# Smart Road and their technologies – A Review

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***Abstract*- Infrastructure is vital for prosperity and economic development of a country. New technologies enhancing the safety, efficiency and sustainability of Transportation systems is the need of the hour. Smart road infrastructure is one such example. This paper reviews the infrastructure for smarter roads and their technologies on a broader perspective.**

***Keywords – smart roads, technologies, safety enhancing, sustainability.***

## I. INTRODUCTION

The growth rate of vehicles on road is increasing exponentially day by day which leads to congestion, pollution and safety problems. Due to the highest motorization growth rate, rapid expansion in road network emerges with a serious impact on road safety levels. The severity of road accidents, measured in terms of number of persons killed per 100 accidents has been increased from 28.5 in 2014 to 29.1 in 2015. The statistical analysis of road accident data reveals that about 1,374 accidents take place every day on Indian roads which further translates into 57 accidents and loss of 17 lives on an average every hour in our country is shown in fig.1 Compared to other states in India, Tamil Nadu has reported the highest number of persons injured in road accidents. The percentage share of National highways, State highways and other roads in total road crashes and persons killed for the past 10 years is shown in fig.2. Just building roads alone will not solve these bottlenecks. We have to make the highway system intelligent in terms of vehicle and road so that Smart Infrastructure coupled with intelligent highway system would pave way to reduce these problems in a better way and make the system sustainable and making it productive. But sustainable transportation development is a challenge to development of Human Technology (Kennedy et.al). The importance to monitor and control subsystems, to predict outcomes and their importance have been discussed by Cuthbert, 1995. Chen and Cheng (2010) emphasised the study of implementation and application of agent based approaches in the area of traffic and transportation. The latest advancements include sensors, wireless communications and computing power, connected by the Internet.

## I. EMERGING TECHNOLOGIES

33,421,323 km of road covers the surface of earth, hence not only laying of roads matter but their maintenance and repair should also involve smart systems.

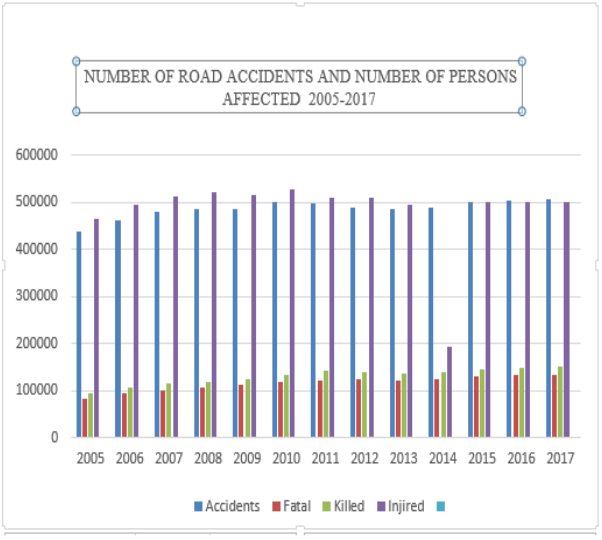


Fig.1 Number of Road accidents and number of Persons
Source: Information supplied by States/UTs (Police Departments)

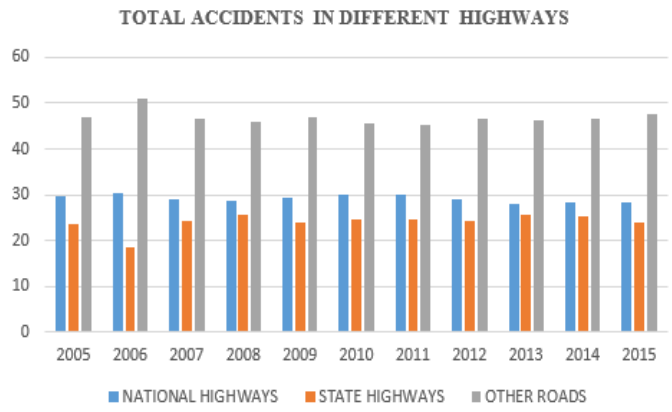


Fig.2 Total Accidents in Different Highways

Current Technologies involve paving materials, using dynamic paint, making road markings glow in the dark paint, anti – icing roads, interactive wind powered lights, inductive power transfer, solar energy roads, pizzo- electric energy roads, Smart geo, Radio Frequency Identification (RFID) GPS linked listening stations for monitor, traffic patterns and accidents. Grouping of vehicles in the form of platoons increases the capacity of roads.

