Developing a Tracking System
using
Mobile Devices with GPS

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Motivation

Traffic and transportation system on roads get more and more complex every day. Although there are equipments and instruments providing extensively detailed information regarding environment to operators of air and naval transportation vehicles, land transportation vehicles lack of such systems. Our purpose is to develop a mobile ad-hoc networking system with GPS which will promote information sharing between vehicles and inform drivers about environment.

Project Description

The proposed system consists of a GPS device, a wireless TX/RX device and a control-interface providing device. The system may have many applications regarding any group of vehicles such as vehicle fleet of a courier company, public transportation vehicles and privately owned cars in traffic. Also it is intended that the proposed system become a default system in vehicles. We provide a broad set of application examples below regarding possible uses.

Currently drivers are informed by traffic signs, police officers and other signs placed at the sideways of the road. However, main limitation in the current traffic system is that the drivers are aware of only what they see. Aim of our proposed system is enhancing information sharing between vehicles in traffic. Information sharing may be in terms of data packets hopping over transmitters and receivers placed in each car. When there is no receiver in the range of a transmitter, other options such as using GSM network may be considered.
To summarize, the aid system consists of three elements; a GPS system, a communication system, and a graphical interface device. GPS system will provide location data; communication system will receive and transmit data between the vehicles (for now no main server is considered, so only vehicles will communicate with each other using an ad hoc network), and the graphical interface will be bridge between the data and the user.

Possible Uses

Self Awareness

In this system, drivers can be notified of status of themselves and other vehicles in proximity (e.g. speed, position, and heading, also their current path if they had set) including types of vehicles (e.g. ambulance, fire truck, police car). This gives drivers a chance to get information as early as possible and act accordingly. For instance, drivers may be notified of an ambulance approaching to them and leave emergency lane for a safe passage of the ambulance.

Commercial Use

Information exchange is not necessarily only between vehicles. There may be other transmitter devices at road side which broadcast information that may be valuable to drivers. For instance, many shopping centers provide number of available parking lots on screens placed at the entrance of car parks. In addition to these screens, wireless transmitters may be placed which will send information of available parking lots. This information may travel from car to car, notifying drivers in other vehicles as well. This system may be applied to car parks in city centers or university campuses at the beginning. As a result, drivers will spot the nearest car park available to them. Other information that can be shared in a similar manner may be coordinates of the nearest gas station or the nearest hospital etc.
Road Information

Road signs maybe equipped with wireless transmitters. One particular use may be regarding speed limit so drivers can learn current speed limit from the screen in vehicles. One particular benefit of using this system is that it enables dynamic changes in speed limit according to traffic density or weather conditions. Similarly, there will be roadside mobile transmitters for other uses. Due to an accident, or a natural disaster roads can be closed; partly or to full extent. In this case, officials will put a transmitter to the site and it will inform the incoming traffic to reduce their speeds or even to change their course.

Accident

Another use may be regarding traffic accidents. Modern automobiles are equipped with sensors which detect collision and trigger safety systems such as airbags. Our proposed system may be integrated with these systems so when an accident occurs it may be reported to a central server via GSM network with coordinates of accident site. This may improve the response time of police, fire station and hospitals to traffic accidents.

Optimization of Traffic Lights

If the proposed system is installed in every vehicle, traffic lights will have information about incoming traffic. Thus, instead of the fixed time lights, the duration of the traffic lights will be adaptive. As an example, in a two sided traffic light system, if there is a heavy traffic flow in one direction and the other side has relatively less dense traffic, the lights will be adjusted to overcome this situation. One side will receive more red lights and similarly duration of the green light will be more at the other side.

Path Optimization

Today’s commercial GPS devices can find the shortest path between two points in the city. But shortest path do not guarantee the fastest solution due to traffic density. The proposed system also will consider the paths according to traffic density together
with the distance. So, optimal course providing fastest travel between two points can be found.

Public Transportation

The proposed system may be adapted to public transportation in cities as well. For instance, each bus may send its coordinates and number of passengers inside to a central server. This information may be transferred to screens placed on central bus stations so the waiting passengers would be able to know the location of the next bus. The number of passengers in buses with respect to time can be logged and examined to determine whether transportation infrastructure is adequate to satisfy the demand. In addition to this, courier firms can use this system to keep track of their fleet and plan deliveries according to status of vehicles.

