TOYOHASHI UNIVERSITY of TECHNOLOGY e-Newsletter

News and views from one of Japan's most innovative and dynamic science and technology-based academic institutes

No. 3, June 2011

Features

A new approach to design robots for health care environments

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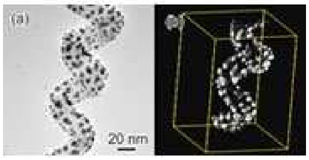

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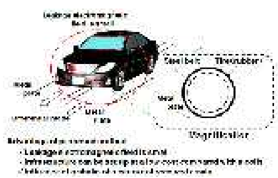

Tech-Overtures

Future Electric Vehicle to Run Far Beyond

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Features

A new approach to design robots for health care environments

Kazuhiko Terashima, head of Toyohashi University of Technology's new Center for Symbiotic Human Robotics Research proposes new 'smart robots' for hospitals.

Japan has made global headlines with its development of humanoid robots that can walk, run, sing, dance, and even peddle bicycles. But Kazuhiko Terashima, head of Toyohashi University of Technology's new Center for Symbiotic Human Robotics Research, asks, "Where are the practical applications from all this research?" Even robotics researchers focused on taking care of humans have little to show for their efforts, says Terashima. The reason, he suggests, is because so much of the research is carried out in laboratories—not in real-world environments like a hospital, care center or the home.

"What's more, researchers generally set robots a single task to perform," he adds. "But in a hospital or care center, a robot must be able to perform a variety of tasks if it is to be useful. It needs to assist a patient or aged person to sit in a chair, lie down on a bed, enter a bath, walk, practice therapy, and so on."

This requires a new thinking in design where robots are considered part of an overall system of care, controlled directly by humans such as nurses and aides, who will be necessary in order to give reassurance to patients. The different tasks will be laid out and conducted in a workflow manner using concepts taken from factory automation. Key technologies for such a scheme under development at the Robotics Center are methods for vibration dampening, omni-directional movement, and sensor-based power-assisted movement.

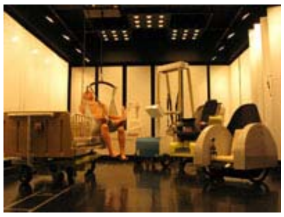
"Instead of spending our funds on building complicated robots of limited use, we're developing much simpler power-assisted systems that can help the infirmed move about comfortably and safely," explains Terashima.

Heavy tasks such as lifting and moving a bed-ridden person, for instance, would be done by a single nurse or assistant using a system of personal power-assisted body cranes incorporating sensors to make the raising, lowering and moving possible with one hand and without causing unpleasant vibrations or swinging. The key to smooth operations here will be the interface between the operator and the system. "It must be simple to use and comfortable to handle with one hand," says Terashima.

To implement such a system will require coming up with a new architecture for hospitals and care centers that would incorporate a system of these overhead cranes. So the researchers are collaborating with doctors from the nearby Fukushimura Hospital, which is supporting the research, who visit the Robotics Center regularly to provide feedback.

"Over the next five years, we will develop this smart system in our Center," says Terashima. "During the following five-year phase, after optimization, we'll transfer it to Fukushimura Hospital. Then after ten years we will be ready to commercialize the system and offer it to the world."

Kazuhiko Terashima, head of Toyohashi University of Technology's new Center for Symbiotic Human Robotics Research



Smart robots at the Center for Symbiotic Human Robotics Research

Omnidirectional wheelchair robot being developed at the Center for Symbiotic Human Robotics Research

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News

Toyohashi Tech faculty and staff participate in the 'Japan Educational Seminar' in Indonesia

The Japan Educational Seminar was held simultaneously in Jakarta, Bandung, and Yogyakarta from 14–17 May 2011. This seminar was held to recruit students from Asian countries where there is growing demand for university education abroad.

Toyohashi Tech was one of 17 Japanese universities that participated in the seminars and demonstrations held in each city. The participants form Toyohashi Tech gave presentations to introduce academic programs, entrance examinations, and support-systems for international students at Toyohashi University of Technology. Students interested in studying in Japan visited university booths for information about the courses and life in Japan.

Associate professors Nobumasa Sekishita of the Department of Mechanical Engineering, and Ryoji Inada of the Department of Electrical and Electronic Information Engineering, joined administration staff to introduce the possibilities at Toyohashi Tech.

