Vehicle Tracking and Reservation for Intelligent Transport System

Submitted By

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Submitted By

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Guided By

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May 2017

Certificate

This is to certify that the major project entitled **”Vehicle Tracking and Reservation for ITS”** submitted by **Jitendrakumar Oza (Roll No: 15MCEI18)**, towards the partial fulfillment of the requirements for the award of degree of Master of Technology in Computer Science and Engineering (Information and Network Security) of Nirma University, Ahmedabad, is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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Statement of Originality

I, **Jitendrakumar Oza**, Roll. No. **15MCEI18**, give undertaking that the Major Project entitled "**Vehicle Tracking and Reservation for ITS**" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in **Computer Science and Engineering (Information and Network Security)** of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made.It contains no material that is previously published or written, except where reference has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Place:

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- Jitendrakumar Oza
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Abstract

Public transport system is the cheap and easy available mode of transport as compared to private transport. Here, We have proposed a system that provides better service than existing transportation system. We have discussed what ITS and features provided by ITS is like: accurate location of public transport. The arrival time of public transport at a particular bus stop. Travel time between source and destination and currently available and occupied seats of the bus. After that, we have mentioned research work completed in the field of public transport. Further, we have discussed different algorithm and data collection and filtration techniques/methods. After that architecture of the system, flow of the system is discuss. Then we have explained our implementation. In that, we have discussed the tools and technologies we have used. Then we have mentioned what improvement that can be added to the algorithm for better results.

Abbreviations

ITS	Intelligent Transport System
GPS	Global Positioning System
IoT	Internet of Things
GPRS	General Packet Radio Service
API	Application Programming Interface
ANN	Artificial Neural Networks
SVM	Support Vector Machines
KNN	K-Nearest Neighbors
GIS	Geographical Information System

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Chapter 1

Introduction

In this chapter, we have discussed Problem Definition then Motivation and in last Features of Intelligent Transport System in detail.

1.1 Problem Definition

The public transport system is cheap and frequent compared to the private transport system, but it is not very popular due to its availability issues. People don't know what the current location of the public transport and when a public transport will come at a particular bus stop. This will make system counter-intuitive because the user doesn't know how much time he/she has to wait for the bus. Besides, it makes the scheduling task difficult as we don't know that bus is on time or it is running late. Also, seat occupancy detail of vehicle. We can make the public transport system more convenient and helpful if we can solve this problem. We have some systems that try to address this issue, but prediction and accuracy of these systems are not very reliable.

1.2 Motivation

The motivation of this project is to build a transport system that utilizes all its resources and gives better services to the user. The system that provides real-time information of the vehicle and can be work dynamically according to requirement. The system can scale up and down based on the user. Provides features that motivate people to use public transport. Also, it answers questions like:

- What is the current location of the bus?

- When will bus reach to next station?
- When will bus arrive at the destination?
- What is the distance and time of journey?
- What is current seat occupancy of the bus?

For providing better services to the user, we have proposed ITS system. ITS is the solution we provide to the future transport system, we with the use of proper tools and methodologies we gives better and accurate results to the user. ITS provides the exact location of the bus, when a bus will arrive at next stop and how much time it will take. Also, the trip time between source and destination. Currently occupied and available seats.

1.3 Intelligent Transport System

Intelligent Transport System (ITS) provides features like:

1.3.1 Accurate Location of public transport

The current location of a bus is critical in ITS. It is used in prediction of arrival time, showing next bus stop and so on. To get an accurate location of the bus, we have used the GPS. GPS send data every 10 sec. Also, we have filter GPS data for better accuracy.

1.3.2 Arrival Time of bus

We have to consider different parameters for accurate prediction of arrival time. As shown in figure 1.1, time distribution of public transport. Around 5% time from total time depicts in congestion, 20% at traffic signals, 23% on dwell, the time required for a passenger to get up and down from the bus. So for accurate prediction of the arrival time of public transport, we have to handle all parameters affecting the prediction.

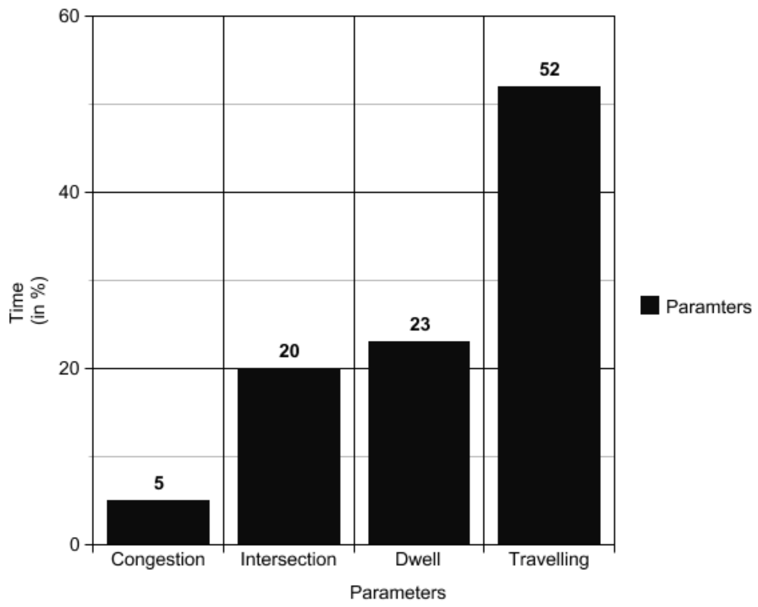


Figure 1.1: Time Distribution of public transport from one stop to next stop [1]

1.3.3 Distance and Time

For accurate prediction of trip time and distance from the source to destination, we have to use the historical and real-time data. First historical data was used for baseline prediction and after that real-time data is used to calculate real-time distance and time required for traveling.

1.3.4 Seat Occupancy

To get detail about the seat in a bus, we have used the different sensor. A sensor will identify the whether a seat occupied or not and after that with a use of Arduino and GPRS we will send this data to the server.

In next chapter, we have explained literature survey in detail.

Chapter 2

Literature Survey

Many researchers have given their specific solution for the current problem in the transportation system. Many papers have been published on this topic, and people are taking interest to implement these concepts. Some of the papers have been applied successfully. But this is a vast subject, and for the different scenario, we have a different solution. Also, new technologies play an important part here. With latest technologies, we can improve old concepts, or we can make our own. In this survey, we have studied different concepts that have been used by various researchers.

2.1 Historical Data

Zhou *et al.* [2] have implemented bus arrival time based on smart card data (SCD). They have collected one week data, including SCD and actual arrival time data. From total 1011 dataset, they have used 446 as training dataset and 565 as a testing dataset. For reducing the error in smart card prediction time, they have included the difference between a smart card swiping time and actual arrival time, swiping time density, seating capacity. Distribution of card swiping time is used for bus arrival time calculation. They have implemented a model that estimate time using time lag between two consecutive SCD and the last card swiping time at different stations. Proposed algorithm has around 10% of error rate. For more accurate prediction vehicle mode, load factor, scheduling can also be considered as parameters. They can also predict time using previous stop arrival time and historical data. For data collection, they have used the smart card which is cheap and efficient. Also, instead of smart card we can use GPS enabled mobile phones for the data collection. Disadvantage of this system is huge infrastructure requirement.

Currently this system is limited to predicting of the bus arrival time before riders swiped their smart cards at bus stop.

Bai *et al.* [3] have implemented a hybrid model. A hybrid model for predicting the base travel time from the historical data they got from the field. Firstly, they have used the well trained SVM model to predict the base travel time from the historical data they got from the field. Then, they have used the Kalman filtering algorithm to improve the accuracy of travel that we predict using SVM model. Prediction model first takes the previously collected data and give it to SVM. SVM then calculates the base arrival time from the data given. This data is sent to Kalman filtering algorithm where data received from svm and real time data are used to predict arrival times of the bus. The main focus of the paper was on bus route sharing the same road and dynamic travel time of buses with different routes. In this they have combined two models for better accuracy. For checking the performance of their algorithm they have compared it with ANN-kalman, SVM, ANN and Kalman. Combined algorithm gives better result compared to the simple algorithm used for comparison in paper. Main disadvantage of this model is, it requires large data set and more training time at initial stage. So algorithm will take some time initial for accurate prediction.

Yu *et al.* [4] have implemented a dynamic model that uses the historical data for the prediction of arrival time. GPS data are collected at regular interval. GPS fitted in the base will send data every 15 or 20 seconds. For data processing first they split route into intersection, line-link and path between intersections. They have also number every bus line and construct the serialization of bus line. They made a prediction model based on cluster analysis and polynomial fitting. They have used the last 1 year data for the testing of system. To prevent effect of different patterns on prediction accuracy, they have used the Euclidean distance with heretical cluster analysis for nearest point. They have also used the hierarchical clustering method and Euclidean distance method because of its low error rate. Prediction model takes the historical data and processes that to save data in a historical database. After that prediction model is called to check for the pattern matching and estimate arrival time. Prediction models were developed under different pattern for use according to system requirement. We can improve the if we consider different delay like: delay at intersection, delay at congestion, delay at bus stops.

