Smart Transportation for Smart Cities

Rohan Rajendra Patil(✉) and Vikas N. Honmane

Computer Science and Engineering,
Walchand College of Engineering, Sangli, India
rprohanpatil2@gmail.com, vhonmane@gmail.com

Abstract. Bus transportation is an important mode of public transportation as it is preferred by many people every day. This mode of transportation plays a huge role in everyday life. But even when so much is dependent of bus transportation, currently there is no system which makes this journey easy and convenient. People face various problems while travelling by bus. Over-Crowded buses and their unpredictable timings make the bus journey very inconvenient. So to provide the bus passengers a convenient way to travel, this system can be used. This system provides crowd information and expected arrival time of the buses to the user's smart phone. The user can be anywhere and with the help of the mobile application, the user can find out the crowd in the buses, their arrival timings etc. which helps the user to take better decisions. Also other features like nearby bus stops is available in user's application. This will reduce the inconvenience and provide systematic way to travel.

Keywords: Smart transportation · Location based crowd calculation
E-ticket using passenger's biometric · Bus travel
Travelling smart phone application

1 Introduction

Many People need to travel every day. Millions of people choose buses as their mode of transportation. But even when buses play such an important role in public transportation, there is no system which makes the bus journey convenient. Even today many people dislike the bus journey due to the over-crowded buses and their unpredictable arrival timings. Pollution is one of the major issues of today. Looking at the pollution levels around the world, we need to fight pollution whenever and wherever possible. Vehicles cause lot of pollution and we can reduce the number of vehicles on the road by diverting people towards buses. Buses have the capacity to accommodate many people. The proposed system makes the bus journey easy and convenient for the passengers. This directly lead to less cars and less pollution.

This system provides estimated arrival time along with the crowd in the bus to the passengers who are using the mobile application. The passengers can be anywhere and they can see which bus to take, when will that bus arrive, how much crowd is there in that bus etc. The user can decide which bus to take and avoid the crowd and inconvenience caused during bus travel. When a passenger enters a bus, this system only needs his/her destination stop and mobile number or fingerprint. The person is

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identified and the ticket is sent to his/her phone via sms. This system saves tons of paper everyday.

2 Related Work

Few researchers have explored this sector and few systems have been developed. But all these systems are far from prefect.

In [1], a Wi-Fi based crowd detection system is explained. This system is deployed in Madrid. The major problem with this system is it detects crowds based on the number of people connected to the bus router. This is unreliable method as many people avoid connecting to the bus Wi-Fi. In [2], a system which is deployed in Pune and Ahmedabad is explained. This system provides the distance and time after which the bus will arrive to the user's bus stop.

In [3], the real time challenges in tracking the bus using GPS is explained. The problem increases when adjacent roads are present. The GPS may show the bus on the wrong road. In [4], explains an application called OneBusAway. This was the first app to bring the estimated arrival time on the user's smart phone. The results clearly showed that access to arrival time increased the satisfaction with bus journey. In [7], QR codes are used to identify the bus stops and search the buses according to the QR code scanned.

In [5, 6, 8–10], tracking algorithms are explained. All the papers explain how a bus or vehicle can be tracked and the estimated arrival time can be sent to the user's smart phone.

3 Methodology

In this system a central server plays the most important role. In short this server is responsible to track and collect all the information about all the buses. The server then manipulates this information and send it to the user's smart phone application.

The system consists of three main components:

3.1 Mobile Applications of Conductor and User

The conductor in each bus has a mobile application. This mobile application can replace the traditional working of the conductor. The mobile application can issue tickets to the customer and also scan the monthly passes. After issuing the tickets or scanning any pass, the ticket and monthly pass information (source and destination stops) is passed to the central server. The location of the bus is constantly updated to the central server. When a ticket is issued, a sms is sent to the passenger which contains the ticket details (Fig. 1).

