Proposal of Intelligent Transportation Systems (ITS) for Mumbai City
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Abstract: Transportation system is very important in day to day life. There are various modes of transportation such as roadways, railways, airways etc. In recent years, technology has progressed further a lot and along with it use of technology in transportation is increased. Also with development of countries and their economies number of vehicles on road has increased. Hence, controlling heavy traffic has become difficult. In order to solve this problem and allow traffic to run efficiently, implementation of new transportation system has become necessary. Here comes the Intelligent Transportation systems (ITS), which not only controls the heavy traffic on main roads and also minimizes the accidents, because of use of ICT (Information & Communication Technology) in all transportation mainly related with road transportation. This paper deals with all the latest technology advancements in ITS, which can be extensively used in Mumbai and all important cities as a part of Smart City features also. Here, basic concepts and background that is useful for the understanding of intelligent transportation systems and their applications is presented and followed by a brief discussion of vehicular communications.

Key Words: Intelligent, Transportation, City, Automatic

1. INTRODUCTION
Many areas of the developing world have urbanized without significant motorization and the formation of suburbs. A small portion of the population can afford automobiles, but the automobiles greatly increase congestion in these multimodal transportation systems. Other parts of the developing world, such as China, India and Brazil remain largely rural but are rapidly urbanizing and industrializing. In these areas a motorized infrastructure is being developed alongside motorization of the population. Great disparity of wealth means that only a fraction of the population can motorize, and therefore the highly dense multimodal transportation system for the poor is cross-cut by the highly motorized transportation system for the rich. Effective vehicular connectivity techniques can significantly enhance efficiency of travel, reduce traffic incidents and improve safety, alleviate the impact of congestion; devising the so-called Intelligent Transportation Systems (ITS) experience. Further, ITS can play a role in the rapid mass evacuation of people in urban centers after large casualty events such as a result of a natural disaster or threat. Much of the infrastructure and planning involved with ITS is the need for homeland security systems. An intelligent transportation system (ITS) is an advanced application which, without embodying intelligence as such, aims to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and ‘smarter’ use of transport networks.

2.IMPORTANT FEATURES
Following are some of the important and salient features of ITS (Intelligent Transportation System). They are being extensively used in all the developed countries

* Automotive navigation system
• Automatic number plate recognition
• Speed cameras
• Parking guidance and information systems
• Floating car data/float cellular data
• Triangulation method
• Vehicle re-identification
• GPS based methods
• Smartphone-based rich monitoring
• Vehicle Re-identification System
• Inductive loop detection
• Video vehicle detection
• Emergency vehicle notification system
• Automobile collision avoidance system
• Electronic toll collection system
• Bus rapid transit system

2.1 Automotive Navigation System

An automotive navigation system usually includes a built-in database of road maps; some systems allow these maps to be updated by connecting the car’s computer with the manufacturer’s website. The device also has a means of receiving signals from GPS satellites, as well as a back-up system in case these signals are cut off by surrounding terrain.

2.2 Automatic Number Plate Recognition (ANPR)

Automatic number plate recognition is a technology that uses optical character recognition on images to read vehicle registration plates. It can use existing closed-circuit television, road-rule enforcement cameras, or cameras specifically designed for the task. ANPR is used by police forces around the world for law enforcement purposes, including checking if a vehicle is registered or licensed.

2.3 Speed Camera

Speed cameras detect the speed of vehicles by using detectors embedded into the road surface or radar technology. If the speed of the vehicle exceeds the legal limit, or a vehicle runs a red light, a digital picture is taken of the offending vehicle. If an offence is detected, a digital image of the vehicle is recorded. The image clearly shows the colour, type, make and numberplate of the vehicle. Digital images also include:
• Date of the offence
• Time of the offence
• Location details of the camera that took the picture
- Direction of travel of the offending vehicle
- Speed of the offending vehicle

**Speed cameras**

2.4 Parking Guidance and Information (PGI)

PGI systems are designed to aid in the search for vacant parking spaces by directing drivers to car parks where occupancy levels are low. The objective is to reduce search time, which in turn reduces congestion on the surrounding roads for other traffic. A Parking Guidance System (PGS) have different elements:

- Detectors
- LED indicators
- Zone Controllers
- Data / Intermediate Controllers

Some manufacturers use LED indicators per space, while others either don't provide any or use one LED indicator for few spaces. The purpose of an LED indicator is to provide guidance to parkers up to the last empty space.