Many students visited the Toyohashi Tech booth

Students listening to a presentation by Toyohashi Tech staff

In addition to the seminars, Toyohashi Tech vice president and administration officer, Dr. Jinno joined vice presidents from 17 Japanese universities and 25 Indonesian universities held a meeting at the General Administration Hall for Higher Education at the Ministry of National Education, to discuss the promotion of academic exchange between universities in Indonesia and Japan.

The meeting of vice presidents, with vice president Kiyokatsu Jinno second from right in the second row

Nobumasa Sekishita and Ryoji Inada (middle) join visitors to the Toyohashi Tech booth for a group photograph

President Yoshiyuki Sakaki visits the Royal Institute of Technology (KTH) to sign a University-to-University Exchange Agreement

On May 17th 2011, Toyohashi University of Technology signed a University-to-University Exchange Agreement with the Royal Institute of Technology (KTH) in Sweden. President Yoshiyuki Sakaki, vice-president Makoto Ishida, professor Mitsuteru Inoue of the Department of Electrical and Electronic information Engineering, and Tetsuo Shinoda, Director of General Affairs Division visited the Royal Institute of Technology (KTH) to participate in a signing ceremony that was attended by faculty members from both universities.

KTH, which was established in 1827, is located in Stockholm and is considered as being one of the top engineering-based universities in Sweden. KTH has eight departments and eight majors providing a variety of courses in science and engineering for its 12,000 undergraduate and 1500 post-graduate students.

During the visit, president Sakaki described the education system and cutting edge research projects at Toyohashi Tech., and vice-president Ishida and colleagues exchanged ideas about the promotion of exchange programs for undergraduate and graduate students, and research collaboration.
The members of the two universities discussed the possibilities of setting up a ‘double degree’ program at the postgraduate level, and the promotion of inter-university exchange.
The delegates also visited the Stockholm Liaison Center of the Japan Society for the Promotion of Science to have a meeting with Mr. Sano, Director of the Liaison Center.


Signing ceremony


President Yoshiyuki Sakaki introduces Toyohashi University of Technology to members of KTH


Per Berglund and Yoshiyuki Sakaki shake hands after the signing ceremony


Royal Institute of Technology court yard


Fourth from right, Per Berglund, KTH Vice President, fifth is President Sakaki

Research highlights

Bioactuator:*Vorticella* actuation in microfluidic systems

Growth of ~50 nm-diameter multi-walled carbon nanocoils

Computer science: Powerful algorithm for segmented alignment of ontologies of arbitrary size

Graphene: Patterning and doping

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Research highlights

Bioactuator:*Vorticella* actuation in microfluidic systems

Moeto Nagai

Vorticella is a microorganism with a stalk capable of linear actuation with a 100 μm working distance. Contraction and extension of the stalk are induced by Ca^{2+} (calcium ions) and chelators such as EDTA and EGTA. As the stalk does not require an external power source for actuation, it has intriguing possibilities for applications in microfluidic systems.

However, controlling *Vorticella* actuation in a microfluidic device remains a major challenge for these applications. Now Moeto Nagai and colleagues in Japan and Usa at Toyohashi University of Technology have demonstrated that pneumatically controlled microvalves can be used as a control system for the actuation of the stalk.

The experiments were conducted in three steps: microfluidic devices were fabricated by multi-layer soft lithography; the *Vorticella* were introduced and cultured in the device; Ca^{2+} and EGTA solution were injected.

The length of the stalks changed between 20 and 60 μm in the presence of Ca^{2+} and EGTA, resulting in a working distance of about 40 μm.

The stalks of *Vorticella* show genuine potential for applications in microsystems such as micro-positioners and microvalves.

Reference:

- Moeto Nagai[1,2],Sangjin Ryu[3],Todd Thorsen[3],Paul Matsudaira[3] and Hiroyuki Fujita[2]
- Chemical control of *Vorticella* bioactuator using microfluidics
- *Lab Chip*, **10**, 1574–1578 (2010).
- Digital Object Identifier (DOI): 10.1039/C003427D
- [1]Moeto Nagai is now at Department of Mechanical Engineering, Toyohashi University of Technology
- [2]Institute of Industrial Science, The University of Tokyo
- [3]Massachusetts Institute of Technology.