Li *et al.* [5] have implemented a linear model for the prediction. They divided the total time into two parts: linear part and residual. For the prediction they have included traffic condition, dwell time, intersection and departure time. Parameter calibration process is used for prediction. First, they classify and determine traffic patterns from the historical data. In the second step, estimation of dwell time, travel time and service time are determined. In the last step, least square method is used for parameter optimization. They used the historical data and classify eight different cluster, a statistical approach was developed for identification of different parameters to be included in the cluster. They also built web application to verify practicability and efficiency. System can predict the bus arrival time at each bus stop with less than 2 minutes. Algorithm can be improved if more parameters are used and historical data can be used more efficiently.

Yu *et al.* [6] have implemented model that predicts the bus arrival time of same stop sharing the different route. For data collection, they used the video survey near CHT bus stop in weekdays. Then data filtration algorithm was applied to eliminate outliners. For the implementation, they have used the dynamic model which consists of two parts: SVM model for estimating base line travel time and Kalman filter for adjusting the base line with latest information. Predictions are measured using mean absolute error, mean absolute percentage error and root mean square error. For the calculation of the actual arrival time and running time, manual method is used. They have calculated the arrival time using the four different methods namely: SVM model, ANN model, KNN model and LR model. They have compared the performance of four different methods, in which Linear Regression (LR) gives the worst performance. KNN is better than LR. KNN and ANN are almost same but ANN is slightly better than KNN. SVM gives the best performance among all. The correlation coefficient (r) of four methods, namely LR, KNN, ANN and SVM is 0.84, 0.85, 0.87, and 0.90. Performance of algorithm can be improved if we use more parameters for prediction according to system requirements.

Chien *et al.* [7] have implemented the ANN prediction model. They have used the two different ANN, link-based ANN and stop-based ANN. For the model development, they have used the fully connected multilayer feedforward network with the Back Propagation (BP) learning algorithm. The link-based ANN is designed to predict bus arrival times at any stops by gathering bus travel times on all visited links between pairs of stops. The stop-based ANN is developed by training group of stop-based data such as the means and standard deviations of volumes, speeds, and delays on the links between a pair of stops. They have used the Enhanced ANN to improve the performance. While the algorithm is predicting the arrival time using the training data, it also considers real time data. To improve the accuracy, they have integrated both models with an adaptive algorithm. For the implementation of the algorithm, they have used the CORSIM simulation model. For the data collection, they have used the RFID detector to detect the particular vehicle and also for the unique identification. The main advantage of this method is that, we can predict the single stop as well as multi stop prediction because of the two different ANN methods are used in the implementation. Prediction algorithm requires large training time as well as data for the accurate prediction. ANN makes system slow and complicated.

2.2 Real Time Data

Weng *et al.* [8] have implemented bus speed estimation model. The prediction model is divided into three parts: Data processing & preprocessing, Data matching & travel speed estimation and correction of travel speed. For data they have used the data provided by Beijing Public Transport Holdings. Data transmission time interval was 30s. In the first phase, they match the GPS and Geographical Information System (GIS) map data to estimate the location of the vehicle and calculation of vehicle from one point to another to generate the proposition arc. In second phase, this movement arc is diagnosed and missing section is added. In the third phase, estimated calculation of bus arrival time performed. In the fourth phase, direction of the bus is determined. Fifth phase is calculation of travel speed between two points. Then field data and model data is compared and it provides 88.4% accuracy. We can improve the accuracy of algorithm by adding more parameters or by improving current parameters according to algorithm requirements.

Liu *et al.* [9] have implemented a framework called WiLocator. They proposed tool named Signal Voronoi Diagram (SVD) that uses the WiFi access points (APs). WiLocator has three components: WiFi enabled smartphones, backend server and user interface. WiFi enabled smartphones are used for the sending WiFi data to backend server and WiFi sensing. Backend server is used for data storing, processing and prediction. User interface (UI) provides communication between WiLocator and users. WiLocator consists of three parts: SVD based bus position, arrival time prediction and traffic map generation. In the second part, they match GPS data and calculate proposition of position. After that estimation of bus speed is calculated. In the last part, if threshold of estimated speed are not reached, then travel speed is corrected. Disadvantage of this system is that, it requires huge infrastructure for accurate prediction. Also user participation is compulsory because system depends on this.

Zaki [10] have implemented hybrid neural network for the prediction of public transport arrival time. In their proposed system, they implemented two models: ANN based and Kalman filter based. Proposed algorithm first receives data from hardware module then processes data and store in database. After that it checks for rule matching and if any rules are matches ANN and predict the arrival time as it uses a Kalman filter to calculate arrival time. In proposed neural network model, there are four layers: input layer, two hidden layers and output layer. There are seven nodes in proposed input layer. First hidden layer has ten nodes and the second hidden layer has 3 nodes. The input layer has one node. A modified Kalman filter is used for prediction. Last three similar days in last three similar weeks historical data is used for prediction. Then simulation was performed using the MATLAB and ANN Simulation gives the mean square error in range of 1.2 minutes on entire route. Kalman filter algorithm simulation gives the mean square error in range of 1.2 minutes on entire route. Algorithm requires lot of data and time for the accurate prediction of arrival time.

Zhou *et al.* [11] have implemented mobile phone based participatory system for the prediction of the arrival time. System architecture divided into three components. The user will convey information about bus stop and interested route. In other side, a user who is seated in bus share data like tower IDs. But first, they have to decide whether the user is on the bus or not. For that, they first check for identification. If users locations confirms in bus then, this data is sent to backend server. Backend server is responsible for all computation. Here data received from the user mobile is processed and query of user is answered. They have created an application that the user is required to install for the participation. After that, user will share its bus information with the server using this application. This system is totally dependent upon the participants and independent from other parameters. They use the mobile phones for sending and receiving data, which makes system cheap and easily available. Disadvantage of system is that it fully dependent on participants, we required participant on bus if we want detail of that bus. Also we required mobile in which we can install our application.

Zhu *et al.* [12] have implemented a model for real time bus arrival time prediction. They have created two different models for prediction: point based and path based. For the calculation of point based prediction, instantaneous velocity (V), GPS information and distance (L) is used for calculation of arrival time. For the prediction of path based arrival time, they have used running time of the bus, delay at bus stops and intersection. From latitude and longitude, they calculate distance. Dynamic traffic information provides average travel time, congestion details and intersection detail. They have calculated the dwell time separately. Also dwell time is divided into two sub category, intersection dwell, stop dwell. They have also used the Mean Absolute Percentage Error for accuracy estimation. Also, they have compared both models. Point based prediction model provides minimum error rate and is more reliable and accurate compare to path based. Their proposed model predicts better because of the real time data adoption, which is not available in the traditional model. Here disadvantage of system it that, it requires regular data for accurate prediction. If data is not available due to issue in hardware or delay in communication cause error in prediction.

Ferris *et al.* [13] have implemented real time public transport tracking system. This paper provides the real time arrival info about Seattle-area bus system. In this, they have created an app and the website for the user to get the bus information as well as for the queries related to the bus trip and bus facilities. They have integrated maps for showing accurate location. They have implemented a system that provides a number of service modules and integrated it using Spring inversion of control framework, a relation database that is handled by hibernate framework. System is able to provide the real time data about bus location and also estimated arrival time of bus at particular station. Proposed system requires huge resources and infrastructure as real time data can not be used directly.

2.3 Hybrid Model

Maiti *et al.* [14] have implemented historical data based bus arrival system. In their proposed model. They first take previously collected data then analysis and pre-process data. At this stage, they try to remove noise, missing values, and bus stops correction. After that, they take this refined data and predict bus arrival time. Arrival time prediction procedure consists location wise speed calculation and time slot wise speed calculation.

They claim that their system is much faster than ANN and SVM. They claims that, their algorithm is 2.5X faster than ANN and 2X faster than SVM also it provides the approx. 75% comparable accuracy, 76% with respect to ANN and 71% accurate with respect to SVM model. For data collection, they have used the ConnectPort X5 R devices to collect bus data of an industry campus at Siruseri, Chennai collected over four months of time period. The sensor sends speed, location, time stamp, card swiping time stamp, and passengers boarding and getting down. The sensor is cheap and lightweight. GPS enabled mobiles phone can also be used as replacement of sensors. Proposed model shows better result than standard ANN and SVM used in the paper for comparison. Lots of historical data is required for accurate prediction and not applicable where situation changes quickly.

