



Accelerometer Based Vehicle Monitoring And Tracking System Using ARM Processor And GPS

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Abstract— This paper mainly deals with concept of Vehicle tracking, Monitoring and providing security by theft. This system is based on ARM7, GSM and GPS is proposed. GSM technology is used to send information about the vehicle by using GPS receiver, information contains location, speed, temperature of vehicle and control message to stop the vehicle in case of theft. ARM7 TDMI-S core processor with LPC 2148 microcontroller collects the information and sends to the Monitoring system using GSM modem. The Monitoring system uses GUI to display the received information. GUI is developed by using Visual Studio 2010. The Monitoring system can turn OFF the vehicle engine by using relays in case of theft.

Keywords- ARM7 TDMI-S, LPC2148, GPS Modem, GSM, Accelerometer.

I. INTRODUCTION

In present days as population increases the number of vehicles also increases. This results in more accidents and deaths and also theft [1]. The result of this system saves death or reduces the death rates, by providing information about the accident to the Monitoring system immediately.

A server computer at the (remote) monitoring station that is continuously waiting for data from the system should record the actions of the vehicle into a database. This contains the information regarding Vehicle velocity, position, identity and temperature in two fashions. The information given to monitoring station is in continuous manner and when the accident occurs. The development of vehicular design brings public many convenience in life but also brings many problems at the same time, for example, traffic congestion, difficulty in monitoring dispersive vehicle, theft and other series of problems[4]. We are intended to made this monitoring wireless using ARM7 hardware platform ported with real time operating system $\mu\text{c}/\text{OS-II}$.

It improves the level of management in buses of travel agencies and cargo transportation vehicles, such as trucks [2].

It also provides security to personal vehicles like car by locking the vehicle engine from remote location using GSM in case of theft [3]. A Monitoring system continuously waits for information sent from vehicle system. The information sent by the vehicle system includes position of a vehicle (Longitude and Latitude), speed and temperature. The information provided to the Monitoring system when accident happens or when user accesses the system to get the information about the vehicle.

Key feature of this design include:

- a) User can access the system to get the information about vehicle at any time whenever needed.
- b) Vehicle system will send the information about vehicle automatically to Monitoring system. This results in medical help in case of accident and in case of theft.
- c) User can stop the vehicle engine, whenever theft of vehicle by using relays.
- d) It includes a temperature sensor that gives temperature in degree Celsius for monitoring the environmental conditions around the goods or other stuff in the transport vehicle.

II. ESSENTIAL HARDWARE OF VEHICLE SYSTEM

1. ARM7 TDMI-S LPC2148 controller
2. GPS Receiver MT 3318
3. GSM modem
4. Relays
5. Accelerometer

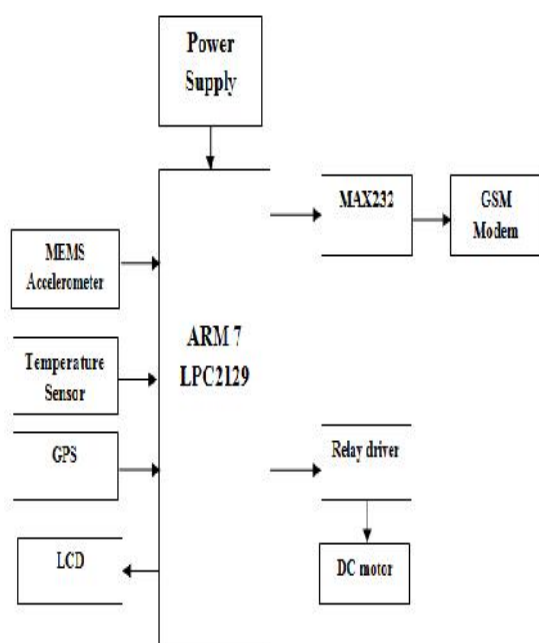


Fig 1: Block diagram

1. Micro controller unit

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.

The vehicle system contains hardware peripherals like, ARM7 TDMI-S Core processor, pressure sensor, temperature sensor, accelerometer, GPS MT 3318 receiver, DC Relay, 16x2 LCD, SD memory card, GSM modem and power supply.