Literature Review

A wireless ad hoc network is a decentralized wireless network. Because there are no routers like in wired networks or access like in managed networks it is called ad hoc. Each node participates in routing by forwarding data for other nodes, and by this approach the determination of which nodes transmit/forward data is decided dynamically.

A mobile ad hoc network (MANET), is a self-configuring network of mobile devices connected by wireless links. Each device is free to move in any direction, changing its links to other devices frequently. Each must forward traffic unrelated to its own use.

Vehicular ad hoc networks are MANET’s that provide communication between nearby vehicles and equipment. Special electronic devices are placed in vehicles that operate in a network with no infrastructure or client-server communication. By establishing such networks, drivers and passengers can be informed about accidents, collision warnings, road sign alarms etc.

Some of the most famous algorithms applied to MANET’s are the ”Dominant Set Based Clustering” algorithms, where you have a subset, i.e. the ”Dominant Set”, of vertices belonging to a graph (in this case
the ad hoc network) and every node in the graph is necessarily adjacent to one of the nodes in that particular set. These algorithms can be used to establish connectivity between nodes and have many advantages in network applications like easing broadcasting and constructing virtual backbones. One recent new algorithm was developed by Deniz Cokuluslu, Kayhan Erciyes and Orhan Dagdeviren[1]. In their article describing the algorithm they devised, it is possible to find explanations and references to a few other too.

Different algorithms are used to achieve different goals, given a mobile ad hoc network. One is the ”Mutual Exclusion Algorithm”[2] that solves the problem where there is a set of processes that need access to some shared resource or piece of code (called critical section) but only one process can be in critical section at any point of time. There is another algorithm called the ”Leader Election Algorithm”. This algorithm involves a consensus on a single distinguished node as a leader for carrying out special duties. This concept has a variety of applications like key distribution, routing coordination, sensor coordination and other tasks. The election may be based on some criteria like battery power or minimum average distance to the other nodes etc. or it may be based done randomly.

**Situation of The Market for the Project**

GPS-based systems are widely used in many countries, responding solutions to many problems in different areas. Apart from the USA’s Global Positioning System (GPS); European Union’s Galileo Positioning System, Russia’s GLONASS and China’s Compass Navigation System are in use as alternatives and complementary to each other. Currently existing GPS-based systems to solve daily life problems make use of one of these global satellite systems.

Investigating the traffic control and information systems with GPS in USA, one can come across many patents regarding the issue. An example[3] is a traffic control unit is included to collect data from plural vehicles (primarily the speed and the heading of the vehicle) and to analyze traffic patterns to control metering lights and speed limits. The invention also has functions like trip planning.

News from Australia states that all GPS vendors united under the umbrella of SUNA to manage traffic mainly in Sydney and Brisbane.
Making use of GPS devices on vehicles, which are broadly used in the country, traffic information is broadcasted to drivers using the Radio Data Service protocol which silently encodes the SUNA Traffic Channel information on an existing FM broadcast service, it is then received by a navigation system and used to identify and, if possible, avoid the traffic. The system also includes translation of information messages about incidents and road works so that drivers could avoid congested roads by collecting raw traffic flow data from a loop sensor network embedded in the road pavement near intersections[4].

SATEL[5], which is an international company having distributors also in Turkey, provides GPS-based applications such as radio modem solutions that enable traffic control, interactive traffic signs and vehicle tracking and positioning; transfer of up-to-date information between/to cars about free parking lots in an area and real-time weather updates and warnings etc; public transportation solutions by informing passengers waiting at bus-stops, metro stations etc about the expected arrival time etc of the vehicle; and lifesaving applications that will make it easy to rescue lives in case of accidents.

Tests for speed control systems including automated tolls/charges are being conducted in London, yet discussions continue[6].

Istanbul Metropolitan Municipality announced that they are going to implement GPS tracking systems to control traffic in Istanbul, following the currently used Electronic Supervision System which is based on digital camera recordings.

References