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SAFE DRIVING USING WIRELESS MONITORING UNITS

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Abstract: *This paper presents an intelligent solution for wireless monitoring of trailers. The system is using vehicular units that communicate through a wireless communication network with a central gateway. The final user can use a software application that offers real-time information about the monitored vehicles in order to communicate with the trailers and send them various commands.*
Key words: *wireless units, semi-autonomous robots, sensors, safe-driving*

1. INTRODUCTION

The system target is to connect all trailers of a company in order to have a better management of their delivers. The necessity of such a system is driven by reasons like meeting timetables for delivering products, have a real-time overview of the location of all vehicles equipped with such a system. (Cui & Ge, 2003) Our experimental model consists of a number of ten trailers equipped with SafeMobile units. These trailers have to be delivered in five different locations from our country.

The principle goal of our project is to create semi-autonomous robots that can deliver the products on a large roadmap with small human interaction from a central command center. The purpose of this paper is to create the software framework for such a system and make simulations.

The wireless monitoring system can control and monitor the mobile assets from a command center through a software application called SafeDispatch that is part of the SafeMobile's Asset Management System line of business products. (Mahmood, 2006) With SafeDispatch the human user can obtain real-time information about the monitored vehicles, such as location, driver tracking information, performed routes vs. planned routes and a lot of information from the sensors connected to the unit – radiation detectors, smoke detectors, gas detectors, anthrax detectors, temperature detectors, pressure sensors, temperature sensors, proximity sensors and video images from the video-camera installed on the unit.

2. SYSTEM ARCHITECTURE

Each vehicle is equipped with a SafeMobile unit. All the sensors are connected and available to send their data. The units can receive commands from command center and can communicate with the command center sending their status information.

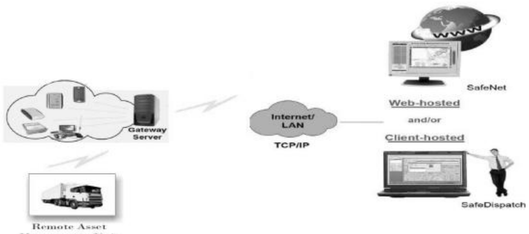

Fig. 1. SafeMobile Architecture

Fig. 2. Open Enterprise AVL Unit

SafeMobile Asset Management System (Fig. 1) consists of three main components: the Remote Unit, the Communication Platform and the Software Application (SafeNet/ SafeDispatch). The Remote Units are available for transmission over a variety of wireless network.

2.1 Remote Unit

For our experiment we have chosen Open Enterprise AVL solution – the most complete information management solution tat offers a very robust platform for any type of vehicle location and sensors.

The unit allows connecting the largest variety of sensors. Sensors can be connected to all the other units that have at least one RS232/analog/digital input. The technical specifications for Open Enterprise AVL (Fig. 2) are:

- Computing platform – Intel ARM9 PXA270
- OS/Software framework – Windows: CE, XP Embedded or Linux: Debian
- Digital signal processing – Freescale 56F83xx
- Interfaces – 2 x External Analogical Inputs, 8 x Digital Inputs, 2 x Digital Outputs, CAN Interfacing, 2 x RS232, 2 x USB, Ethernet 100 MB
- Location technology – 16 channels/SiRF-III GPS

The communication platform can be: Cellular GSM, Cellular eDEN, WiFi, TETRA, Ethernet, Bluetooth.

2.2 Sensor Network

Open Enterprise AVL can be connected to any type of sensor if the sensor has an analog/digital/RS232 output. For RS232 output, the unit is performing an internal unpacking of the data. For digital output the threshold voltage is 7V. For analogical output the value is read from the pins and converted through a CAN.

The data received from the sensors is packed into a message that is sent to the central gateway through a wireless communication platform. On the Gateway the message is unpacked and then packed in an XML format that is sent to the software application through SSL protocol. In Fig. 3 there are represented different types of sensors that can be connected to the Open Enterprise AVL Unit.

