Making Electric Vehicles Easier to Use

Development of wireless charging systems

Environmentally friendly electric vehicles are continuing their rise in popularity. However, many think connecting power cables to electric vehicles is cumbersome. Wireless charging technology is one way to alleviate this concern. We are developing a system that automatically charges electric vehicles while they are parked in parking lots.

Test vehicle equipped with wireless charging system

Just as the name implies, wireless charging technology is a technology for transmitting electricity from one place to another without using power cables. This technology is coming into use for devices that use a relatively small amount of electricity and are used near water, such as electric shavers and electric toothbrushes. Applying this technology to electric vehicles and plug-in hybrid vehicles (which combine an engine and battery) spares you the trouble of connecting a power cable to your vehicle every time you want to charge it and allows those who are not good at handling electric devices to use electric vehicles and plug-in hybrid vehicles with ease. It is hoped that in the near future, these vehicles can be automatically charged to full while they are stopped at traffic lights.

Highly coupled magnetic resonance wireless charging technology

One of the main features of highly coupled magnetic resonance wireless charging technology, which is under development by IHI, is that electricity can be transmitted efficiently even though there is a relatively wide gap between the coil on the ground and the coil on the bottom of the vehicle. This means that vehicles can be charged even when they are not centered in the parking space because of the driver not being good at parking. This technology can make charging electric vehicles easy, which is something that must be repeated every day.

This system can transmit up to 3.3 kW of electricity between two coils located 15 to 20 cm apart. This 3.3 kW of electricity falls under “normal charge,” as specified in an American electric vehicle standard, and with this amount of electricity, an electric vehicle can be fully charged in about 8 hours, though it depends on the battery capacity.

It would be ideal if the coil on the bottom of the vehicle were always immediately above the coil on the ground, but it is hard to always park a vehicle in the exact same position. With this system, even if a vehicle is parked up to 20 cm from dead center of the coil on the ground, the vehicle can be charged without a significant reduction

Item	Unit	Performance
Transmitted power	kW	Up to 3.3
Energy transfer efficiency	%	About 90
Distance between the coils	cm	15 to 20
Maximum allowable offset between coils	cm	Up to 20

Power transmission performance

in efficiency. Roughly speaking, it does not matter if the offset between the coils on the ground and on the bottom of the vehicle is as large as a tire width. We think if a simple means of guidance is provided in a parking space, it should not be too hard to park a vehicle so that the offset between the coils is smaller than a tire width.

History of wireless charging technology

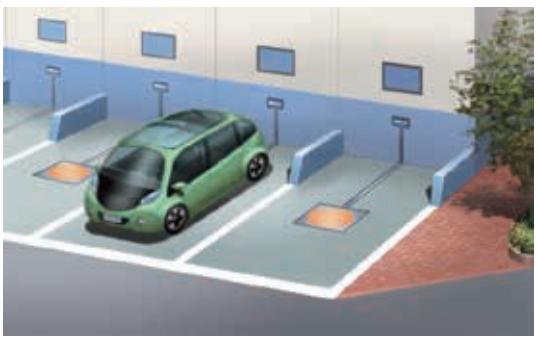
Among the records of early attempts to use wireless power technology for large amounts of power is a document that states that in 1980, a wireless power system was used to supply power to electric trains running in a mine in the Soviet Union. It is likely that the wireless charging system was employed because of the risk of fire in the mine. At that time, the frequency of power transmission was a low 5 kHz, so the efficiency was probably not so high. The electricity could be transmitted over a distance of only a few centimeters.

In the 1990s, it became possible to control large electric currents at relatively high frequencies of 20 kHz or more, which rapidly accelerated the development of wireless power technology. Today, this technology has been used for a wider range of applications, such as unmanned carriages running in semiconductor production plants where dust is not allowed. Energy transfer efficiency has been improved to about 90%, and wireless power systems of this type are now the mainstream. However, the transmission distance has not been improved much, though it depends on the coil size.

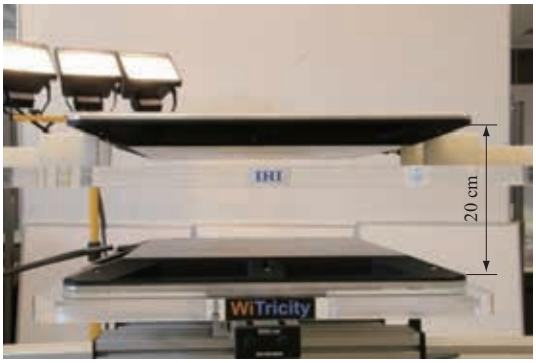
Joint development of wireless charging systems

The recent joint development of highly coupled magnetic resonance wireless charging technology by IHI and WiTricity Corporation (U.S.) has enabled transmission of electricity over a distance of a few tens of centimeters with high efficiency.

This technology derives from research at the Massachusetts Institute of Technology (MIT) where a research team successfully illuminated a 60 W bulb from a distance of approximately 2 m in 2007. This outcome defied the then current knowledge of wireless power technology in terms of transmission distance and attracted lots of attention. In



Example of installation in an outdoor parking space



Wireless charging system

2011, IHI concluded a license agreement with WiTricity Corporation, which had taken over the technology from MIT, and began joint development of wireless charging systems.

This technology is nearly complete at the laboratory level, so development is focusing on the practical use of this technology. With our focus on charging electric vehicles and plug-in hybrid vehicles, we are working hard to develop a system that can easily be used by anyone. In this development, we are pursuing convenience and comfort. For example, we are pursuing a system that allows users to charge their vehicles without the troublesome task of inserting a large plug into the socket, and that enables charging even if the position of the transmitter and the position of the receiver are offset.

In the near future, easier-to-use, environmentally cleaner vehicles will emerge which can be charged by using natural energy, for example, vehicles that use electricity generated by solar cells on the roof.

Soon after that, we foresee a large-output power transmission system emerging that enables vehicles to be charged while they are running on highways and stopped at traffic lights. We believe that the time will come when we can drive electric vehicles as far as we want, without worrying about the charging battery.

Mini commentary

Highly coupled magnetic resonance wireless charging system

When the resonant frequency of the off-vehicle wireless charging source device is almost the same as that of the on-vehicle power capture device, a resonance occurs in the magnetic field between the two devices. Highly coupled magnetic resonance wireless charging systems can transmit electricity by using this resonance phenomenon even if there is a relatively wide gap between the off-vehicle wireless charging source device and on-vehicle power capture device.

Inquiries:
Project Incubation Department,
Products Development Center,
Corporate Research & Development, IHI Corporation
Phone: +81-45-759-2224
Website: www.ihi.co.jp/en/