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Research Article

Development Of Fleet Tracking Systems Using Direct CAN Data

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Abstract

The controller area network (CAN) is a highly integrated system using serial bus and communications protocol to connect intelligent devices for real-time control applications.

Passenger safety, the safety of transported goods and road efficiency of vehicles are important issues for vehicle fleets. Monitoring of these data has an important place in increasing efficiency. Instantly controlling information such as vehicle speed, travel time, tire pressures, and fuel conditions from a single center provides a healthier fleet tracking.

This study aims to provide maximum efficiency for vehicle fleets by transferring the instant data from the vehicles to a center.

The introduced system, which has the capability to transfer instant data such as vehicle's speed, engine's rpm and temperature etc., makes great contributions, especially to the development of the autonomous transportation system. The results show that important vehicle data can be transferred with great accuracy and monitored remotely.

Keywords: CAN(Controller Area Network), Data transfer, Serial Network, CAN-Bus, ECU(Electronic Control Unit)

Doğrudan CAN Verilerini Kullanan Filo Takip Sistemlerinin Geliştirilmesi

Öz

Kontrolör alan ağı (CAN), gerçek zamanlı kontrol uygulamaları için, akıllı cihazları bağlamak için seri veri yolu ve iletişim protokolü kullanan yüksek düzeyde entegre bir sistemdir.

Yolcu güvenliği, taşınan malların güvenliği ve araçların yol verimliliği, araç filoları için önemli konulardır. Bu verilerin izlenmesi verimliliğin artırılmasında önemli bir yere sahiptir. Araç hızı, seyahat süresi, lastik basınçları, yakıt durumu gibi bilgilerin tek merkezden anlık olarak kontrol edilmesi, daha sağlıklı bir filo takibi sağlar.

Bu çalışma ile araçlardan alınan anlık verilerin bir merkeze aktarılarak araç filoları için maksimum verim sağlanması amaçlanmaktadır. Araç hızı, motor devri ve harareti gibi anlık verileri transfer etme özelliğine sahip olan tanıtılan sistem, özellikle otonom ulaşım sisteminin geliştirilmesine büyük katkı sağlıyor. Sonuçlar, önemli araç verilerinin büyük bir doğrulukla aktarılabileceğini ve uzaktan izlenebileceğini gösteriyor.

Anahtar Kelimeler: CAN(Denetleyici Alan Ağı), Veri aktarımı, Seri Veri Yolu, CAN-Bus, ECU(Elektronik Kontrol Ünitesi)

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1. Introduction

CAN (controller area network) is a high-speed, half-return, two-wire system. It is a microprocessor-based system that enables other subsystems of a system to communicate with each other. The first studies on the CAN Bus system were made in 1983 by BOSCH, a German company. The system developed in the first few years proved its efficiency by being tested in automobiles. In the late 1980s, the first CAN control cards started to be produced and in 1991, the Mercedes-Benz W140 was produced as the vehicle with the first CAN communication protocol. The CAN Protocol was adopted as an international standard by ISO in 1993. In 1995, SAE (Society of Automotive Engineers) adopted the CAN Protocol as a standard in diesel engine applications. CAN Bus was used in all of the automobiles produced in the process until other communication systems started to be used. It becomes widespread in a short time since it physically alleviates the hardware load on a system and its success in transmission speed. After its success in the automotive industry, it has also been used in industrial automation systems, medical devices, maritime industry, test equipment and mobile machinery.[1]-[3]

In automotive electronics, systems such as engine control units, sensors, and airbags are controlled via CAN. CAN connection using bitrates up to 1 Mbit/s. High operating speed is especially necessary for safety systems such as vehicle airbags, electronic transmission, driving stability systems (such as ESP), instrument clusters and anti-slip systems.[1]-[2]

The main working principle is that most of the systems in vehicles are transferred to a single central management unit over a serial bus. There may be more than one bus system on the same car.

There are bus systems developed under the needs of the companies, developing technology and innovations. If all systems were to transfer data with separate connection units, this would cause a lot of cable clutter in the vehicle. CAN helps to reduce this density and to communicate systems over a single bus with a double helix cable. Thanks to its high-speed data transmission, it enables many security systems in the vehicle to react instantly. Transmitters on the CAN line can send and receive messages to the system. Real-time operating systems can now be used even with small 8-bit processors. Another aim of this thesis is on the design of such an operating system and embedded system.

