Project Summary

Texas Department of Transportation

0-5536: Application of RF Tags in Highway Reference Markers

Background

Radio Frequency Identification (RFID) is a newly developed technology which is widely used in product tracking, transportation payment, animal tracking, and inventory systems. It uses electromagnetic fields to accomplish long-range, low-data-rate wireless communication. Especially in a wireless sensor application area which normally requires low-data-rate and low-power-consumption communication, passive RFID is a good candidate for application due to its low cost and low maintenance fee, and no need to change batteries. A passive RFID system can also be applied in a highway reference marker locating area.

Reference markers are signs denoting mileage location information from the beginning of a highway to a specific place on that highway. They are easily displaced by construction workers during highway maintenance. The Texas Department of Transportation (TxDOT) faces difficulties in restoring reference markers to their original locations. Research was needed to develop a low-cost and long-life-span system which could efficiently monitor huge numbers of markers along Texas highways.

What the Researchers Did

Researchers developed a Highway Reference Markers Locating System based on passive long-range RFID technology that can be helpful in overcoming these difficulties.

The whole system consists of hardware and software including a reader mounted on a vehicle and tags mounted on reference markers. The reader can transmit a microwave signal continuously and illuminate the tags on the marker side. Then the tags powered up by the reader will reflect back signals which have been modulated with the markers' information.

Each tag uses the most advanced passive RFID chips, ATA5590, with a properly designed reader and tag antennas. The reading range can reach up to 45 feet.

The software system is mainly in charge of collecting data in real time and analyzing data afterwards. It can collect RFID data and GPS/DMI data simultaneously in high-speed conditions.

Research Performed by:

University of Houston (UH)

Research Supervisor:
Richard Liu, UH

Researcher:
Yu Cai, UH

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What They Found

The field test was conducted on Loop 1, in Austin, Texas. The basic principle of the test was like playing a hide-and-seek game. The object of this test was to find the reading rate under different driving speeds and to determine location resolutions. Moreover, the reading range was also tested. Tags were mounted along the highway and their location saved in a database without letting testers know in advance. The van mounted with the reader system drove along Loop 1 and the driver listened to a beeping sound from the transceiver to check if there was a tag nearby in real time. While the beeper made the beeping sound, the system collected the RFID/GPS/DMI data simultaneously and compared them to get the precise location of the tag. The tag information in the field test normally includes the series number of the tag.

Researchers found that the reading rate could normally reach up to 100% with a driving speed up to 55 m.p.h. The locating resolution is a function of the driving speed, timer resolution, GPS resolution, and DMI resolution together. For specific cases the location resolution could be up to 0.8 feet. The tags could be located up to 45 feet away from the edge of the road and still be detected by the reader.

What This Means

In this project, researchers used passive RFID technology to implement a reference marker locating system. This technology makes it possible to monitor huge amounts of highway reference markers on long Texas highway systems efficiently with low maintenance fees. The cost of each passive tag is less than 2 dollars, and the life span of a passive tag can be up to 10 years.

In order to get a longer reading range, a semi-active RFID system can also be used to locate reference markers in the future. Currently on the market the longest reading range of this kind of semi-active system can be up to 100 meters with a 3- to 5-year life span.

RFID tags can potentially be implemented in the next-generation reference marker locating system. This will allow the automatic location of reference markers and could enhance the pavement data collection systems.

For More Information:
Research Engineer - German Claros, TxDOT, 512-465-7403
Project Director - Phillip Hempel, TxDOT, 512-465-3650
Research Supervisor - Richard Liu, UH, 713-743-4421

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Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080
512-465-7403