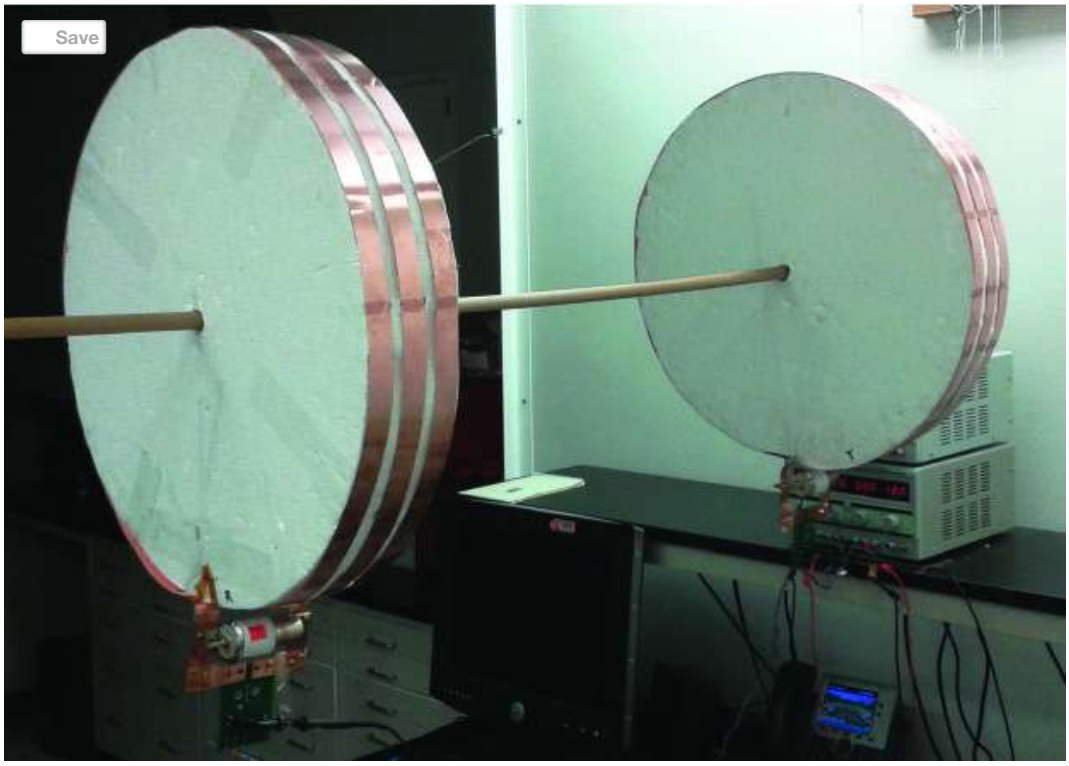


Stanford scientists have created a device that wirelessly transmits electricity to a movable disc. The technology could some day be used to charge moving electric vehicles and personal devices. Credit: Sid Assawaworrarit/Stanford University

If electric cars could recharge while driving down a highway, it would virtually eliminate concerns about their range and lower their cost, perhaps making electricity the standard fuel for vehicles.

Now Stanford University scientists have overcome a major hurdle to such a future by wirelessly transmitting electricity to a nearby moving object. Their results are published in the June 15 edition of *Nature*.

"In addition to advancing the wireless charging of vehicles and personal devices like cellphones, our new technology may untether robotics in manufacturing, which also are on the move," said Shanhui Fan, a professor of electrical engineering and senior author of the study. "We still need to significantly increase the amount of electricity being transferred to charge electric cars, but we may not need to push the distance too much more."

The group built on existing technology developed in 2007 at MIT for transmitting electricity wirelessly over a distance of a few feet to a stationary object. In the new work, the team transmitted electricity wirelessly to a moving LED lightbulb. That demonstration only involved a 1-milliwatt charge, whereas electric cars often require tens of kilowatts to operate. The team is now working on greatly increasing the amount of electricity that can be transferred, and tweaking the system to extend the transfer distance and improve efficiency.

from a series of coils connected to an electric current embedded in the road."

Some transportation experts envision an automated highway system where driverless electric vehicles are wirelessly charged by solar power or other renewable energy sources. The goal would be to reduce accidents and dramatically improve the flow of traffic while lowering greenhouse gas emissions.

Wireless technology could also assist GPS navigation of driverless cars. GPS is accurate up to about 35 feet. For safety, autonomous cars need to be in the center of the lane where the transmitter coils would be embedded, providing very precise positioning for GPS satellites.

Magnetic resonance

Mid-range wireless power transfer, as developed at Stanford and other research universities, is based on magnetic resonance coupling. Just as major power plants generate alternating currents by rotating coils of wire between magnets, electricity moving through wires creates an oscillating magnetic field. This field also causes electrons in a nearby coil of wires to oscillate, thereby transferring power wirelessly. The transfer efficiency is further enhanced if both coils are tuned to the same magnetic resonance frequency and are positioned at the correct angle.