The ease of mass production and its compatibility with different uses have led to the widespread use of CAN in the industry. The low cost of production and the fact that it is a durable system with a high guarantee also makes it preferred. It eases the system load, especially in systems where different units work in partnership with each other. At the same time, it is preferred because of its very low error rate and long-term error-free operation. Due to its widespread use, ISO 11898 standards have been determined for the standardized system. ISO contains the first two basic layers of the OSI reference model.

Systems on the vehicle communicate based on addresses. Therefore, it is necessary to reach the addresses of the units first. The addresses of the units are determined by the listening process in vehicles. After this stage, efforts are made to reach these addresses. A direct connection to the CAN line can be achieved by using the necessary equipment. With the circuit to be designed and programmed in the project, instant information has been obtained from the vehicle by accessing the CAN line of a vehicle and the received information has been transferred to a visual panel for the fleet center. Getting visual information about the vehicle will be beneficial in terms of travel safety and efficiency of the fleet.[4]

In this study, CAN data is taken from the vehicle and transferred to a center with the GSM module. The technical details of the study are explained in the second section. hardware features and the way it works are mentioned.

2. Material and Method

OSI (Open System Interconnection) communication model is used in CAN protocol. According to this model, the first two layers, Data Link and Physical layers, are used by CAN, and high-level protocols (HLPs) are used for the other layers. [5]

One of the biggest advantages of CAN, and perhaps the reason why it is so preferred, is that it provides short data transfers with medium bandwidth (up to 1 Mbit/s), high efficiency, and provides asynchronous media access control (CSMA type). Line topology is the most widely used method. It is a message-based protocol since CAN data is sent to all connected modules on the system.[6]

There are various studies and improvements on data transfer speed. CAN bus systems, used with optical connections and fiber optic systems, provide both data transfer rate, safe separation of high voltages and prevention of Electromagnetic Interference (EMI).[7]

2.1. Hardware

There are two important points to access CAN data in a vehicle. First of all, a circuit containing a microprocessor to be used in the electronic part should be designed to be directly connected to the system. In the project, modular connections on a perforated copper plate were preferred. In this way, easy intervention is provided in case of a possible error or malfunction. In the second part, the necessary microprocessor is programmed so that the designed hardware can access the system. Arduino's interface and library were sufficient for this.

2.1.1. Vehicle Side Hardware

An Arduino Nano module with an ATmega328P microprocessor was used for the study. The ATmega328P is an 8-bit, low-power CMOS microprocessor built on RISC architecture with AVR enhancements. The ATmega328P executes powerful instructions in a single clock cycle to achieve efficiency close to 1 MIPS per MHz, enabling the system designer to balance power consumption and processing performance as efficiently as possible.[8] This module was chosen for the project because it relieves the workspace in terms of size and has sufficient memory and processing power for processing and transferring data that is pulled from the car. The hardware now includes an MCP 2551 High Speed CAN Transceiver because the module lacks a structure that directly offers CAN connectivity. The MCP2551 is a high-speed CAN transceiver that serves as the physical bus's interface with a CAN protocol controller. It is a gadget with fault tolerance. The MCP2551 device offers differential transmit and receive functionality for the CAN protocol controller and complies entirely with the ISO 11898 standard, including the 24V requirements. It has a maximum operating speed of 1 Mb/s.[9] The MCP2551 Transceiver IC's CANL and CANH outputs are directly connected to the vehicle's CAN line. The digital signals that each CAN communication system module loads onto the CAN Bus cable must be drawn to the proper level for transmission. The MCP2551 IC has the ability to buffer strong voltage waves on the bus with the CAN module that are brought on by external sources. It offers 500 kBps communication speed, which is the car's standard data transmission rate, in the communication portion with the vehicle.

The hardware takes its power from the vehicle because it is directly connected to the CAN line of the car. Cars have an internal voltage of about 12V. The modules need an operating voltage of 5V on average. The input voltage is set to 5V using an LM2559 Stepdown voltage reducer. The LM2596 Stepdown module is a regulator circuit that has a switching frequency of 150 kHz, can handle a 3A load, and can be modified at fixed output voltages of 3.3V, 5V, and 12V.[10] In this manner, the hardware's Arduino Nano module is not subjected to an additional load. Due to the current it consumes, the GSM module is further fed from a second LM2559.

