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Implementation of Intelligent Roadways for Road Safety, Reduced Traffic Congestion and Energy Conservation

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Abstract: This research paper is aimed towards improving the current traffic conditions in our country by implementing a sophisticated and intelligent roadways system. This implementation will result in reduction of traffic congestion, thereby saving time and energy, reducing fuel cost which is caused due to long traffic jams, quick medical services in case of accidents, and contributing in the reduction of Global Warming. This will make our roads safer and also help us save and conserve energy.

I. INTRODUCTION

Our country suffers from an endless trouble of traffic jams nowadays. Earlier, traffic congestion was an overlooked affair because of scarce vehicular usage, but today, with the tremendous increase in the number of vehicles on the road, it has become an unavoidable and severe problem. An uncontrolled traffic disperses into an unfavorable chain of events that begins from small cluster of vehicles and transforming into impossible traffic conditions. Apart from traffic jams, there are episodes of accidents which are caused mostly due to human error i.e. unawareness of traffic rules, driving under influence of drugs or alcohol, or road rage that can be caused even due to bad traffic experience itself. To eliminate such conditions, we need to introduce a traffic system: that controls the on-going traffic in real-time and manage their free flow, that remains constantly interacted with the traffic, and that help avoid catastrophic incidents from happening.

II. OBJECTIVES

To implement a traffic system that will:

- Be an Intelligent system that will maintain the lane discipline – one of the most important aspect in maintaining traffic.
- Comprise of traffic signals that are interconnected and synchronized with each other allowing the traffic to flow smoothly.
- Have intelligent traffic signals that will adjust the halt timing according to the real-time analysis of current flow of traffic.
- Help reduce journey time cause by reducing traffic jam.
- Maintain Law and Order and road discipline.
- Smart roads that can not only be used for transport but also to generate and save energy.

III. INTELLIGENT SIGNALS AND SMART ROAD CONCEPTS:

1. **Synchronized Traffic Signals:** One of the critical reason for a traffic congestion is that traffic signals do not communicate with each other. This leads to unparalleled movement of vehicles which eventually causes clusters. If all the traffic signals are programmed to be in constant communication with each other, this might help reduce the above problem. Currently, the technique used in traffic signals is a Fixed-Time Control(FTC) technique which is a predetermined synchronization. This is effective only when there is less fluctuation in traffic. But if the traffic increases and decreases constantly, the efficiency of FTC decreases. So, if traffic Signals are in Dynamic Control(DC), we can adjust the signals according to the rise and fall in traffic. This will help reduce traffic congestion more efficiently in comparison with FTC.
2. **Halt-Time Adjusting Traffic Signals:** Imagine a four-way road where the traffic flows in one direction at a time controlled two traffic signals. There is quite a heavy traffic on one signal and negligible traffic on the other. And both the signals are having equals halt time. Ultimately, this will result in unnecessary long waiting times which will create traffic congestion scenarios. To avoid wastage of time and energy due to this, we can implement signals which can sense the magnitude of the traffic and adjust the wait time accordingly. This will prove to help reduce journey time and traffic congestion.
3. **Monitor for Lane-Discipline:** Lane-Discipline also plays an important role in traffic stability. Improper use

