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Electricity without cables or plugs

How can you charge electric cars without plugging them into the power grid for hours on end? How can industrial robots be "refueled" during operation? And how does wireless energy transfer improve medical technology? These questions have occupied Prof. Nejila Parspour, Director of the Institute of Electrical Energy Conversion (IEW) at the University of Stuttgart, for more than twenty years. Below is an interview with Parspour, a scientist who has significantly advanced inductive energy transfer and opened up new applications for this future technology.

Professor Parspour, you are a pioneer in the field of inductive charging. What does this technology involve?

Inductive charging means transferring electrical energy from a transmitter to a receiver without cables or plugs – that is, without any physical connection – using alternating magnetic fields.

And how does that work, exactly?

Cables are coiled into a loop. When alternating electric current flows through such a coil, a magnetic field forms around it, continuously changing its polarity. A second coil is positioned in the receiver directly above the transmitter's magnetic field. Parts of the first magnetic field then pass through the magnetic field of the second coil. This generates the electric voltage needed for energy transfer. If you hold a light bulb against this, it will light up. It may sound simple, but with larger air gaps, additional electronics and sophisticated control and regulation algorithms are required, making the system considerably more complex.

What are the advantages of this technology?

For users, it is primarily a matter of convenience. No one wants the tangled mess of cables we all know, and inductive charging can significantly reduce the number of cables. Another major advantage is that it makes devices more reliable, efficient, and safe. Cables are a frequent source of problems, particularly in devices that are in motion. In industrial robots, for example, broken cables and faulty connectors lead to numerous maintenance calls. Additionally, without cables getting in the way, we can design entirely different kinds of devices.

What does inductive charging mean for the use of electric cars?

It gives drivers the freedom to park their cars in designated spots and have them charge automatically. We can now even connect electric vehicles to the grid automatically and charge them while driving. On the A6, there is already a test stretch equipped with the corresponding charging infrastructure beneath the road surface. This significantly reduces the issue with range. We can build smaller batteries that require less material, fewer raw resources, and less lithium. The vehicles themselves become lighter and more efficient. Above all, electric cars can also feed energy back into the grid. They act as flexible loads and energy storage systems, making the integration of renewable energy much easier.

You also foresee promising applications in a variety of other fields.

The very first application we explored was actually robotics. However, we have long been exploring ways to deliver electrical energy to the body wirelessly. Nowadays, there are many medical devices implanted in the body, such as cardiac assist systems – pumps that require a significant amount of energy. Currently, energy is transmitted through cables that pass through the skin, creating a potential entry point for infections. We have succeeded in eliminating the cable in an "artificial heart." Another exciting application is sensor technology.

How advanced are your wireless systems now?

For stationary charging systems, we have achieved an efficiency of 95 percent. At that level, we can compete with wired systems. For moving objects, we also achieve over 90 percent efficiency. We know how to design our coils and how to develop the complex electronic circuits. We are now working, for example, on innovative algorithms for control systems that allow us to be more flexible and adapt to changing scenarios.

How far has wireless energy transfer advanced in practical applications?

This technology is now advanced enough to be put to practical use. Many companies in the Stuttgart region and throughout Baden-Württemberg are already working intensively on this. There are also promising start-ups. The business community knows that it can find well-trained specialists for this technology in the Stuttgart region. The electrical machine engineering sector is very interested in transmitting energy wirelessly in order to be able to build motors without rare earths magnets. And this is what we are developing. We are very proud that it has found its way into industry. Autonomous AGVs are already being charged wirelessly at stationary points. And this also applies to the autonomous robots of the future. Now we are working on charging them while they are in motion, so that they can operate 24 hours a day. Amplink, a spin-off from our institute, is working on precisely this topic. Stuttgart is on its way to becoming a wireless power city.

And what is the situation in the automotive sector?

Tesla is already using inductive charging in autonomous vehicles in the USA. This is likely to serve as motivation for other manufacturers as well. I am convinced that as the number of electric vehicles increases, this will naturally follow. If a bold manufacturer comes along and implements inductive charging systems, it will catch on – just like wireless charging for smartphones. Consumers will want to use it.

What would it take to really get inductive power transfer off the ground?

We have solved the technical challenges. And the industrial sector is very interested. The challenges we face now are more political and societal in nature. If we want to see this technology deployed everywhere, we need openness to innovation from both industry and politics.

What motivates you personally?

The application itself. The longer I research in this field, the more areas I discover where I think, Wow, this could make life easier, save materials, help people, and make production more efficient. My team and I aim to design all electrical systems and devices to minimize resource use and ensure low operational emissions.

About Professor Nejila Parspour

Nejila Parspour has been a professor of electrical energy conversion at the University of Stuttgart since 2007 and has been head of the newly founded Institute of Electrical Energy Conversion (IEW) there since June 2011. The institute is one of the world's leading research centers in the field of wireless electric power transfer. For projects in the fields of electromobility and production engineering, the IEW collaborates with, among others, the ARENA2036 research campus.

Professor Parspour is an electrical engineer, who holds a doctorate, is a member of the German Academy of Science and Engineering (acatech) and of the research directorate of the Innovation Campus Future Mobility (ICM). She heads the Steinbeis Consulting Center for Electromobility and Drive Technology and participates in the Strategic Dialogue on the Automotive Industry in Baden-Württemberg. Highlights of her scientific career include positions at the Technical University of Berlin, the University of California, Berkeley, and the University of Bremen. Parspour has received, among others, the Technology Prize of the State of Bremen and the "Übermorgenmacher" award from the State of Baden-Württemberg.

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