Gong *et al.* [15] have implemented a hybrid model for the bus arrival time. For the prediction, they have selected both historical and real time data. Real time data can't be directly used. So they preprocessed data so that it can be used in the prediction model. Preprocessing consist following steps: data matching, data modification, data conversion. They have used the Moving Average Model (MAM), Moving Average Dynamic Adjustment Model (MADA) and Hybrid method based on Hybrid Moving Average and Dynamic Adjustment (HMADA) model for prediction of arrival time. Performance index of MSE and MAPE are used to evaluate the prediction model. They suggest that HMADA can make up the shortening of MAM and MADA. Also, they suggest that GPS data must be preprocessed before it can be used for the prediction model directly. Also, they stressed the importance of upper bound of station in the prediction. Model uses average speed which is not efficient.

Padmanaban *et al.* [16] have implemented real arrival time prediction system. This system used the historical data methodology for the prediction. For data collection, they have taken route no. 21-L in Chennai. They have collected one week data of two public transport. They have collected latitude, longitude and time stamp from GPS fitted in a bus. After that Haversine formula is used to calculate distance. Then, they have developed an automated procedure for calculating delay at bus stops. Then, they have used their algorithm to predict the arrival time of the third bus with the use of the previously collected data. For prediction, they have divided travel into two different parts: running time and delay time. They have also included the different types of delay like traffic signal delay, bus stop delay, etc. The have also used the Kalman filtering algorithm for better accuracy. They have merged the historical data with the real time data to improve the performance of the prediction algorithm. Based on Historical data which is not accurate when there is delay in system and required more data for accurate prediction.

Chien *et al.* [17] have implemented two prediction model: historical data model and real time data model. They have collected data from the New York City Thruway. For the data collection, they have used the road side terminals. To improve data they have eliminated result of a particular vehicle if data of vehicle highly deviates from the average vehicle data in a particular time period. They process and filter few data as per the prediction algorithm requirement. Two prediction methods are tested in this, path based and link based. They have also used the Kalman filtering algorithm for better accuracy. For the implementation, they have used the improved version of the CORSIM simulation model. They have not used the real time data directly as it needs to be refined to make it appropriate for use in implementation. From the experiments they have performed, they conclude that the link based prediction is accurate and reliable compare to path based. Path based is accurate when there is uniform traffic condition and path is short. System requires huge infrastructure for data collection method. Real time data cannot be used directly for prediction and not applicable on heterogeneous traffic condition.

2.4 Summery of Literature Survey

Authors	**Methodology**	**Pros**	**Cons**
Zhou *et al.* [2]	Frequency distribution, regression	Smart card data is used efficiently for calculation of arrival time.	Require appropriate infrastructure for better result, which is not easy.
Bai *et al.* [3]	SVM	Used the SVM and Kalman filter to improve the accuracy of algorithm.	Requires large data and more training time for SVM.

Yu *et al.* [4]	Historical Data	Well designed model that does not required extra computation time to access real time data.	Prediction model does not consider delay at traffic signals and intersection. This can reduce the performance of algorithm.
Li *et al.* [5]	Statistical approach, Historical data	They divided data into two parts for better analysis.	Algorithm can be improved if more parameters are used and historical data can be used more efficiently.
Yu *et al.* [6]	SVM, kNN, ANN, LR	They have implemented four models and conclude that the SVM gives better results than other three.	Performance can be improved if we use more parameters for prediction.
Chien *et al.* [7]	Artificial Neural Network (ANN)	Link based and Path based enhanced ANN is used for prediction.	Prediction algorithm requires large training time as well as data for the accurate prediction. ANN makes system slow and complicated.
Weng *et al.* [8]	Real time data	They use the GPS and bus Geographical Information System (GIS) map to get accurate location of bus.	More parameters can be included to improve the performance of overall system.

Liu *et al.* [9]	Real time, passenger participation	Use of WiFi hotspot for prediction and communication.	Not applicable when there is no WiFi nearby and requires passenger participation.
Zaki *et al.* [10]	ANN, Kalman filter	Use of hybrid model improves the accuracy of algorithm.	Algorithm requires lot of data and time for the prediction.
Zhou *et al.* [11]	Passenger participation	Use of mobile phones for collecting and sending data makes system efficient and easy.	Totally dependent on participants data which makes system less reliable.
Zhu *et al.* [12]	Real time data	Separates calculation for the delay at bus stops and intersection.	Real time method is not applicable where there is delay or loss of data.
Ferris et al [13]	Real time data	User can access real time location of vehicle using application, website, SMS, IVR.	Proposed system requires huge resources and infrastructure as real time data can not be used directly.
Maiti *et al.* [14]	Historical data	They used the sensors fitted in buses and used limited parameters to make prediction model less complex and more accurate.	Lots of historical data is required for accurate prediction and not applicable where situation changes quickly.

Gong *et al.* [15]	Historical Data, Real time data	Three models are used for prediction.	Model uses average speed which is not efficient.
Padmanaban *et al.* [16]	Historical Data based Approach	Consider delay separately for better result	Based on Historical data which is not accurate when there is delay in system and required more data for accurate prediction
Chien *et al.* [17]	Kalman Filtering Algorithm	Road side terminals (RST) and E-ZPass system is used for data collection.	Real time data can not be used directly for prediction and not applicable on heterogeneous traffic condition.

Table 2.1: Literature Survey Summary

In next chapter, We have explained our proposed system.

Chapter 3

Proposed System

In this chapter we have discussed architecture of proposed system then a flow of system after that system operations and behavior explained in detail.

3.1 Proposed System Architecture

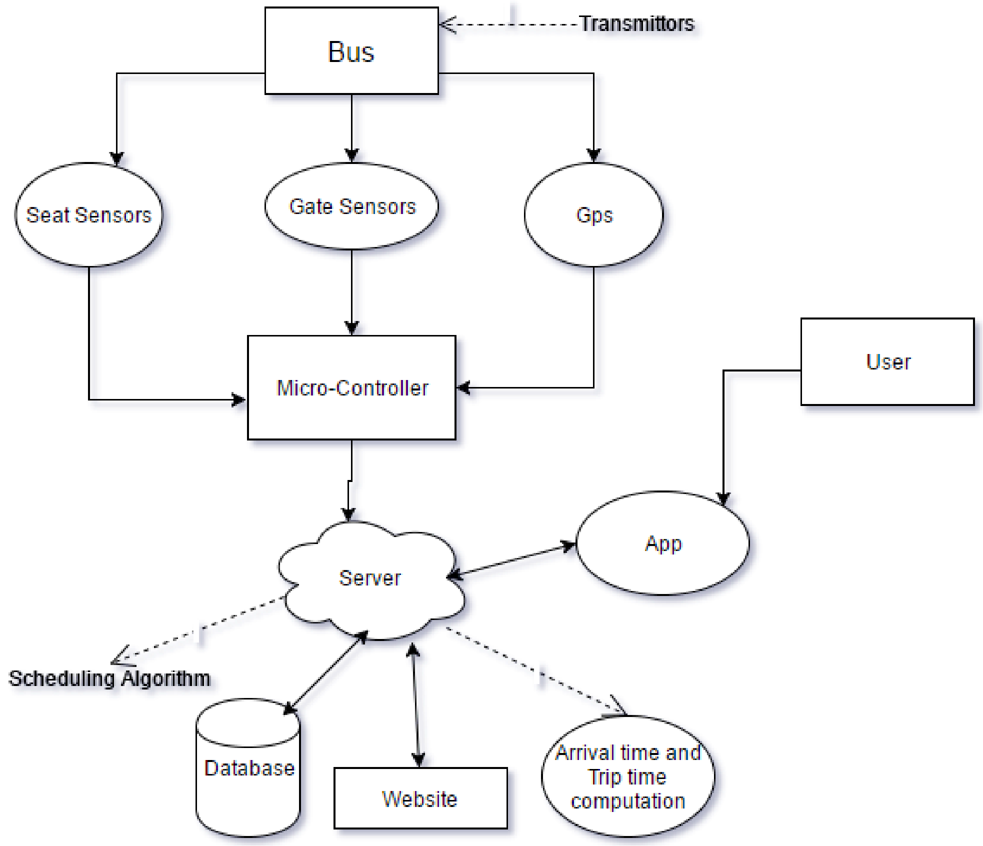


Figure 3.1: System Block Diagram

Figure 3.1 show the block diagram of the whole ITS. As you can see from the diagram, bus have the different hardware and system for the data collection and the communication to the central database. Data center have their storage as well as computation mechanism for the algorithm. Arduino has collected this sensors data, and with the use of data sending technique like GPRS, data transmitted to the central database.

After data received by the central database, it will be stored in the data center for the further use. Data obtained by different sensors are used for the calculation of the arrival time of public transport at particular point, trip time of transport as well as we can schedule or reschedule our transport system as per the requirements.

This data now used by the different user via various ways such as a mobile phone application or a website for the user interaction with the system. All computation are done at the data center to reduce application load and provide fast and better result of the algorithm to the user and also reduce data consumption and mobile phone resources.

