

Toll and Traffic Management System for Express Highways



Aditya Gupta, Riya Agarwal, Akriti, Prabhat Singh, Harsh Khatter

Abstract: Now a days, toll plazas at the highways are operated manually, where a vehicle comes near the toll booth and toll collector collects the cash and enter the vehicle data and provides a receipt. Manually operated Toll Plaza Systems leads to longer waiting time of vehicles and heavy traffic at the highways. To overcome this issue of traffic congestion and time management and to bring automation in the toll management system, we have introduced an innovative, optimized and revolutionary system. This paper is putting forward an efficient and cost-effective technique of automatic toll collection. The system is based on the mobile GPS network and will use various APIs for development. The cost to be paid at the toll gate is auto decided as per the government limits and the toll booth charges. System will use online payment gateways to collect those revenues. If the balance is low in the user's account then it can be recharged at the booth itself. At the user's end, If the toll tax payment is delayed by certain timeline then user will be informed by an alert message and if delay still exists then strict actions will be imposed along with proper penalty charges for the same. This system is the novelty to the existing toll system. It will have a wide impact on people's life as its scope will lead to safe and enhanced productivity through the use of advanced technologies. This will also minimize fraud and will provide user convenience. It will also enhance the operational efficiency of toll collector.

Keywords: GPS based Tracking; Mobile based application; Fair and Transparent Toll Distribution and Revenue Collection.

I. INTRODUCTION

In India, the total length of national highways is 142,126 Kms and still increasing at a very rapid rate along with every passing year. It results to the establishment of new toll booths and results in delay in traveling at rush points as they have to wait in lane for the toll booths. And in accordance with the report released in 2016 regarding the vehicle density on road per km (till 2015) is **39 vehicles/km** along with having a growth ratio of 2.37 times of vehicle with respect to the growth in the road length all over India.

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Which means there is a major chance of having long lane of waiting on Toll at the time of rush. Because of which, through this mobile application along with having a centralized system and distributed network system of mobile based GPS, we have tried to resolve this issue along with providing a way of greater ensuring of fair and transparent approach of toll revenue collection. There are various other ways already introduced to minimize the restriction in the flow of vehicle on roads for example of introducing number plate scanning system and imposing the toll amount on the owner of the car. [1, 7, 8]

In countries like India the establishment of such system costs too expensive on the budget for National Highway that results to failure on the ground of network establishment along with maintenance of the system at regular developing environment. In contrast, with the help of our study imposed in direction of this issue, this less hardware established and software-based system, the idea of automation in toll system and fair and transparent revenue collection can be achieved. And this paper is wholly dedicated to the aspects regarding that.

Secondly, along with the automation point, there is a chance of having an over-speeding on road, this is also being cared by our system idea for which we didn't need to add new technology, in our present, just we needs to calculate through GPS how much distance it has been covered by the vehicle in limited period of time. If it crosses the speed limit, then a prompt comes to the user that he/she is over-speeding and helps to provide better vehicle control to the user along with guiding map route to the user to reach in minimum time span using Google APIs.

Our aims behind proposing this app-based system is to upgrade our traditional Highway management system to a more reliable and safer road-based system by tracking speed of motor vehicle and introducing more simple and economical way of toll distribution methodology. It results to the introduction of Intelligent Express Highways which is the demand of the growing India. This system can also work 24x7 without any human interventions as this application is connected to the high processing-based systems with high level of cyber security. This system also enables online payment methodology in government sector too.

