

# RFID-BASED AUTOMATIC BUS TICKETING: FEATURES AND TRENDS

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# **RFID-BASED AUTOMATIC BUS TICKETING: FEATURES AND TRENDS**

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Abstract. Recent advancements in various technologies have made remarkable developments in various fields for public welfare and public transport is one such area. In the near future public bus transport system with advanced technologies like Radio Frequency Identification Device (RFID), GSM, GPS, ZigBee and RF modules will gain spotlight due to their advantage of higher convenience and greater life standards as compared to the conventional bus systems. In this paper, a comprehensive review of all several proposed bus ticketing and bus information methods has been presented in detail. The study brings out improved solution in terms of cost, convenience, user satisfaction and future implementation. The choice of working modules and their efficient performance has been discussed along with the highlighted importance of the need of technology for welfare of common public and visually impaired.

#### 1. Introduction

There are around 6.7 billion people in this world, out of which 161 million are visually impaired. There are various challenges faced by visually impaired based on their specific level of vision [1]. For most of the blind and visually impaired persons, the only viable mobility option to seek education, work and social connectivity is public transport [2]. However, they face many complex problems and challenges to navigate especially while walking in the street and catching a bus. Hence, in order to ease the accessibility of transportation for the visually impaired, various solutions are proposed [3]. Also, in traditional ticketing system, each & everyday lots of tickets which are usually paper based which consists of the date and the destination are being printed and sealed. The throwing of tickets by the passengers pollutes the environment and causes a loss of trees from which paper is made. Therefore, a solution is provided by using automatic ticket systems. It enables operators to avoid malpractices such as transferring tickets from one passenger to another and sharing of tickets, which avoids confrontation or mesh between the supervisors and passengers and helps in safer handling of data. It also saves the transportation operators with time and personal costs [4].

#### 2. Background

Authors of the project titled "Voice operated guidance systems for vision impaired people: investigating a user-centred open source model" developed a talking GPS system using a user centred client server approach for easy navigation [1]. It uses a speech-recognition speech-synthesis interface.

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The prototype solution includes a custom web application which accesses the Google maps API. On the other hand, the information in [3] suggests a technology ATVMS (Automatic Ticket Vending via Messaging Service) which uses SMS (Short Messaging Service) or GSM as a medium to issue tickets which is financially and spatially viable. [3]

The race of development continued in the project "RFID navigation system for the visually impaired" designed an embedded RFID reader at the bottom of the walking stick which comes in contact with a number of tags on the ground. The user can enter the destination through voice recognition system and he is guided by the voice output. The menu which can be picked by pressing buttons on the stick gives the user the options such as to hear more information on their current location, identify nearby locations, and receive directions from their current location to the next [4].

Authors in [5] proposed Ticket friend mechanism employed in automatic ticket vending machine consists of smart card RFID reader, PIC microcontroller, ZigBee, GSM which is utilized in bus stand. Ticket friendly machine holds the user account identity. As the smart card is inserted the RFID card reads the user account and the destination entered by the user. ZigBee transmits the data related to transport arrival at that instant of inserting smart cards is transferred and displayed. [5]

Others in [6] proposed two units, a bus unit and a handheld unit for the blind. Bus unit is used to find the availability of blind in the bus station and displays it to the bus driver in the screen that consists of a ZigBee transceiver with a microcontroller. The blind unit consists of a speech recognition system, which identifies the destination provided as a voice input by the blind person and also gives a voice output of the corresponding bus number using ZigBee. [6]

Furthermore, the findings in [7] suggested a glove worn in hand of visually impaired which has an RFID reader and a voice output which indicates the presence of an object around.

This followed by the recommendations in [8] of a system with RFID card which automatically calculates the travel expense by sensing the source and destination locations through GPS. It also monitors the number of passengers entering the transport and also checks if it is equal to the number of passengers and the person can be fined. Authors in [9] developed a system that includes a mobile RFID reader, ZigBee transceiver for transmitting the tag's information and Text to speech converter for obtaining information through voice to the user and on the server side ZigBee transceiver. RFID passive tag network are employed on the path.

Findings in [10] offer a system in which the transmitter transmits the information regarding the details of the bus when the smart card is entered. The transmitter detail received by the receiver helps it to distinguish between different buses. Voice announcement system is used to give the output regarding the details.

