A vehicle Diagnosis and Control System via Mobile Network

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Abstract - The advance of mobile and telematics technologies has produced vehicles with various convenient services for drivers. Specifically lots of researches and several technologies have been developed to provide services of a remote vehicle diagnosis and control. The existing and representative product for a vehicle control is a RCS (remote control system), but it has a problem of short control distance and fragile security. In this paper, a telematics terminal embedded with CDMA and GPS is designed, which can be connected to the Internet. It allows a driver with a cellular phone to remotely diagnosis and control a vehicle via wireless network and SMS.

Keywords: Telematics, Embedded System, Mobile Platform, Mobile Network, SMS.

1 Introduction

Telematics, which is a compound word of a telecommunication and informatics, provides drivers with useful driving information such as driving path guidance, accident or robbery detection, traffic conditions and other valuable data at real time. As the number of vehicles on the road has steadily risen during the last 10 years, the traffic accidents, the congestion, and road damage have also increased dramatically. Telematics is a main force at the IT filed oncoming generation. A government makes a selection 9 product of IT839 strategy and tries to encourage industry. Telematics are considered as a promising way of reducing these kinds of problems. Recently, good-quality contents and cheap terminals with good performance and communication capability are required to offer various network services.

In this paper, a target board of the telematics is designed, embedded with a CDMA mobile communication modem and GPS module based on embedded linux. In addition to, a methodology is proposed and implements to confirm a vehicle status communication with a telematics server linked internet and terminal at a vehicle using a cellular phone at local area and control using SMS (Short Message Service). In order to do, we use a mobile terminal platform SK-VM based on JAVA.

This paper consists of the followings: Section 2 introduces a vehicle control methods for the telematics services and terminal platforms are in used at the cellular phone. Section 3 introduces system organize and operation that is a vehicle diagnosis and control for the telematics system. The simulation environment and the experimental results are analyzed in section 4. Finally, the conclusions are made in section 5.

2 Vehicle control method for the telematics services

Vehicle control method for the telematics services

The present vehicle control techniques through the telematics services in a distance are divided into voice recognition, DTMF (Dual Tone Multi Frequency) signal, and RCS (Remote Control System). Voice recognition technique has problems with noise generation, which can lead to variation between sent and received commands, among other problems[1][2][3]. The DTMF signal method, with a key pressed on the phone, generates and transmits a different frequency for each symbol. Its problems are following; hardware circuit for separating frequencies becomes complex and the precision and stability of the

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tone frequency is determined by the oscillator and it is significantly affected by supply voltage, time and the environmental temperature[4]. The most prevalent product for a vehicle control system is currently RCS (remote control system), but it is hampered by short range and fragile security[5].

2.1 Terminal Platform for Cellular Phone

Terminal platforms for the better telematics services used in the cellular phones, are divided into WAP, BREW, and SK-VM. WAP (Wireless Application Protocol) service is designed as a protocol to extend internet services in the cellular phone, handy beeper and PDA. It cannot access HTTP directly, but rather go to connect to HTTP through a WAP gateway. Therefore, there is an increase in the cost of services and security weakness because of possibility to observe the information of users from the WAP Gateway[7][8]. The BREW is a wireless internet terminal platform developed by Qualcomm and used commercially by KTF, Korea at first in the world. It is a set of solutions which is needed to provide BREW services. It offers various multimedia API for multimedia functions, but it is subject to royalty payments to the developer and locks the user into BREW's software and platform[9]. SK-VM has developed a Clean Room configuration from J2ME, which provides an environment for the execution of a Java program on a cellular phone. In addition, it supports API of the OEM-Specific Class defined by SKT, Korea, so it is possible to provide services using sound, vibration, calling, and SMS (Short Message Service) functions of the API[10]. The system proposed in this paper is implemented based on the SK-VM platform.