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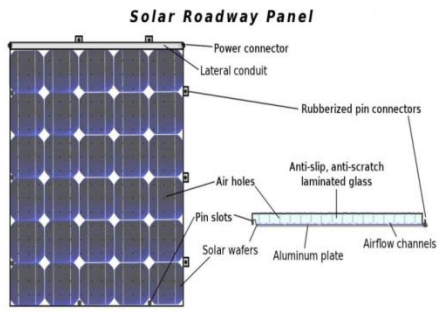
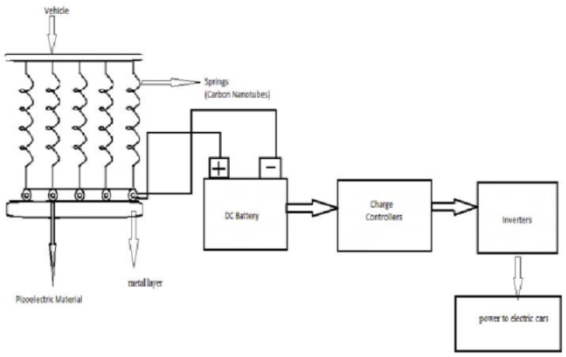
of road-lane causes traffic jams and accidents. People in our country suffer from problem called 'unawareness' of lane-discipline which leads to petty fights, vehicle collision etc. which leads to traffic clot. Vehicles according to their weight, size and class are assigned specific lanes on the road. But, many vehicle operators do no follow this discipline. So, we can implement monitoring devices which monitor each lane at a particular interval on the road. If a vehicle is not moving on their designated lane, the monitoring device will warn the vehicle. If the vehicle does not obey the warning, the vehicle will be penalized for this offense. This will make people aware of lane-discipline which will drastically help reduce traffic congestion and also reduce road accidents.

4. **Interactive lights:** This concept will help save wastage of energy used to power streets lamps at night. Currently, all the street lights at night remain powered even when it's not necessary. This results in futile use of energy. So, we can implement interactive street lights that sense the presence of vehicles or people and light-up only required lamps up to a certain visible range. Hence, energy can be conserved.
5. **Solar Roadways (SR):** Solar roadways, as the name suggests, are roads made of solar panel. They are made of tempered glass that can withstand tremendous weight. The idea behind solar roads is to provide intelligent roads that are capable of generating energy which can be used in diverse applications. These roads need not have painted road markings as they have LED lights built-in which serves this purpose. They also do no cause potholes. These roads are waterproof and snow-proof and can used to move, treat and store water. They also provide emergency warning system that can be useful in many ways like indication of earthquake or during flood conditions.



6. **Piezoelectric Implementations:** Piezoelectricity refers to electricity produced due to mechanical pressure. Piezoelectric generators can be implemented in roads and footpaths that will generate and store electricity which can be used to light street lamps and provide emergency power supplies.



IV. CHALLENGES OF IMPLEMENTING SMART ROADS

The implementation of these technologies is a big challenge. Following are the deductions:

- This is a very huge project as we need to change the entire roadway, replace or modify all the traffic signals and make additional space to include these technologies in the road which might take a very long time. This is a revolutionary step.
- Most of the technologies are still a theory or under test conditions. We do not have a hands on product that is ready to be implemented. The time-boundaries of completing this technologies are not yet defined.
- We can only think to implement this system in selected places, at present. Because it is not possible to replace all the roadways. There are geographical and economical reasons that are to be considered.

V. MERITS AND DEMERITS

Merits:

- An intelligent road system can help reduce traffic congestion by managing the traffic by real time statistics.
- It will provide faster transportation and lower the cost of the journey by eliminating affecting factors like poor traffic management and jams.
- Prevent injury and death caused due to accidents. This events occur because of unsystematic traffic behaviors. By intelligent roads sense, we can avoid vehicle collision hence reducing the adversity.
- Help generate clean energy using solar roads and piezoelectric roads. Also, reduces the consumption of electricity by using interactive lights.
- Elevates the society towards a higher standard of living. Provides comfort to people and keep environment healthy.

Demerits:

- There can be an issue of acceptance. There are chances that people in the society might be incompatible with such a change. Or the rate of acceptance might be low.
- As the systems are interconnected, if there is a glitch in the server which connects the signals, the entire system might fail until the problem is solved.
- The implementation costs of these technologies is too high for our country's economy. Using such amount of money might not be feasible and implicable.
- The maintenance of such system will be quite high. And if proper maintenance is not done, this might result in failure which can be catastrophic.

VI. CONCLUSION

As the rise in roadways problems, we need to take corrective steps to solve these problem and to make our roads congestion free and safe. Hence, implementing such advance technologies will help us reach our goals. It is quite some time when we will be able to apply our theory to the practical world. But, with the technologies growing with exponential rates, its not long when these theories will become practically applicable which will make the world we know a much better and safer place to live.

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