Smart Toll Pay:An Android Based Application for Hardware-less Toll Payment

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Abstract

The growth in the population of cars has increased a lot and is predicted to burst through in the coming years . All of this introduces more traffic , more pollution and more cost to people . We cannot control the growth in the population of cars but can do a thing or two by tweaking some functionalities in some of the systems used by these cars . One such system is a Toll system and we could change the traditional way of a Toll system working into a modern way by utilizing the technology available to us. Here we introduce a new way of functioning of Toll System making use of Geofencing and real time database which greatly reduces the efforts taken at the Toll and helps both the human and the nature.

Keywords: GPS, QR , RFID ,Geofence, FastTag.

1. Introduction

We introduce a Smart Toll Pay System against all the odds of the traditional hardware and manual collecting methods of a Toll in India .Pay once to fill your account and then no need to stop on Toll .All the details would be available to the Toll Collector. We do make use of geofencing and gps to make sure that the user is notified as the reaches the Toll and then within a blink of eye the transaction is done and the user can just pass through without any scanning of the tag or manual work to be done.

1.1 Existing System

Most of the systems we investigated where making use of hardware technologies , or generating a QR code .If we talk about hardware , then the technologies user are RFID: RFID is an electronic payment system that uses a sticker to pass through toll. The RFID sticker , also called an RFID tag, is unique to each vehicle and is embedded with a radio frequency chip and is affixed to either the windscreen or the headlamp of the vehicle . The RFID tag is linked to the Touch 'n Go eWallet from which the fare will be deducted . Most of the systems we investigated where making use of hardware technologies , or generating a QR code

If we talk about hardware , then the technologies user are RFID: RFID is an electronic payment system that uses a sticker to pass through toll.[2] The RFID sticker , also called an RFID tag, is occurrence of errors. Moreover, it is cumbersome and time consuming . With the increase in volume of vehicles it is becoming more difficult to keep the physical records Also the fast tag method introduced recently has not been a success as we come to know from the news because of the non responsive and slow sensors of the fast tag[4]

Disadvantages of Existing System: FastTag , the current hot topic is said to have the following disadvantages People who rarely have to travel on highways have to bear the purchase cost and security deposit of Fastag . RFID scanner goes through technical issues, leaving a FasTag user in a fix to pay the toll amount in cash.FasTag can be stolen or lost .There may be times when the toll charge may be deducted twice from your account , in the wake of a technical error. Other than that, you may face the issue of your FASTag not working. What this essentially means is that your vehicle may go through the RFID scanner and it is not able to detect your FASTag .Traditional way of Toll Payment has been causing traffic which then causes wastage of fuel .Existing System also does have pilferage[6]

2. Review of Literature

1)"Implementation of Location based Services in Android using GPS and Location based services"[1]

Authors: Manav Singhal, Anupam Shukla
This paper helps us explain how to make use of location based services provided by Google. This explains making use of these services on android platform and hence there implementation..

2)"A Comparative Study of Toll Collection Systems in India"[2]
Authors : Bharavi Joshi , Kajal Bhagat , Jekishan Parmar
This paper explains us by comparing all the existing Toll collection systems including manual , RFID and also the latest technology used i.e FastTag .It gives us a clear idea about the what things to consider while making out application.

3)"Cloud Based Web Application supporting Vehcile Toll Payment"

 Authors : Ashwini T N , P N Rachana , Savitha D G
The system explains making use and integration of various technologies including the cloud to create a Vehicle Toll Payment System . The system makes use of NFC card which brings hardware into it .

4)"Application of Queuing Theory of Toll Plaza-A-Case Study "[4]

Authors : Sangavi D G, Megha G C , Prajendra H R, Pinte Lumdike
The system explains the working of queues in the Toll . Different vehicles need to follow different lanes while the manual collection of Toll . The system helps us to know how to design out system while observing the lane theory of Tolls in mind .

5)"Geo -fencing Infrastructure : Location Based Service "[5]

Authors : Sachin W. Rahate, Dr. M.Z. Shaikh
This system explains making use of GeoFencing technology forr location based services. This paper gives us an idea about implementing the virtual boundary .