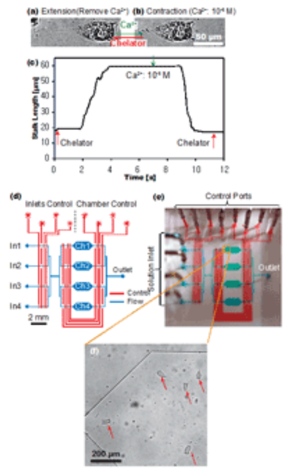

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Figure caption: (a)—(c) Length change in a *Vorticella* stalk in a different [Ca^{2+}]. A rise of [Ca^{2+}] drives the stalk contraction. A removal of [Ca^{2+}] induces the stalk extension. (d) Structure and (e) picture of the microfluidic device. (f) Five cells of *Vorticella* cultured in the device.

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Research highlights

Growth of ~50 nm-diameter multi-walled carbon nanocoils

Carbon nanocoils (CNCs) are composed of helical shaped carbon nanofibers and show promise as fillers, electromagnetic wave absorbers, and tactile sensors.

However, in spite of the tremendous efforts to produce contrary, the vast majority of CNCs are amorphous, exhibiting larger fiber and coil diameters than carbon nanotubes.

In an attempt to resolve this issue, Masashi Yokota and colleagues at Toyohashi University of Technology in Japan report the growth of thin CNCs with coil diameters of 50 nm by catalytic chemical vapor deposition (CCVD).

The thin CNCs were synthesized by the following procedure: mixing Fe and Sn powders and Y-type zeolite in dilute hydrochloric acid solution; sonicating the resulting solution and drying in a furnace; passing a gas mixture of C_2H_2/N_2 over the zeolite with the Fe and Sn catalysts in a quartz tube reactor at 700°C.

The thin CNCs had fiber and coil diameters of 15 nm and 50 nm, respectively, with a hollow and multi-walled structure of cylindrical graphitic layers. The researchers refer to the thin CNCs as 'multi-walled CNC', which had a left hand helix that was confirmed by electron tomography.

Reducing the diameter of the CNCs induced the structural changes from amorphous to graphitic, which implies the enhancement of the electrical as well as mechanical characteristics. This multi-walled CNCs may find applications in battery technology and nanoelectromechanical systems.

Yoshiyuki Suda

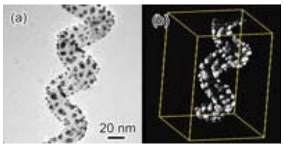

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Figure caption: Electron tomography of a multi-walled carbon nanocoil (MWCNC). (a) TEM micrograph of the MWCNC coated with Au nanoparticles. (b) Reconstructed 3D image of the MWCNC.

Reference:

- Masashi Yokota, Yoshiyuki Suda, Hirofumi Takikawa, Hitoshi Ue, Kazuki Shimizu, and Yoshito Umeda.
- Structural analysis of multi-walled carbon nanocoils synthesized with Fe-Sn catalyst supported on zeolite.
- *Journal of Nanoscience and Nanotechnology* **11**, 2344–2348 (2011).
- Digital Object Identifier (DOI): 10.1166/jnn.2011.3126
- Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology.
- Department website: http://www.tut.ac.jp/english/introduction/department02.html

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Research highlights

Computer science: Powerful algorithm for segmented alignment of ontologies of arbitrary size

A large range of internet-based ontologies are available on for sharing common knowledge bases. However, the proliferation of such ontologies has led to disorder, which creates difficulties in their effectiveness.

Thus this disorder has led to demands 'ontology alignment' to literally align two or more seemingly similar, but quite different ontologies for unified understanding.

As a solution to these issues, Md. Hanif Seddiqui and Masaki Aono at Toyohashi University of Technology have developed an efficient and scalable algorithm for ontology alignment: the so-called 'Anchor-Flood algorithm'.

Notably, the Anchor-Flood algorithm achieved the best running time in the OAEI 2009 (Ontology Alignment Evaluation Initiative) contest.

The Anchor-Flood algorithm can be applied not only to ontology alignment problems, but also for similarity measurements for data in two graphs. This includes potentially many areas of research including web link analysis and web community mining.