In addition, authors in [11] established a system which consists of RFID reader integrated with the ZigBee technology, which provides all information regarding the booking such as the seat number allotted, the cost etc. to both the operator as well as the passenger through GSM.

Researchers in [12] used GPS system and smart cards to make travelling smarter. Smart card holds the data of the passenger and GPS gives the location that helps in distance calculation. When the passenger enters and leaves the bus the smart card can be used and the money that has been paid in advance will be deducted from the card based on the distance travelled.

Authors in [13] sheds light on a system which will help blind people to catch buses easily using vibrating device, alarm and a tactile interface through a wireless communication system between the

transmitter and the receiver. VIPs will also get information about bus arrival and departure time. This system also assists the bus operator to know the presence of a VIP on the road.

Article [14] proposed a system consisting of an RFID tag in the front door to indicate arrival and at the rear door to indicate departure. The passenger can enter information of their departure and destination locations through a keypad which is connected to a reader contained in each bus that is connected to a main server. According to the route distance between departure & destination, it calculates the ticket fare and deducts the credit from the RFID tag based ticket electronically.

Scholars in [15] suggested a user friendly, automated system of ticketing as well as the credit transaction with the use of RFID based tickets. It consists of a automated server which updates every time a passenger swipes the RFID based tickets.

Lastly, authors in [17] proposed a precise and user friendly automated ticketing system using RFID tickets and GPS which will automatically deduct the passenger's fare according to the distance travelled as well as the identify the details of the passenger.

The findings as well as the drawbacks of the aforementioned literatures are summarised in table 1.

Ref. No	Technology Used	Tasks Accomplished	Drawbacks Or Further
[1]	GPS, client server, impaired vision, speech recognition, guidance, navigation	<ul> <li>It uses a user-centric client server approach for the development of a new electronic way finding system.</li> <li>Speech recognition is employed</li> <li>Intuitive hands-free recognition technology</li> </ul>	<ul> <li>Electronic compass</li> <li>Announcing distances</li> <li>Use push to talk</li> <li>Can be used to navigate buses.</li> </ul>
[2]	GSM, ATVMs	<ul> <li>Tickets are generated using card.</li> <li>Data is transmitted from station server to main server and from main server to parent server within small intervals of time.</li> <li>The details are deleted automatically in every two days from the main server</li> </ul>	<ul> <li>Full scale modelling can be done further.</li> <li>Mainly applicable for Indian railways.</li> <li>Inclusion of facilities for visually impaired is possible.</li> </ul>
[3]		• A walking stick with RFID reader gives voice output for navigation depending on tag's location	<ul> <li>More than one RFID tag is required.</li> <li>Integration of this unit with mobile.</li> </ul>

Table 1: Summary of literatures

		• Also, user can pick a menu on the stick for easy navigation	
[4]	RF technology, Voice Announcement, GPS	Bus is identified by this passenger infotainment system	• No ticket vending is done
[5]	Wireless sensor networks, Speech Recognition System, Voice Synthesizer, GPS, ZigBee.	<ul> <li>The blind gives the input about the place he has to reach</li> <li>The desired bus that the blind want to take is notified to him</li> <li>There is an alarm in the bus unit alerting the presence of blind</li> <li>The blind is intimated when the bus reaches the correct location</li> </ul>	• It is the responsibility of the bus driver to guide the bus towards the blind.
[6]	RFID Tag, RFID Reader, Ultrasonic sensors.	<ul> <li>A beep sound is produced if an object is detected in front of the Glove.</li> <li>A spectacle with ultrasonic sensor gives directions through a value output</li> </ul>	<ul> <li>Further this can be employed to guide a blind person towards a bus.</li> </ul>
[7]	RFID	<ul> <li>Details of the user are stored in the tag.</li> <li>Tag is swiped and the ticket is generated automatically</li> </ul>	Remaining balance can be shown.
[8]	Navigation Recognition, RFID, ZigBee, text to speech.	<ul> <li>RFID tags are present along the pathway for navigation.</li> <li>Also, data that is, person's details is stored in the tags</li> </ul>	<ul> <li>Communication delay is there.</li> <li>Inclusion of the destination can help in better navigation.</li> </ul>
[9]	RFID , ZigBee, GPS, PIC microcontroller	<ul> <li>The details of transport can be predetermined.</li> <li>Automatic ticket vending</li> <li>Alcohol sensor detects if a person is drunk and does not allow him inside.</li> <li>The route map is shown by GPS and voice.</li> </ul>	<ul> <li>GSM facility can be included</li> <li>Details of the remaining balance can be shown.</li> </ul>
[10]	RFID reader, ARM Processer , GSM, GPS and ZigBee	• Automatic seating allotment of the passenger and ticketing details sent to bus	<ul> <li>It is difficult for blind person to enter data in the keyboard if he is uneducated.</li> </ul>