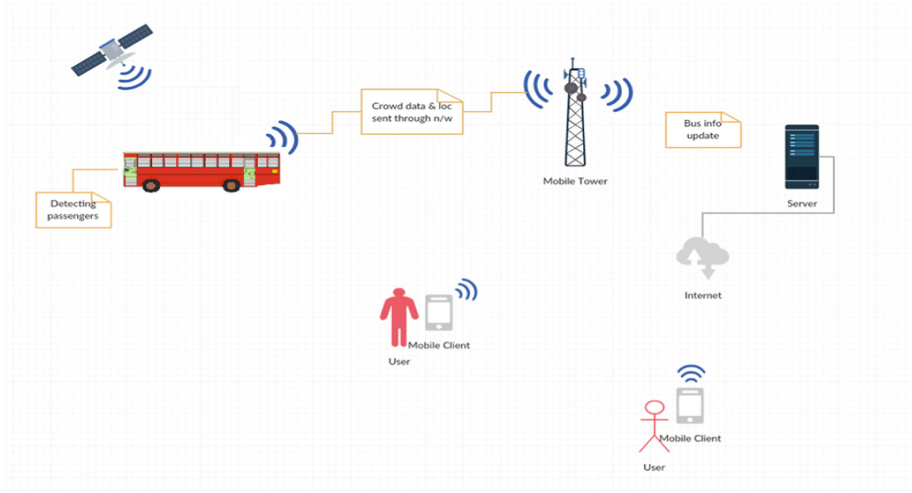


Fig. 1. System diagram

3.2 Central Server

The central server keeps track of the buses at all the time. Different buses are on different routes at a given time, all the buses have their bus id to distinguish them from others. The conductor's application constantly sends the ticket and pass information along with the location of the bus to the central server. The server collects this information and performs its task of crowd detection. Then this information is made available on the user's smart phone application through internet. The user can find out the crowd in the bus, also the server has information like all the bus stops and routes and timings of all the buses etc. so user can find out next bus, nearest bus stops etc. To inform the user about estimated arrival time, Google maps api is used and by entering source destination as the bus's current location and destination as the preferred stop, the system finds out the estimated arrival timing. With all this information, the app also provides crowd prediction based on previous crowd levels. For this Artificial Intelligence is used.

The central server calculates crowd by maintaining a counter. Initially, the counter is initialized to 0. Whenever new tickets are issued or pass is scanned, the counter is incremented based on the number of tickets and monthly passes. The server constantly tracks the bus and it also has the ticket information containing source stop and destination stop. So whenever the bus reaches a stop, it checks for tickets and passes whose destination stop is the current stop. These number of tickets and passes are stored in temporary variable and the temporary variable is deducted from the counter. Thus we get accurate crowd information everytime.

- Initially, Counter Ci = 0;
- Counter Ci = Ci + Tickets issued + Monthly passes scanned.
- Temp ti = All the passengers whose destination stop is the current stop.
- Counter Ci = Ci − ti.

3.3 Artificial Intelligence

Artificial Intelligence algorithms can be used here to predict the crowd. Some algorithms are Decision Tree, Naive Bayes, Hidden Markov Model etc.

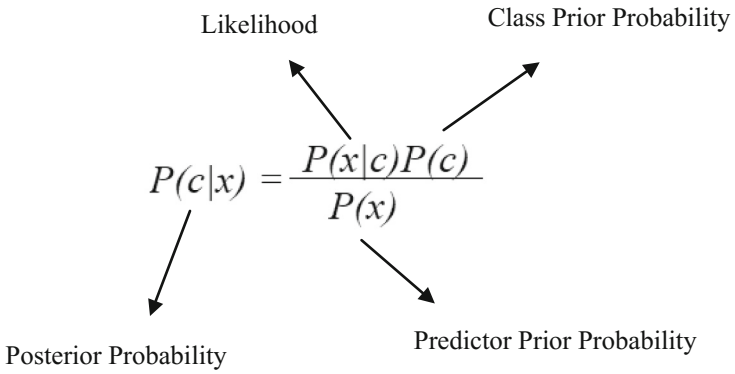
Decision Tree: Decision tree is a model of decisions and their possible outcomes. It is a supervised learning model, which is used for classification. Entropy is calculated as follows.

$$\text{Entropy: } - \boldsymbol{E}(\boldsymbol{S}) = \sum\nolimits_{i=1}^{c} -P_i \log_2 P_i \tag{1}$$

When the set is divided on attribute, Information gain is calculated, it is gained with the decrease in entropy. To select attribute on which splitting should be done is selected by high entropy. The decision tree has few problems decision tree construction is complex and as data changes tree need to be update.

Hidden Markov Model: HMM consists of finite set of states and each of its stated are associated with probability distribution. Transition form one state to another state is given by transition probabilities. In a specific state, an output is generated according to associated probabilities.

Naïve Bayes: Naive Bayes algorithm is used for constructing classifiers: models that give labels to instances of problem, demonstrated as vectors of feature values, here the labels are taken from some specific set.



- P(c|x) is the predicted crowd levels in the bus according to the month.
- P(x|c) is the Likelihood of the crowd levels in that bus.
- P(c) is the past experience of the crowd levels in the bus.
- P(x) is the past experience of the crowd levels in the month.