The SIM800L GSM/GPRS module is the final piece of hardware in the vehicle component. The GSM/GPRS SIM800L module operates on the GSM 850MHz, EGSM 900MHz, DCS 1800MHz, and PCS 1900MHz frequencies. The GPRS multi-slot class 12/class 10 (optional) capability of the SIM800H and SIM800L supports the GPRS coding schemes CS-1, CS-2, CS-3, and CS-4. Its working voltage falls between 3.4 and 4.4 volts. The center receives the data from the car through this module.[11]

The process applied to the receiver side is easier than the other part and is software-based. The data received with the GSM module can be directly controlled by the center. Since the data comes instantly, no continuous data recording is made, but when necessary, the data is sent to a database. In this study, an instrument panel was designed as the central part and connected to a single vehicle.

The application was carried out for a single vehicle and the instantaneous data is 98% accurate.

2.2. Software

Arduino interface and libraries are used in the study. First of all, the AT commands required for the GSM modules to be connected to each other are set. It is necessary to match the GSM numbers to match the modules. After the GSM modules are paired, the data transfer process is performed and the received data is displayed on the central panel.

2.3. Implementation and Stages of the Study

There are 2 logic levels on the CAN Bus. These are Dominant (logic 0) and Recessive (logic 1) voltage levels. The dominant logic level occurs when the differential voltage between CANH and CANL is above the defined voltage level. The defined level is around 1.2V. Recessive logic occurs when the differential voltage between two lines is below a defined level. Usually, this level is 0V. Figure 3.7. shows the voltage levels between CANH and CANL. [12]

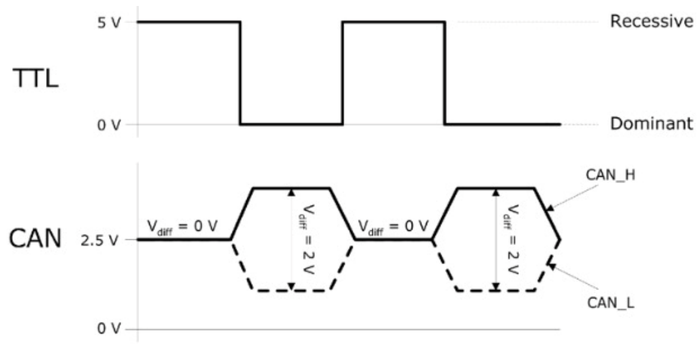

Fig. 1 The Voltage Levels Between CANH And CANL [13]

There are many systems in the vehicle. The presence of a bus line where these systems can communicate in a common and synchronized way alleviates the hardware load. However, some systems do not communicate with CAN-Bus, they have their separate lines. Factors such as the brand, model, and year of manufacture of the vehicle increase the systems in the vehicle or change the communication system of these systems. The CAN-Bus system is a general bus line and most systems are connected to it.

The vehicle used in the project is a 2006 Ford Fiesta. The internal structure of the instrument panel of the vehicle is shown in the figure below. Based on this, it is understood which information on the instrument panel is transmitted via the CAN bus. Then, using the diagnostic device, it is determined through which IDs these data are transferred.

Since the software and technologies developed for each vehicle are different, the IDs of the data to be accessed may also differ. The process of connecting the vehicle's ECU system with the diagnostic tester can be called listening to the vehicle. The data is in hexadecimal structure, so a direct transfer to the passenger side cannot be provided. In addition, the data do not directly show their decimal counterparts. For example, if the data shown in the ID for speed is 4E, the speed is not 78. For this, it is necessary to perform some proportioning operations.

