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Fool Proof Ticketing System for Public Transport

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***Abstract*—The world is moving towards automation. The job of conductor is one of the many that is on the wane due to automation. The most popular form of automated ticketing is using RFID. RFID based ticketing system is inexpensive to implement and reliable in operation. Cities across the world have successfully implemented this technology in metro trains and some cities like Singapore have also successfully implemented in the buses. The void that lies in all the above-mentioned places is a fool-proof system. The systems rely on the promptness of the passengers for ensuring ticketless travel. This paper presents a method to avoid ticketless travel by implementing a two-way authentication for the head-count. A mismatch in the outputs of both would imply ticketless travel**

***Index Terms*—Automation, Cloud, Fool-Proof Public Transport, RFID, Ticketing, Ticketless Travel, Urban development**

I. Introduction

RFID has wide applications, from being used in smart cards all over the world to access and control various objects. RFID has been used to a certain extent in major cities around the world. The proposed system can be used for systematic operations in several cases.

In the megacity of Bengaluru, most of the bus travel is ticket based which leads to unnecessary confusion and complications. Such a system often leads to corruption, system loss and is cumbersome. The proposed system merges tracking and ticketing to solve the persisting problems. RFID based system also has the advantage of being user friendly, cost effective and easy to operate. As RFID functions at a high speed, it can perform effectively even if there are a large number of users.

The public carrying the RFID-enabled smart card will have access to all the buses plying through the city. The system will store user data automatically and will transfer the required data to the main server. The server will automatically update the transactions for each user. This automated system will be easy to use, reduce the losses and prevent the chaos which occurs in buses.

II. Literature Survey

In [1], The paper describes about the implementation of automatic ticketing system in the city of Dhaka. It deals with deploying RFID readers on the bus for the passive tags issued to the users. There's also an implementation of the detection algorithm which controls the entry and exit of passengers. There are 2 tags installed in the bus – one at the front and another at the rear. The RFID reader present at the bus stop reads the tag installed at the rear of the bus and this used to log the arrival and departure times of the bus at the bus stop which helps the transport corporation to monitor the punctuality of the operations.

In [2], the ticketing system is based on the precise calculation of the distance travelled by the bus. A device called cyclometer is coupled to the wheels of the bus which works in a way very similar to the hall effect sensor used for measuring the total number of wheel rotations and hence determining the distance travelled. The fare from the user's credit would be withdrawn in accordance with the distance travelled.

III. Overview of Technology Used

A. Radio Frequency Identification (RFID)

The Radio-frequency identification (RFID) is a wireless technology that uses radio signals ranging from 3 kHz to 300 GHz. It is mainly used to transmit data of a few bits. An RFID device consists of two fundamental components: tags and readers. A reader, also known as the interrogator, emits radio frequency signal which interacts with the tag. The tag then responds by sending its Unique Permanent Identification (UID) number burned-in during the manufacturing process.

IV. Hardware Description

A. RFID Tag

RFID tags are of 2 types: Active and Passive. Every RFID tag has a microchip and an integrated antenna. The microchip contains the UID. These cards may be of different size and range. Passive tags (tags without batteries) have long life and shorter reading range and are ideal in cases of mass identification and less capital investment. Cards shaped S50 RFID cards are ideal for the usage for Public Transport. Passive tag is chosen in this project.

B. RFID Reader

The module used in the proposed UHF based system the reader is chosen with an interrogation range of a few centimeters. Readers with ISO8000–6C protocol compliant can read multiple tags as these active readers transmit power mainly by electric vector.

C. *Core*

The core part of the system is a simple 8-bit microcontroller with an on-chip Wi-Fi to access the cloud storage for the data of the tags scanned at the bus stops.

V. SUGGESTED SOLUTION IN DETAIL

A. *Methodology*

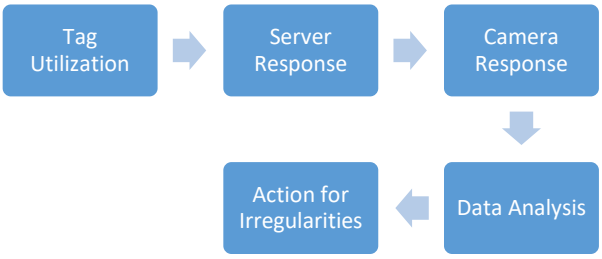

Figure 1: Block diagram of the methodology abstraction

- When the bus reaches a bus stop, the driver will have to press a button which wakes the microcontroller from the sleep mode.
- The RFID module is initialized to scan the tags and scans the tags at 2-3 tags per second.
- After the scan of the tags, the driver presses the button again which stops scanning of the tags.
- The scanned tags are compared with those already scanned to check if it marks the alighting of existing passenger or boarding of new passenger.