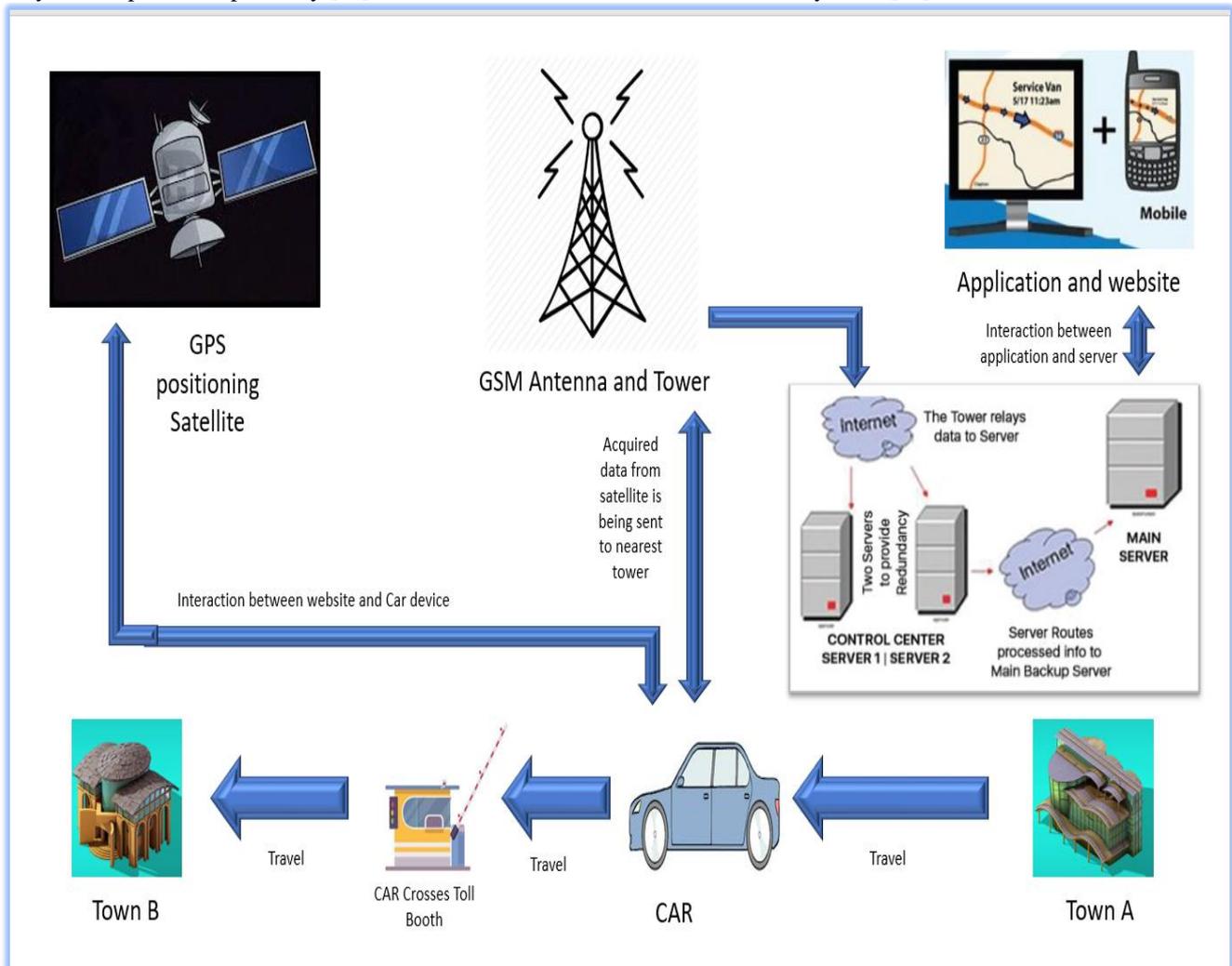
II. DESIGN OF A TOLL MANAGEMENT SYSTEM

We need to focus on some major points while designing our toll management system. Which are:

- A. Indian and western road networking system
 - S. Babu and B.S. Manoj has skillfully described about the road networking systems in india and western countries.[3]

- P. Khanzode, S. Nigam, S. P. Karthikeyan, K. S. Kumar and I. J. Raglend have skillfully described about the road map to the Indian power scenario by 2020.[6]
- B. Case studies of previous and present toll systems in India [1]
- C. Case studies on toll-based system in various different countries and revolution in them
 - Myung-Soon Chang, Kyung-Woo Kang and his team has described about the Toll based system in Korean Highway along with the improvement in them. [9]
 - Itsuro Otaki, Yoshikazu Imanishi and their team have skillfully described about distance-based toll system in Tokyo Metropolitan Expressway.[10]

- D. Safety of human on road transportation and Speed control system of various vehicles
 - R. Shankar and A. V. Singh has described about using VANETs for human safety during road transportation.[2]
 - B. T. N. Diogo, C. Luvizon and R. Minetto have described about the speed estimations of various vehicle through image processing system.[7]
 - M. Gorajanal, P. Mannikeri, V. Nayak, V. Deshpande and M. Bhille have described about the Record management system.[4]
- E. Environmental aspects and effects due to the influence of toll systems [12]