This paper proposes and implements how to build a telematics terminal equipped with CDMA and GPS running embedded Linux, to check a vehicle's state through communication between telematics server and vehicle terminals using a cellular phone and to control a vehicle using SMS as shown in Figure 1. In order to do this, we use the SK-VM platform which is mobile terminal platform based on JAVA to design, implement and evaluate it.

3 A Vehicle Diagnosis and Control System

3.1 System Organization

The proposed system is divided into diagnosis and control systems. The diagnosis system is for confirming the status and location of vehicle using cellular phone, which is implemented based on the SK-VM. SK-VM provides an environment for the execution of a Java program on a cellular phone. In addition, it supports API of the OEM-Specific Class defined by SKT, so it is possible to provide services using sound, vibration, calling, and SMS (Short Message Service) functions of the API[10]. The control system, using an embedded CDMA modem in telematics terminal, is designed to use SMS to control the vehicle. SMS is a point to point services, is defined for digital cellular communication system to transmit a character string each cellular phone by European Telecommunication Standard Institute.

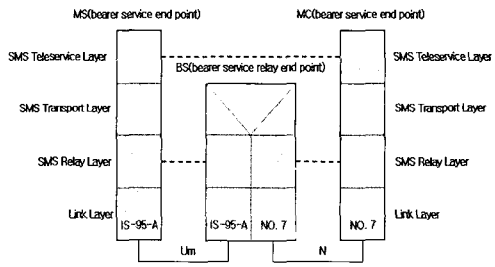


Figure 1. SMS protocol stack

SMS has abilities data transmission of its own. It provides variable services like a telemetring, remote control, emergency disaster broadcasting, emergency call, and short advertisement. In the case of SMS, it is safe with a high transmission rate and highly secure by using point to point communication unlike LAN. Furthermore, as the reception rate is over 99%, it can be widely used, irregardless of service providers[8].

The components of the vehicle diagnosis and control system consist of a cellular phone, a server for the telematics services, and an in-vehicle terminal as shown in Figure 2.

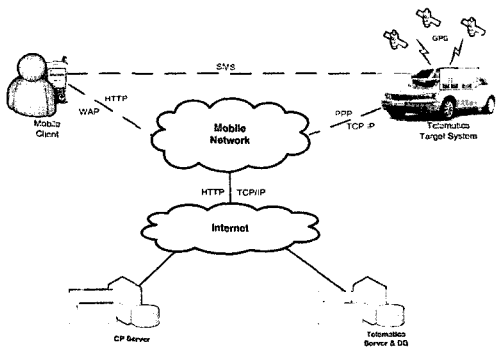


Figure 2. System Block Diagram

A cellular phone has designed considerable user interface, and built a menu vehicle diagnosis, control, location, and authentication. It can connect to the telematics server and receive the status and location data of the vehicle via HTTP and displays this information to the user. On the other hand, the SMS code is transmitted to the in-vehicle terminal to control it. As shown Figure 3.

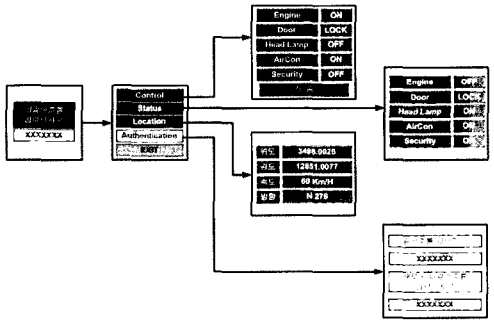


Figure 3. Vehicle diagnosis and control menu for Cellular phone

The communication protocol and the message transmission specification are required for the server system to monitor and control the client system. The SMS permits only the characters to be transferred within the size of 80 bytes. Therefore, the message should be compact to minimize the amount of transmission and appropriate to monitor the vehicle status exactly. The message transmission specification for the SMS between mobile telecommunication device and telematics terminal is needed to acquire information from the various vehicle sensors, and monitor and control the vehicle status. The head lamp control, the door control and the air conditional control as well as the checkout of the vehicle status are available in the developed system as shown Figure 4.