Meanwhile the camera installed detects the movement of passenger and matches with the data of the RFID reader. If the numbers do not match, action will be taken against irregularity.

This technique will help in optimizing latency. About 40 tags can be read in 12 seconds which is the average stop time of a bus in a bus stop.Another advantage of RFID is that it does not require Line of sight (LoS). [4]

The proposed MFRC522 is a highly integrated reader/writer IC for contactless communication at13.56 MHz. It has a high transfer speeds up to 848 kBd in both directions. Various serial communication protocols are supported. Operating one slave device would be best implemented using SPI thereby avoiding the overheads of addressing. [7]

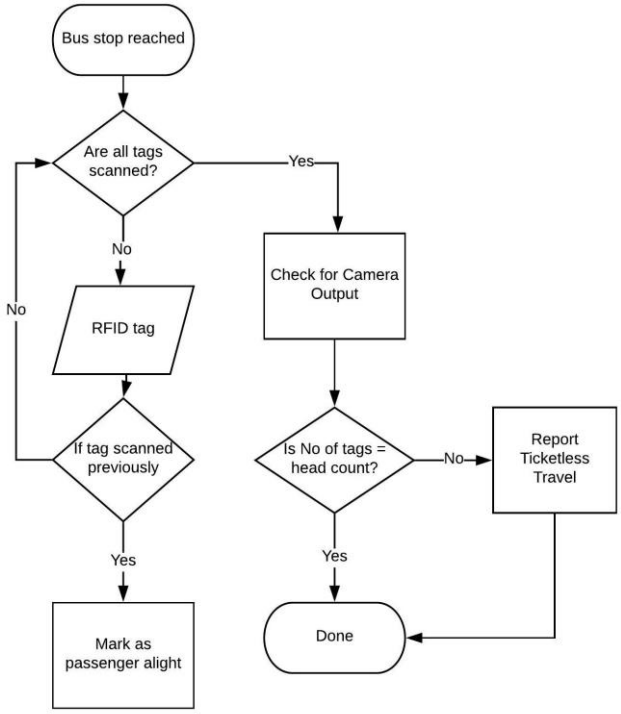

Figure 2: Flowchart showing on site operation of the proposed device at every bus stop

B. *Software Challenge for Geolocation*

The software implementation Geolocation helps in minimizing hardware complexity to a great extent. The biggest advantage of software (firmware) is maintenance. If there is a plan to include means to upgrade or change the firmware, it enables deploying as many revisions as possible to match the requirements which is not possible on hardware.

Other than that, it's a matter of complexity. If the hardware solution turns out not to be too complex, it's preferable to go without software and the required microcontroller or processor. If it reaches a point where the hardware design would become too complex and/or take up too much PCB space, then the hardware solution would not be commercially viable.

The proposed solution has software implementation for obtaining Geolocation of the bus. The Geolocation API by various vendors such as Google enables the operator to make HTTP requests to get the coordinates of the current position.
The Geolocation API defines a high-level interface to location information associated with the hosting device, such as latitude and longitude. Common sources of location information include Global Positioning System (GPS) and location inferred from network signals such as IP address, RFID, Wi-Fi and Bluetooth MAC addresses, and GSM/CDMA cell IDs.

C. *Working of Geolocation*

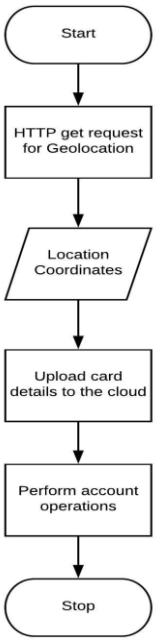

Figure 3: Flowchart showing the working of Geolocation process.

When the bus reaches the bus stop, a HTTP request is made using the Geolocation API. The RFID tags scanned will be updated with their locations in the server. Then when the tag is scanned again while the passenger is alighting, the Geolocation is updated again. The distance travelled will be obtained via the source and destination coordinates.

