IR sensors, GSM, LCD. The road is attached with RFID tags and a RFID reader will be on a bus. Both tags and reader are connected to the microcontroller. When the bus moves across the RFID tags attached to the road, the RFID reader connected with a bus reads the RFID tag number and provides the corresponding information stored in the database through android application via GSM. The information will be regarding the bus location or arrival time. The IR sensors will be placed across the road to detect TC. Whenever sensor detects vehicles for a specified time interval the LCD displays the message of TC. This message is transmitted to the android application of the bus riders.

5.1 Micro-Navigation

Many passengers who are traveling in a bus will not be knowing which the stop that they have to get down is, at present, they are at which location, at what time they will reach the destination etc. To overcome all these problems the best navigational assistance that can be provided to the public is through micro navigation. MN gives a bus passenger the fine-grained information of his journey.

To reduce the uncertainty and anxiety of the passengers in their journeys progress MN is used. MN system involves semantic hashing scheme which detects the bus in which the passenger is traveling currently and provides fine-grained navigational progress guidance to the passenger. It helps in tracking all the situations that come across the passenger's journey and alerts them through a simple, user-friendly and an attractive graphical user interface.

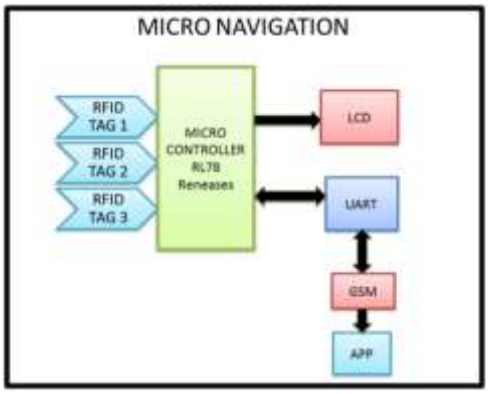

Figure 2: Architecture Diagram of MN

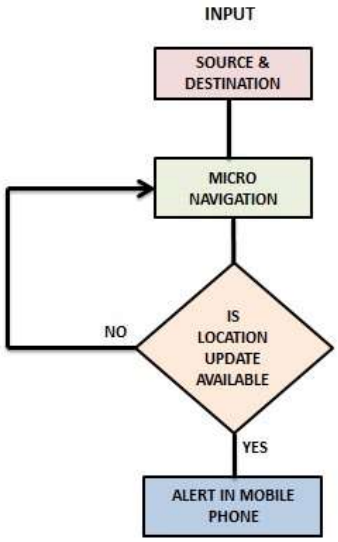

Figure 3: Flowchart of MN

Working

When passenger boards a vehicle, provides the source and destination as input in his mobile application. Tracking scheme executes and tracks the vehicle in which the passenger has boarded. RFID reader will be fixed to the vehicle and RFID tags on the sides of the road. So when the vehicle moves across a road and as it approaches the RFID tag, the RFID reader on the vehicle reads the RFID tag number and sends the corresponding information that is stored with respect to that tag number to the passenger either as a message or voice out. All the information like current stop name, major building's name, organisation, road details etc. will be sent from the server to the client (passenger) through GSM with the means of an android app.

5.2 Crowd Aware Route Recommendation

CARR brings aware about the traffic congestions and recommends the best alternate less crowded routes. Crowd aware route recommendation collects and predicts crowd levels on vehicle journeys to suggest better and less crowded routes to bus riders.

In this growing population of people, even the population of vehicles is growing larger and larger. This leads to the negative impact of traffic/crowd congestion without comfortable and proper navigational assistance.

There is a need for novel information services to resolve the problems of crowd congestion. One such mechanism that supports our idea is „CARR".

However, to sense real-time crowd information across larger scale public transport networks, fully automatic approaches are required which can operate without constant and manual interventions of transport users.

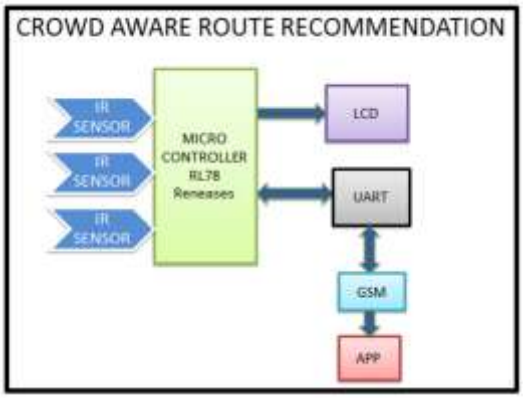

Figure 4: Architecture Diagram of CARR

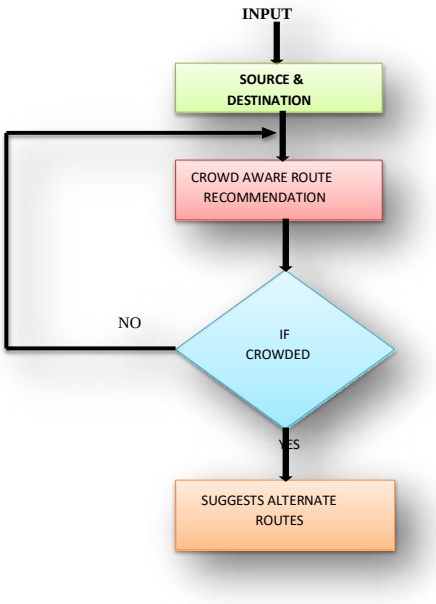

Figure 5: Flowchart of CARR

Working

The IR Sensors installed at the sides of the roads senses the crowd of the vehicles and transmits this information. Sensing of the crowd or crowd aware is done through the time interval mechanism which means that every IR Sensors will be provided with a certain time interval. If the vehicles are dumped in that route or congested until the time elapses or even still, this is sensed as the crowd and this information will be stored in the local laptop server. When the driver wants to know about the traffic updates, if he provides the input as a source, destination and current route in the android app, the timely update of crowd information will be provided along with the awareness about the traffic congestion ahead.