4 Internal Data Processing

The internal data processing of the system is showed below in Fig. 2. When a passenger enters a bus, the conductor asks for destination stop of the passenger. The conductor can either enter the mobile number of the passenger or scan the finger of the passenger. The fingerprint details are sent to Aadhar database. The mobile number of the passenger is fetched from the aadhar database. The ticket is sent to the passenger's mobile phone through sms. İf the fingerprint is used instead of entering the mobile number manually then lot of time is saved while issuing tickets. The conductor can issue ticket in three simple steps, the conductor has to enter source stop, destination stop and scan the finger of the passenger. The ticket will be automatically sent to the passenger via sms. The conductor can also scan monthly passes of the passengers. The source and destination stops of each passenger is known to the conductor's app. The application sends this data to the central server along with the location of the bus. This information is sent using internet. The server acquires this information from all the buses. The server then keeps track of the crowd in all the buses. Initially the crowd counter is initialized to zero. When a ticket is issued or pass is scanned, the counter is increased and when the bus reaches a bus stop, all the passengers whose destination stop is the current reached stop are reduced from the counter. Thus we can accurately find out the crowds in all the buses. The mobile application uses Google Map api. Thus by entering the current position of the bus as source stop and by entering passenger's stop as destination, estimate arrival time is found out. The crowd information and the arrival time is sent to the user's smart phone app. If the user thinks that the arriving bus is too crowded, then the user can see the list of all the buses which travel to the user's destination. The user can select any bus from the list which suits their timing and view the crowd in that bus and also the estimated arrival time.

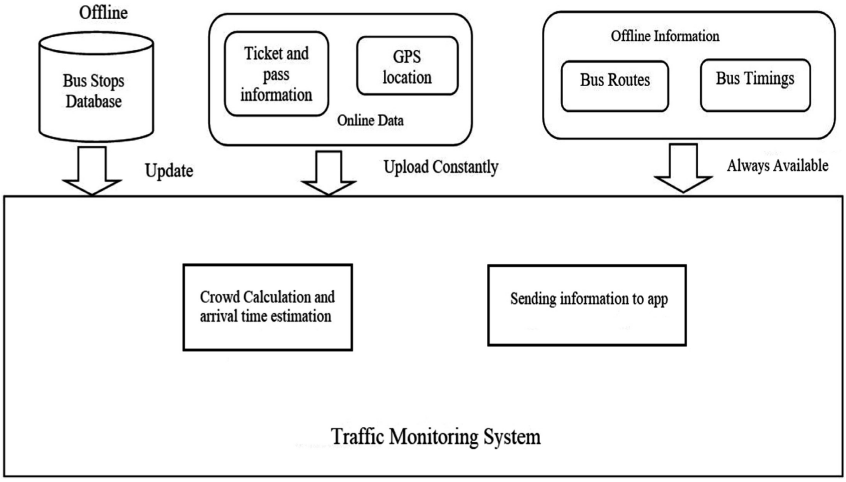


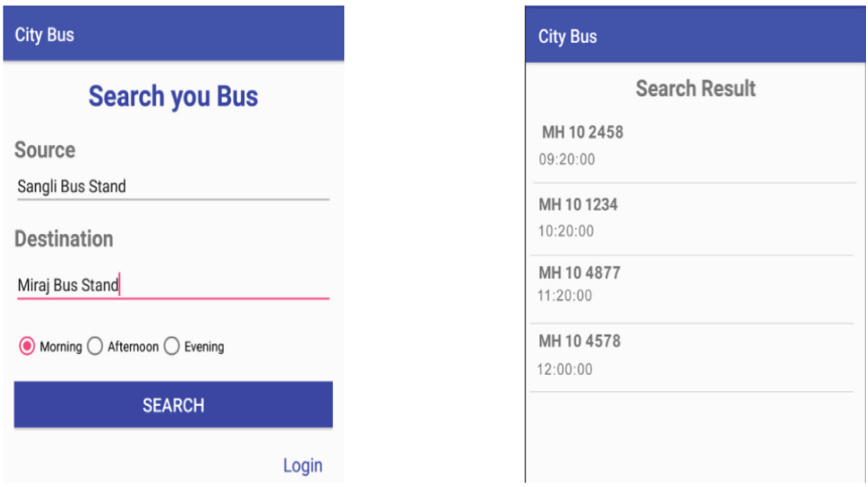
Fig. 2. Internal data processing

All the information about all the buses, their timetable, their routes, all the stops is stored in database. This information is stored on central server and is available offline. This information is very rarely updated. Online data is collected in buses. As tickets are issued their source and destination stops and source and destination stops of the monthly pass passengers is collected and sent to the server along with the location of the bus. This information is constantly updated to the central server. The updated information is collected by the server and is processed with offline information. The user can be anywhere and with the help of the mobile application the user can find out the appropriate bus, the crowd in that bus, location of the bus, timing of next bus etc. The app also provides many other features like nearby bus stops.