6)"Online Toll Payment System"[6]

Authors: Fathima .G, Jayamala .J, Keerthika .S

 Online Toll Payment System is an android application which is developed for reducing the traffic by making use of the online payment similar our idea . But the difference is that when the user reaches 1-2 kms from Toll a notification is given .

7)"Data security of Android applications"[7]

Authors: Jesse Obiri-Yeboah, Man Qi
The paper tells us about how to make sensitive data of the users more secured and use it in the android applications.

8)"Vehicle Tracking with Geo Fencing on Android Platform"[8]

Authors:D.Suganthi , S.Pau1Raj John, Shamil J.S, Dhruva G. Patel
Geofencing is being used in this system and gives us some more ideas about how to improve the geofencing implementation in our project.

9) "Study of Google Firebase API for Android"[9]

Authors:Navdeep Singh
 The purpose of this study is to get to know the firebase api more and also know the   features the

FireBase api can offer which we can implement in out application.

10)"Smart Toll Payment System Using Android Applications" [10]

Authors: Srisailanath, JhansiRani P, B S RamyaReddy, Anitha B L, Laxmi Swetha Yerramsetty

The system also needs the user to show the QR code to the Toll Collector which is then time consuming as its a manual process.
11)"Enhanced Battery for Android Phones using the Power of Cloud through Data Synchronization"[11]

 Authors : Sumandeep Kaur, Sugandha Sharma , Mayank Arora
This article shows a review of the Cloud Computing , mobile Cloud Computing and data synchronization between mobile and cloud .

12) " REDUCING SIZE OF UPDATES IN ANDROID APPLICATIONS"[12]

Authors:Hari H. Rajai ,Prof. Sachin Bojewar

This paper helps us understand how to keep size of android application update in a limit.

13) "Geo-fencing Infrastructure: Location Based Service"[13]
Authors.'SachinW.Rahate, Dr. M.Z. Shaikh

Another paper on geofencing technology which helps us more about how to implement the geofence in out system

3. Proposed System

Our system consists of two parts : the client and the server . The client is on an android -based cell phone and the server is Google Firebase providing us with features like mobile authentication , real time database and geo query . The toll collector would be provided with an interface where in he would be able to see the list of vehicles passed through the toll with all the information such as Name of the vehicle ,Cost of Toll ,Image of the vehicle ,Cost of vehicle , Name of the User.

The real time query would be fired whenever the user reaches a particular distance from the toll .The fused location provider is the one which is used .The fused location provider is a location API in Google Play services that intelligently combines different signals to provide the location information that your app needs . Geofencing is a location -based service in which an app or other software uses GPS , RFID , Wi-Fi or cellular data to trigger a pre- programmed action when a mobile device or RFID tag enters or exits a virtual boundary set up around a geographical location , known as a geofence .

 Depending on how a geofence is configured it can prompt mobile push notifications, trigger text messages or alerts , send targeted advertisements on social media, allow tracking on vehicle fleets , disable certain technology or deliver location -based marketing data.[5] .Geofences in our system are identified by circles having blue radius,these geofences are identified by three components which are the latitude and longitude and the radius of the geofence .in our system are identified by circles having blue radius , these geofences are identified by three components which are the latitude and longitude and the radius of the geofence

.In our system , we make use of notifications when a user reaches a distance from toll , he is notified about the name of the toll he is approaching by our distance calculation algorithm and then the cost the of the toll for that type of vehicle is pulled from the database and then the balance is deducted .Our system won't allow a user to use the application until and unless he has a certain minimum balance in his account.

This minimum balance criteria for a particular user is based upon the type of vehicle he has registered

, suppose the vehicle registered is an LMV then the minimum balance is set to Rs 45 as from the information gathered we came to know that the minimum balance for an LMV vehicle is Rs 45 , so a user having a balance of Rs 45 with our application would be allowed to proceed with using of the application.