HTTP request can be performed once the TCP connection is established. The HTTP/1.0 specification defined the GET, POST and HEAD methods and the HTTP/1.1 specification. [6]

The convention has been established that the GET and HEAD methods should not have the significance of taking an action other than retrieval. These methods ought to be considered "safe". Therefore, GET is chosen over other methods.

The response sent by the server back to the client is handled by the request controller on the client side which is decoded in XML or JSON. The data in the JSON format is extracted to obtain the Geolocation.

VI. COMMUTER DETECTION

Bus corporations around the country face huge losses due to ticket-less travel. The proposed system plans to curb this loss by detecting the commuters or passengers in the bus.

A method called Single Shot Detection (SSD) is used to detect the commuters. SSD is a method which was first developed by Google and then further improved upon by the open source community. SSD tend to be more accurate and simpler to use than other available methods. It also provides a higher throughput.

In SSD, we use a single deep neural network to detect objects. Here we use bounding boxes for the requisite objects. The boxes are discretized based on the information available to the SSD and the scaling is done based on the feature map location. When the prediction has to be done the network generates a range of values based on the boxes produced in the previous step. Necessary adjustments are made to match the object shape. Data from multiple feature maps are combined so that objects of various sizes can be handled with ease.
The proposed SSD model is simple relative to other methods. These other methods require object proposal and re-sampling which increases the complexity and reduces the accuracy. The proposed model is easier to train as it encapsulates a large number of functionalities into a single network. Experimental results have proved that our model is faster and more accurate than its contemporaries. The model also has high accuracies with small image sizes.

This paper proposes multiple cameras to be used in the bus so that we can quantitatively identify the number of commuters travelling in the bus. By comparing this identified value with that of the commuters who have used their cards to travel by the bus we can determine the number of ticket-less commuters. With this information, necessary action can be taken.

The major difference between the proposed system and that presently being used is the usage of live video stream which are provided by the cameras to determine the number of commuters and the ability to take real time action.

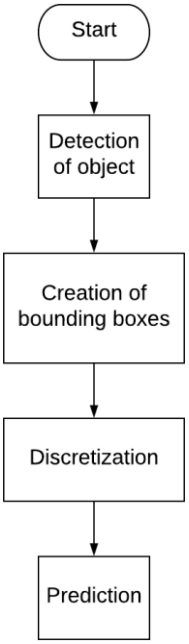

Figure 4: Flowchart for commuter detection.

VII. CONCLUSION

The proposed system is expected to be fully automated, fool-proof, easy to maintain and convenient. The whole system can also be used for other modes of transport as well. Using this

system, we can prevent any unwanted events from occurring. Minimizing the hardware also implies easier reconfiguration, increased reliability, much lesser maintenance expenditures. By monitoring the passengers during their journey, we can prevent the menace of ticket-less travel from occurring. There are various possibilities such as reducing traffic jams and the chaos which is experienced in a bus stop of any large city can be avoided.

VIII. RESULTS

User ID	Date & Time	Latitude	Longitude	Available Balance
8E644283	13/04/2018 09:20:06	12.92000	77.50000	Rs20.00
D0F17889	13/04/2018 09:20:10	12.92000	77.50000	Rs40.00

Figure5:Portal implemented for collecting data such as the tag UID, date & time, the Geolocation and Available Balance.

```
 UID tag : 8E 64 42 83
 Entry passenger 1
0       100
Existing balance =
100


 UID tag : 8E 64 42 83
 Exit passenger 1
0       90
Existing balance =
90


 UID tag : 8E 64 42 83
 Entry passenger 1
0       90
Existing balance =
90


 UID tag : 8E 64 42 83
 Exit passenger 1
0       80
Existing balance =
80
```

Figure6: Showing the activities just after the bus enters the bus stop. 'Passenger 1' is an example of a passenger boarding and alighting the bus.

Figure7: Commuter face detection is done by the camera installed.

In figure5, the google document records the changes in each of the RFID tags after each transaction (or commute).

In figure6, we can see the real-time changes of the values in the RFID tag.

In figure 7, the proposed system produces bounding boxes around the faces of the commuters which is used for detecting the number of commuters in the bus.

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