However, the continuous flow of electricity can only be maintained if some aspects of the circuits, such as the frequency, are manually tuned as the object moves. So, either the energy transmitting coil and receiver coil must remain nearly stationary, or the device must be tuned automatically and continuously - a significantly complex process.

To address the challenge, the Stanford team eliminated the radio-frequency source in the transmitter and replaced it with a commercially available voltage amplifier and feedback resistor. This system automatically figures out the right frequency for different distances without the need for human interference.

Bridge Collapse C
Perspectives S
More from Genera

The group used an off-the-shelf, general-purpose amplifier with a relatively low efficiency of about 10 percent. They say custom-made amplifiers can improve that efficiency to more than 90 percent.

"We can rethink how to deliver electricity not only to our cars, but to smaller devices on or in our bodies," Fan said. "For anything that could benefit from dynamic, wireless charging, this is potentially very important."

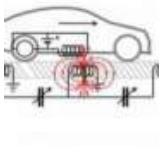
Explore further: **Wireless power could revolutionize highway transportation, researchers say**

More information: Sid Assawaworrarit et al. Robust wireless power transfer using a nonlinear parity?time-symmetric circuit, *Nature* (2017). **DOI: 10.1038/nature22404**

Journal reference: Nature

Provided by: Stanford University

Related Stories



Wireless power could revolutionize highway transportation, researchers say February 1, 2012

A Stanford University research team has designed a high-efficiency charging system that uses magnetic fields to wirelessly transmit large electric currents between metal coils placed several feet apart. The long-term goal ...

New approach advances wireless power transfer for electric vehicles November 14, 2013

Researchers from North Carolina State University have developed new technology and techniques for transmitting power wirelessly from a stationary source to a mobile receiver – moving engineers closer to their goal of creating ...

Key factors for wireless power transfer July 31, 2013

Recommended for you

Earth's health could benefi power, self-sustaining farn

September 13, 2018

What will it take to save this blue marble

The Apple Watch is inching medical device September 13, 2

Apple is trying to turn its smartwatch from better health by slowly evolving it into a r

many people before.

antialias_physorg 4 / 5 (4) Jun 14, 2017

The frequency changing part? Haven't seen that before.

TheGhostofOtto1923 2.3 / 5 (3) Jun 14, 2017

"For safety, autonomous cars need to be in the center of the lane where the transmitter coils would be embedded"

-My AI car will be programmed to swerve from left to right to avoid potholes and manhole covers and catch basins.

KBK 1.4 / 5 (10) Jun 14, 2017

Anyone with one quarter of a brain cell is not interested in any kind of wireless transmitted electrical POWER. Any sort of field of that intensity is very detrimental to biological systems.

It's a death trap. Stay away from it.

It does not have to be qualified as a statement, it's a known quantity and the research as been out there for years. From many different quarters.

Why do people keep working on and pushing this toxic crap?

Oh yes. money greed and illiteracy on the matter on the biological side of things.

It may make good engineering sense, but it is a total human disaster.

Parsec not rated yet Jun 14, 2017

I have often pondered the application of this sort of technology to art. I envision a large number of tiny aircraft all powered wirelessly, endlessly swirling and creating intricate 3 dimensional patterns in space. In fact, it's not hard to visualize (since the power source is external), these tiny aircraft being small enough to actually form the basis for true 3-D visualization projects. This of course is not something that would be trivial to engineer because the requirement that the receiving coils be large enough to be resonant with the frequency of the magnetic fields transmitting the power.

I submit this as food for thought to my fellow science lovers. Are their any budding artists out there?

Parsec 4 / 5 (5) Jun 14, 2017

KBK - your comments have no scientific basis whatsoever. Einstein received a nobel prize for his work explaining the photoelectric effect in 1906. Fundamentally, if the quanta of energy is lower than the quanta required for an effect on a molecule, the actual number (i.e. power) of the quanta doesn't matter.

While it is certainly true that high power magnetic fields can cause secondary effects, the real truth is that if the frequency is adjusted so that it cannot ionize anything or be absorbed and converted to heat, you cannot demonstrate any toxicity inherent in that power. There is no known mechanism connecting the fields to any possible toxic effect.

I am not suggesting that its impossible, but that it's extremely unlikely. It certainly has a low enough probability that such a possibility should not preclude research into the technology.

Parsec 3.7 / 5 (3) Jun 14, 2017

> Not new, or special. Surprised they could publish something about this... as it's been done by many, many people before.

No... not really. The new part of the device here is a simple and inexpensive mechanism to avoid the

You want correlation and evidence, I bring you some.

Then, cell phones and the RF, and proximity issues. In Germany, no cell towers are allowed within, what, 500 meters or more, from any school. They KNOW it is bad for people. Then the WiFi in homes.

the studies were done ~after~ the near multi-trillions of dollars were involved and ~of course~ those studies will find no effects. Unless you look close enough at the authorship. trillions on the table will find a lot of room to put off the inevitable.