Reference:

- Md. Hanif Seddiqui, Masaki Aono
- An efficient and scalable algorithm for segmented alignment of ontologies of arbitrary size.
- *Journal of Web Semantics: Science, Services and Agents on the World Wide Web 7*, 344–356 (2009).
- Digital Object Identifier (DOI): 10.1016/j.websem.2009.09.001
- Department of Computer Science and Engineering, Toyohashi University of Technology

Masaki Aono

Md. Hanif Seddiqui

Enlarge Image
Fig: Ontology alignment contest (Anchor Flood achieved No.1 speed).

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Research highlights

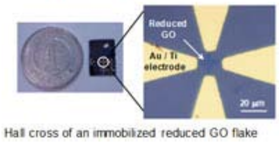
Graphene: Patterning and doping

Adarsh Sandhu, Chief scientist at EIIRIS and head the new *EIIRIS-Graphene Research Group (GRG)*

Innovative approaches for patterning graphene oxide and chemical doping of graphene for nanoelectronics.

The chemical synthesis of graphene is considered as an efficient means of mass producing graphene-based compounds. Typically, the chemical process of producing graphene consists of first chemical exfoliation of graphite to produce graphene oxide (GO) flakes, followed by the reduction of the GO, which yields graphene flakes. Now in spite of the proliferation of chemical approaches for the synthesis there are still two fundamental issues to resolve. First is the development of protocols for integrating chemical synthesis with device fabrication technology, namely, methods for the positioning GO or graphene flakes at specific locations on substrates to enable photolithography and device fabrication, without having to 'hunt' for graphene. The second issue is an effective and controlled means of doping graphene in solution—again an important factor for real life applications of this material.

Here in two recent publications, Adarsh Sandhu at Toyohashi University of Technology and colleagues demonstrate novel approaches to resolve the issues of device patterning and doping of graphene.



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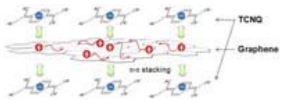
Immobilization and device fabrication of GO flakes

In *JJAP* [1] Adarsh Sandhu and his doctoral student Ryousuke Ishikawa describe a straightforward process for positioning individual flakes of graphene oxide at specific locations of a substrate and subsequent fabrication of device structures using individual flakes of chemically derived graphene. Notably, the researchers exploited the negatively charged surface of GO flakes, and successfully patterned GO flakes onto photolithographically defined positively charged regions on silicon substrates. The immobilized GO flakes were reduced in a saturated vapor of hydrazine monohydrate at 80°C for 18 h and post-annealing in vacuum. Electrical measurements using photolithographically defined Hall crosses showed the monolayer films of reduced GO films to have a carrier concentration and mobility of 10^{11} cm^{-2} and 10 cm^2/Vs, respectively.

In addition, the researchers addressed the issue of doping in *Nanoscale Research Letters* [2], where they describe an inexpensive method of producing chemically derived graphene-based transparent conducting films (TCFs) via charge transfer by conjugated organic molecules. In this approach, the process of GO reduction and carrier doping were carried out in liquid phase, that is, without the use of vacuums, which is an advantage for mass production of doped graphene of touch panel displays and solar cell panels.



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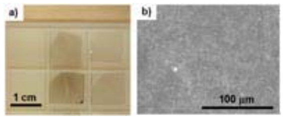
Schematic diagram of doping graphene by adsorbed TCNQ molecules

GO films produced by Hummer's method were reduced to form graphene by dispersing GO into an aqueous solution containing N_2H_4, a strong reductant (with NH_3 to adjust pH) in a water bath at 95°C water bath for 1 h, when the and the color of the dispersion changed from brownish color to gray. Finally, the solvent of reduced graphene oxide (RGO) dispersion was replaced by N,N-dimethylformamide (DMF) using an evaporator.



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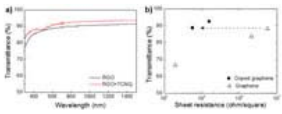
Graphene films on glass substrate. (a) Photograph and (b) SEM image.

Doping graphene via charge transfer by tetracyanoquinodimethane (TCNQ)—well-known as a powerful electron accepter, which is expected to favor electron transfer from graphene into TCNQ molecules, thereby leading to p-type doping of graphene films—molecules. Importantly, small quantities of TCNQ drastically improved the resistivity without degradation of optical transparency.