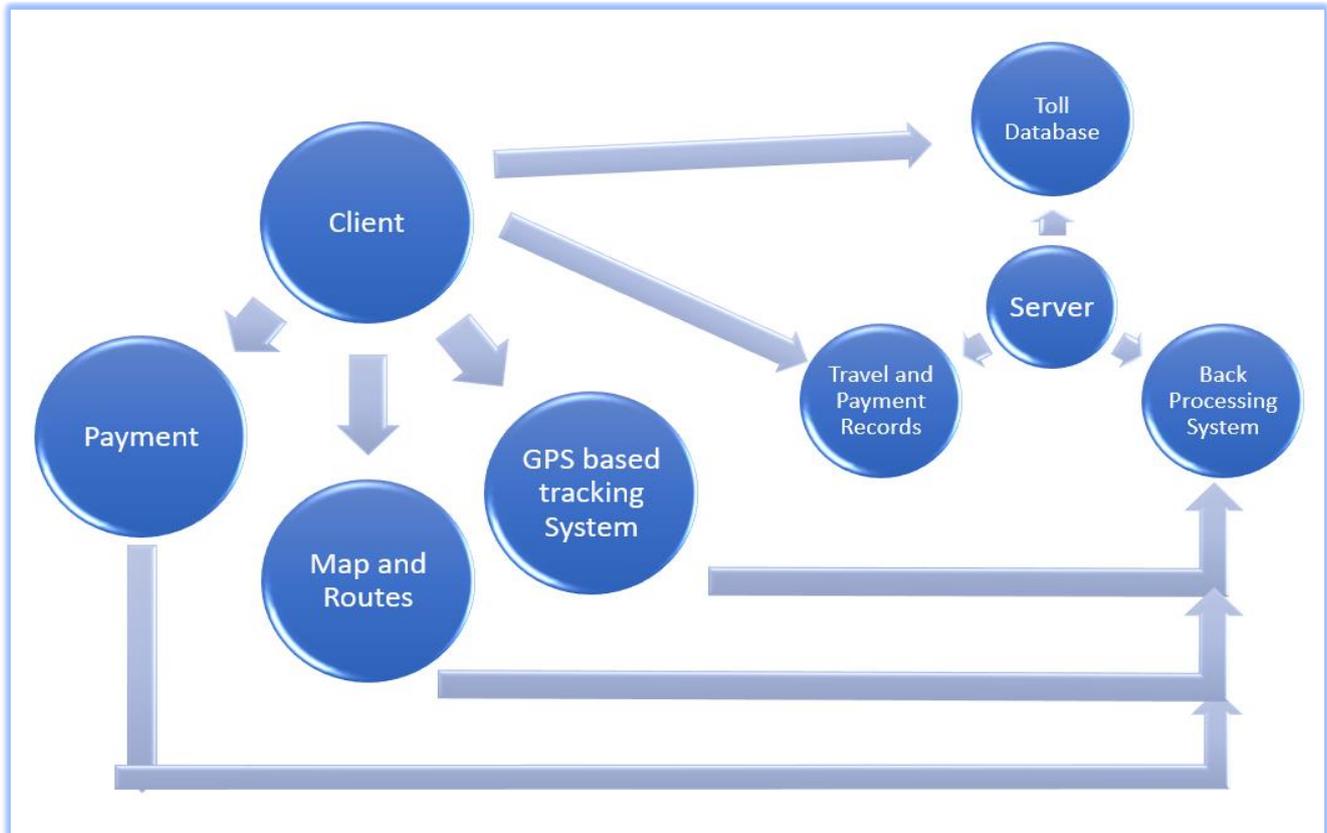


- F. Optimized and reliable vehicle positioning system
 - J. Huang, X. Li, Y. Sun and Q. Xu have described about the highly reliable vehicle positioning system. [5]
 - Issam Damaj and Rached Zantout have described about the GPS based tracking system using Chip based technology.[11]

Through this paper, we have proposed an integrating self-management GPS network-based system for designing Intelligent Highway having a unique methodology for innovating Toll System in India. It follows a well-designed network of GPS system for calculation of speed, gates/ toll checks for toll revenue collection in Highways. This GPS

just needs of establishment of network to identify the location more precisely.

Above shown pic shows the network that would going to work in this proposed Intelligent Highway System. In this architecture, we have to make sure that every application is connected to proper network and internet as well as vehicle is also equipped with GPS monitoring System to interact with nearest Tower and GPS satellite to locate its location on Google location map. Along with that, in our application, while starting every ride, user have to enter the vehicle number, so that with help of our system, we can map the vehicle location with the device.



As it's a mobile application, it doesn't require a very heavy load processor in mobile system and most of the processing is being done at the centralized server along with secure gateway systems for maintaining transparency and security at Global working as this system requires to be reliable to handle load at rush hours. Until now, in this paper, we have proposed an idea and for designing the back-server system, in today's world, inter correlation between block-chain and distributed systems is the best and reliable system but still works on its study and working is going on to maximize the performance as much as possible.

