Ways to Avoid Traffic Congestion in India and Make India Smarter-A Prelude

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***Abstract*--Due to the proliferation in the number of vehicles on the road, traffic congestion and accidents are bound to exist. Traffic control has been an issue since humans put the first wheel on the first cart. The modern world demands mobility to reduce overall traffic congestion, so many technologies and traffic scenario of area were taken into condition such that in any situation the vehicles can moved. The reason for congestion is due to the fact that the current transportation infrastructure and current mass technology that applied to vehicle are unable to cope with the influx of vehicles on the road. India is experiencing rapid urbanization and motorization from the past decades; since the urban population is growing at a rate of 1.2% per year in turn the motor vehicles are growing at a rate of 9.7%. To alleviate the above mentioned problems the implementation of the concept "smart road" is introduced which is the fusion of technology that includes Information Technology (IT), Intelligent Transportation System (ITS) which includes sensor base and detecting system where traffic jam and vehicular accident can be avoided and the car users are more comfortable to travel. Traffic management poses many critical challenges in most modern cities, this system provides both practically important to traffic data collection and control information and can trace criminal or illegal vehicles, stolen cars, etc. With many technologies all the problems related to economy, energy, time saving and health can make the road become smart.**

Keywords:- Traffic congestion; traffic growth; smart highways; sensors; safety.

I. INTRODUCTION

Over the last few years, the use of the term "smart" has become a widespread practice at all levels, there is hardly a city that does not aspire to be a Smart City. Technology tends to become smart in numerous areas like buildings, water supply, mobility, public service, waste and even energy is smart similarly roads must transform themselves in order to play a relevant role in this "revolution". There cannot be a smart city without a smart road when worked together can provide citizens with smart mobility. Smart road is termed as number of different technologies incorporated for improving the operation of traffic light and street lighting and also for monitoring the condition of the roads, traffic levels and the speed of vehicles. Smart roads can provide real-time information to drivers about weather conditions such as icy roads and also traffic information such as congestion and parking availability, etc. Smart roads are particularly useful on risky or mountainous roads to make driving safer a priority by warning about incoming traffic or landslides. Smart roads can also generate energy to use for street lights or to charge electric vehicles as they move. Figure 1 represents the Internet of Things (IoT) based smart road concept.

Fig 1: *IoT enabled smart road concept; Source weblink:* https://tmrblog.com-demand-for-automated-vehicles-to-spur-usage-of-smart-highways

II. LITERATURE SURVEY

Malik et al (1995) describes two projects applying computer vision to intelligent vehicle highway systems. The first project has resulted in the development of a system for monitoring traffic scenes using video information. The objective is to estimate traffic parameters such as flow rates, speeds and link travel times, as well as to detect quickly disruptive incidents such as stalled vehicles and accidents. The second project is aimed at developing vision as a sensor technology for vehicle control. The novel feature of this project, compared to most previous approaches, is the extensive use of binocular stereopsis. First, it provides information for obstacle detection, grouping, and range estimation which is directly used for longitudinal control. Secondly, the obstacle-ground separation enables robust localization of partially included lane boundaries as v/ell as the dynamic update of camera rig parameters to deal with vibrations and vertical road curvature.

Venkataramana (2018) has studies and reported on the infrastructure that 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 also reviews the infrastructure for smarter roads and their technologies on a broader perspective.

Mansoori and Achar (2018) worked on the efficiency of smart roads and opine that using IOT devices in transportation is a special idea which makes the drivers to drive safer than before. The authors say that the first motive of smart road is to provide safety, use less amount of electricity and reduce traffic. This can be implemented by using advanced technologies like light sensors, ultrasonic sensors, camera, motion sensors, IoT devices, interactive lighting system, solar roadways, glow in the night, the wind powered light system, the electric priority lane etc. Traffic is a growing problem in India causing fuel wastage, time wastage & pollution. In

Indian road-traffic, the problems like crowded roads, unpredictable time to travel from one place to another are some serious problems which is also polluted and noisy. Now, researchers have started to introduce connected vehicle technology which is difficult to implement on roads. This project presents a low cost innovative technology for smart roads. The wastage of electricity from street lights can be minimized by using the motion sensors and light sensors due to which the loss of electricity can be prevented. Different technologies have been introduced to reduce traffic jams.