3.2 Flow of System

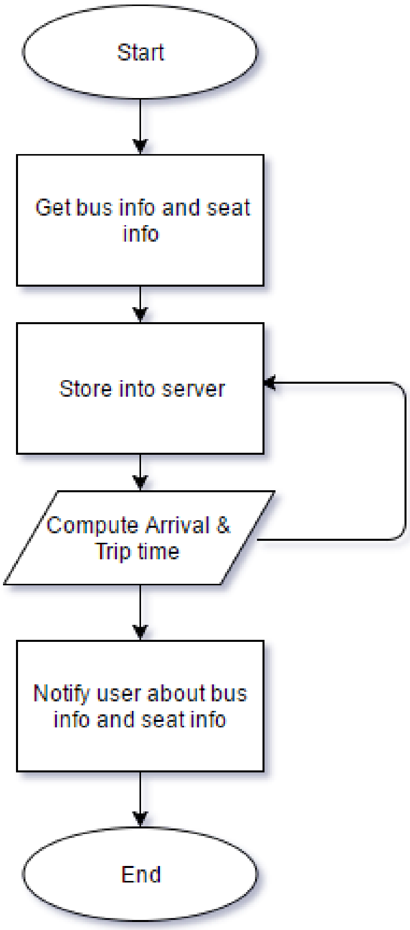

Start
Get bus info and seat info
Store into server
Compute Arrival & Trip time
Notify user about bus info and seat info
End

Figure 3.2: System Flow Diagram

Figure 3.2 show the flow diagram of system. Data will be collected from the GPS and other sensors. Then this data stored on the server for the further process. Then it will be used for the computation of the arrival time and trip time algorithm. The user will get this information for the booking of the bus ticket.

3.3 System Operations

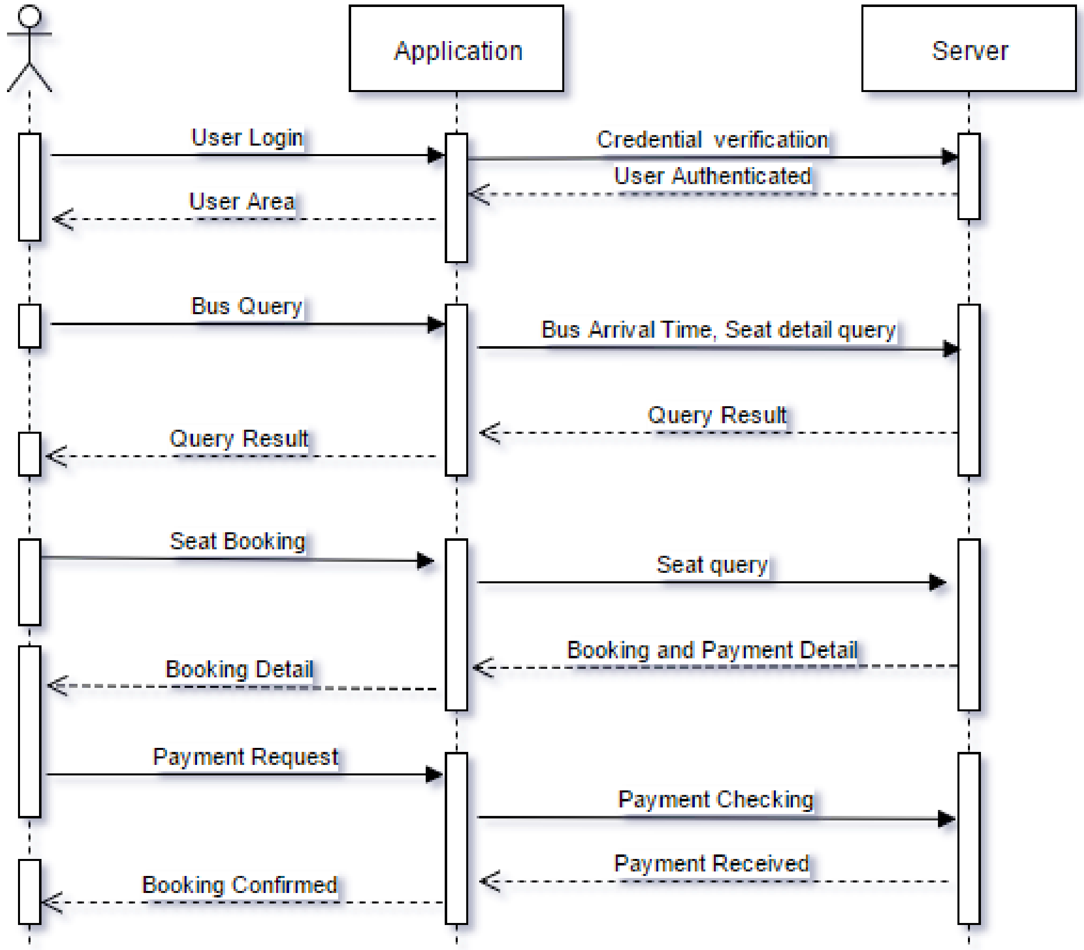


Figure 3.3: System Sequence Diagram

Figure 3.3 show the sequence of system. The first user has to login into their account and account is verified. After that user will be able to get the information for the seat booking. After confirmation, the user has to prompt for the payment, and after successful payment, the user notified about their seat confirmation.

3.4 Behavior of System

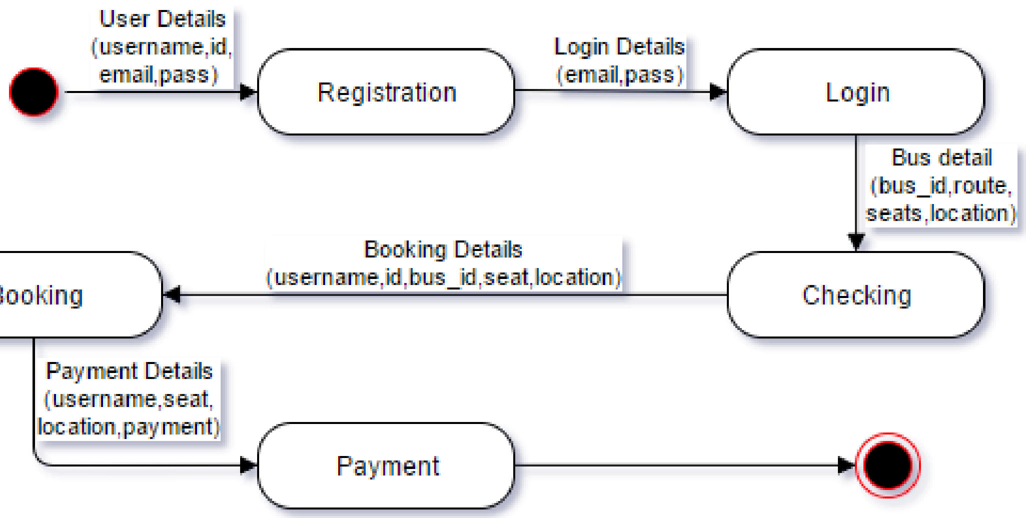


Figure 3.4: System State Diagram

State diagram shown in the figure 3.4, first user have to register them self and then they login into the application and check the available bus detail. After getting the appropriate bus information, the user can go to the booking page, and seat selection and other details verified, then user makes payment of selected seats and after successful payment user will get their receipt.

In next chapter, we have mention tools and technologies we have used for implementation and screenshot of the application.

Chapter 4

Implementation

In this chapter, we have discussed different tools and technologies used for implementation and screenshot of application with the proper description of each component.

4.1 Tools and Technologies

For front end development of ITS, we have developed an Android application. Main reason behind the selection of Android as a platform is a mass customer base. Current market share of Android is around 70%.

Figure 4.1 show the current market share of different mobile OS. Android has many benefits over other mobile OS. Main reason is currently available devices in the market. Also Android is open source, and Android did not charge anything for placing the application on their marketplace. Another main reason behind the selection of Android as the tool is its large set of libraries and APIs. Android provide the simple and easy to use layout and features. User interface and memory management are excellent in Android

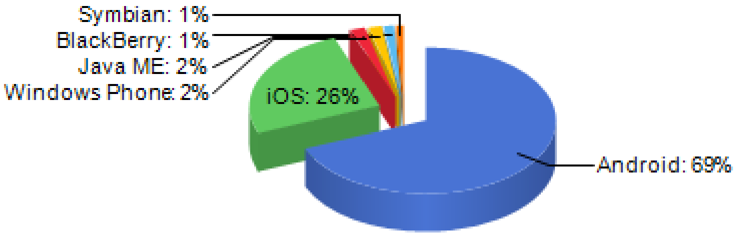


Figure 4.1: Current Market Share of Android

mobile. Application created in one version is upward and downward compatible with the Android.