**Detector and LED**

Parking space available on each level

**Indication of occupied and vacant space through led**

2.5 Floating Car Data

Floating car data (FCD), also known as floating cellular data, is a method to determine the traffic speed on the road network. It is based on the collection of localization data, speed, direction of travel and time information from mobile phones in vehicles that are being driven. These data are the essential source for traffic information and for most intelligent transportation systems (ITS)

**Working of floating car data**
2.6 Vehicle Re-identification (VRI)

Vehicle re-identification methods require sets of detectors mounted along the road. In this technique, a unique serial number for a device in the vehicle is detected at one location and then detected again (re-identified) further down the road. Travel times and speed are calculated by comparing the time at which a specific device is detected by pairs of sensors. The data is fed through the government-dedicated broadband wireless infrastructure to the traffic management center to be used in adaptive traffic control of the traffic lights.

2.7 Induction Loop

An induction or inductive loop is an electromagnetic communication or detection system which uses a moving magnet to induce an electric current in a nearby wire. Induction loops are used for transmission and reception of communication signals, or for detection of metal objects in metal detectors or vehicle presence indicators. A common modern use for induction loops is to provide hearing assistance to hearing-aid users.

2.8 Video Imaging Vehicle Detection System (VIVDS)

In modern intelligent transportation systems, the video image vehicle detection system (VIVDS) is gradually becoming one of the popular methods at signalized traffic intersection due to its convenient installation and rich information content provided.

2.9 Emergency Vehicle Notification Systems (EVNS)

The in-vehicle eCall is generated either manually by the vehicle occupants or automatically via activation of in-vehicle sensors after an accident. When activated, the in-vehicle eCall device will establish an emergency call carrying both voice and data directly to the nearest emergency point. The voice call enables the vehicle occupant to communicate with the trained eCall operator.

2.10 Automobile Collision Avoidance Systems (ACAV)

Automobile collision avoidance systems operate under the guiding principle that even if an impending collision is unavoidable, the right corrective measures can reduce the severity of an accident. Here, collision avoidance systems use a variety of sensors that are capable of detecting unavoidable obstructions in front of a moving vehicle. In addition to automatic braking, some collision avoidance and pre crash systems can also include:

Working of collision avoidance system
2.11 Electronic Toll Collection (ETC)

It aims to eliminate the delay on toll roads by collecting tolls electronically. ETC determines whether the cars passing are enrolled in the program, alerts enforcers for those that are not, and electronically debits the accounts of registered car owners without requiring them to stop.

2.12 Bus Rapid Transit System

Bus rapid transit system (BRTS) is a BRT system includes roadway that is dedicated to buses, and gives priority to buses at intersections where buses may interact with other traffic; alongside design features to reduce delays caused by passengers boarding or leaving buses, or purchasing fares.

4. LITERATURE SURVEY

Following are some of the places in India & Abroad, where ITS has been implemented.

IN INDIA:

4.1 Chennai: Chennai has initiated advance traffic management system. This system comprises of putting up a complete monitoring system using surveillance cameras for traffic rules violators, especially at junctions, named as Traffic Regulatory Management System (TRMS).

4.2 Mumbai: Mumbai has implemented area traffic control project that deals with management of traffic flows at major junctions. Technological help is also taken from latest gadgets like, accelerometer guns, smart cameras for vehicle number detection, radar sensor, etc.

4.3 Bengaluru and Hyderabad: A pilot project has been introduced where real-time traffic scenario of major intersection and its secondary connector roads can be obtained through internet in Bengaluru and Hyderabad. SMS based system is also available to the road users and motorists to get the updates for traffic jams and restricted accesses due to ongoing construction and maintenance activities.
4.4 **New Delhi** Basically, with a web-based platform, this project was initiated for providing morning and evening peak hour traffic condition of selected locations. The idea was also to initiate SMS service with monthly subscription charges but this service failed to function due to weak response from people and unavailability of the data.

**Advanced Parking Management in Delhi**

4.5 **Pune: Bus rapid transport system (BRTS)**

In BRTS system separate lanes are provided for public transport buses where any other vehicles other than these buses are debarred to enter. The advantage of such system is efficiency and transportation speed of public buses increases due to which passengers may give great response in using public transportation system instead of using private vehicles reducing congestion on roads and is also good for environment.

**Bus rapid transport system (BRTS)**

IN ABROAD:

4.6 **United States of America**: ITS is coordinated through Research and Innovative Technology Administration wing (RITA) of U.S. Department of Transportation in the country. Along some federal and private agencies, RITA focuses on ITS initiatives like Telephone Data Dissemination.