Hock (2019) has reported that roadways are constantly in flux, either through repair and construction or continual improvement. With recent development is smart technologies, companies and research group alike have been hard work devising ways to make the road safer and more driver-friendly, and enable the use of development coming from the automotive sector. This report also discusses a wide variety of these technologies and how they will continue to be developed in the future.

Hati (2016) report the use of solar roadway i.e., a road surface that generates electricity by solar panels and light emitting diode (LED) signage that can be driven on. It generates electricity by solar power photovoltaic cells. Each solar road panel (roughly 3.658m x 3.658 m) interlinks with neighboring panels to form the solar roadways system. This concept is used to replace highways, roads, parking lots, driveways and sidewalks with such system. The energy generated by solar road panels will replace the current need of fossil fuel with little extra cost.

Many other researches like Kumar et al (2017) looked into recent developments and research trends in collision avoidance/warning systems and automation of vehicle longitudinal/lateral control tasks. Toh et al (2019) discussed the current state, developments, and some of the emerging advances in transportation technologies and how these advances in smart roads will prepare the society towards the realization of future smart cities. Earls (2018) has explained how IoT can collaborate with smart roads. Nasar et al (2018) has worked on the possibility of taking advantage over roads to generate energy by pressure and movements of vehicles on these roads and convert kinetic energy into electric energy by piezoelectric devices that can be termed as smart roads. Shabbir (2017) studies on roads in fusion of various technologies like internet of things for monitoring betterment of life. Karpinski et al (2006) proposed the use of a wireless sensor network of “cat’s eye” augmented with embedded processing, communication, and sensing capabilities to monitor vehicle behaviour on augmented roads. Upadhayaya (2016) research explains about the basic idea of smart cities with its component and applicability in our cities. Pallavi (2018) reviewed on different sensor frameworks by analysing the pros and cons of each in cost, reliability, accuracy, efficiency, and maintenance overhead. Rath (2018) has worked on the smart traffic management system for traffic control using automated mechanical and electronic devices. In [16] combination of Glow-worm Swarm Optimization (GSO) and Support Vector Machine (SVM) is used for decision making process in battery storage to reduce the electricity tariff.

III. WHY INDIA FACES TRAFFIC CONGESTION?

Indian cities are grown since ages and thus were never planned with a futuristic growth and future perspective. According to some statistics, in the past decade (2009-2019), India is facing rapid urbanization and mobilization which has led to a growth rate of 1.2% in urban population and with a vehicle registration growth rate up to 9.7% (Keelery, 2020). Radhika and Prabhakar (2017) have given a detailed analysis of Bengaluru, one of the fastest growing cities. The authors have also studied the impact of burgoing development of the city and its impact on the sustainable living in the city. Like Bengaluru, almost all Indian cities were never prepared in terms of infrastructure development in olden day and the sudden rise in vehicles on the roads led to commotion. Thus, Indian cities have been struggling for smooth commuting due to increased urban activities, rising motorization, inadequate transportation management system, inefficient transport planning and execution. Even the economic development and higher aspirations have significantly increased the vehicle demand in the country. This situation persists till a proper urban planning and design is executed as a long term plan. To overcome these issues many rules along with smart technologies are involved like in April 2018, the Union Ministry of Road Transport and Highways fixed the maximum speed limit on expressways at 120 km/h, for national highways at 100 km/h, and for urban roads at 70 km/h for vehicles like cars, jeeps etc. The traffic congestion in India can be rectified by the following remedial measures -

- Checking the urban growth for past and future decades.
- New smart cities to be developed.
- Spreading out proper road, rail, and air network to smaller cities.
- Starting of new government offices cities
- Widening of existing roads and installation of smart technologies.
- Encouraging people to use public transport
- Providing the robust technology to enable people to access real time information on traffic mobility and congestion
- Developing a new network of metros should be addressed on top priority.

Figure 2 gives a schematic representation on strategies for smart roads.