		<ul> <li>operator through GSM</li> <li>Use of smart card to enter the bus as security.</li> </ul>	• Arrival and departure details are not known.
[11]	Electronic Bus Ticketing, GPS, Smart Card, RFID.	• The smart cards and GPS systems are used for automatic ticketing	• Further upgrade by using ATM cards instead of smart cards
[12]	RF transmitter/ receiver, VIP, PDA(Personal Digital Assistant): VIPs hand held device, RF Module, Bus Module	<ul> <li>Blind gets information about bus arrival and departure time</li> <li>Assist the bus operator to know the presence of VIP on the road</li> </ul>	<ul> <li>Ticketing of blind person is not done</li> <li>It is the responsibility of the bus driver to guide the bus towards the VIP</li> </ul>
[13]	Radio frequency identification detection(RFID)	<ul> <li>User gets the information of the bus, the route of the bus along with the arrival time</li> <li>Screen in bus shows the next destination of the bus.</li> </ul>	<ul> <li>Inputting source and destination is time consuming.</li> <li>Notification can be given to user also.</li> </ul>
[14]	RFID ticketing; Public transport system;	<ul> <li>The screen at every bus stop notifies the departure time of the last bus of any route.</li> <li>The money is deducted automatically based on the input.</li> </ul>	• Money left in the account after transaction is not mentioned.
[15]	RFID, ARM processor, GPS	<ul> <li>Data is read, filtered and false reads are eliminated.</li> <li>Money is automatically deducted from the account.</li> </ul>	<ul> <li>Bill is printed which leads to overuse of paper.</li> <li>GSM can be used for ticketing</li> </ul>

#### 3. Overview of Used Technologies

## *3.1. Radio Frequency Identification and Detection (RFID)*

The Radio-frequency identification (RFID) is a wireless technology that uses low frequency radio signals ranging from 3 kHz to 300 GHz in order to transfer small bits of data between RFID devices [4]. An RFID device consists of two fundamental components: tags and readers [2]. The communication between the reader and the tag is achieved via the transmission of electromagnetic waves. A reader is used to magnetize the tag and decode the information from the tag. Tags store and process information stored in it [7]. A reader emits radio frequency signal which interacts with the tag. This energizes the pin or bar code producing its own magnetic field with a unique interference pattern which corresponds to a unique number which is read by the tag [7].

Tags can be classified based on their power source and maximum range as active, passive and semipassive. Now an active and semi- passive tags have internal batteries, which increases the cost of the tag. In addition, semi- passive tags require an advanced internal hardware. Hence, its use is not viable. The various parameters by which active and passive tags are classified are listed in table 2.

Characteristics	Active RFID	Passive RFID
Power supply	By battery	No power source
Signal Broadcasting	Automatic	After read is read
Communication range	Long Range >=200m	Short Range <=3m
Sensor Activity	Continuous Monitoring	Only when tag is powered by reader
Speed	High speed	Limited speed
Power requirement	Low power levels	Higher power levels
Security	High	Low

#### Table 2: Comparison of Active and Passive RFID

Passive RFID is of interest because the tags do not require batteries or maintenance. The tags also have an indefinite operational life and are small enough to fit into a practical adhesive label. RFID has an attractive economic proposition [2].

#### 3.2. Smart Card

Smart cards also called as touch and go cards can be used as a replacement to cash, tokens and passes. Smart card refers to a memory or microprocessor is embedded in a computerized chip which is called as smart cards. A convenient and secured way of data storage and transfer is provided [11].

# 3.3. ZigBee

ZigBee is a small size wireless sensor network. It is an embedded device having processing and computational capability consisting of a radio frequency (RF) transceiver, on board sensors/actuators, memory and a power source [15]. The RF transceiver used in ZigBee is IEEE 802.15.4 compliant and 2.4 GHz true single-chip CC2420 designed for low-power and low-voltage wireless applications and is used to transmit or receive the data [6].