For application development we have used **Android Studio** [18]. Android Studio provides easy apps creation and design templates. Android Studio now also provide the Gradle-based build. It also provides the quick error fix and syntax error check. For the catch performance, version control, etc. it provides the lint tool. For the app-signing, it uses the ProGuard. It also provide the drag and drop types features for the user interface creation.[19]

Different library and packages used for implementation and communication of application and server. For communication between app and server, we have used the Android Volley[20] library. For From and to location suggestion, we have used the Android Place API[21]. Google Maps API used for showing the route on maps.

For the backend, we have used PHP server and MySQL database. PHP server was used for all prediction and computation. All data related to ITS stored in the MySQL database. Following are the structure of the different table that we have used for data storage.

Column Name	Type	Size	Attribute	Other Para.
ID	int	11	PRIMARY KEY	Auto Increment
Username	char	25	UNIQUE	
Email	char	50	UNIQUE	
Password	hash	255	REQUIRED	Salt

Table 4.1: User Information

Table 4.1 is structure of user information system. This table is used to check user status and save new user data. In this table, we are storing the username, email, and password of the user. This table use for storing information provided by the user at registration page and checking user on the login page.

Column Name	Type	Size	Attribute	Other Para.
ID	int	11	PRIMARY KEY	Auto Increment
From Location	char	255	UNIQUE	
Waypoints	char	255	UNIQUE	
To Location	char	255	UNIQUE	
Departure	Time		REQUIRED	Not Null
Price	int	50	REQUIRED	Not Null

Table 4.2: Bus Route

Table 4.2 is structure of bus route. This table is used to check whether there is any single or connecting bus route is available or not. Also, it used to send bus route data to the server that later can use for showing route and bus information to the user.

Column Name	Type	Size	Attribute	Other Para.
id	int	11	PRIMARY KEY	Auto Increment
Stop Name	char	255	UNIQUE	
Latitude	float	50	UNIQUE	
Longitude	float	50	UNIQUE	

Table 4.3: Bus Stop

Table 4.3 is structure of bus stop. In this table, all bus stop latitude and longitude stored and we can use it for displaying the route on maps. Also, we can use it to find the nearest point from the LatLng position.

Column Name	Type	Size	Attribute	Other Para.
id	int	11	PRIMARY KEY	Auto Increment
Seat No	char	255	UNIQUE	
Available	boolean	1	UNIQUE	
Bus ID No	int	10	UNIQUE	

Table 4.4: Seat Information

Table 4.4 is structure of Seat Information. In this table list of seats are mentioned, and it will send data to the user when the user request for availability of seats. When user book a seat in the application, seat details sent back to the server to update its status from available to occupied.

4.2 Android Application

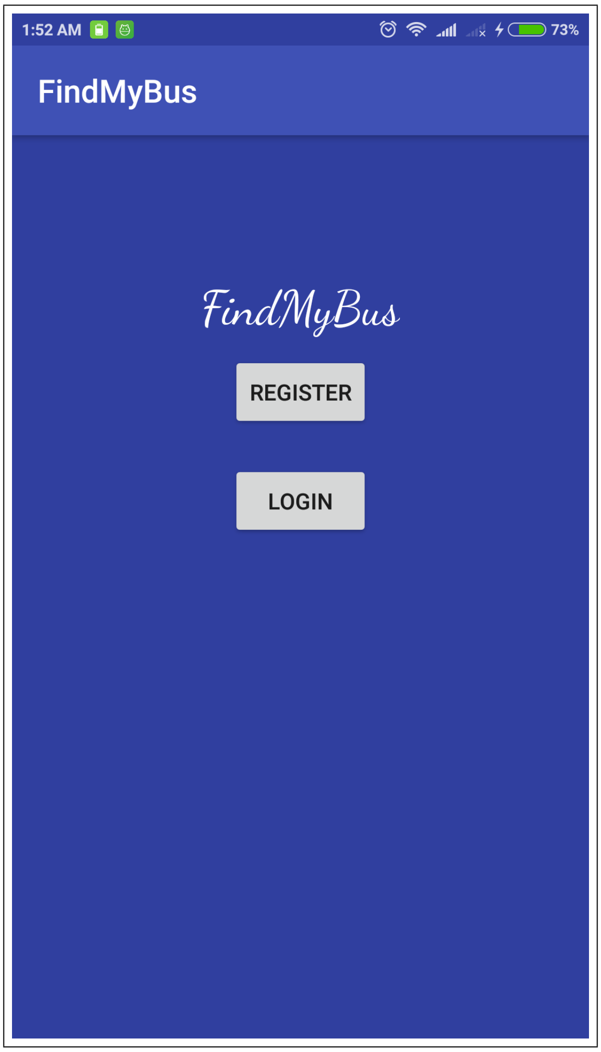


Figure 4.2: Application Home Page

Figure 4.2 represents home page of application. The home page contains two buttons: Register and Login. Onclick events will load respected page.

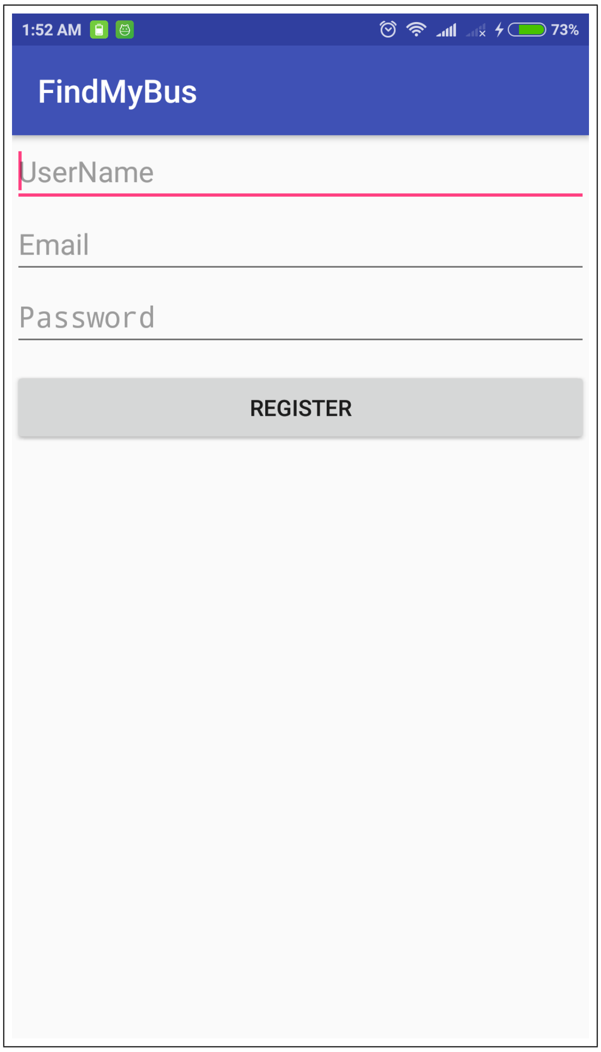


Figure 4.3: Registration Page

Figure 4.3 represents registration page. Registration page contains three edit text field with registration button. When use fills the data and click on registration, all data send to the server, and if no duplication found, data will be stored into user information table of MySQL database.

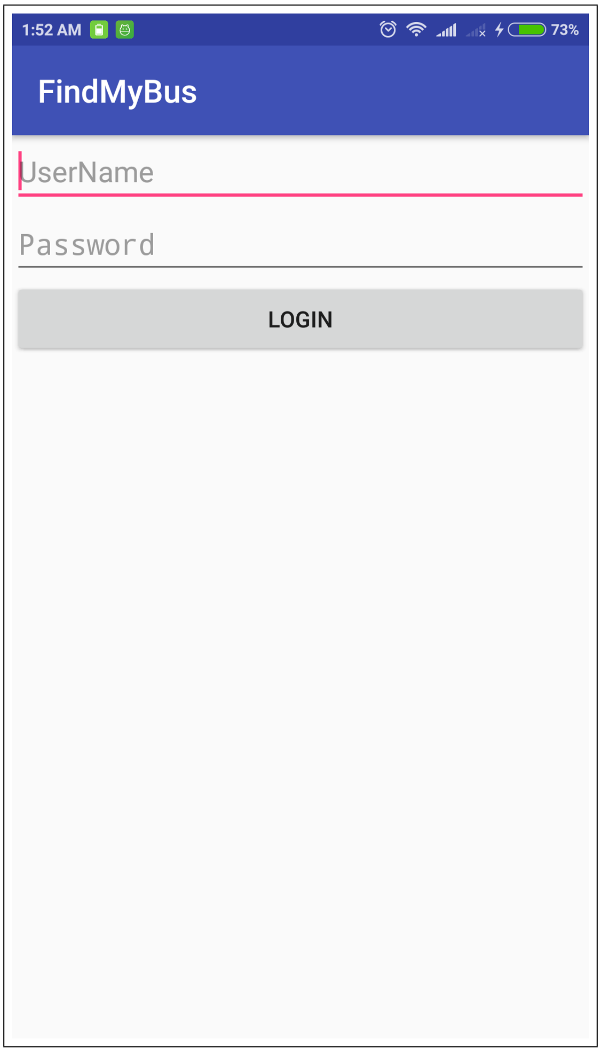


Figure 4.4: Login Page

Figure 4.4 represents login page. Login page contains two edit text field and a login button. When a user fills data and clicks on login button, we check for user details, if successful then the user will login into system otherwise an error will pop up.