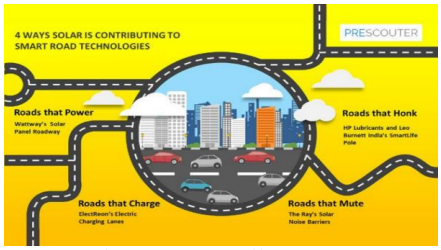

Fig.2 Smart solutions for combating traffic congestion, Source Weblink: PreSourcetwitter.com-smart roads

IV. SMART SOLUTION FOR TRAFFIC CONGESTION - DISCUSSION

Various technologies which are tested or implemented are reviewed and listed below which deals with the roadways helping in a smart way to erase the problems faced in roads. Implementation of these technologies will aid in smart transportation facility i.e., roads that are interactive, communicative and safer to the drivers which can help in nullifying the accidents to some extent.

A. Roads that Honk

The Roads that Honk is a technology that gives safe driving facility in hilly areas. This has been implemented in India in NH1, i.e., the Jammu-Srinagar highway, which is one of the most dangerous roads in the world with a number of hairpin bends. The implementation of this technology near the hairpin bends helps in determining the speed of the incoming vehicles and warns them about vehicles ahead, by honking. To determine the speed of vehicles, these poles use radar sensors that transmit electromagnetic waves. These waves bounce back when they encounter a vehicle. Depending on the change in frequency and the time taken by the wave to reach back, the speed and distance of the oncoming vehicle are determined. Figure 3 gives the aerial view of the road that honk technology implemented in NH1.

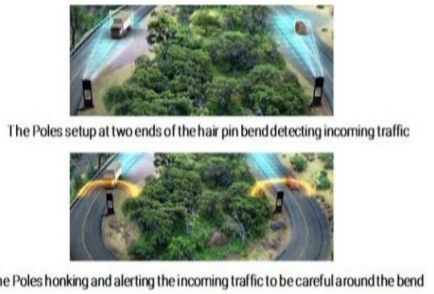

Fig.3: The aerial view of the road that honks technology implemented in NH1.

Source weblinkhttps://www.google.com/-pswordpress-production.s3.amazonaws.com.

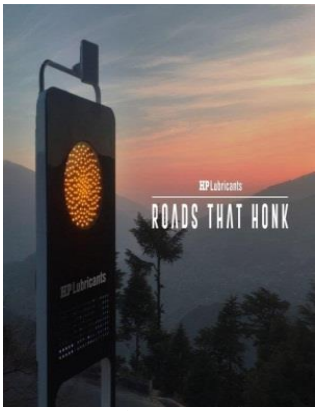

Fig.4*: Smart life pole by HP Lubricant.*

Source web link: www.indiatoday.in-auto-new-hp-lubricants-and-leo-burnett-india-create-innovative-intelligent-road-system

B. Roads that Charge

The Roads that Charge is a technology where roads are embedded with electric field, which charges the electric vehicles as it travels on that road. The road is fitted with a magnetic device which can generate electricity through an electromagnetic field. A similar device is present under the electric vehicles to pick up the electric charge. Electric vehicles traveling in this designated lane were tested as a trial in March 2016 in cooperation with the municipality of Tel Aviv and Teknion - Israel Institute of Technology. They have reported that less than 15% of the route needs to be upgraded with the device to provide enough electric charge on the route. The vehicles can use significantly smaller batteries since they can be charged on the go.

In India almost 27% of the air pollution is caused by vehicles, if this method is implemented in many parts of India roads and if introducing Electric Vehicle becomes a trend, the pollution percentage will decrease gradually and be an alternative to vehicles which run on fuel. Figure 5 gives a live example of electric charged roads in South Korea.

Fig. 5*: The aerial view of roads that charge.*

Source weblink: www.constructionweekonline-lucknow-smart-city-invites-bids-for-smart-road

C. Roads that Power

Roads that Power or Solar Roadways was a first major Watt way solar road project trial section, which is made up of some 2,880 photovoltaic panels, is located on Route RD5 in northern France. Solar Roadways uses smart solar panels to create roadways. These solar panels can generate enough energy using the sun, to charge electric vehicles. This project is to install hexagonal shaped solar panels on glass roads. Where the tempered Glass used is a renewable, ecofriendly and is designed to formulate strength to support the weight of semi-truck up to 113,398kg (114 tons). These roads are flexible and have extra stability against wear. They also contain LEDs to dynamically change lane or parking configurations as per the situation. This is particularly useful in the dark to warn about obstacles such as debris or animal on the road. Since these panels have embedded heating elements, they can also melt snow and ice on roads and microprocessor that can be able to communicate with the central control station and vehicle. The panels would create highway system that would pay for itself by generating renewable energy. The electricity from the roads can be used to power nearby buildings and also to the power hubs for storages. It has a life span of roughly 20 years. The solar roads to be installed around 1Km Jinan, China (2017). The two-lane road covers 5,875 sq. m and can generate unto 1million kWatt-hr of power which can suffice 800 Chinese home and cost $458 per square meter.