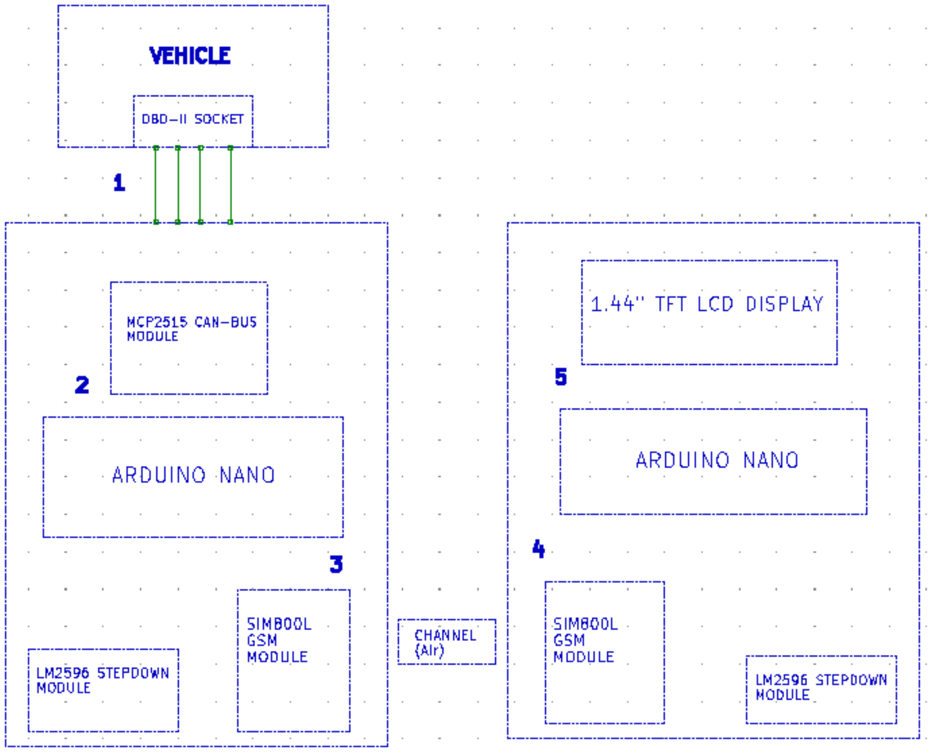

Fig. 2 Block Diagram of The Introduced System

It is necessary to mention the connection of the equipment to the vehicle. First, CAN-H, CAN-L, +12V supply voltage and chassis grounding are taken from the vehicle's OBD-II socket. The part numbered 1 in the diagram is the reception of CAN-H and CAN-L information. The received information is first sent to the MCP2551 CAN Transceiver in the MCP2515 CAN-Bus Module. This is a relay unit that enables the import and export of integrated CAN data. In this respect, the MCP2551 IC can be thought of as a mouth. The received data is transferred to the MCP2515 IC. The MCP2515 IC converts the CAN information received from the vehicle into a digital signal, making it programmable and understandable by the Arduino module. In this respect, the MCP2515 IC can be considered as the speaking ability of the mouth.

The information received and converted into a comprehensible form for the system is transferred to the Arduino Nano module in section number 2. In this section, the information that comes with the program to be prepared is filtered and sent to the SIM800L GSM module to be transferred. Some microprocessor models can do the work of the MCP2515 internally, that is, they contain a CAN controller internally. Since there is no CAN controller unit in Arduino, MCP2515 IC is needed.

The information received in section numbered 3 is transferred to the SIM800L GSM Module. The information is transferred from here to the SIM800L GSM module, which has been on the other circuit. Inter-circuit communication is designed in this section.

The information coming to the GSM module in the circuit with the indicator is received by the Arduino in section number 4. It is transferred to the 1.44" TFT LCD panel for viewing by performing the necessary programming operations. The transfer process is numbered 5.

The LM25916 IC reduced the +12V supply voltage received from the vehicle at all of these stages to around +5V, which is the required level for the system. In other words, CAN-H, and CAN-L has been connected to the MCP2515 CAN Module, and the supply voltage has been connected to the LM2596 Step-down Module. In the circuit with the indicator, the supply has been provided by a +9V battery.

Fig. 3 Boxed And Ready-To-Use Transmitter Device

Fig. 4 Boxed And Ready-To-Use Receiver Indicator Device

3. Results and Discussion

As seen in the results, the project works following its purpose. The speed, speed and temperature information received from the vehicle are instantly transferred to the passenger section. Since CAN data is transmitted at certain time intervals, the receiving and transmitting times of these data are important in the coding part.

Some of the information on the instrument panel of the vehicle was transferred with great accuracy. Likewise, it has been seen that other data carried by the vehicle's CAN-Bus line can be transferred in this way. In this way, it is possible to connect and control a fleet of vehicles to a single center.

Fig. 5 Test Result

Fig. 6 Test Result

4. Conclusions and Recommendations

It was checked that the study was completed in accordance with its purpose and that it was used. The data received from the vehicle was transferred to the central device with great accuracy and the information control of the vehicle was ensured.

The system developed for fleet tracking is especially important in the transportation sector. Thanks to this system, instant information flow is provided from the vehicles and the information is controlled from the center. The system is suitable for use in many areas and can be used a lot in the future. It can be used in important areas such as checking the information of driverless vehicles in the developing autonomous transportation sector.

The CAN-Bus system, which is also used in the industry, paves the way for developments in this field as well.

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