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INSIGHT'17 - Advanced Transportation Systems And Infrastructure Development in Developing India

Smart Highways – An Innovation Towards Mobility

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Abstract :- **Nowadays, our chosen mode of transport not only takes us from A to B, but they make our lives easier and journeys more pleasant. Therefore, our infrastructure needs to facilitate us. There is always room for improvement in usage, interaction and safety of traffic flow. Smart highways and smart roads are terms for a number of different proposals to incorporate technologies into roads for the operation of autonomous cars, for lighting and for monitoring the condition of the road. This innovative concept creates an entirely new mobility experience for drivers, cyclists and pedestrians. Ideas from this testing ground are increasingly becoming part of our everyday landscape. Intelligent transportation systems usually refers to the use of information and communication technologies in the fields of road transport, including infrastructure, vehicles, users, traffic management and mobility management as well as interfaces with other modes of transport. This clearly shows that mobility can be smarter, more interactive and more sustainable without having to widen roads or lay more rail connections. It is simply a case of putting demand first. This paper describes the necessity of smart highways, its advantages over conventional highways, the latest and advanced technologies used in smart highways and how this leads to a sustainable and eco-friendly environment. It starts with the disadvantages of conventional highways and how smart highways provide a solution to every problem. Issues like need for smart highways and how highways in India can be smart are also given due attention. Finally, the paper concludes with future scope of Smart Highways.**

Keywords: **- Autonomous Cars, Mobility, Sustainable Environment, Traffic Management**

I. INTRODUCTION

We live in cities of endless grey concrete roads, surrounded by steel lamps and they have a huge visual impact on our cities. But why do the roads remain so rough and without imagination? Why not turn them into a vision of mobility, a symbol for future?

- Daan Roosegaarde

In the last 25 years, the number of kilometers travelled per person has increased to approximately 40%. However, this growth is beginning to level off. There seemed to be a limit to our need for mobility, especially when it comes to using cars. Thus, the issue of mobility is all about offering sustainable transport solutions. For a long time, we have had super intelligent cars, but really dump roads. In the past decades, large investments have been going into developing smart cars but a very little have been given to the development of smart roads. Smart Highway is an interactive and sustainable road that includes a five-step plan for modernizing European roadways. It proposes embedding highways with technology that can visually communicate when the road is slippery, charge your electric car as you drive, and generate electricity for its own lights. The goal is to make roads more sustainable and interactive by using light, energy and road signs that automatically adapt to the traffic situations. The Smart Highway is not a completely new road, but rather a kit of parts that can be applied to existing roads as needed. Smart Highway is a tactile, high tech environment in which the viewer and space become one. This connection, established between ideology and technology results in what Roosegaarde calls as 'Techno-poetry'. With his unique approach, Daan Roosegaarde is offering the world an entirely new approach to roads, which is not only beautiful and alluring but also a sustainable and cost-effective solution, thus offering a unique design to both developing and developed countries.

Why Smart Highways?

1) Safety: Protecting our dear loved ones, regardless if they are travelling by car, bike or on foot, making sure they arrive safely at their destination is the top priority of all our traffic solutions. Reliable high quality products, excellent optical performance signalization and powerful monitoring systems combined with quick service provides safe and reliable solutions for year to come.

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2) Information: By presenting the right information at the right time to public transport passengers and accessibility and safety can be improved. Research shows that up to 30% of motorists change route when they receive information about travel tome or obstacles, which means the road network will be used in a more effective way. A good flow of information also provides a more comfortable ride and reduces stresses for both public transport and public health.
3) Motion: Along with requirements of improved accessibility, environmental improvements and traffic safety, follows the need for smarter transportation systems, where several types of transportation shares the road space.
4) Environment: Creating a sustainable traffic solution is challenge for all modern times. By investing in smart and adaptive traffic solutions, traffic flow will be improved.

All the above-mentioned criteria can be satisfied by implementing ideas like:

i) Glow in the dark lines
ii) Electric Priority Lane
iii) Wind Lights
iv) Dynamic Paints
v) Interactive Lights.

Glow in the dark lines

These glowing lines use luminescent paints. Luminous paint or luminescent paint is paint that exhibits luminescence. In other words, it gives off visible light through fluorescence, phosphorescence, or radio luminescence. Fluorescent paints offer a wide range of pigments and chroma which also 'glow' when exposed to the long-wave "ultraviolet" frequencies (UV). These UV frequencies are found in sunlight and some artificial lights, but they and their glowing-paint applications are popularly known as Black Light and 'black-light effects', respectively. Phosphorescent paint is made from phosphors such as silver-activated zinc sulfide or doped strontium aluminate, and typically glows a pale green to greenish-blue color. The mechanism for producing light is similar to that of fluorescent paint, but the emission of visible light persists long after it has been exposed to light. Phosphorescent paints have a sustained glow which lasts for up to 12 hours after exposure to light, fading over time. Radio luminescent paint contains a radioactive isotope (radionuclide) combined with a radio luminescent substance. The isotopes selected are typically strong emitters of fast electrons (beta radiation), preferred since this radiation will not penetrate an enclosure. Radio luminescent paints will glow without exposure to light until the radioactive isotope has decayed (or the phosphor degrades), which may be many years. They are therefore sometimes referred to as "self-luminous". Therefore, these glowing roads on the smart highways get charged by solar energy during the day and then glows up to 10 to 12 hours when it gets dark. They provide more visible road markings as compared to conventional paints. They also add beauty to the roads.