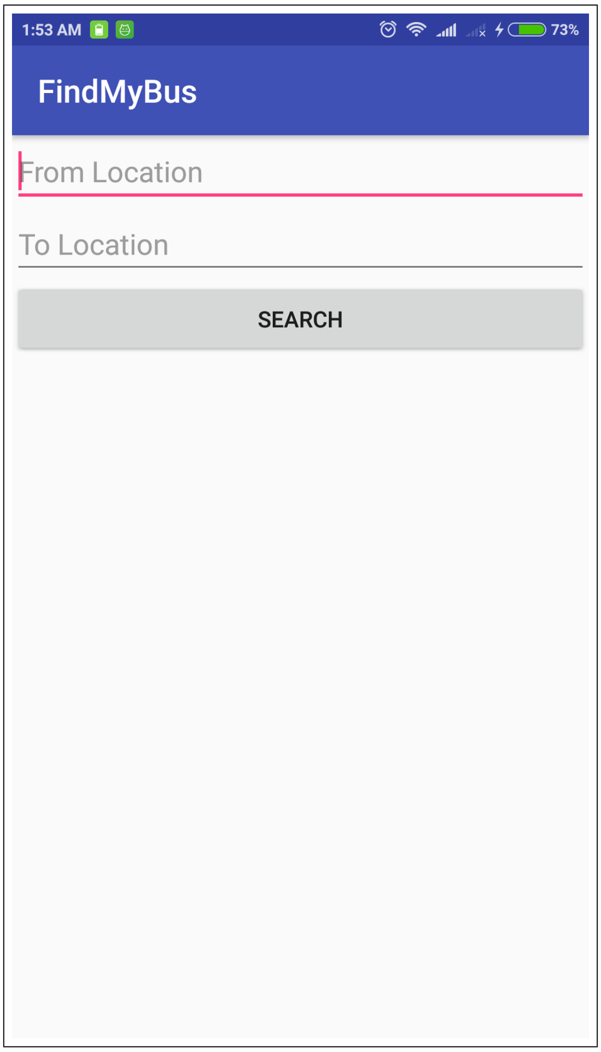
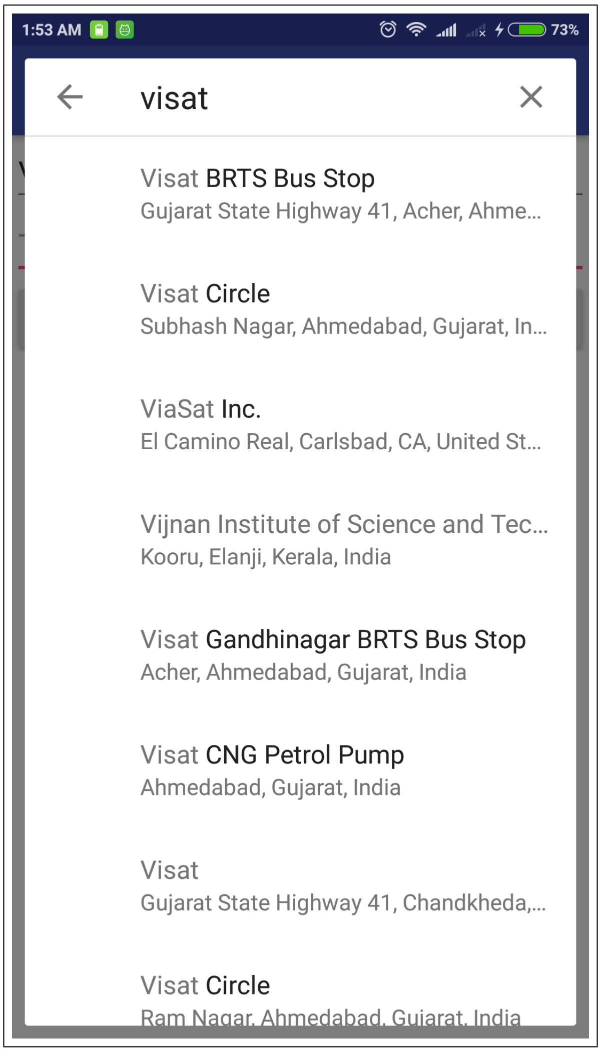


Figure 4.5: Search Page

Figure 4.5 represents search page. Search page contains two edit text field and search button. When a user clicks on edit text field, pop-up edit text will open as show in figure 4.6. When a user fills all details and clicks on search, it communicates with the backend server to find the path between from and to locations.



visat

Visat BRTS Bus Stop
Gujarat State Highway 41, Acher, Ahme...

Visat Circle
Subhash Nagar, Ahmedabad, Gujarat, In...

ViaSat Inc.
El Camino Real, Carlsbad, CA, United St...

Vijnan Institute of Science and Tec...
Kooru, Elanji, Kerala, India

Visat Gandhinagar BRTS Bus Stop
Acher, Ahmedabad, Gujarat, India

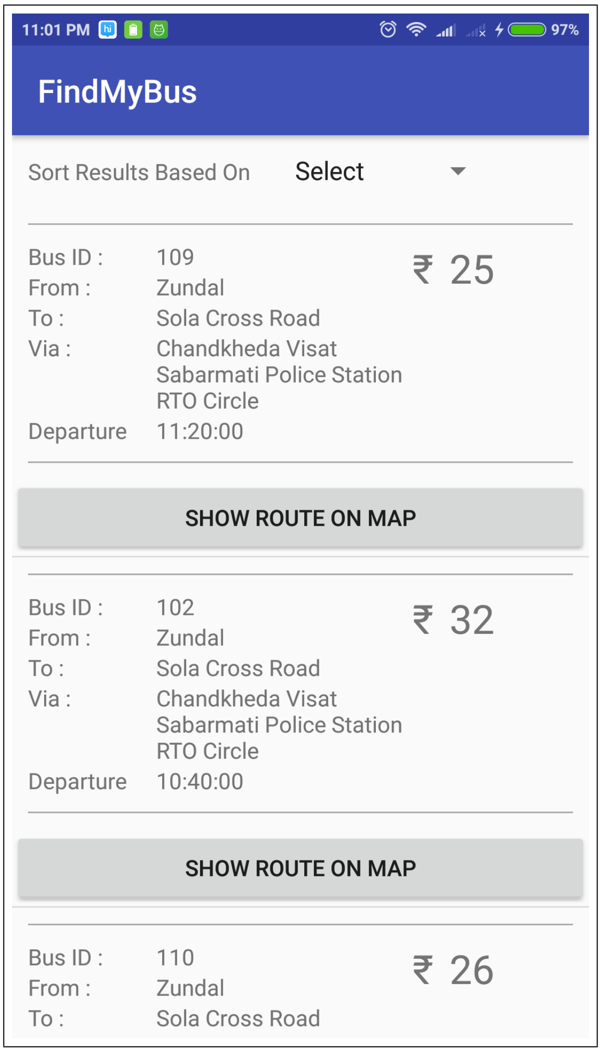
Visat CNG Petrol Pump
Ahmedabad, Gujarat, India

Visat
Gujarat State Highway 41, Chandkheda,...

Visat Circle
Ram Nagar, Ahmedabad, Gujarat, India

Figure 4.6: Search Suggestion

Figure 4.6 represents search suggestion page. Search suggestion page includes edit text field. When a user clicks on edit text field and input data, it will call Google Place API in the backend and give place suggestion based on input data.