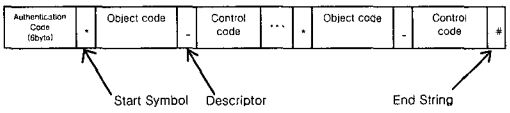


Figure 4. SMS message frame

The proposed specification for the message transmission is shown in the Figure 4. The message is largely divided into the certification code field, object code field and the control code field. The object code should be started with "*" the control code begins and ends with "_" and "#", respectively. The authentication code, the object code, and the control code are defined.

Telematics server implements using Apache web server and My-SQL database and it offers information stored in its database to the user after authorization process when a request from user's cellular phone is received. It also stores or renews the information depending on new data received from the in vehicle terminal as shown Figure 5.

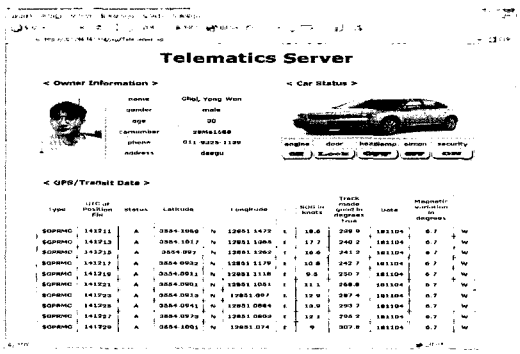


Figure 5. Telematics web server

The in-vehicle terminal should considered variable telematics services like a navigation, video, audio, and multimedia. Therefore, in this paper, it is designed oneself high performance CPU, mass storage memory, big LCD for user interface, GPS for location data, CDMA modem for wireless data communication. It

offers vehicle status and location information via an embedded CDMA network to the telematics server as shown Table 1.

Table 1. Telematics Terminal Spec

LIST	Component
Processor	Intel PXA255
Memory	SDRAM 64M, Flash 32M
GPS	LassenSQ 12ch
CDMA Modem	DTSS-1800
Display	6.4" TFT-LCD
Storage	CF Memory Card
Network	PCMCIA Wireless-LAN
Extension	USB Host & Slave

The Figure 7 shows telematics terminal and its S/W for proposed telematics services. The S/W makes up device driver for CDMA and GPS based on embedded linux. Also It is designed GIU using QT/Embedded.

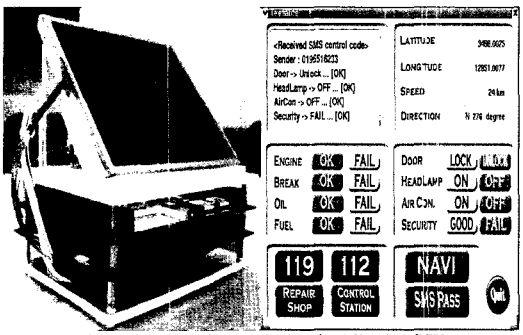


Figure 6. Telematics terminal and application S/W

3.2 Mobile Communication for vehicle diagnosis and control

The proposed system operation is divided into cellular phone and server, server and in-vehicle terminal, cellular phone and in-vehicle terminal. Each operation is shown Figure 7.

- Communication between cellular phone and server
  1. HTTP connection request using URL address on the cellular phone
  2. recent vehicle status and location information query at server
  3. Return stored data in database for query
  4. supply a new information for user using transmitted data

- communication between terminal and server
  1. connection request using CDMA modem, diagnosis S/W check the vehicle status change
  2. Status and location information data transmit to the server currently
  3. renewal database at server

- communication between cellular phone and in-vehicle terminal
  1. SMS control code transmit to the terminal for vehicle control
  2. Received SMS data analysis and device control
  3. connect to the server via CDMA modem, transmit a changed status and location data
  4. renewal database at server