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Physical properties of doped graphene films. (a) Optical transmittance spectra and (b) Summary of optical and electrical properties.

Reference

- [1] Ryousuke Ishikawa[1], Masashi Bando[1], Yoshitaka Morimoto[1], and Adarsh Sandhu[1,2] Patterning of Two-Dimensional Graphene Oxide on Silicon Substrates *Japanese Journal of Applied Physics* **49**, 06GC02, (2010)
  Abstract: http://jjap.jsap.jp/link?JJAP/49/06GC02
- [2] Ryousuke Ishikawa[1,2], Masashi Bando[1], Yoshitaka Morimoto[1], Adarsh Sandhu[1,2] Doping graphene films via chemically mediated charge transfer *Nanoscale Research Letters* **6**, 111, (2011)
  Open access: http://www.nanoscalereslett.com/content/6/1/111

Related information

- [1]Department of Electrical and Electronic Engineering, Tokyo Institute of Technology, 2-12-1 O-okayama, Meguro, Tokyo 152-8552, Japan
- [2]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology, 1-1 Hibarigaoka, Tempaku-cho, Toyohashi, Aichi 441-8580, Japan
  EIIRIS URL: http://www.eiiris.tut.ac.jp/

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Club Activities

A Wind Orchestra of note

Students looking for a creative way to blow off steam could hardly do better than join the Wind Orchestra at Toyohashi Tech. That's the recommendation of some 40 members, including club leader Yuuki Tanji, a third-year undergraduate student studying architecture.

The club is home to players of the flute, oboe, clarinet, saxophone, trumpet, trombone, and several other wind instruments, as well as a variety of drums. Some members own their instruments, while others borrow instruments from the university.

"We meet three times a week for practice and rehearsals," says Tanji. "Each session lasts at least two hours and about 20 to 30 or so members come regularly, which shows how enthusiastic they are."

The kind of music the club plays is classical and some popular pieces, with the members deciding among themselves on the repertoire. New members are recruited through word-of-mouth, a web page (http://tutwo.fc2web.com/) advertising club activities and by performing at the Toyohashi Tech annual festival in the summer.

Tanji's choice of instrument is the saxophone. "I tried playing a variety of instruments, but I found the sax to be the most enjoyable," he says. "I really like the sound."

Beginners are also welcome. "In fact, around half the members are learning to play," says Yuuki Mitoma, a third-year student in mechanical engineering and the club's vice-leader. "It's okay if you don't have any experience because we will help you learn. I teach newcomers how to plat the trombone—my favorite instrument."

The big event of the year, regular concert, is performing before an audience of 600 people at the Life Port Toyohashi Concert Hall. The club has given 26 such major performances since it was founded not long after Toyohashi Tech itself was established in 1976. In addition, the club is invited by local communities to give concerts at local festivals and primary schools, and occasionally performs at hospitals.

Left to right: Associate professor Hiroshi Okada (advisor to the club); Yuuki Tanji (leader of the orchestra); and Yuuki Mitoma (deputy-leader).

Members of the orchestra at the Toyohashi Life Port Concert Hall.

Excursions

International students visit Kyoto and surrounding region to experience Japanese culture on a study trip organized by Toyohashi Tech

On 8th March 2011, international students studying at Toyohashi Tech went on a two day trip to Kyoto and the surrounding region as part of their second Study Trip for FY 2010. This trip was arranged by the Center for International Relations (CIR), based on requests from international students.

Fifty six international students, three members of staff and five Japanese tutors took the *shinkansen* to Kyoto and visited Kyoto International Manga Museum, *Nijo* castle, and several temples in Kyoto, as well as a ceramic museum and *Ninja* House both located in nearby Koga city.

Japanese Manga (cartoons) is now popular in many countries, and the Toyohashi Tech international students learnt about the history of Japanese Manga and enjoyed looking at many different translations at the Kyoto International Manga Museum.

During the trip the students also visited *Nijo* castle, *Kinkaku-ji* temple, *Ryoan-ji*, and other world heritage sites in Kyoto. For some students the visit to the Ninja house in Koga city was the highlight of the two days.

The CIR planned carefully to satisfy the wide range of needs of the students, who are from all over the world, with different cultural backgrounds, and some with specific food restrictions.