The Fig-1 explains the flow of the proposed system from the user registration to the transaction and how the geofencing will undergo the automatic deduction of the balance from the user account.
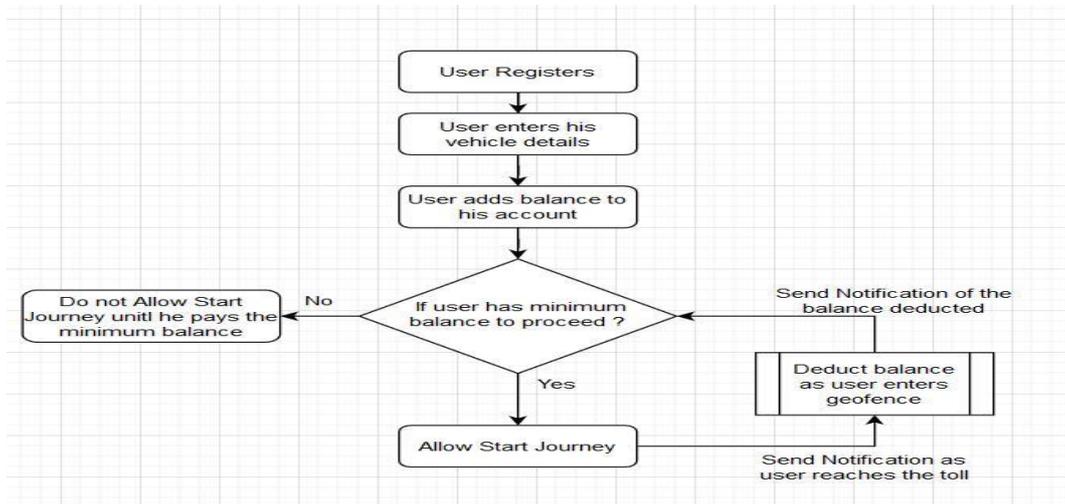

Figure-1:Flow Diagram of Proposed System

4. Result and Analysis

Our system working has been depicted by the sequence diagram . The user in this system is the one using the application , the application frontend is the android application user interface used by the user and the backend is the Firebase providing us various features which were talked about earlier .The Toll Collector frontend would receive the data from the firebase database in real time so when the user reaches a particular distance from the toll, the toll collector is notified about the vehicle incoming with all the details.

4.1 User registration

The user will first be provided with the registration screen and the details will then be stored on the firebase database.
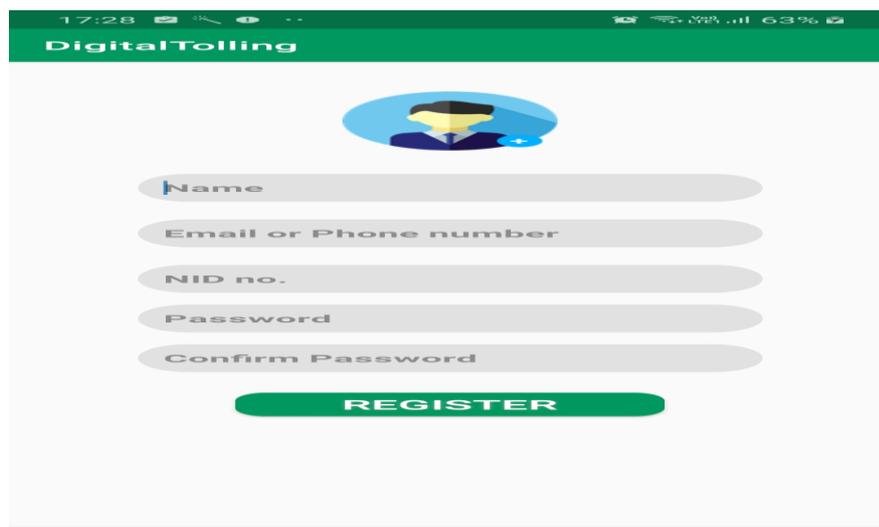