Smart projects that are being implemented includes Virginia smart road in the US, NH-1 in India, Solar roadways in US and wireless charging in south Korea. Virgnia have used fibre optic system to communicate between vehicles and embedded sensors simulating for different weather and Lighting conditions. NH -1 road between Jammu and Srinagar is made smart by installing smart life poles. They use radar sensors transmitting electromagnetic waves which will encounter a vehicle depending on change in frequency and time to reach the speed can be calculated. Solar roadways use smart solar panels and have embedded heating elements for melting ice and snow. Carquinez bridge had wireless sensor nodes been implemented in South Korea. By incorporating piezo-electric generators in the roads, we can convert the vibrations caused by the vehicle into electricity.

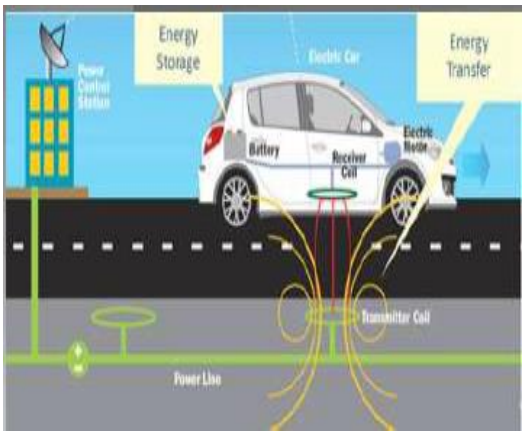


Fig .3 Smart cars (Source: Pushkar Dutt sharma)

## II. BACKGROUND OF IMPLEMENTED TECHNOLOGIES

The automated highway system is defined as a lane or set of lanes where specially equipped cars, trucks and buses could travel together under computer control (Rillings, 1996). Tanigughi and shimanot (2004) showed that dynamic routing and scheduling model (VRPTW-D) can reduce congestion. Tubaishat et.al. (2009) showed that real-time adaptive sensor used on traffic light can increase 30-50% improvement on average trip waiting time Dash and Kumar (2012) investigated Traffic control mode Switching based on input from infrared relay system. Data driven intelligent transport systems to improve functions and services our transportation system was studied by Zhang et.al. Sumit Mallik studied the role of information technology in creating synergetic effect in communication networks. It is suggested that the use of GPS, GIS, remote sensing will result in greater mobility of traffic. Together with the use of Bluetooth, wifi, sensors will provide and better coordination between vehicle to vehicle. Fagnant and Kockelman (2014) studied agent based model and how each autonomous vehicle can replace around eleven conventional vehicles, and resulting in overall energy savings. Morrow et.al. (2014) energy use impacts of autonomous vehicles. Pelletier et.al developed smart card data for strategic, tactical, and operational purposes for Improving the public transportation system and sustainability. M.Bugdol, Z.Segiet et.al (2014) elucidates with an attempt of using magnetic sensors to detect the vehicle appearance on the road. Development of this system is to minimize the crucial task of traffic intensity (Fig.3). According to Lucia Janusova and Silvia cicmancova (2015) the paper deals with an importance of the critical transportation infrastructure and various methods to protect it. An existing technology such as management software security cameras, CCTV, GPS dynamic route guidance etc. are preferred to assist the protection of transportation system. Apart from roadways, the ERTMS implements to enhance the railway signaling network by reducing the carbon emissions.