Toyohashi Tech is located in Aichi prefecture, in central Japan. Heading west, Kyoto in less than one hour by Shinkansen from Toyohashi, and towards the east, Tokyo is only 90 minutes away.

Students pose for a photograph in front of Kinkaku-ji; the famous Buddhist temple in Kyoto.

At the gates of Nijo castle in Kyoto built by Tokugawa shogunate in 1626.

A snap shot at the ceramics museum

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Tech-Overtures

Future Electric Vehicle to Run Far Beyond

Electrically powered vehicles (EV) are promising environmentally friendly alternatives for combustion engine-based automobiles. Electric motors offer significant advantages including high energy efficiency; low noise emission; low temperature operation; no emission of exhaust gases; and the possibility of power regeneration from kinetic motion when a vehicle slows down.

However, batteries used in present-day EV limit the continuous running distance from one charge. Furthermore, it takes an impractical long time to recharge the batteries, and loading larger batteries increases the onboard load, which leads to greater consumption of energy to move vehicles. And notably, batteries are too expensive for use in replacing all existing cars, buses, and trucks.

Here, Masahiro Hanazawa at Toyota Central R&D Labs. and Takashi Ohira at Toyohashi University of Technology (Toyohashi Tech) propose a potentially revolutionary solution for powering EVs capable of running unlimited distances. The basic concept stems from electric railways, where each car of the train is power from an overhead wire while the car runs on tracks. The researchers imagined how an automobile running along a road could do so without resorting to dangerous contacting devices such as pantographs, and finally came up with a profound and novel idea: The source of energy from power lines is up-converted into radio frequency (RF) by high-speed inverters implanted along tracks in the road. The RF voltage is applied to a balanced metal track embedded under the surface of the road. The EV picks up the RF voltage via electrical capacitance between the metal and a steel belt installed inside of the tires of the EV.

The researchers conducted feasibility experiments to test their ideas, and to explore the RF frequencies where such power transfer is effective and practical. In the experiments, the researchers put small metal plates on the floor and inside a tire, and positioned another metal plate above the tire. Finally, they measured the electrical impedance between the two plates. This set-up should be equivalent to double the impedance between a plate and a steel belt.

Experimental results showed the impedance to depend linearly on the RF frequency, and to exhibit 2000-j700 ohm at 1 MHz. Then the researchers designed and implemented a 50 ohm reactance circuit to match this, where 50 ohm is the standard impedance for RF transmission lines. This experimental set-up enabled a high transmission efficiency with sub 1 dB loss.

Although these were low power experiments, they demonstrate the feasibility of energy transfer from the road to a running automobile. If this energy transfer could be increased to tens of kW on express ways, then in the future it may be possible to take EV from your house to the nearest interchange with a small battery and then cruise on the expressway via this feeder system as far as you want without concern about battery discharge problems.

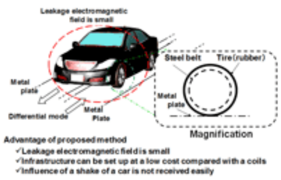
Reference:

Masahiro Hanazawa and Takashi Ohira, "Power Transfer for a Running Automobile", IEEE MTT-S International Microwave Workshop Series on Innovative Wireless Power Transmission, IMWS-IWPT2011, pp.77-80, Kyoto, May 2011.

- Affiliations: Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology.
- website: http://www.tut.ac.jp/english/introduction/department02.html

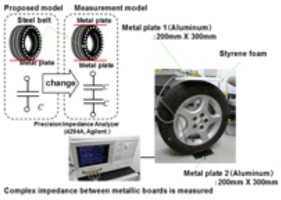
Takashi Ohira, Toyohashi Tech

Masahiro Hanazawa, Toyota Central R&D Labs Inc.



Enlarge Image

Caption: A schematic of the proposed power transfer system for a running automobile. This system transmits electric power thorough a capacitor composed of a steel belt and a metal plate attached to the road, and the power feed in differential mode. Notably, the leakage electromagnetic field is small, and the infrastructure can be set up at low cost compared with coils.



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Caption: The proposed model and measurement model. As a the measurement model a metallic board were arranged above and below the tire, and the complex impedance was measured. Pieces of styrene foam of different thickness were placed between the upper surface of the tire and metallic plate. The measurement frequency was from 10 kHz to 10 MHz.