Whereas, this method can be implemented all over the country, but due to high cost these roads can be implemented

in areas suffering from electricity. Figure 6 shows an example of a solar road way.

Fig.6: *example of solar panelled roads.*
Source weblink: wiki.uiowa.edu-displaygreenergy-Solar-Road ways

D. Glowing Lines

Glowing Lines are road makings than can replace lamp post. These are road markings made using paint that contains photo-illuminating powder which is similar to the traditional paints the Translucent paints, where it charges up during the day and glows at night. These green glow markings stretch for 500 m long and will glow for up to 8 hours every night, transforming your driving experience Torn-like. They have a life span of about 5 years. This method can be implanted than basic lamp post as it is cost efficient.
Indian highways or in the hilly areas are best places where these lights warn the driver the alignment of the road before hand and in areas where there are no street lights. These paints can also be used all over India and also as warning paints as it glows at night. These are much handy in forest or denser areas for warnings and for alignment. Figure 7 shows the glowing lines implemented in Oss highway, Netherland.

Fig.7: Glowing line on Oss highway.
Source weblink: www.wprl.org -dutch-test-glow-dark-road-future

E. Interactive Lights

Interactive Lights is the technology that works on motion-sensor lights. Interactive Light works when a car approaches from a particular stretch of road, the motion sensors will light up only that section of the road. The lights will grow brighter as the car comes closer and will slowly dim away as it passes. Interactive Light is useful for highways that are less-travelled or not always packed with cars**.**
This technology comes in useful when there is very less or no traffic. Especially rural highways in India where there is very rare vehicle movement this method can be used so there is no wastage of electricity. Figure 8 represents the working of sensor based interactive lights.

Fig.8: *Example of interactive lights Source weblink:* www.howitworksdaily. com-modern-highways.

F. Wind Powered Lights

Wind Powered Lights are not like the sensor based interactive lights there are also wind-powered lights where the light gets powered up by itself using pinwheels which generates electricity. It works by harnessing wind drafts from passing cars into electric. The electricity is used to light up the lights on the road path. It's basically requires wind to power up the wind-powered light as and by cars pass that area.
National highways street lights in India can be replaced by wind powered lights as there is 24\7 vehicular moment so the pinwheels are hit by the wind and thus helps in glowing of the lights. Figure 9 is an example of wind turbine attached to lamp post for electricity.

Fig.9: *Wind powered lamp post.*
Source weblink: re-energy-industrial-solutions

G. Dynamic Paints

Dynamic Paints or temperature-sensitive paint are similar to glowing line but with an extra ingredient of temperature sensitive element. They get activated when temperature drops enough to create hazards. Since almost 24% of accidents are caused due to weather conditions which can be reduced.

Fig.10: Dynamic paints example.
Source weblink: encrypted-tbn0.gstatic.com/images

This method is not of much use in for India roads except for the northern parts of India where there is snowfall. Figure 10 is a working example of dynamic paints.

Figure 11 shows the overall view of smart technologies in smart roads.

Fig.11: *Smart Road Technologies*
Source: pswordpress-production.s3. mazonaws.com

VII. CONCLUSION

Roads nowadays can no longer remain as only a medium to travel from one place to another. We can now use it to charge electric cars and homes using solar energy due to its large exposed surface area. There is also technology to keep portions of the roads well-lit with more energy-efficient and environment friendly technology and methods. Hopefully in future there will be more upcoming technology to make our roads smarter and safer to travel on. The solar roadway has some technology to solve the problem of oil dependency in a relatively short period of times. Generally, the solar roadways will create an intelligent and secure highway infrastructure that pays for itself, where it eliminates the need for coal-fired or nuclear power plants. On the implementation of smart roads to a developing country like India can be a forward step towards being a developed county.

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