Klachek and Korjagin (2015) discussed about the application of the intelligent transport security system (ITSS) Rijurekha Sen and Bhaskaran Raman examined the slow infrastructural growth and connectivity with increasing volume and difficulties of non-lane based difficulties of intelligent transportation systems. Various applications like Incident detection, Vehicle classification, Monitoring, Intersection control are also discussed. Chinta Sudhakar Rao, M. Parida, and S.S. Jain examined the influence o**f** ITS devices and how to interchange information between drivers and how they respond. The age, frequency of trips, had impact on it and VMS board response. Jumlah *et al.* founded Dedicated Short Range Communication (DSRC) for car communication. Kandar et.al presented the relationship of communication and RADAR technologies with ITS. Warner and Åberg conducted a study to analyze drivers speeding behavior after long-term use of an ISA speed warning device. This study demonstrated that the average time of driving above the speed limit greatly decreased when the warning system was activated. Maria Spichkova et.al (2016) illustrated about an approach for an intelligent speed validation and adaptation of a vehicle. In this paper they suggest a number of models for an indication of speed check. This is resulted based on the two implementations of the model (iOS and an Android app) for Intelligent Speed Adaptation. A significant amount of research has been done by Sergei Korjagin and Pavel Klachek ( 2017 ) enabling to combine the macro traffic control at road with fine adjustment at micro level of physiological and intellectual actions of a driver (Fig.4). This approach tends to enhance an environmental situation and social mobility. Proposed biocybernetical – management paradigm overcomes all the traditional concepts of car and improves the road network to optimize the traffic control.

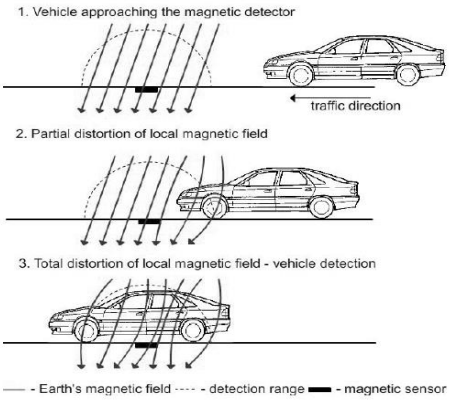


Fig.3. Earth's magnetic field distortion caused by a moving vehicle (source: M.Bugdol, Z.Segiet et.al (2014) Volume 9 Issue 1)

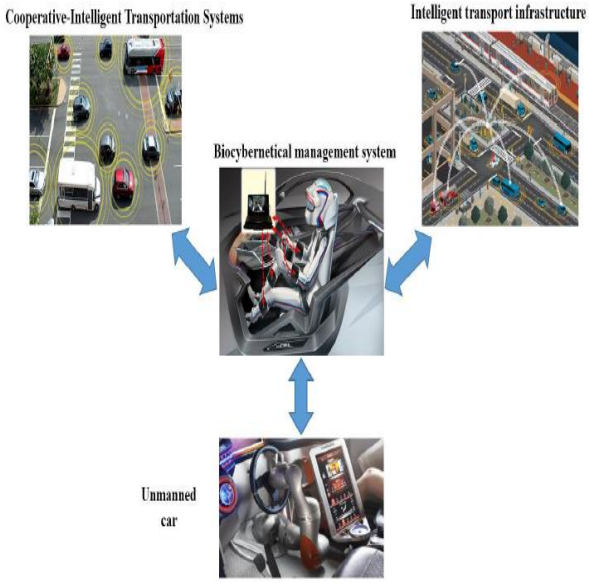


Fig.4 Highly intelligent environment-system ITSS.
(Source - Sergei Korjagin and Pavel Klachek / Transportation Research Procedia 20 ( 2017 ) 326 – 333 )

## III. SUMMARY AND CONCLUSION

In developing countries like India the probe of smart infrastructure in association with communication and ITS to solve traffic problems is necessary. By adopting these technologies that will suit to the individual country's requirements will aid to combat pollution, accidents, traffic jam etc. Investigation for inter- junction Co-ordination of movement of emergency vehicles finding the shortest path can be undertaken. The implementation of smarter roads in developing countries demand, costs, persistent efforts, continuing research, long term strategic planning and funding for smart highway system. Taking all into consideration, the detectors are expected to become more applicable for the intelligent traffic control systems in the future.

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