Figure-2:User Registration

4.2 Vehicle Registration

The user will then have to capture the image of his car with number plate clearly seen and also register other details of the user vehicle The image would be used as records for the Toll collector to uniquely identify the car . The image is captured by the camera the phone has.
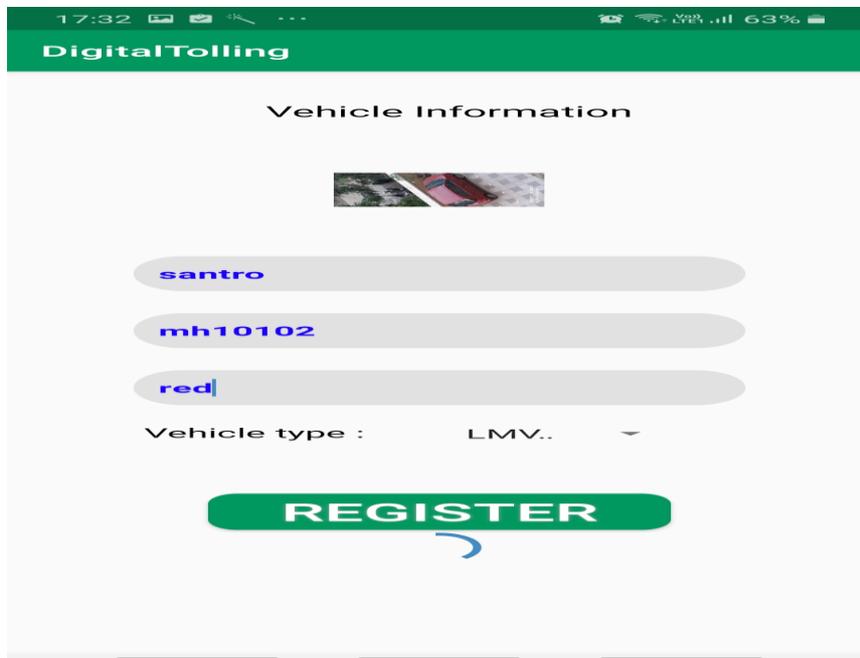

Figure-3:Vehicle Registration

4.3 Dashboard
After successful registration of the user and the vehicle the user will be provided with an interactive dashboard show in Fig -3

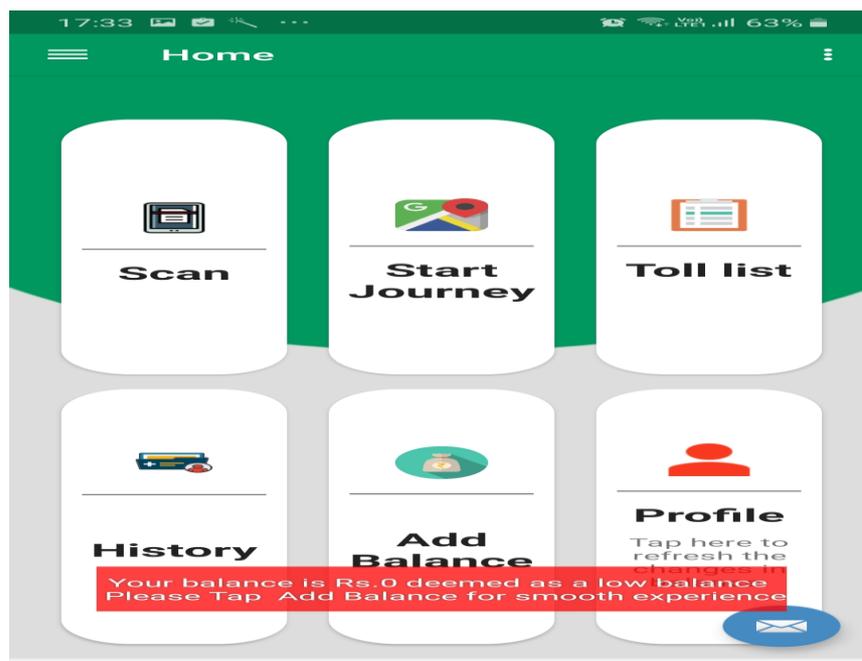**Figure-3:Dashboard of System**

4.4 Add Balance

Users after their first login or when their balance drops below a certain minimum value will have the Add Balance tab active or else it would show the balance available .The user can use any upi for payment.

Our application will check the phone to see any upi payment application installed and then would ask the user to choose from one and proceed with the payment.

If the user does not have any payment application he will need to install one and then set it up accordingly and then the installed application would be automatically detected by our application while making payment

The UPI can be set in the code accordingly depending on the account to which the balance needs to be transferred. This account can be to account of the government responsible for managing the Toll affairs for a country/state.