11:01 PM 97%

FindMyBus

Sort Results Based On Select

Bus ID : 109
From : Zundal
To : Sola Cross Road
Via : Chandkheda Visat
Sabarmati Police Station
RTO Circle
Departure 11:20:00

₹ 25

SHOW ROUTE ON MAP

Bus ID : 102
From : Zundal
To : Sola Cross Road
Via : Chandkheda Visat
Sabarmati Police Station
RTO Circle
Departure 10:40:00

₹ 32

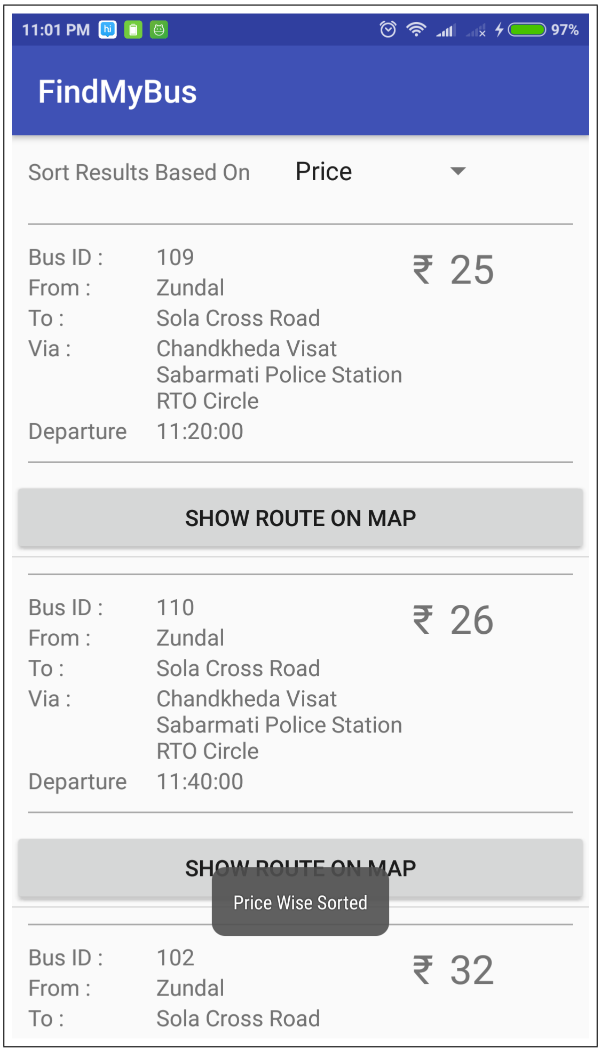
SHOW ROUTE ON MAP

Bus ID : 110
From : Zundal
To : Sola Cross Road

₹ 26

Figure 4.7: Single Route Result Page

Figure 4.7 represents Search result page with single route. Single Route Result Page contains five text view and button. When a user fills from and to location details show in 4.5, back end server will get data and check whether a single route is available or not. If bus route found, it will send course detail back to the android application. Page contains details like Bus ID, From, To, Waypoints, Price, Seats, Distance, and Duration. When a user clicks on a button, another activity will start, and it shows the route on maps with bus detail.



11:01 PM 97%

FindMyBus

Sort Results Based On Price

Bus ID : 109
From : Zundal
To : Sola Cross Road
Via : Chandkheda Visat
Sabarmati Police Station
RTO Circle
Departure 11:20:00

₹ 25

Bus ID : 110
From : Zundal
To : Sola Cross Road
Via : Chandkheda Visat
Sabarmati Police Station
RTO Circle
Departure 11:40:00

₹ 26

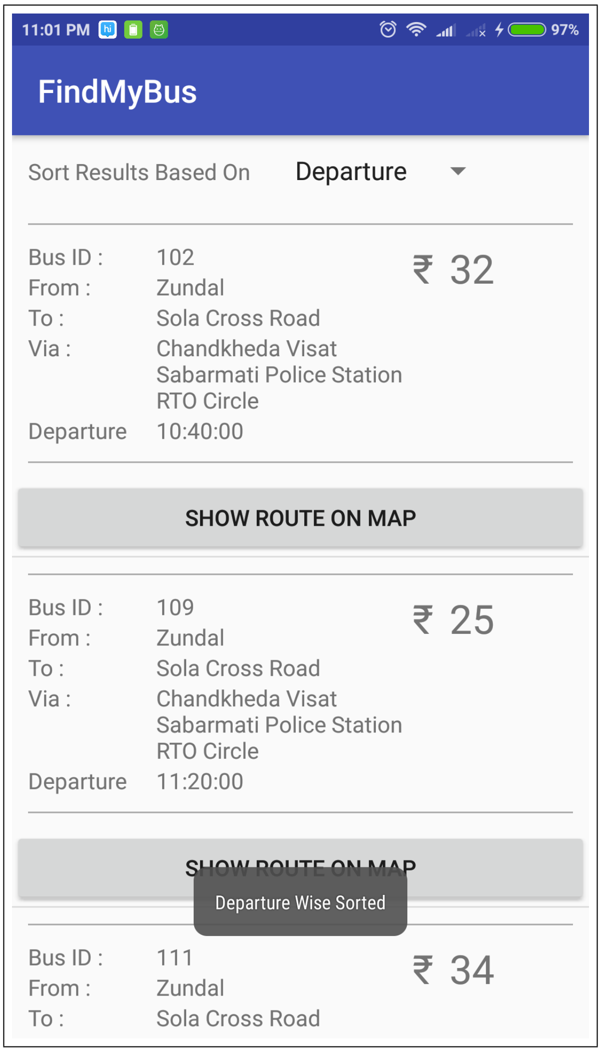
Price Wise Sorted

Bus ID : 102
From : Zundal
To : Sola Cross Road

₹ 32

Figure 4.8: Price wise sorted list

Figure 4.8 represents price wise sorted list page. We can sort search result data that we get after putting from and to data in a search field. We can sort our results according to price and departure time. In this, we have sorted data price wise.



11:01 PM 97%

FindMyBus

Sort Results Based On Departure

Bus ID :	102	₹ 32
From :	Zundal	
To :	Sola Cross Road	
Via :	Chandkheda Visat Sabarmati Police Station RTO Circle	
Departure	10:40:00	

SHOW ROUTE ON MAP

Bus ID :	109	₹ 25
From :	Zundal	
To :	Sola Cross Road	
Via :	Chandkheda Visat Sabarmati Police Station RTO Circle	
Departure	11:20:00	

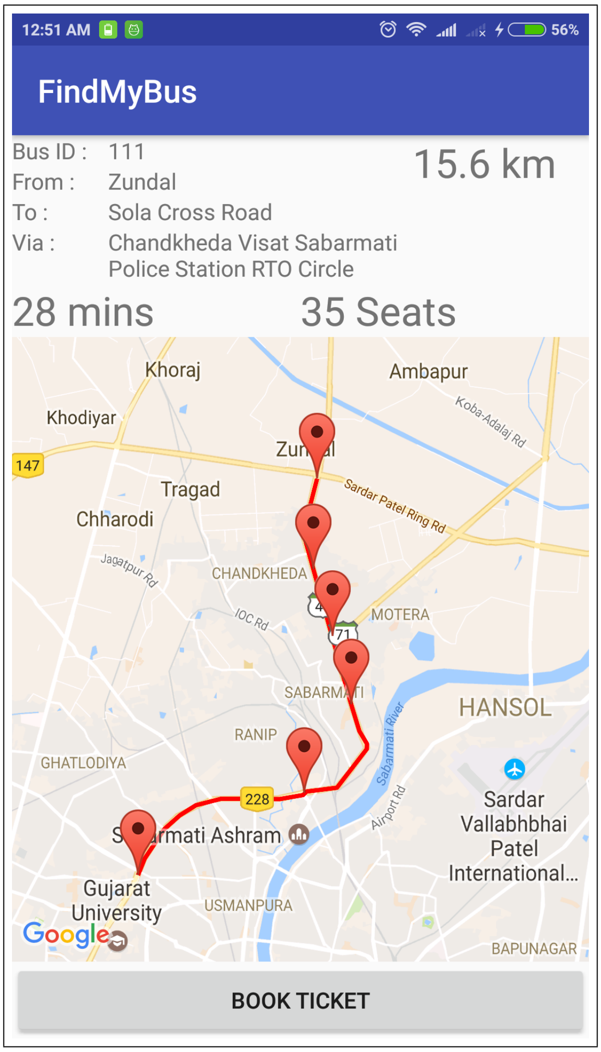
SHOW ROUTE ON MAP

Departure Wise Sorted

Bus ID :	111	₹ 34
From :	Zundal	
To :	Sola Cross Road	

Figure 4.9: Departure time wise sorted list

Figure 4.9 represents departure time wise sorted list page. We can sort search result data that we get after putting from and to data in a search field. We can sort our results according to price and departure time. In this, we have sorted data departure time wise.