4.7 **Europe**: Europe’s ITS broadly falls under Road Transport Informatics (RTI). RTI emphasises on two interrelating programs - Road Infrastructures for Vehicle safety in Europe (DRiVE) and PROgram for European Traffic with Highest Efficiency and Unprecedented Safety (PROMETHEUS).

**Number Plate Recognition in Germany**

4.8 **United Kingdom**: Intelligent Speed Adaptation has been implemented which displays the allowable speed limit on the dashboard of the vehicle, that constantly reminds the driver not to exceed the limit by mistake. This system is facilitated by the vehicle mounted GPS that detects location of the vehicle and shows the allowable speed limit in the display.

**GPS System in UK**
4.9 **Dubai**: Middle East has been banking heavily on ITS for its fastest growing transportation sector in the world since 2001. The first phase of world’s most refined ITS project was started by Dubai municipality. The features of the ITS in Dubai are as follows:

- Traffic jam alerts to vehicle drivers to alter the route.
- Diversion of inconvenience free normal flowing traffic from the lane having accident.
- Automated feasible changes in speed limits in the case of accidents or bottlenecks.

**Traffic Signal Prioritisation for emergency vehicles in Dubai**

4.10 **Canada**: Canada is the first country to introduce ITS and Toronto was the first city in the world to install computer controlled traffic signal system on the road in 1959.

**Electronic Toll Collection in Canada**

5. **ANALYSIS OF LITERATURE SURVEY**

**In INDIA**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of smart city</th>
<th>Important features of ITS(Intelligent Transportation Systems)</th>
</tr>
</thead>
</table>
| 1.      | Chennai                  | • CCTV surveillance cameras  
                         | • Automatic Number Plate Reader cameras  
                         | • Pan Tilt Zoom cameras  
                         | • Automatic Traffic Control system  
                         | • FM radio traffic update system  
                         | • Speed cameras  |
| 2.      | Mumbai                   | • Accelerometer guns  
                         | • Vehicle number detection camera  
                         | • Radar sensors  
                         | • Electronic toll collection system  
                         | • CCTV cameras  |
| 3.      | Bengaluru                | • Real-time traffic scenario images via internet  
                         | • Speed guns  
                         | • CCTV cameras  |
| 4.      | Ahmedabad &Chandigarh    | • Electronic toll collection system  
                         | • Automated Vehicle tracking  
                         | • public information system about the bus arrival  
                         | • RLVD(Red Light Violation Detection) System  
                         | • ANPR(Automated Number Plate Recognition) camera systems  |
| 5.      | Pune, Delhi, Bangalore,  | • Bus rapid transit system  |
Chennai

6. Delhi (Palika bazar, Delhi)  
   • Advanced parking management system

7. Indore  
   • RLVD(Red Light Violation Detection) System  
   • ANPR(Automated Number Plate Recognition) camera systems

8. Hyderabad, Surat  
   • RLVD(Red Light Violation Detection) System  
   • ANPR(Automated Number Plate Recognition) camera systems  
   • CCTV cameras

### In ABROAD

<table>
<thead>
<tr>
<th>SR NO.</th>
<th>COUNTRY</th>
<th>Important features of ITS(Intelligent Transportation Systems)</th>
</tr>
</thead>
</table>
| 1.     | USA                      | • 3 digit telephone number (511) to provide current information on traffic conditions  
          |                                                                   | • Co-operative intersection collision avoidance system  
          |                                                                   | • Automatic toll collection system  
          |                                                                   | • Speed cameras  
          |                                                                   | • Number plate recognition system  
          |                                                                   | • Video vehicle detection |
| 2.     | European countries       | • Co-operative intersection collision avoidance system  
          |                                                                   | • Automatic toll collection system  
          |                                                                   | • Speed cameras  
          |                                                                   | • Number plate recognition system  
          |                                                                   | • Automatic detection of crossing cyclist and pedestrians |
| 3.     | United kingdom(U,K)     | • Speed cameras  
          |                                                                   | • CCTV cameras  
          |                                                                   | • Electronic toll collection  
          |                                                                   | • Intelligent speed adaption screens  
          |                                                                   | • GPS system |
| 4.     | Dubai                    | • Traffic signal prioritisation for emergency vehicles  
          |                                                                   | • Speed cameras  
          |                                                                   | • Automatic number plate recognition system  
          |                                                                   | • Electronic toll collection system |
| 5.     | Canada                   | • Collision avoidance system  
          |                                                                   | • Sensor based driving safety enhancement  
          |                                                                   | • Emergency management services  
          |                                                                   | • Public transport services consisting transit system  
          |                                                                   | • Automatic signal based on traffic  
          |                                                                   | • Electronic payment services |

