Research Article Impact Factor: 4.226 ISSN: 2319-507X
Vasu MD, IJPRET, 2014; Volume 3 (3): 85-92 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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NEW APPROACH TO RFID ASSISTED NAVIGATION SYSTEMS FOR VANETS

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Accepted Date: 24/10/2014; Published Date: 01/11/2014

Abstract: With technological advancement, recent VANET applications such as safe driving and emergency rescue often demand high position accuracy. Unfortunately, however, conventional localization systems, e.g., GPS, hardly meet new accuracy requirements. To overcome this limitation, this paper proposes an RFID-assisted localization system. The proposed system employs the DGPS concept to improve GPS accuracy. A vehicle obtains two different position data: GPS coordinate from its own GPS receiver and accurate physical position via RFID communication. Then, it computes GPS error and shares it with neighbors to help them correct inaccurate GPS coordinates. To evaluate the proposed system, we conduct extensive experiments both on a simulator and on a real world test-bed.

Keywords: RFID, Microcontroller and GPS

PAPER-QR CODE

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Access Online On:

www.ijpret.com

How to Cite This Article:

Vasu MD, Venkatesh K; IJPRET, 2014; Volume 3 (3): 85-92

INTRODUCTION

In Vehicular Ad hoc Networks (VANETs), vehicles exchange data with each other or with a roadside infrastructure in order to use various applications from Internet access to safety applications. The VANET applications often assume that vehicles' real-time position is provided. This is reasonable because GPS receivers have become popular in vehicles today. For instance, navigation applications make use of GPS data for finding their location. However, critical applications that support safe driving require more accurate position information so that advanced localization techniques have been proposed to support them.

In wireless networks, signal propagation properties, e.g., Received Signal Strength Indicator (RSSI) or Time of Arrival (ToA), have been exploited for localization. Cellular localization uses propagation delay of the signals from transmission towers to calculate the ‘‘absolute’’ position. However, due to distortion and interference, a wireless channel is too unstable to guarantee consistent and accurate position. Among existing schemes, Differential GPS (DGPS) improves position accuracy to the level of tens of centimeters in the best case. In road environment, however, its accuracy degrades steeply as a vehicle goes far away from a reference point.

In order to provide accurate position in VANET, this paper proposes a novel localization system assisted by Radio- Frequency Identification (RFID). The main inspiration of our design is the notion of DGPS to improve GPS accuracy. A GPS vehicle, a vehicle equipped with a GPS system, obtains exact position data from an RFID tag on a roadside unit using an RFID reader while driving. Then, it broadcasts the calculated GPS error value to neighbour vehicles via IEEE 802.11 radio. A non-GPS vehicle, which does not have a GPS system, computes its position using our single peer localization scheme.

When the non-GPS vehicle encounters a vehicle having accurate position data, they exchange position and travel information via RFID and 802.11 radios, respectively.

At the end of this process, the non-GPS vehicle can estimate its accurate position from the received data.

Our primary contribution is the design of a novel accurate localization system that does not use signal strength or propagation properties. Moreover, a non-GPS vehicle is able to estimate its own accurate position from a neighbour vehicle. To prove feasibility, we investigate the various parameters of the RFID technology and analyse their impact on accurate positioning in VANET.

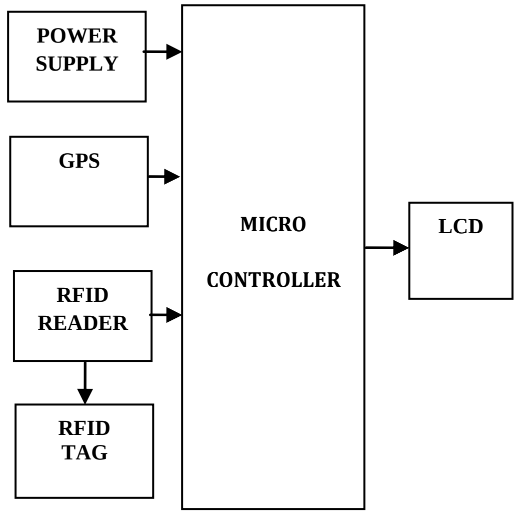

Fig 1: Block diagram for proposed method

Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

ARM7TDMI: ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs.

Liquid-crystal display (**LCD**)**:** is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

GPS: The Global Positioning System (GPS) is a satellite based navigation system that sends and receives radio signals. A GPS receiver acquires these signals and provides the user with information. Using GPS technology, one can determine location, velocity and time, 24 hours a day, in any weather conditions anywhere in the world for free.

GPS was formally known as the NAVSTAR (Navigation Satellite Timing and Ranging). Global Positioning System was originally developed for military. Because of its popular navigation capabilities and because GPS technology can be accessed using small, inexpensive equipment, the government made the system available for civilian use. The USA owns GPS technology and the Department of Defence (DOD) maintains it.

Fig 2: A GPS Satellite

GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time. Four GPS satellite signals are used to compute positions in three dimensions and the time offset in the receiver clock.

1. The architectural components of GPS are typically referred to as the control segment (ground stations), the space segment (satellites) and the user segment (receivers). The goal of the Global Positioning System (GPS) is to determine the position of a person or any object on Earth in three dimensions: east-west, north-south and vertical (longitude, latitude and altitude). Signals from three overhead satellites provide this information. Each satellite sends a signal that codes where the satellite is and the time of emission of the signal. The receiver clock times the reception of each signal, then subtracts the emission time to determine the time lapse and hence how far the signal has traveled (at the speed of light).