The entire conclusion of this is that changes to the payment system can be done easily with just few steps and then the application can be deployed again without any other thing affected.
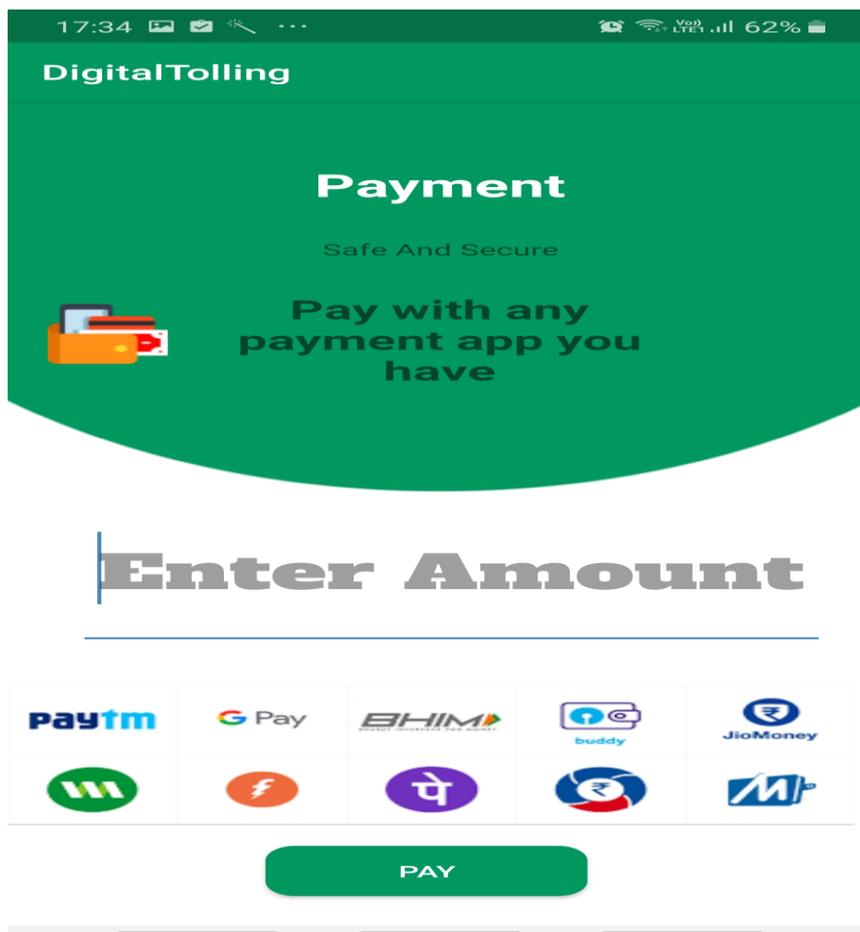

Figure-4:Payment Screen of System

4.5 Start Journey

After the minimum balance criteria has been fulfilled the user would be allowed to start the journey . Our system will make user of fused location provider which get the location of the user device .When the user reaches a particular distance from the geofence he would be shown a notification about the incoming toll which tells the user about the name of the toll .