Bus ID : 111

From : Zundal

To : Sola Cross Road

Via : Chandkheda Visat Sabarmati Police Station RTO Circle

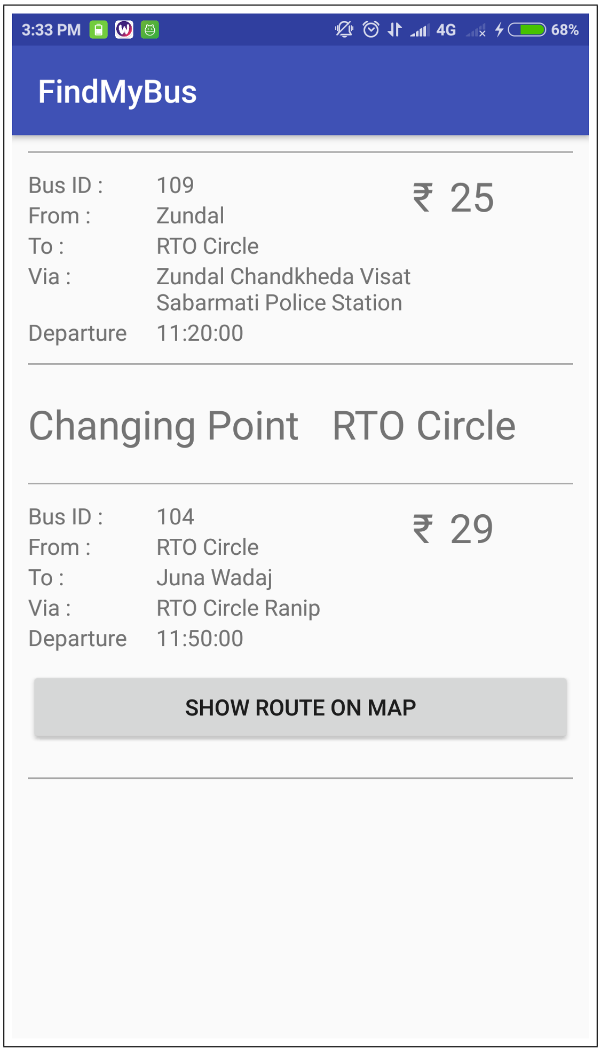
15.6 km

28 mins

35 Seats

Figure 4.10: Route with connecting bus result Page

Figure 4.10 represents route representation on Google Maps. Show Route on Google Maps with Bus Route Result Page contains seven text view and button. If user clicks show route on maps button in Figure 4.7 this activity will start. Page contains details like Bus ID, From, To, Waypoints, Price, Seats, Distance, and Duration. When a user clicks on a button, another activity will start for seat booking.



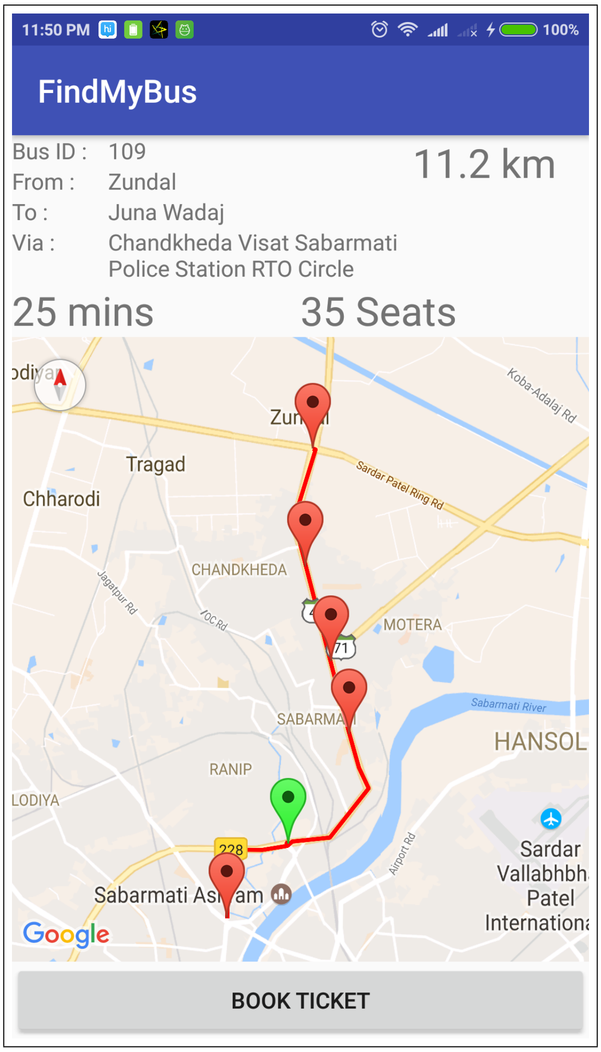
Bus ID : 109
From : Zundal
To : RTO Circle
Via : Zundal Chandkheda Visat Sabarmati Police Station
Departure 11:20:00
₹ 25

Changing Point RTO Circle

Bus ID : 104
From : RTO Circle
To : Juna Wadaj
Via : RTO Circle Ranip
Departure 11:50:00
₹ 29

Figure 4.11: Route with connecting bus result Page

Figure 4.11 represents Search result page with connecting bus route. The route with connecting bus Result Page contains ten text view and button. When a user fills from and to location details show in 4.5, back end server will get data and check whether a single route is available or not. If direct route not found, it will check for connecting route and if there is any path found then detail will be sent back to an android application. Page contains details like Bus ID, From, To, Waypoints, Price, Seats, Distance, and Duration. When a user clicks on a button, another activity will start, and it shows the route on maps with bus detail.



Bus ID : 109
From : Zundal
To : Juna Wadaj
Via : Chandkheda Visat Sabarmati Police Station RTO Circle

11.2 km

25 mins

35 Seats

Figure 4.12: Show Route on Google Maps with Bus Route Result Page

Figure 4.12 represents changing bus route representation on Google Maps. Show Route on Google Maps with Bus Route Result Page contains seven text view and button. Here **GREEN** marker represents the changing point. When a user clicks on show route on maps button illustrated in figure 4.11 this activity will start. Page contains details like Bus ID, From, To, Waypoints, Price, Seats, Distance, and Duration. When a user clicks on a button, another activity will start for seat booking.

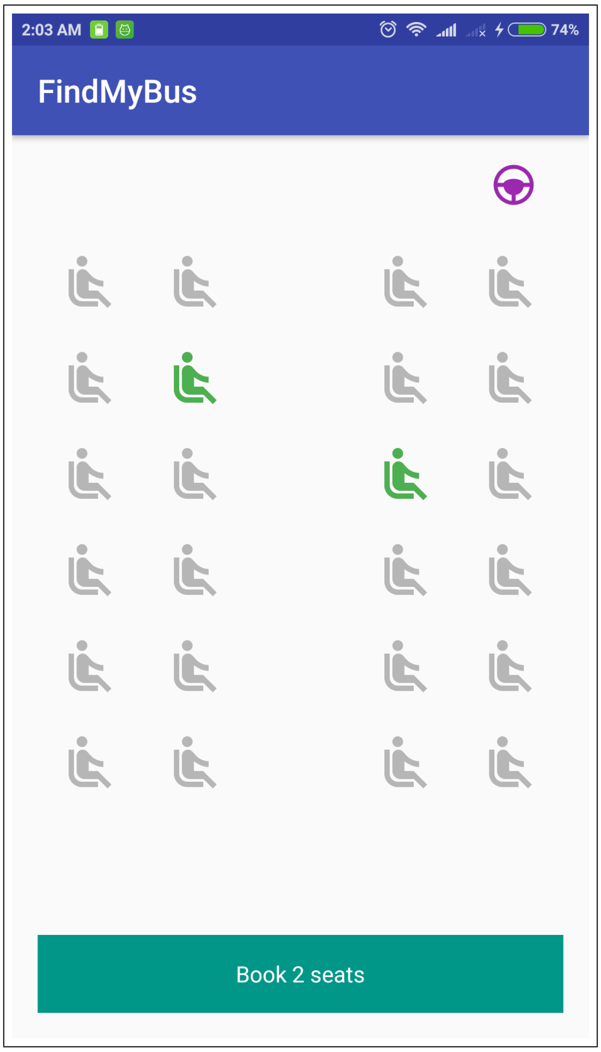


Figure 4.13: Seat Booking Page

Figure 4.13 represents seat booking page. In this page, a user can select a particular seat by click on that seat. In screenshot currently, two seats are chosen, and green color represents elected seats, available seats represent by gray color.

In next chapter, we have mention conclusion and future scope of the project.

Chapter 5

Conclusion

5.1 Conclusion

Intelligent Transport System (ITS) is an efficient and user-friendly way of tracking and reservation of public transport. ITS overcomes the limitation of a current transportation system. GPS along with Arduino are used for tracking of the vehicle and send vehicle data to the server at a particular period. ITS provides accurate location of the vehicle with the use of GPS fitted in the bus. Arrival time algorithm designed with previous and current vehicle data received periodically, for accurate prediction. Also, the Pressure sensor used for checking the occupancy of the bus and send this data to the server to notify about current seat availability of a vehicle to the user. Also, connecting bus facility is there if the possible alternative route is possible between one stop to another stop.

5.2 Future Scope

Till now we have implemented arrival time prediction algorithm for prediction of travel time between source and destination and Android application for user interaction/interface. In the further implementation, we can add an option of selection of bus based on route, arrival time of bus and price. Also, we can improve arrival time prediction algorithm by adding more parameters or another approach.

Appendix A

Paper Accepted for Publication

Paper accepted for oral presentation at **"International Conference on Recent Innovations in Computer Science and Information Technology (RICSIT-2017)"** scheduled to be held on 19th May, 2017 at University Institute of Information Technology (UIIT), Himachal Pradesh University, Shimla and also selected for publication in the ***International Journal of Control Theory and Applications*** (SCOPUS Indexed as well as in UGC approved lists of Journal (SR No: 2804)).

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