The accuracy of GPS depends on a number of factors, number of channels on the receiver, number of satellites in view, and signal interference caused by buildings, mountains and ionosphere disturbances. Accuracy should be within 15 meters (without SA) provided the receiver has a clear shot at a minimum of four satellites.

There are several methods that can improve GPS accuracy. Two commonly discussed are Differential GPS (DGPS) and Wide Area Augmentations System (WAAS). These improve accuracy to within 1 to 3 meters. DGPS uses fixed, mounted GPS receivers to calculate the difference between their actual known position and the calculated GPS position. This difference is then broadcast over a local FM signal. GPS units within range of the local FM signal can improve their position accuracy to within 1cm over short distances (but more typically 3-5 meters).

RFID: Radio frequency identification (RFID) is a general term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object wirelessly using radio waves. RFID technologies are grouped under the more generic Automatic Identification (Auto ID) technologies.

In recent years, radio frequency identification technology has moved from obscurity into mainstream applications that help speed the handling of manufactured goods and materials. RFID enables identification from a distance and unlike earlier bar-code technology; it does so without requiring a line of sight. RFID tags support a larger set of unique IDs than bar codes and can incorporate additional data such as manufacturer, product type and even measure environmental factors such as temperature. Furthermore, RFID systems can discern many different tags located in the same general area without human assistance.

Many types of RFID exist, but at the highest level, we can divide RFID devices into two classes:

Active and **passive**.

Fig 3: Types of Tags

Active tags require a power source i.e., they are either connected to a powered infrastructure or use energy stored in an integrated battery. In the latter case, a tag's lifetime is limited by the stored energy, balanced against the number of read operations the device must undergo. However, batteries make the cost, size, and lifetime of active tags impractical for the retail trade.

Passive RFID is of interest because the tags don't require batteries or maintenance. The tags also have an indefinite operational life and are small enough to fit into a practical adhesive label. A passive tag consists of three parts: an antenna, a semiconductor chip attached to the antenna and some form of encapsulation. The tag reader is responsible for powering and communicating with a tag. The tag antenna captures energy and transfers the tag's ID (the tag's chip coordinates this process). The encapsulation maintains the tag's integrity and protects the antenna and chip from environmental conditions or reagents.

RF (Radio Frequency) communication occurs by the transference of data over electromagnetic waves. By generating a specific electromagnetic wave at the source, its effect can be noticed at the receiver far from the source, which then identifies it and thus the information.

In an RFID system, the RFID tag which contains the tagged data of the object generates a signal containing the respective information which is read by the RFID reader, which then may pass this information to a processor for processing the obtained information for that particular application.

Thus, an RFID System can be visualized as the sum of the following three components:

1. RFID tag or transponder
2. RFID reader or transceiver
3. Data processing subsystem

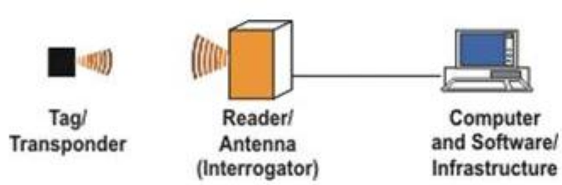

Fig 4: Architecture of RFID system

An RFID tag is composed of an antenna, a wireless transducer and an encapsulating material. These tags can be either active or passive. While the active tags have on-chip power, passive tags use the power induced by the magnetic field of the RFID reader. Thus passive tags are cheaper but with lower range (<10mts) and more sensitive to regulatory and environmental constraints, as compared to active tags.

An RFID reader consists of an antenna, transceiver and decoder, which sends periodic signals to inquire about any tag in vicinity. On receiving any signal from a tag it passes on that information to the data processor. The data processing subsystem provides the means of processing and storing the data.

Much like tuning in to the favourite radio station, RFID tags and readers must be tuned into the same frequency to enable communications. RFID systems can use a variety of frequencies to communicate, but because radio waves work and act differently at different frequencies, a frequency for a specific RFID system is often dependant on its application. High frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer transmission ranges of more than 90 feet, although wavelengths in the 2.4 GHz range are absorbed by water, which includes the human body and therefore has limitations.

Two fundamentally different RFID design approaches exist for transferring power from the reader to the tag: magnetic

induction and electromagnetic (EM) wave capture. These two designs take advantage of the EM properties associated with an RF antenna—the *near field* and the *far field*. Both can transfer enough power to a remote tag to sustain its

Operation—typically between 10W and 1 mW, depending on the tag type.

CONCLUSION

Hence a new localization system in VANETs, RF-GPS, which exploits a RFID system. It develops the mobile version of the DGPS system. RF-GPS calibrates GPS error and thus allows a vehicle to compute its accurate position. Moreover, a vehicle, which does not have a GPS receiver or cannot use the receiver temporarily, is also able to estimate its accurate position with the single peer localization scheme. The proposed RFID-assisted localization system has been evaluated extensively via simulations and real world experiments. The test-bed experiments focused more on the feasibility of the RFID system on a vehicular environment. The simulations and the real world experiments together show feasibility and performance of the proposed RF-GPS system.

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