# 3.4. Global Positioning System (GPS)

The Global Positioning System (GPS) is a space based radio navigation system that provides reliable navigation, positioning, and timing services to civilian users on a continuous worldwide basis. GPS receiver retrieves the latitude and longitude and hence helps in determining its position and time [6]. Hence, it can be used to obtain the source and destination locations of a passenger while travelling [7].

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## 3.5. Ultrasonic Sensors

Ultrasonic sensor emits continuous ultrasonic bursts of short duration which rebounds while encountering any object. When the echo is detected, the output pulse provided by the sensor to the host terminates. Hence, the distance of the object corresponds to the width of this pulse.

# 4. Inferences

## 4.1. Inferences on Use of RFID

RFID has greater data-collection capabilities than magnetic [2]. The waves used in RFID are the lower ones in the electromagnetic spectrum and hence are not dangerous [15]. Also, it is proximity based rather than being based on swiping or scanning [4].

# 4.2. RFID over Ticket Vending

In conventional paper based ticketing, the bus conductor prints and seals lots of tickets with the fare and the date on the ticket. These tickets are thrown away after the travel by the passengers polluting the environment and causes loss of trees from which the paper is manufactured [15].

Using automatic ticket systems time and personal costs of the transportation authorities can be saved. It enables an organized way of fare collection. Low maintenance costs and reduced fraud-induced losses are the further advantages [15].

## 4.3. RFID over Smart Card

RFID is cost effective as it requires lesser memory space. It provides a single technology system which reduces the maintenance cost. RFID ticketing provides a single technology system which consequently reduces the maintenance cost [11].

# 4.4. RFID over GPS

GPS tracking device, which can locate irrespective of the weather conditions, can prove to be unsuitable for tracking the location of a bus in sub- terrestrial bus stops since a line-of-sight is demanded between its transmitter and receiver ignoring which causes attenuation of GPS signals [5]. This can be overcome by using RF transceiver that has a communication range of 1000m and demands neither line-of-sight communication nor satellite communication [2]. Hence RFID based ticketing is much more user friendly, durable, easily operable, reliable, affordable and portable [15].

Also, some of the GPS systems require an input and/or output to be given using Braille keyboards whereas not all visually impaired people can read Braille [1].

## 4.5. RFID over Image Processing

Bus identification using image processing is done by using a web camera fitted in the walking cane of a blind. But the image quality of the web cam and requirement of line-of –sight between the object and camera are the real challenges faced. Also, recognition of tags during night time or during a cloudy day is tough. These drawbacks can be overcome by RFID technology effectively [6].

# 4.6. Inferences on Use of ZigBee

ZigBee offers a cost effective and two- way communication. Also, the communication in ZigBee is not affected by interference unlike in radio signals used in RFID technology [6].

#### 4.7. Inferences on Use of Ultrasonic Sensors

The various constraints produced by RFID technology such as interference and complexity can be overcome by the combined usage of RFID circuit and ultrasonic sensors [7].

#### 5. Suggested Solution

The proposed model is divided into two modules. In the first module, the ticketing process will be automated with wireless banking facility. The wireless banking is made possible using RFID card and reader. The passenger will possess a card which will hold the primary details of the particular passenger in the memory. At the boarding and destination point when the passenger will bring the card in the vicinity of the reader the details in the card will be transmitted through radio frequency. The reader receives the data and sends it to the micro controller unit for further processing. Using GPS module the boarding and destination location will be fetched thereby generating travel fare and the details regarding the travel will be intimated to the passenger using GSM. The block diagram for this module is shown in Figure 1.



Figure 1.Hardware Module I for automatic ticketing

The second module will be a hand held device for visually impaired people which constitutes of RF module through which when the bus driver will be heading towards a particular bus station will press a key which will initiate the transmission of the details of the bus to the hand held module of the visually impaired person. On receiving the radio frequency the signal will be decoded by decoder and the details will be given to the visually impaired through a voice output. This module is also provided with an ultrasonic sensor for uninterrupted navigation. The block diagram of the blind unit module is as shown in Figure 2.



Figure 2.Hardware module II for visually impaired person

# 6. Conclusion

This paper gave an in-depth review of latest features and trends of automatic ticketing techniques out there. It is shown that some proposed solutions give cheaper, more precise and easier use than others. The ultimate goal being making the life of the layman and impaired easier by providing them with bus notification through voice output and help navigate freely.

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