5 Results and Discussions

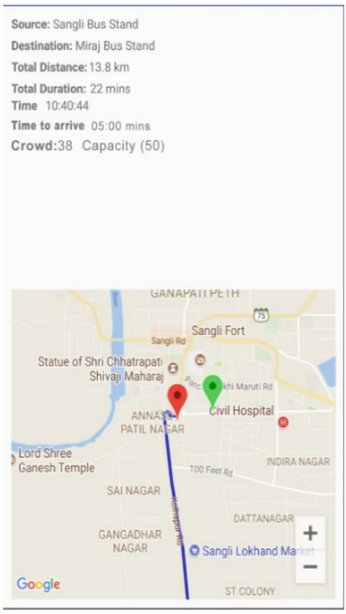
The user application needs only source, destination stops and timing of travel. The application appropriately finds out the buses and provides a list of available buses. The user can find out the appropriate bus from the list.

Figures 3a, b and 4c show the mobile application of user. The buses are fetched perfectly. The user can see the whole list of the buses. After choosing a bus, the user can see all the details of that bus like crowd in that bus, estimate arrival time of the bus, duration of the journey etc. The user can find out the suitable bus based on these details.

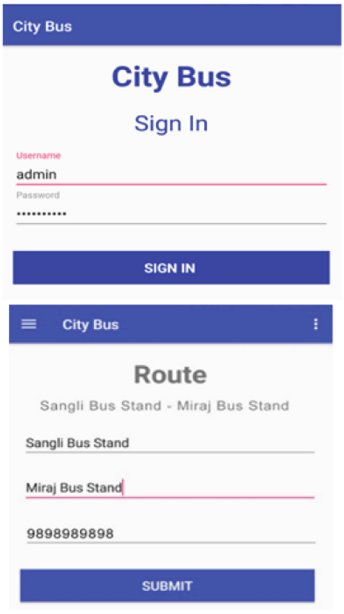


(a) (b)

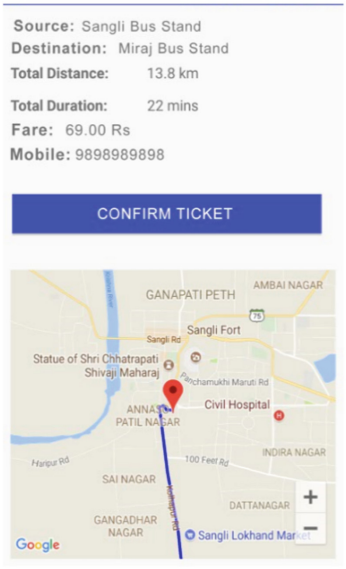
Fig. 3. Screenshots of passenger's mobile application



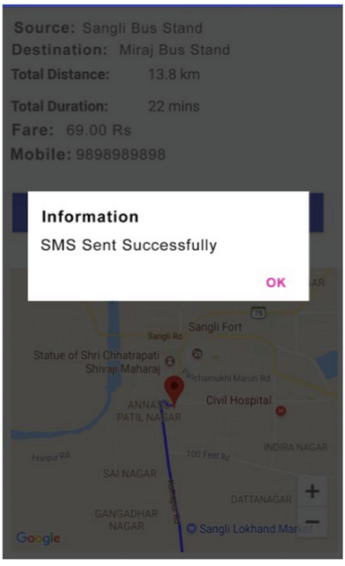
(c)



(d)



(e)



(f)

Fig. 4. Screenshots of passenger and conductor mobile applications.

Figure 4d, e and f show the conductor's mobile application. The conductor needs to login first. When the conductor logs in, a route is assigned to that conductor (the router is set previously by the administrator). The conductor just needs the source stop, destination stop and the mobile number or the fingerprint of the passenger. The fare is calculated and after confirming the ticket, all these details are sent to server and server sends the e-ticket to the passenger's mobile. In case of fingerprint scanner, the server first fetches the mobile number of the passenger from the Aadhar database and then sends the e-ticket.

6 Conclusion and Future Scope

This system overcomes current disadvantages. Users don't need to wait on bus stops for over-crowded buses. Users can continue their work and access the bus information from anywhere. User can save time and find appropriate bus based on crowd information. Tourists can find nearby bus stops, appropriate buses etc. with the help of this system.

In future, this system can be extended to book tickets online and detect the ticket as soon as the passenger enters the bus. Social platforms like Twitter can be used to scan twits and alert the users about high crowd during festivals, concerts etc.

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