The temperature sensor provides temperature per degree Celsius to an ARM7 processor. The temperature sensor is interfaced to an ADC1 of ARM7 processor. Vehicle speed, position and temperature are stored in a SD card. The SD card is interfaced to an ARM processor by using SPI (Serial Peripheral Interface). This information is shown on LCD that is interfaced to a GPIO0 and sends it to a Monitoring system (receiver side) by GSM module

wirelessly that is interfaced to a UART0 of ARM processor.

Features of ARM7 TDMI-S LPC2148:

- ARM7 TDMI –S LPC2148 microcontroller with 512 Kbyte program Flash and 32+8 Kbyte SRAM.
- 16/32-bit ARM7TDMI-S microcontroller in a 64 or 144 pin package.
- 32.768 kHz RTC crystal.
- Onboard Peripherals
 - 2x16 character LCD with background light
 - Joystick switch
 - UART-to-USB bridge interface on UART #0
 - USB 2.0 device interface
 - RGB-LED, each color can be controlled via PWM Signal.
 - 8 LEDs
 - Temperature sensor (LM75) on I2C bus
 - Pushbutton on P0.14 (interrupt input)
 - 8x8 LED matrix, controlled via shift registers in the SPI bus
 - MMC/SD memory card interface
 - Step motor (bipolar driving)
- 60 MHz maximum CPU clock available from programmable on-chip Phase-Locked Loop.
- Dual power supply
 - CPU operating voltage range of 1.65V to 1.95V (1.8V +/- 8.3%).
 - I/O power supply range of 3.0V to 3.6V (3.3V +/-10%).
- In-System Programming (ISP) and In-Application Programming (IAP) via on-chip boot-loader software. Flash programming takes 1 ms per 512 byte line. Single sector or full chip erase takes 400 ms.

2. GPS MODEM

A GPS modem is used to get the signals and receive the signals from the satellites. In this project, GPS modem get the signals from the satellites and those are given to the microcontroller. The signals may be in the form of the coordinates; these are represented in form of the latitudes, longitudes and altitudes.



Fig 2: GPS modem

A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include

- the time the message was transmitted
- precise orbital information (the ephemeris)
- the general system health and rough orbits of all GPS satellites (the almanac).

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite. These distances along with the satellites' locations are used with the possible aid of depending on which algorithm is used, to compute the position of the receiver. This position is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.

Three satellites might seem enough to solve for position since space has three dimensions and a position near the Earth's surface can be assumed. However, even a very small clock error multiplied by the very large speed of light, the speed at which satellite signals propagate— results in a large positional error. Therefore receivers use four or more satellites to solve for the receiver's location and time. The very accurately computed time is effectively hidden by most GPS applications, which use only the location. A few specialized GPS applications do however use the time; these include time transfer, traffic signal timing, and synchronization of cell phone base stations.

3. GSM MODEM

Global System for Mobile communication. This

GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Applications like SMS Control, data transfer, remote control and logging can be developed easily.

This GSM modem is a highly flexible plug and play quad band GSM modem for direct and easy integration to RS232 applications. Supports features like Voice, SMS, Data/Fax, GPRS and integrated TCP/IP stack.

This system uses SIM 300 GSM module in text mode. This system uses SIM300 GSM module that provide 900/1800/1900MHz Tri-band for VOICE, SMS, DATA, and FAX. This module is operates on AT command. AT command is an abbreviation for Attention command that is recognized by GSM Module. "AT command set for GSM Mobile Equipment" describes the Main AT commands to Communicate via a serial interface with the GSM subsystem of the phone. The GSM modem is interfaced to microcontroller through UART0 serial communication.

Examples of AT commands:

Table 1: AT Commands

Command	Description
AT	Check if serial interface and GSM modem is working
ATA	Answer an incoming call
ATD<>MEM<>N<>	Originate call to phone number in memory
ATDL	Redial last telephone number used

Architecture of the GSM Network:

In a GSM network, the user terminal is called a mobile station. A mobile station is made up of a SIM (Subscriber Identity Module) card allowing the user to be uniquely identified and a mobile terminal. The terminals (devices) are identified by a unique 15-digit identification number called IMEI (International Mobile Equipment Identity). Each SIM card also has a unique (and secret) identification number called IMSI (International Mobile Subscriber Identity). This code can be protected using a 4-digit key called a PIN code.