### 6. IMPORTANT FEATURES PROPOSED TO BE IMPLEMENTED in MUMBAI

Mumbai is the Industrial, Financial & Business Capitol of India. As per the 2018 census, the total population of Greater Mumbai is about 1.4 crores and total MMR(Mumbai Metropolitan Region) is about 2.0 crores. The no. of 2-wheelers & 4-wheelers running on all the roads is also increased by 4 times in the last 10 years. This has created lot of traffic jams & road accidents. In order to effectively run the road system, the following
important features of ITS are to be proposed / implemented immediately. Based on the studies in India & Abroad, following are some of the suggestions for ITS or ITMS (Intelligent Transport Management Systems).

Conceived as a part of Smart City Project, ITM/ITMS aims to tackle the city’s traffic woes by:

- Tracking traffic conditions on the real-time basis.
- Enhancing traffic discipline through effective enforcements
- Increasing road safety by monitoring vehicles, preventing accidents and allowing citizens to make informed travel choices.
- Creating linkages to support information sharing through traffic controllers and an information portal, variable message signs, web services, IOTs and APIs.
- Assimilating and analyzing real-time traffic information and trends to enable automated adaptive traffic control and improved visualization of ambient situations in the city.
- Facilitating data-driven decisions for better management of utilities and services.

6.1 Need for ITMS: According to the traffic police, the current traffic infrastructure cannot handle the ever increasing population & vehicles. “A need was to develop an ITS/ITMS, which would improve the efficiency of traffic on Mumbai roads”. According to Mumbai Traffic police department, following are the extra new gadget to be provided for efficient control of traffic in Island City. They are

- 4,705 new traffic signals at various junctions
- 300 RLVD (Automatic Number Plate Recognition) cameras
- 300 Cameras to identify vehicles moving on the wrong way
- 300 Cameras to track corner parking.

6.2 Overall benefits of ITS/ITMS for Mumbai City:

Following are the various traffic infrastructures to be incorporated for Mumbai city, which will give max. Benefits in terms of safety of public as well as smooth running of traffic.

1. **ATCS (Adaptive Traffic Control System)**: Mid-block traffic monitoring camera will use ATCS to study real-time congestions and adjust signal timings to un-clog specific areas.

2. **STS (Smart Traffic Sensors)**: Used for effective traffic management and analysis.

3. **ANPR (Automatic Number Plate Recognition)**: This system is used to help in identifying no. Of plates of vehicles.
4. **RLVD**(Red Light Violation Detection) : This system is used to capture the details of signal-hopping vehicles, which will be controlled by a central **Speed Violation Detection (SVD)** system.

5. **PAS**(Public Address System) : ITM can also address public and will have dynamic messaging signages for vehicles and pedestrians.

6. **CCC**(Command Control Center) : The monitoring system will be setup at the traffic police headquarters, to have the overall picture of a particular area or a city as a whole.

7. **Real-time Traffic Information System (RTIS)**

   The RTIS prototype uses advanced technologies (GPS, video cameras, wireless communication, traffic models and algorithms) to provide traffic information that is updated every minute. **Variable Message Signs (VMS)**: Snapshot images of information to be displayed on electronic sign boards about current traffic conditions, at key locations.

8. **Electronic toll collection system (ETCS)**

   This is implemented in various cities like Mumbai, Ahmedabad, Bangalore, etc. In this system one has to refill the RFID tag with balance. After this recharge with this tag vehicle can pass toll plazas without stopping to pay any amount since the money is automatically cut and collected from the users tag account. This feature helps in speedy transportation in cities with heavy traffic.
9. **Advanced parking management system (APMS)**

In this system, while entering the parking lots, indicators are provided which indicate number of parking spaces available on various floors of the building structure. Indicators are also provided above the parking of vehicle to assist drivers from long distance if the parking is vacant or full below the indicator.

7. **SUMMARY AND CONCLUSIONS**

Following could be the conclusion based on the proposed intelligent transportation systems for Mumbai city, to be planned as a smart city:

1. Studied in detail of various features and aspects in Intelligent Transportation Systems.
2. Identifying the benefits and facilities provided with respect to ITS in those sites
3. Detailed features of the ITS could be incorporated for the future development of transportation systems in any urban area.
4. To suggest the detailed features and facilities to develop ITS in Mumbai

8. **FUTURE SCOPE OF THE WORK**

Following could be the future scope of work, before implementing the ITS project.
1. Detailed cost of the project to be studies in future, when implemented.
2. Public views to be taken into consideration before implementing.

**REFERENCES**