2.3 Communication Platform

The communication platform is represented by the following states:

- The GPS module sends its data to the processor
- The processor collects data sensors and processes them
- All the data are packed and sent through the communication platform to the central Gateway
- The Gateway unpacks the data and loads them in databases

Fig. 3. Sensor network with Open Enterprise AVL Unit

2.4 Gateway Architecture

The Gateway is a software application capable of receiving data from units and unpacked them for loading in the SafeMobile databases. The Gateway has a backup module – if one connection to a Gateway cannot be established, then the backup module is used. When the Gateway is trying to establish a connection to the servers, it selects from a priority list (three of them can be set). (Dobrescu et al., 2008)

Our solution is proposing a distributed star topology for the Gateways (Fig. 4). All the computers in the star topologies are connected to central devices like hub, switch or router.

A star network generally requires more cable than a bus topology, but a failure in a star network will only take down one computer's network access, and not the entire network. On the other hand, if the hub fails, the entire network will also fail. In order to avoid a general crash because of the router's failure, two routers connected in a parallel scheme are used. (Chisalita & Shahmenhri, 2002)

3. SOFTWARE APPLICATION

The final user is monitoring all the SafeMobile units with a software application called SafeDispatch/SafeNet. SafeNet is SafeMobile's web-hosted application which allows users to access their fleet via an Internet connection. Some of the features offered by SafeNet are: excessive speed monitoring, event recording, historical position reports, vehicle poling, alarms. SafeNet is using Oracle Application Server Grid.

SafeDispatch is SafeMobile's client hosted application; it provides a rich graphical user interface to the dispatch and automatically plots units' positions using Microsoft MapPoint. The major features for SafeDispatch are: creating tabs to track vehicles, checking the speed vehicle and monitoring different routes that the vehicle performs; information about routes performed vs. routes planned; driver tracking information; map interactive features such as driver directions based on vehicle current location, finding nearby vehicles and place of interest

SafeDispatch allows tracking units through different tracking tabs; live tab displays real-time information about the mobile assets; history tabs show history information on selected units. SafeDispatch has a module alarm that is activated by an extern event sent by the unit. Units can generate events such as: changing the state for an analogical input (opened/closed door, panic button on/off), passing a threshold speed. The available reports in SafeDispatch are: Speeding Report, End of Day Report, Stops/Stops with Engine on, Fleet Report and Geo-fencing Report.

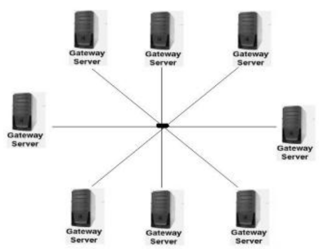

Fig. 4. Gateway Achitecture

4. EXPERIMENTAL RESULTS

Our experiments were made inside of a laboratory where we create a small roadmap. We used ten cars equipped with SafeMobile units. The cars could be turned on/off manually and they are using batteries as supply power. (Huang, 2006)

From the command center we send messages to the SafeMobile units containing the map created on the laboratory and the planned route. The component en charge with moving the car is collecting the information sent through the wireless network, unpacked them in a more appropriate format for a machine and then execute them.

We test a part of the sensors in order to see the car's behavior in an emergency situation. We put a small burning candle inside the car. The behavior was the expected one: the car stops and sends an alarm signal to the command center.

The major problems that we noticed are related to crossing streets. Every car has his own command component that is not communicating with the other command components of the others cars. The car is able to stop at the crossing streets but it's not able to let other car to pass if the driving rules impose it. The both cars stop with engine on in such a situation. As future work we are planning to enlarge the cars capabilities of taking decisions at crossing streets. At this moment when the cars cannot make a decision an alarm signal is sent to the command center and the human user is taking that decision and passing it to the cars.

Another problem of our system is the reduced life-time of the supply batteries. We have to change them very often.

5. FUTURE WORK

As future work we are going to implement the following features for our system:

- Improve taking decisions algorithm especially for the crossing streets
- Add traffic roundabout capabilities
- Use the video camera as image recognition system for driving indicators and semaphores

The next experiment for our system will consist in a real car equipped with SafeMobile unit and the decisions component. We will make a roadmap with our university campus and let the car running on this map.

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