Electric Priority Lane

The main problem faced in environment today are the emissions from the vehicles. So the best solutions to these problems are Electric Cars. An electric car is an automobile that is propelled by one or more electric motors, using electrical energy stored in rechargeable batteries or another energy storage device. There are many hurdles that are related to the introduction of full electric vehicles – first of all the limited range which is due to the limited energy density of the existing battery chemistries inferior to gasoline or diesel powered vehicles. By introduction of wireless charging, substantial benefits can be achieved with respect to user interaction, availability and automation compared to wired charging. For this electromagnet are used. The road side electromagnet is called primary coil and the vehicle side electromagnet is called secondary coil. If current is flowing through the primary coil, a magnetic induction field is created which will cause a flow of current in the secondary coil by Faraday's law of Induction. The efficiency of induction based energy transfer is going down quickly with the increasing distance between the coils. But the efficiency can be substantially increased if the frequencies of the electromagnetic fields of the primary and secondary coils are brought to resonance. We distinguish the charging categories as follows.

1) Stationary – In stationary the electric energy is transferred to a parked vehicle.
2) Quasi dynamic – The electric energy is transferred from the road side primary coil system of limited length to a secondary coil of a slowly moving vehicle.
3) Dynamic – With dynamic wireless charging, the energy is transferred via a special driving lane equipped with a primary coil system at a high power level to a secondary coil of a vehicle moving with high velocity

Wind Lights

Air flow can produce significant mechanical power. Windmills are used for their mechanical power, wind pumps for water pumping, and sails to propel ships, but the most frequent current use is to turn a generator for electrical power. Wind power, as an alternative to burning fossil fuels, is plentiful,

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renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, and uses little land. The net effects on the environment are far less problematic than those of nonrenewable power sources. As of 2015, Denmark generates 40% of its electricity from wind and at least 83 other countries around the world are using wind power to supply their electricity grids. Wind power capacity has expanded to 369,553 MW by December 2014, and total wind energy production is growing rapidly and has reached around 4% of worldwide electricity usage.

In Wind Lights, pinwheel generators are placed on the verge of the highways. These pinwheels are attached with street bulbs. So, when a car or any other vehicle passes by, the draft of the vehicle rotates the pinwheel which in turn switches on the lights.

Dynamic Paints

Dynamic Paints are temperature sensitive paints. Under normal conditions they remain transparent, but when the temperature drop enough to create hazards like black ice, it becomes visible to the road and reveals warning on the road.

High resolution non-intrusive measurements of temperature using temperature sensitive paints (TSP) have been demonstrated by several researchers. These measurements include boundary layer transition in a cryogenic wind tunnel and heat transfer measurements on the impingement surface of compressible impinging jets. A typical TSP consists of the luminescent molecule and an oxygen impermeable binder. The basis of the temperature sensitive paint method is the sensitivity of the luminescent molecules to their thermal environment. The luminescent molecule is placed in an exited state by absorption of a photon. The exited molecule deactivates through the emission of photon. A rise in temperature of the luminescent molecule will increase the probability that the molecule will return to its ground state by a radiation less process known as thermal quenching. The temperature of the painted surface can be determined by monitoring the fluorescent intensity of the painted surface.

Interactive Light

Lighting that emits too much light or shines when it is not needed is wasteful. Wasting energy has huge economic and environmental consequences. In an average year in the U.S. alone, outdoor lighting uses 120 terawatt-hours of energy, mostly to illuminate streets and parking lots. That is enough energy to meet New York's total electricity needs for two years. IDA estimates that at least 30% of all outdoor lighting in the U.S. alone is wasted mostly by lights that aren't shielded. That adds up to $3.3 billion and the release of 21 million tons of carbon dioxide per year. To offset all that carbon dioxide, we will have to plant 875 trees yearly. So, smart highways have a good solution for this. They have Interactive Lights. This uses sensors to detect an approaching car, at which it switches on. The light grows brighter as the car comes near and then dims as it passes. In this way, the road is only lit when needed rather than pouring light on empty streets.

II. FUTURE SCOPE OF SMART HIGHWAYS IN INDIA

Roads now no longer remain as a medium to travel from one place to another, we can now use it to charge electric cars and harness 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 there will be more upcoming technology to make our roads smarter and safer to travel on. A smart highway is the need of present time because a lot of energy is saved as we can use Green energy and other supportive technologies like cloud computing for faster data communication and rapid action taking as and when demanded. Altogether there is a lot of scope on highways specially to be converted into a smart highway.

III. CONCLUSION

Mankind started his journey to cover long distances by foot. Slowly they invented wheel and that gives mankind the speed and power to shorten the long distances. The travel time was cut down to days and month from months and year. After inventing the wheel, the second idea was to develop roads on which the vehicle can travel easily. We now have fast moving vehicles all over the world and world class highways to ride on it. Now there is a need to make the highways smart. A smart highway is the need of the present time. Indian highways specially need to be converted into smart highways as it is well placed geographically. It has abundant sunlight and other green resources.
So, let us all take one step forward in making our roads more smarter, safer and beautiful.

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