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Automated Bus:Eco Friendly Mode of Transportation for Smart City

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Abstract *— As India's population continues to grow at an alarming rate, it brings with it the related problems of pollution and unchecked migration to cities. Even as Indian cities continue to expand, infrastructure growth is unable to keep pace with urbanization. From large amounts of untreated sewage to high levels of pollution, urban India is caught in a maze of problems. To cope with increasing urbanization, India is in dire need of smart, cost-effective and efficient solutions. Smart transportation is one aspect of the smart city. Because of low efficiency, transportation has become the second largest industry of carbon emissions. It not only affects the smart transportation, but also affects the smart environment. So efficiency of the transportation is very important to the smart transportation and smart city. With this it is necessary to study alternatives like Automated Bus Systems which are eco-friendly as well as efficient. Automation in road transport has the potential to reduce the negative impact of several societal challenges such as number of road accidents and subsequent injuries and fatalities, the impact of road transport on the environment, and the flow of traffic and mobility of people in urban areas with exploding population.*

Keywords- Automation, Mobility, Cost, Efficiency, Impact, Carbon Emission

I. INTRODUCTION

India, the second most populous country in the world, and a fast growing economy, is seeing terrible road congestion problems in its cities. The problem is often felt in almost all major cities. This is primarily because infrastructure growth is slow compared to growth in number of vehicles, due to space and cost constraints. Traffic in India is chaotic and largely different from the western traffic. Building infrastructure, levying proper taxes to curb private vehicle growth and improving public transport facilities are long-term solutions to this problem. These permanent solution approaches need government intervention. The concept of smart transportation systems is expected to become critical in addressing the challenges posed by an increasing number of mega cities in both developed and developing regions in maintaining safety, smooth traffic flow and an environmentally friendly and sustainable urban environment. Consumer and commercial telematics are important, along with new emergency call systems and electronic toll collection. Advanced systems for preventing accidents via vehicle-to-vehicle and vehicle-to-infrastructure communications are also significant, but are being positioned in relation to growing cellular connectivity for vehicles.

The zero carbon, zero emission city of the future will require a high-level-of-service passenger transit system to accommodate the trips that in cities are typically performed by automobile. Mass transit, or group transit, is badly suited for this purpose as it can't replicate the service as supplied by the automobile. Also from the energy use point of view, with the exception of peak hours, mass transit is extremely inefficient as it requires that large vehicles travel nearly empty to respect a schedule. The sustainable city requires an on-demand, door-to-door, personal, zero emissions, energy efficient transport service that can be obtained by means of automated, electric powered taxis. Inefficient traffic management, route planning and driving performance all contribute to high level of CO_2 emissions

Figure 1. Driverless ParkShuttle Bus

II. AUTOMATION IN TRANSPORTATION

Research has been undertaken in Europe in recent years with the aim of implementing fully automated road collective transport systems. Several studies have been conducted in European countries in context of automation in road transport.CityMobil2 has carried out various demonstrations and has successfully operated Automated Bus in Rivium business park outside Rotterdam in Netherlands. In India Urban Transport planners and engineers are constantly working on various solutions to remove congestion and provide effective transport system which can handle peak hour load of passengers. The automation of certain driving functions in conjunction with smart and connected usage of infrastructure will lead to more efficient fuel consumption and will help to reduce the environmental impact of road transport. In this direction Automated Public Transport Systems can also prove of significant importance.

Highly or full automation will contribute to the enhancement of traffic safety by reducing the driver‘s workload, in terms of driving, and minimizing the human errors and incidents due to driver distraction or reduced vigilance. Another important impact will be the reduction of congestion in urban areas and on motorways by optimising driving styles, minimizing speed variations. This will reduce vehicle emissions and fuel consumption per kilometre driven and will therefore have a positive impact on the environment. Before implementation it’s necessary to study levels of automation in transportation.

2.1. Levels of Automation

The definitions below cover the complete range of vehicle automation, ranging from vehicles that do not have any of their control systems automated through fully automated vehicles.

- *Manual Driving*: Human driver undertakes the manual driving task.
- *Driver Assistance*: The driver continuously monitors and controls all longitudinal and lateral support provided by systems that may automate some aspects of driving task.
- *Partial Automation*: This level involves automation of at least two primary control functions while driver is still responsible for monitoring the roadway and safe operation and is expected to take control at any time.
- *High Automation*: Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control.
- *Full Automation*: The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. This includes both occupied and unoccupied vehicles. By design, safe operation rests solely on the automated vehicle system.

Implementation of automation through platooning is also quite mature from technical point of view.

2.2. Autonomous Vehicle Requirements

- Automatic Transmissions.
- Diverse and redundant sensors (optical, infrared, radar, ultrasonic, and laser) capable of operating in diverse conditions (rain, snow, unpaved roads, tunnels, etc.).
- Wireless networks. Short range systems for vehicle-to-vehicle communications, and long range systems to access maps, software upgrades, road condition reports, and emergency messages.
- Navigation, including GPS systems and special maps.
- Automated Controls (steering, braking, and signals).
- Servers, software and power supplies with high reliability standards.
- Additional testing, maintenance and repair costs for critical components such as sensors and controls.