The most efficient and smart feature of this module is that along with the crowd aware alert service it also suggests/ provides the driver with other best less crowded routes. All the information from the server to the client (driver) is provided through GSM with the means of the android app.

5.3 Bus Arrival Time Estimation

The best means of public transport is the bus system. But still, the main reason for the discomfort and inconvenience in the bus as public means is the unpredictable bus schedules. Hence this can be solved through bus arrival time estimation process. BATE module collects bus locations and predicts the estimated arrival time of the bus to the passenger's location with a shared route details. As we know time is a most precious thing, uncertainty and anxiety of passengers are usually due to unnecessary waiting for the bus and wasting the time at bus stops. BATE module provides proper planning of the journey and efficient usage of time.

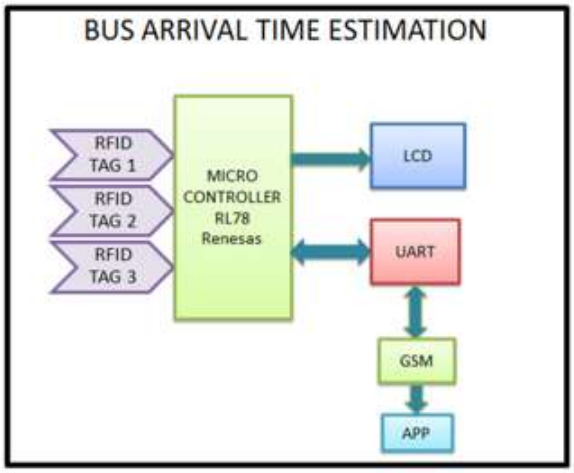

Figure 6 Architecture Diagram of BATE

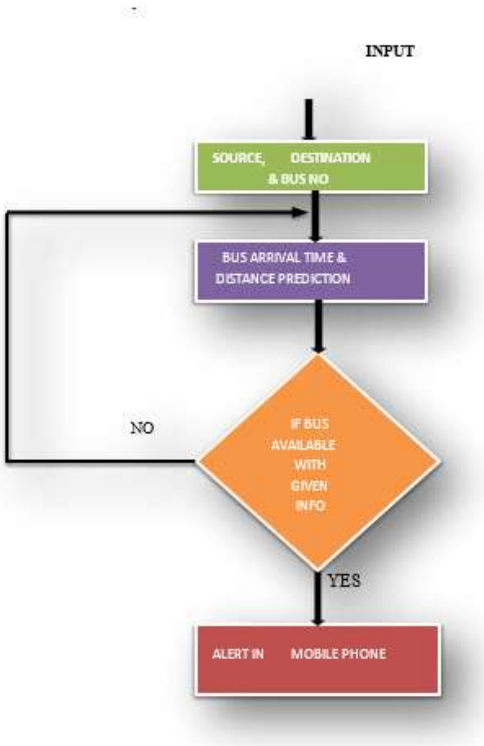

Figure 7: Flowchart of BATE

Working

RFID tags are installed on the roadsides and reader on the bus. The passenger waiting at the bus stop gives the source and destination and required bus number through a mobile app. Once this is done, the current location of the bus will be tracked using RFID tag and reader. After tracking the location of the bus, the estimated time interval to reach the passenger's location will be calculated. This will be done by providing the time interval at every RFID tag to cover the distance. Hence the estimated bus arrival time will be provided as both messages and through voice out. All information about current bus location and estimated bus arrival time from server to the client through GSM in the mobile app.

VI. TESTING AND RESULTS

6.1 MN

This will be the input provided by the passenger through an android mobile application.
Input: Source and destination details.
Output: Navigational details.
Fine-grained information about the things (like stops, major buildings, roads etc.) that comes across the journey.

(a) (b)

Figure 8: (a) Input source and destination of the bus. (b) Corresponding bus stop name is displayed while navigating.

6.2 CARR

Input: Request for crowd update.
Output:

- Crowd aware route alert: This is the information about the traffic congestion or crowd found due to any road construction, special events or bad weather blocking the journey progress.
- Best route recommendation: On sensing the crowd, the driver will be provided with the information about the less crowded routes for making the journey smooth and fast.

Figure 9: **When traffic detected a message is sent In** the Android application.

6.3 BATE

This is the information regarding where the requested bus is.
Input: Source, destination and bus number.
Output: Arrival time estimation
This is the information regarding the accurate time at which the bus would approach the passenger at passenger's location.

(a) (b)

Figure 10: (a) Input the source and destination of the bus. (b) Estimated bus arrival time is displayed on the screen.

CONCLUSION

The review of issues concerned with PTS such as too much of vehicle crowd which leads to traffic congestion and harming the environment by the emission of poisonous gasses, no proper journey updates and unable to predict bus arrival time is addressed. This makes the system unreliable. This paper overcomes all the above-addressed issues with the help of three modules such as CARR., MN, and BATE. The real-time information can be provided to the public in a reliable and efficient manner through GUI using SPTS.

FUTURE ENHANCEMENTS

Furthermore, this paper can be implemented in real-time for public usage using GPS, GSM, SENSORS and RFID Tags etc. By using the assistances of Google Earth and sensors the crowd congestions due to different means like road blockages or processions etc. can be easily detected. Time management can be done in an efficient manner. By this implementation, we can make the city smart and digitalized.

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