The usage of block-chain is in accordance to create the most reliable networking for payment part, so that, there is a minimized possibility of error and faults in money transfer. And with the idea of using distributed systems is to bring sustainability in location detection as well as proper functionality of communication between server and application.

III. TECHNOLOGIES USED

For designing this Toll System, we have focused and studied about following technologies:

- A. GPS tracking system and Connectivity
- B. Google Map Platform and API's
- C. Flutter and its usage for Application Development
- D. Payment Gateways and usage

IV. IMPLEMENTATION

The major challenge in the implementation of the project is to create an application who is needed to much reliable and self-sufficient to maintain its sustainability in rush hours. So that, our goal can be achieved through this project and proposed idea. For which, we needed to design a highly precise interaction establishment between Client and Server

along with on time problem solving facility to maximize its efficiency.

On the basis on the required data and technology usage, we have put forward an interaction access of client using application (as shown in above picture) to the specific points that are as follows:

A. Payment System and Gateway:

As automation is being the major topic of focus and introduction of this work, the payment mode at the toll also be automated such that it is secured and safe.

B. Google Map and Route:

As the toll should be monitored automatically, we need to make our system so reliable along with google map and routing mechanism such that transparency can be maintained.

C. Travel and payment records:

Basically, on case of online payments and routing that we have done, we want to have a record system, so that, in future if we want to look about a travel we have done can be searched easily.

D. Toll information on specific route:

It basically, a google API based GPS detection system in which while travelling from city 1 to 2, we can get information of every toll that comes in the path.

E. GPS tracking System:

It's the standardized System of satellites and server-based system to find the accurate location of vehicle and the client in the travelling route.

Similarly, on grounds of functionality of server and system, user didn't have any knowledge and access in various points:

A. Master database:

Master database is the main database which have record of each and every client along with record of every travels, payments and searches on the application that he/she has done.

B. Back processing unit of server:

It refers to the main processing unit or we can say the CPU of the whole system as all records, even GPS processing and system controls are being handled by it. In this, Client doesn't need to know about it, but needs to have proper functionality of the system which is dependent on it.

C. Inter communication channel of devices:

As data is to be transferred to various places through towers, so a highly reliable network is to be established between application and the server.

D. Knowledge of gateway usage:

Knowledge of previously used gateway as well as the methodology preferred by the consumer is the basic key point that needs to be focused but not to be known by the client.

That means, Client have full access to look to the database of him/her along with proper knowledge of the travels that he/she has done and amount is being paid by the user. If he/she has any issue regarding any travel record and payment, he/she can tell issue by generating issue token regarding the issue in app itself on which control executive will catch back on the topic issue and tries to resolve it as soon as possible. This application is an android based application for now in which Google APIs and Gateways is being used to create a secure channel and multiple checks and barriers are also being set, so that, there is minimum chance of unauthorized usage and money related issues. And as mentioned earlier, we are designing the back system using block chain and the distributed systems to maximize its work and load capacity with high security network.

V. SPEED MANAGEMENT

Along with automation, the condition of toll can booths are being minimized which results to the arising of issue regarding the over-speeding of motor vehicles. Occurrence of which is highly risky on Highways.

For this, GPS tracking enables us to find the speeding every sec (or half a min) from the start by calculating the distance covered with respect to the time taken for covering it. For making up the rules and regulations more precise and safer, through this app, for over speeding record of the motor vehicle will be forwarded to Police for penalty only after the ignorance of the reminder and over speeding more than 2 times.

It will enable our system easy to use and more reliable to road usage as it will make sure the safety of people while driving or travelling through motor vehicles by minimizing the case or recklessly over speeding on roads.

VI. REASON BEHIND USING GPS

- A. Easily Available.
- B. Highly integrated location detecting system
- C. Google API support and dependencies

VII. RESULTS

Through our analysis and implementation of our proposed system, we are able to achieve the following things as results:

- A. More reliable and efficient system comparable to RFID system
- B. More efficient Toll revenue collection possibilities along with transparency in transactions and amount collection
- C. Sufficient Traffic Congestion reduction around Toll Areas
- D. Establishment and maintenance cost reduction in Toll Systems

VIII. CONCLUSION

Through this idea, the traditional concept of having toll booths to collect toll revenues can be replaced and upgraded easily and more reliable system can be established along with minimizing the restrictions coming in the flow of motor vehicles as well as the introduction of GPS based concept of speed monitoring of the motor vehicles that can helps in decreasing road incidents in sufficient amount. It would help in easy availability of the routes with the help of highly integrated location detecting system. And for coming future, our major focus is now going to make our back-system processing, i.e., main server processing more reliable, durable, and self-sufficient in itself to handle heavy load of rush hours.

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