Don't put up with the same shit here. Get educated on these matters.

Bart_A not rated yet Jun 14, 2017

OK. So they lit up an LED with a mW of power.
Cars need 10 million times more power, per this article.
Putting in the necessary huge copper transformers continuously over millions of kilometers----do the math. At $5.5 per kg of copper, using perhaps 100kg/m of road, and there are 14.6M of paved lane-kilometers in the US.
That more than $8 Trillion. And that is just the cost of the copper.
Add in power line routing, construction costs, etc, and it will easily double. Probably more.

And then the questions, how effecient is it really going to be? There will be large losses in power transfer. Running costs compared to gasoline could be much more expensive.

someone11235813 5 / 5 (1) Jun 15, 2017

Those who fret about brain damage from their cell phones (EM radiation not Twitter) will have a field day with this.

dirk_bruere not rated yet Jun 15, 2017

I built a resonant charger for batteries in the 90s, but the company I built it for never took it anywhere.

Eikka 1 / 5 (2) Jun 15, 2017

> There is no known mechanism connecting the fields to any possible toxic effect.

Observe transcranial magnetic stimulation. Very high power oscillating magnetic fields cause currents in conducting media, which includes the human body as we are more or less like sacks of salt water.

The toxicity comes from these electric currents causing or inhibiting chemical reactions. This is not significant for milliwatt-level sources like wifi antennas or cellphones, which have a neglible magnetic component in the field anyhow, but it becomes important when you are trying to transmit a million times more power solely through the magnetic field, and you stick a person in or even near the beam.

In any case, the economic case of laying trillions of miles of copper coil and electronics under every road is just not there. Not even for all the main highways. Just the system idle losses would be astronomical, as most road surface is 99% of the time free of vehicles.

Eikka 1 / 5 (1) Jun 15, 2017

The issue with inductive power transfer, resonant or otherwise, is that you cannot limit it to run only between the transmitter and the reciever.

Any hoop of metal placed in the field will pick up some energy - like a metal wristwatch around your arm. Also the steel bottom pan of your car will pick some of it and heat up. That makes it dangerous for any high levels of power beyond a few Watts, and also highly inefficient. You're basically turning every road surface into an induction cooker.

> The issue with inductive power transfer, resonant or otherwise, is that you cannot limit it to run only between the transmitter and the reciever.

Deep misunderstanding of inductive power transfer.

If no inductive coupling is available then the power is retained in the transmitter's field and recovered when it collapses. You're lying again, @Eikka.

Eikka 1 / 5 (1) Jun 22, 2017

> If no inductive coupling is available then the power is retained in the transmitter's field and recovered when it collapses

There's ALWAYS some inductive coupling available. It is inevitable, as any electrically conducting material can form eddy currents in an oscillating magnetic field. Free electrons in a material experience electromotive force in the changing field, and start to move: electric current.

Not all of the energy in the field is coupled, of course. The high frequency of the field confines current along the surfaces of conductors, which limits the transfer of energy by high resistance, but this effect depends on the magnetic permeability of the material: salt water experiences very little skin effect, whereas an iron bar will experience a lot.

That also means a person picks up more energy from the field than a crowbar.

> Deep misunderstanding of inductive power transfer.
> You're lying again, @Eikka

This would be a perfect spot for "No, You."

antialias_physorg not rated yet Jun 22, 2017

> A charge-as-you-drive system would overcome these limitations

I don't think charging would be needed - just enough to keep you going. Have the on-board batteries for the 'first and last mile' and highways equipped with this induction system. Range-problem solved (well, maybe...supplying enough energy for every car on a highway at the same time might be difficult)

> Those who fret about brain damage from their cell phones will have a field day with this.

The issue with old phones was power deposited in the brain. The current phones are so low power this isn't an issue (for the car chargers it wouldn't be either, since you're well shielded inside a car and the coils in the street are only active while a car is above it). The issue with phones nowadays is the steep flanks due to high frequencies/digital transmissions. Even though these are low energy they are high power (can induce currents accross cell membranes) But since no one uses voice calls these days...meh.

Da Schneib not rated yet Jun 22, 2017

So, @Eikka, are you one of the nutjobs who thinks power transmission lines are dangerous, too, because of all that inductive power transfer?

Just askin'.

Eikka not rated yet Jun 22, 2017

> So, @Eikka, are you one of the nutjobs who thinks power transmission lines are dangerous, too, because of all that inductive power transfer?

Eikka not rated yet Jun 22, 2017

for the car chargers it wouldn't be either, since you're well shielded inside a car

Not really. It's hard to stop a magnetic field, and doing so would actually absorb quite a lot of the field's energy.

Ask yourself, what happens with one of those wi-tricity devices if you put a sheet of aluminium foil between the transmitter and the reciever.

Commenting is closed for this article.