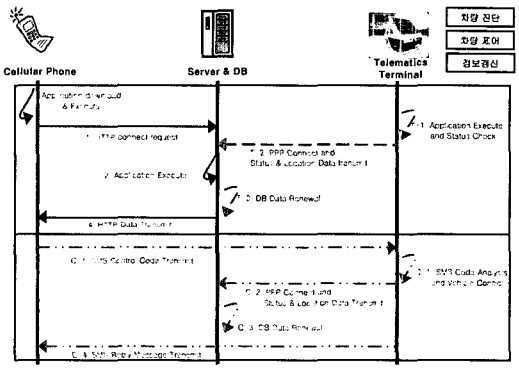


Figure 7. system operation flow

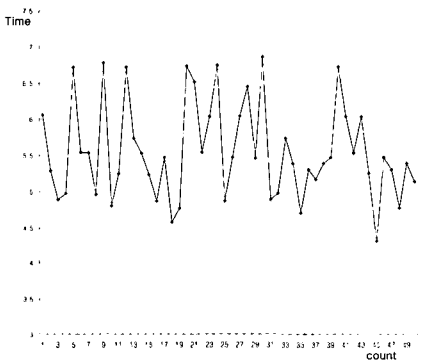
4 Evaluation and result

A telematics service using cellular network has a cost problem while connect a communication link. In order to solve this problem, in this paper adopted method when a communication necessary connected a cellular network. In this case, it is considered that connection time and data transmit rate to the server via cellular network. To confirm a performance proposed vehicle diagnosis and control system via cellular network, evaluation execute and analysis SMS control message transmit time, connection time and data transmit success rate. Environment of evaluation as shown Table 2.

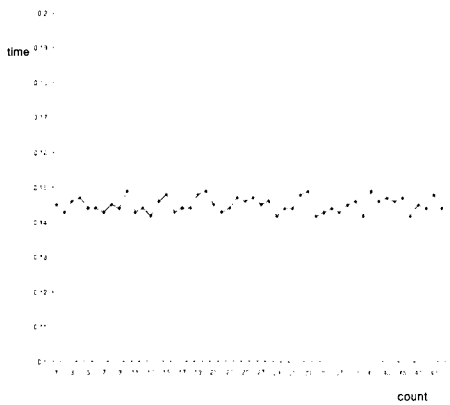
Table 2. Environment of evaluation

Cellular Phone	Samsung SCH-X600(SKT)
CDMA Modem	AnyData DTSS-1800(LGT)
Server	P4-2.4GHz, 512M, 10M Ethernet

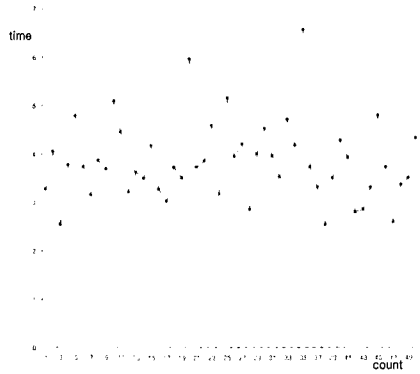
- HTTP connection time measurement at the telematics server via cellular phone
  - Min : 4.3 Sec
  - Max : 6.853 Sec
  - Average : 5.548 Sec
  - Connect success rate : 100%



- 1 packets data receive time
  - Min : 0.142 Sec
  - Max : 0.149 Sec
  - Average : 0.145 Sec
  - Transmit success rate : 100%



- SMS control message transmit time
  - Min : 2.542 Sec
  - Max : 6.56 Sec
  - Average : 3.838 Sec
  - Transmit success rate : 100%



5 Conclusions

In this paper, it is proposed and implemented that a vehicle diagnosis and control method via cellular network. In order to, a mobile platform is used in the cellular phone, a telematics terminal embedded CDMA and GPS and web server is designed for the proposed telematics service model. It has 5.5 second average connection time to the telematics server, 3.8 second average SMS control message transmit time, and 100% reliability message transmit rate. These results are difficult to apply to close to a driver's safety, but are suitable method a simple vehicle control like a door or windows. In the future, the researches that improve the stability and the reliability of the control system will be done and the experiments will be performed on the real vehicles.

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