Wireless power supply system for running electric vehicles

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1. Electric vehicle

Electric vehicles available in the market today are considered one of the most remarkable ways to approach environmental issues we have, due to their high efficiency in energy utilization.

However, those electric vehicles have their own restrictive conditions, such as “extreme increase in electricity consumption caused by high speed run and their heavy weight” and “short running distance in order to lower the price”. In order to improve these issues, much research has been carried out on improving efficiency in electricity consumption, as well as advancing storage battery technologies. These studies have been effective in improving the usability and uptake of electric vehicles currently available, but at the same time, are limited to the technology in the vehicles themselves. Instead, our focus here is to develop technology to charge the battery by supplying electricity to moving vehicles. For that reason, technological development on road facilities also plays an essential part. The National Institute for Land and Infrastructure Management has recently commenced basic research using several models, in partnership with Tokyo University, in order to achieve this goal.

2. Wireless power supply technology

The most common way to charge battery for an electric vehicle today is using a cable, however, many studies have been carried out on developing wireless charging technology. While many of these use microwaves or electromagnetic induction techniques, we have been looking at the “magnetic field resonance system”, recently introduced by MIT, as a way of establishing a wireless power supply system on roads.

The benefits of the magnetic field resonance system are its longer transmission distance and higher resilience to positional gaps, compared to the electromagnetic induction technique. In addition, as opposed to the microwave system which uses the far-field (the region where the electromagnetic field disperses), it offers magnetic coupling between transmitter and receiver in the near-field (the region where electromagnetic wave doesn't disperse but stays around the transmission device), thus we believe it to be an easier approach to provide safety measures for optimizing controls and preventing leaks of electromagnetic radiation.

3. Wireless power supply using a Magnetic Resonance System

When installing a transmission system in a road, it is best not to change the current road format in order to maintain the level of convenience for driving. Also, it is most desirable to place the transmitter under the road, so that stable power supply conditions can be achieved while accommodating different car sizes, without demanding special driving skills. For road structure and maintenance reasons, it should be installed within the roadbed, more than 60cm deep, rather than in the asphalt surface.

The magnetic field resonance system is regarded to be excellent as a power supply technology for running vehicles for the following reasons: (i) The magnetic field being hardly affected by the gravel or asphalt used for building roads, (ii) the distance between transmitter and receiver can be as much as 1~2 meters, (iii) a higher tolerance for positional gaps.

4. Supplying electricity for running vehicles

The majority of recent studies on wireless power supply technologies target off-road electricity supply while the vehicle is parked; thus many of existing magnetic field resonance systems use transmitters and receivers of same size and shape, which make them inappropriate for supplying power to running vehicles. At the National Institute for Land and Infrastructure Management, we have verified transmission capability in an experiment using a model, enabling a stable electricity supply on the move by using a transmission coil and a receiver coil that are very different in size. (See the image below)

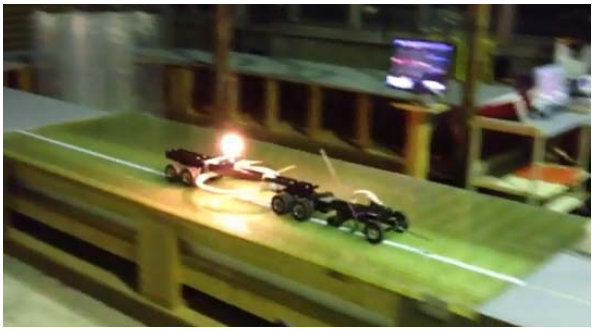

Image: The experimental model

In the future, aiming for a life-sized experiment, we will work on improving transmission distance and efficiency, as well as attempting to eliminate magnetic radiation leaks to the surroundings. We will continue to develop technology to enable electricity supply for running electric vehicles on the road.