The SIM card therefore allows each user to be identified independently of the terminal used during communication with a base station. Communications occur through a radio link (air interface) between a mobile station and a base station.



Fig 3: GSM Modem

4. RELAY

The relay is an electromagnetic switch. When relay is activated, then it closes the loop of ignition, hence start the Engine. When relay is de-activated, it opens the loop of ignition, hence stop the ignition of the automobile.



Fig 4: Electromechanical Relay

5. Accelerometer

Accelerometer measures acceleration. Acceleration is the time rate of change of velocity. This means how quickly changes speed. The measurement of acceleration is used as an input into some types of control systems. Accelerometer sensor is used to measure static (earth Gravity) or dynamic acceleration in all three axes, forward/backward, left/right and up/down. The output of accelerometer provides 1.65V to 3.3V in positive direction and in negative direction the voltage drop from 1.65V to 0V. The output of accelerometer is in analogue form with three different output voltages each representing X, Y and Z direction of motion. These three voltage signal are processed through ADC0 on three different Channels available on ARM.

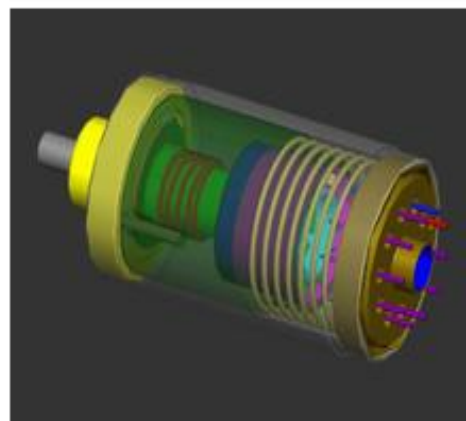


Fig. 5: Accelerometer

An accelerometer measures proper acceleration which is the acceleration it experiences relative to freefall, and is the acceleration that is felt by people and objects. Put another way, at any point in space time the equivalence principle guarantees the existence of a local inertial frame, and an accelerometer measures the acceleration relative to that frame.

Modern accelerometers are often small micro electro-mechanical systems (MEMS), and are indeed the simplest MEMS devices possible, consisting of little more than a cantilever beam with a proof mass (also known as seismic mass). Damping results from the residual gas sealed in the device. As long as the Q-factor is not too low, damping does not result in a lower sensitivity.

III. MONITORING SYSTEM

The information provided by the GSM modem is in the form of text. The text mode information is send to the PC by interfacing GSM Modem to the PC using MAX 232 which is USB to Serial converter. The information received by the GSM modem at Monitoring system is sent by the vehicle system. The information contains Location, Speed, and Identity of a vehicle and Temperature. This information is displayed on GUI and stored into the database. By using this information can also send to the nearest hospital or police system to help the victims. Here GUI is developed by the visual Studio 2010.

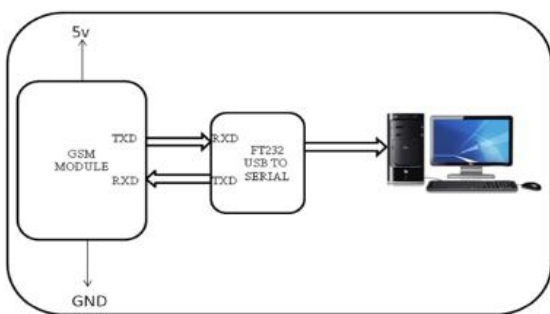


Fig 6: Interfacing of GSM module with PC

IV. SOFTWARES USED

a) *Kiel μ vision4 IDE:*

Keil μ Vision4 IDE (Integrated Development Environment) is based on windows front end for the C Compiler and assembler. Keil μ Vision4 is used to write embedded C programs. Embedded C is a high level language, which includes many aspects of the ANSI (American National Standard Institute) C programming language.