Our System will then connect the Firebase to get the details of the user and also the vehicle , then the balance is fetched and deducted from the Toll cost for that particular user .In this there would not be a case of low balance as the user has already statisfied the minimum balance criteria .Toll collector would also be notified with the image of teh vehicle and all the vehicle details about the vehicle passing through his toll.After some time the user will get a notification of the amount deducted from his balance.
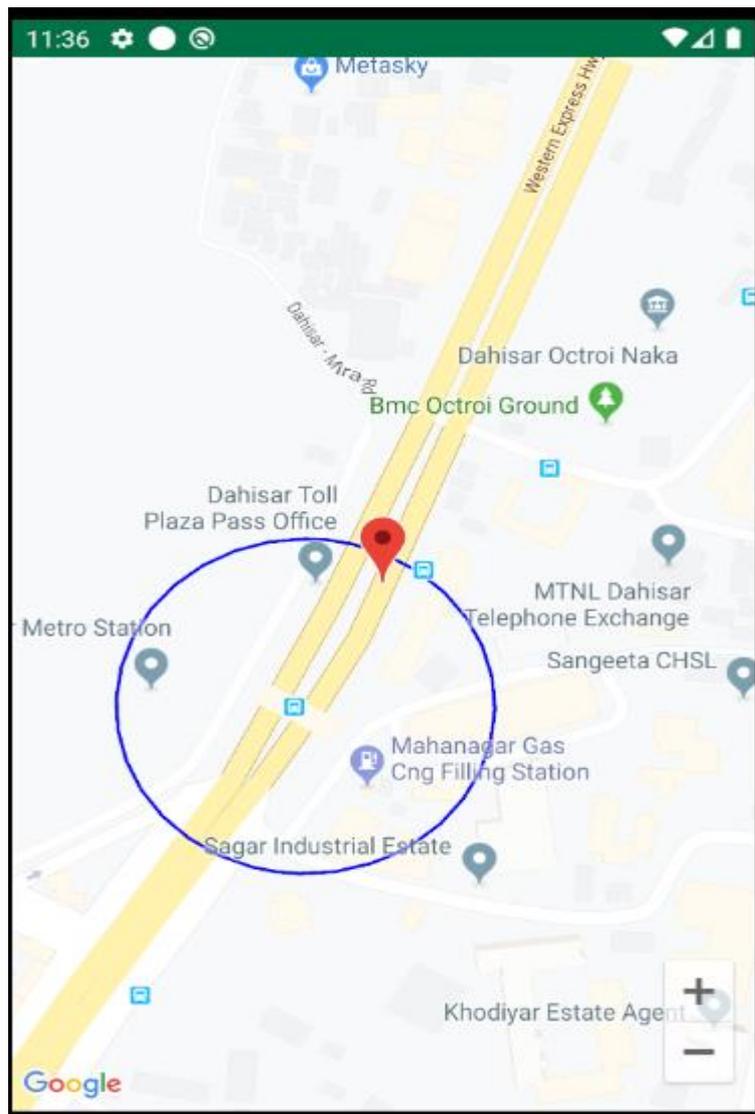

Figure-5:User reaches near Toll

As soon as the user reaches the Toll which in our case enters the geofence a notification is sent on his phone which is shown in Fig-7 .The user can keep the app minimized .
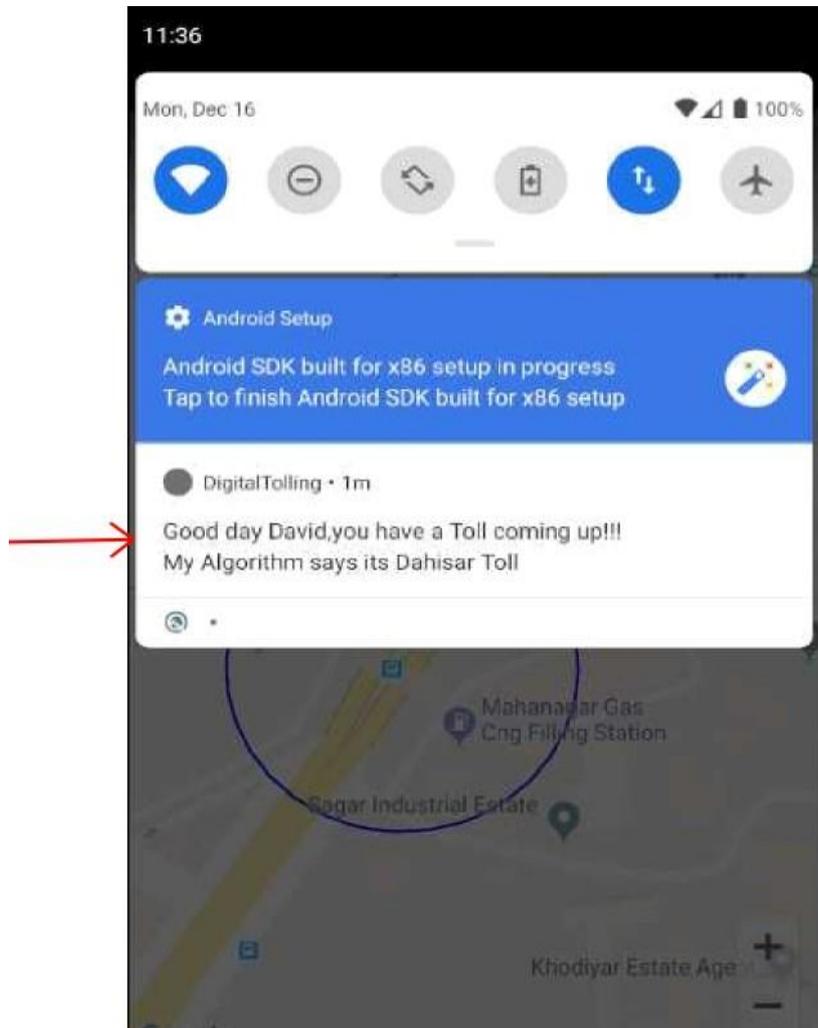

Figure-6:Notification on the user screen indicating the Toll

The Fig-7 denotes that when the user reaches a particular distance from the toll he gets a notification as discussed earlier. Now after the users leaves the toll , the required amount is deducted from his balance and then a notification is sent to him.