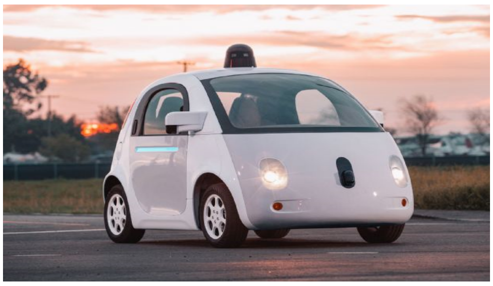

Figure 2. Google Self Driving Car Prototype

III. POTENTIAL IMPACTS

Automation in public transport offer enormous potential to improve the safety, efficiency and sustainability of road traffic, especially in cities. Users will experience significant benefits including less time spent in traffic and wasted time looking for parking, more productive in-vehicle time and reduced risk of accidents and delays. It can radically change the need and type of infrastructure. Subsequent impacts on land uses are inevitable in the long term. Urban and Transport Planners need to anticipate the impacts, develop enabling legislation and plan for these changes in order to gain the maximum benefits.

3.1. Benefits

- *Reduced driver stress.* Reduce the stress of driving and allow motorists to rest and work while traveling.
- *Reduced driver costs.* Reduce costs of paid drivers for taxis and commercial transport.
- *Mobility for non-drivers.* Provide independent mobility for non-drivers, and therefore reduce the need for motorists to chauffeur non-drivers, and to subsidize public transit.
- *Increased safety.* May reduce many common accident risks and therefore crash costs and insurance premiums. May reduce high-risk driving, such as when impaired.
- *Increased road capacity, reduced costs.* May allow platooning (vehicle groups traveling close together), narrower lanes, and reduced intersection stops, reducing congestion and roadway costs.
- *More efficient parking, reduced costs.* Can drop off passengers and find a parking space, increasing motorist convenience and reducing total parking costs.
- *Increase fuel efficiency and reduce pollution.* May increase fuel efficiency and reduce pollution emissions.
- *Supports shared vehicles.* Could facilitate car sharing (vehicle rental services that substitute for personal vehicle ownership), which can provide various savings.

3.2. Costs

- *Increases costs.* Requires additional vehicle equipment, services and maintenance, and possibly roadway infrastructure.
- *Additional risks.* May introduce new risks, such as system failures, be less safe under certain conditions, and encourage road users to take additional risks (offsetting behavior).
- *Security and Privacy concerns.* May be used for criminal and terrorist activities, vulnerable to information abuse (hacking), and features such as GPS tracking and data sharing may raise privacy concerns.
- *Induced vehicle travel and increased external costs.* By increasing travel convenience and affordability, autonomous vehicles may induce additional vehicle travel, increasing external costs of parking, crashes and pollution.
- *Social equity concerns.* May have unfair impacts, for example, by reducing other modes' convenience and safety.
- *Reduced employment and business activity.* Jobs for drivers should decline, and there may be less demand for vehicle repairs due to reduced crash rates.
- *Misplaced planning emphasis.* Focusing on autonomous vehicle solutions may discourage communities from implementing conventional but cost-effective transport projects such as pedestrian and transit improvements, pricing reforms and other demand management studies.

IV. LONG TERM SCENARIO

Over the next few decades, Automated Road Vehicles (small driverless buses) can help create a more compact and energy-efficient urban form. In contrast, automation of private cars would make it easier to commute long distances, and could increase total energy use. Automated Bus will eventually be able to operate at moderate speeds on public streets. But some exclusive lanes would still be desirable, since these can be much narrower than conventional lanes, and can be routed where conventional streets are not acceptable because of noise, pollution, or overhead clearance issues. Automated roadway system could be at-grade with underpasses beneath cross streets, thus reducing cost and visual intrusion compared with elevated structures. The land taken by exclusive lanes would be much less than that saved by reduced parking and road requirements for conventional autos. A trip in such a system might involve traveling on both public streets and exclusive automated roadways.

V. CONCLUSION

There is considerable uncertainty concerning autonomous vehicle benefits, costs and travel impacts. In matter of few years self-driving vehicles will be reliable and affordable, providing user savings that offset costs, and they will significantly reduce congestion and parking congestion, roadway infrastructure costs, accidents and pollution emissions which justify policies that encourage their implementation. However, autonomous vehicles will require additional equipment, services and maintenance that will probably increase user costs. Autonomous vehicle implementation is just one of many trends expected to affect future transport demands and costs, planning decisions. Its ultimate impacts depend on how it interacts with other trends, such as shifts from private to shared vehicles. Some strategies, such as platooning, may require special lanes dedicated to autonomous vehicles to maximize potential benefits. There is wide scope of research concerning overall impact and cost-benefit analysis.

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