b) *GUI:*

The GUI for the proposed system is designed on Visual Studio 2010. C# is a simple, modern, object-oriented, and type-safe programming language. Microsoft's C# compiler for the .NET Framework is a conforming implementation of both of these standards. **Exception handling** provides a structured and extensible approach to error detection and recovery. Also this language is compatible with all Microsoft applications.

c) *μ C/OS-II*

μ C/OS-II is a real time operating system that is portable, ramble, scalable, preemptive, real-time deterministic

Multitasking kernel for microprocessors, microcontrollers and DSPs. μ C/OS-II manages up to 250 applications

Tasks (3). RTOS can be ported to ARM hardware, and then the system can deal with much more complicated tasks. Real-time (RT) indicates an expectant response or reaction to an event on the instant of its evolution. And Operating

System (OS) is a system program that provides an interface between hardware and application programs. The μ C/OS-II is used for timing constraints.

An Operating system (OS) is nothing but a collection

of system calls or functions which provides an interface between Hardware and application programs. RTOS is key to many embedded systems and provides a platform to build applications. All embedded systems are not designed with RTOS. Embedded systems with relatively simple/small hardware/code might not require an RTOS.

V. WORKING SYSTEM

The entire vehicle system is installed in the vehicle as shown in below figure and Monitoring system at remote location. The entire system works in the following cases.



Fig 7: Complete model of a system.

First case is, when vehicle get accident the pressure sensor and accelerometer senses and sends sensed values to the microcontroller. The microcontroller then collects the information like position, speed from the GPS receiver and also collects the values from the temperature sensor. Then the microcontroller sends complete information to the GSM modem, this information is in the form of text mode. The GSM modem sends received information by microcontroller to the Monitoring system. The Monitoring system receives message and verifies the identification, if in-valid then the message will be discarded; otherwise the information is displayed on the GUI. Then we can get exact location of a vehicle by plotting the longitude and latitude values on Google maps. Then we forward the message to the nearest hospital or Police system to help the victims.

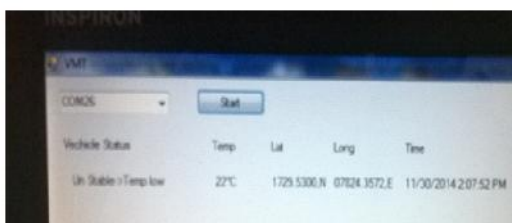
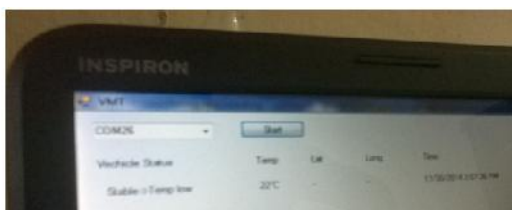


Fig.8: Monitoring systems at remote locations

Second case is, when user wants to access the system to know the vehicle information, the user will send request message to the Vehicle system from Monitoring system through GSM modem. The GSM modem at Vehicle system receives user request and verifies, if in-valid discards the message, otherwise forwards message to the microcontroller. The microcontroller collects the necessary information from different peripherals and sends back to the GSM modem. The GSM modem will forward information to the Monitoring system, and then the information is displayed on the GUI.

Third case is, when the user comes to know that, the Vehicle is theft, and then the user will send the stop message to the vehicle system. The microcontroller receives the STOP message and turn OFF the relay which is connected to the vehicle engine. By this case we can provide the security to the Vehicle.

VI. CONCLUSION

The Vehicular System provides information of a vehicle like velocity, position, through a GPS module and identity of a vehicle to a monitoring station and to a mobile phone according to a definite event stored in a program or a query from a monitoring station.

Finally concluded that the vehicle system provides information of a vehicle like, position and speed through a GPS receiver, and temperature to a monitoring system. Using Accelerometer and Pressure sensor accident can be identified and information is send to a Monitoring system. That information is send to the nearest hospital / police system. The information at Monitoring system is

displayed on GUI. A user can access the system whenever at any time. This system provides security in case of theft. The vehicle can be identified and stopped at anywhere. This system can be installed in cargo trucks, buses and cars

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