Transportation Consortium of South Central States

Smart Charging of Future Electric Vehicles Using Roadway Infrastructure

Key Points

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$65,000

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Tran-SET
University of Texas at San Antonio
University of New Mexico

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$130,000

Brief Project Description

Inspired by the great amount of renewable energy sources available on the roadways such as mechanical pressure and frictional heat, and aiming to tackle today's challenges caused by the limited battery capacity of modern electric and self-driving cars, this research project will explore, develop and implement innovative smart charging techniques for vehicles of the future (electric and self-driving cars) – namely, **smart and illuminative charging (SIC)** – by integrating existing roadways, state-of-the-art nanomaterials and power electronics technologies to create a smart, sustainable transportation infrastructure.

Problem Statement

Due to increasingly large demands for reduced driver stress, independent mobility for non-drivers, and increased safety and in-vehicle infotainment, further research is needed on the development of novel roadways that can adapt for future vehicles (e.g., electric or self-driving cars). For example, electric vehicles (EVs) are promoted as a key contributor to building this new sustainable mobility system as they are generally more energy-efficient than those powered by fossil fuels. Increasing the use of EVs can result in considerably lower emissions of carbon dioxide and other air pollutants. However, additional electricity has been required to charge EV batteries, partially offsetting their benefits due to additional emissions that result from increased electricity production.

Future vehicles may need to be equipped with large-capacity batteries to operate for a satisfactory distance. Lithium-ion batteries, which are the most commonly used in today's EVs, can only operate for about a 300 mile range until they need to be recharged. In addition, contemporary battery technologies have shortcomings of long charging time, large size and weight, limited life time and relatively high cost.

Objectives

The objective of this study is to develop innovative charging techniques for EVs – namely, **smart and illuminative charging (SIC)** - by using renewable energy sources available on roadways such as mechanical pressure and frictional heat. The study will achieve this objective by:

- Implementing a novel wireless charging power system where: (a) nanomaterials-powered light-emitting diodes (LEDs) as the energy transmitter, are embedded under a transparent polymer modified nanocomposite (TPMN) overlay, which is reinforced with fiber reinforced polymer (FRP) strips, and (b) thin-film photovoltaic (PV) solar panels as the energy receiver, are placed under each vehicle.
- Developing an energy harvesting technique to complement a vehicle's battery recharging system by exploiting piezoelectric and thermoelectric properties of nanomaterials embedded in vehicle tires.

Intended Implementation of Research

Education and Workforce Development

The research activities will provide participating researchers (one PhD student and post-doctoral researcher) with hands-on experience in laboratory testing and analysis of energy harvesting mechanisms. The findings will be incorporated into a graduate level course on electric vehicles as a separate module on energy harvestings techniques. Furthermore, a researcher exchange program will be established between the two involved institutions, where the participating researcher will spend time at the external collaborative institution.

Outreach

This study will arrange one field trip for undergraduate and high school students to visit the involved laboratories (at both institutions). These field trips will be provide a hands-on demonstration of the energy harvesting materials, and the proof-of-concept module for the SIC. The research team will also be involved in the University of New Mexico Summer Transportation Institute – introducing integrated civil and electrical engineering concepts on future roads/infrastructure to students through a series of hands-on activities. In addition, seminars and webinars explaining the concept and project results will be offered to DOTs, cities, utilities and industry.

Anticipated Impacts/Benefits of Implementation

Results of the proposed study will: (1) deliver a novel wireless charging power system and (2) deliver an energy harvesting technique to further complement a vehicle's battery recharging system. More generally, it will lead to:

- Adapting the existing transportation infrastructure for the introduction of electric and self-driving vehicles.
- Reducing the carbon dioxide and the air pollutant emissions from the road transport sector.
- Decreasing the dependence on fuel by using permanent, renewable energy sources, thus having a major impact in case of the gas shortage due to extreme weather events (for example, hurricanes).
- Promoting engineering education and training (including Hispanic minority students) through the proposed research and technology implementation.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/research-in-progress/)
- TRB's in Progress (RIP) database (https://rip.trb.org/View/1505462)