The Fig-8 then indicates that when the user leaves the geofence which to our application means that the user has left the Toll .The required balance is deducted from the user's wallet that he already added and a notification is given as shown in the Fig-8.
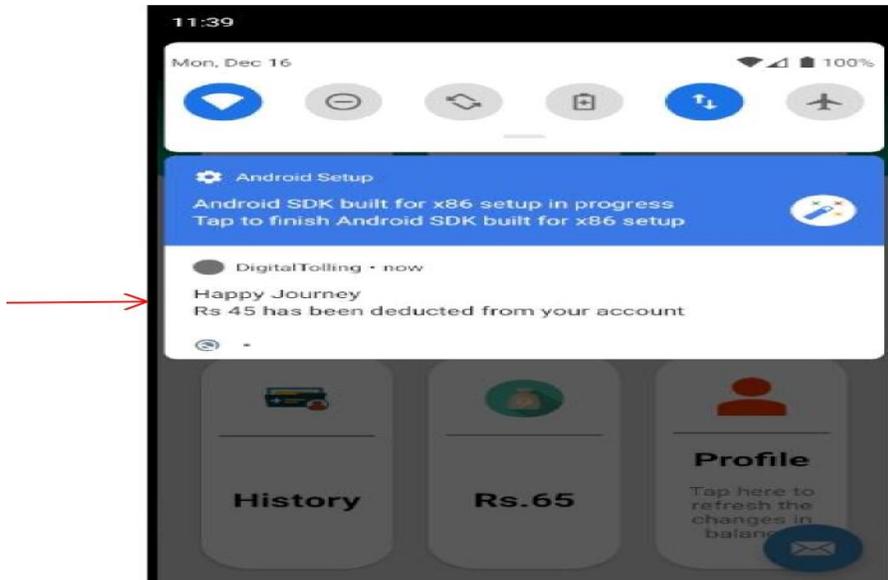
Figure-7:Notification on the user screen indicating deducted amount

4.6 Records

 The records are then stored on the firebase database in realtmie. These records contain the vehicle image, the username , the toll name , the cost of toll and the timestamp . These records can then be sent to the Toll collector for verification. The records can be found in the History tab of the dashboard .

 The following is shown in the below diagram .As our system maintains proper records of all the transactions the user has made and when the balance of the user is deducted with the timestamp so there won't be any condition of theft or also corruption.

This records are saved in the firebase database and are rendered to the user when ever the user wants to have a look on the history of the transactions. The record feature allows us to have complete transparency and thereby increasing the customers trust in our application

Figure-8: Screen showing history of transactions

5. Conclusion

As we all know that the toll payment techniques present in the market right now are not much efficient as they do not meet the three main properties such as time , cost and effort . In case of time , the techniques present are very time consuming as they require waiting of a particular individual for completing the toll payment process. In case of cost, the techniques present consists of hardware components or etc which cost effective. In case of effort, the techniques present requires effort from both the vehicle user and toll collector.

In the case of efforts , we reduce the efforts of both the vehicle user and the toll collector as for vehicle user there is no need of looking for money of suitable denomination and wasting valuable time also leading to more traffic and for toll collector there is no need to stretch hand out for collection of money . Overall , the system helps both the user as well as the Toll Collector in terms of the time , effort, cost as discussed in the earlier paragraphs.

Our system also doesn't need the user to fix the route where the user is going to travel as in case of some systems.The system is dynamic for its payment module also wherein modifications in the payment can be done quite easily.As it is the case for other systems , introducing a automated toll payment will surely reduce the traffic caused by vehicles waiting in queues and which would then surely reduce its evil effects on the environment. So we can conclude that our system is well nurtured for facing the future as we make our way through this avaricious world

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