FUEL MONITORING AND VEHICLE TRACKING USING GPS, GSM AND MSP430F149

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ABSTRACT

In today's world, actual record of fuel filled and fuel consumption in vehicles is not maintained. It results in a financial loss. To avoid this we are implementing a microcontroller based fuel monitoring and vehicle tracking system. We have used the reed switch which works according to the principle of Hall Effect for sensing the amount of fuel filled in the vehicle and amount of fuel consumed. Then this record is stored in the system memory. This system stores the record for several logs. We have used the MSP430F149 microcontroller for our system. It is a ultra low power, 16 bit RISC architecture controller. It contains inbuilt 12 bit ADC, serial communication interface. Real Time Clock (RTC) is also provided to keep the track of time. Also we have used the GPS technology to track the vehicle. In this paper, the implementation of embedded control system based on the microcontroller is presented. The embedded control system can achieve many tasks of the effective fleet management, such as fuel monitoring, vehicle tracking. Using GPS vehicle tracking technology and viewing interactive maps enable us to see where it was losing money, time and wasting fuel (such as on duplicated journeys).

KEYWORDS: *Fleet management, GPS, Reed switch, MSP430F149.*

I. INTRODUCTION

The challenges of successful monitoring involve efficient and specific design, and a commitment to implementation of the monitoring project, from data collection to reporting and using results. Fleet tracking is the use of GPS technology to identify, locate and maintain contact reports with one or more fleet vehicles. The location history of individual fleet vehicles allows precisely time-managed, current and forward journey planning, responsive to changing travelling conditions.

Applications of commercial vehicle tracking solutions in the fields of transport, logistics, haulage and multi-drop delivery environments can include optimized fleet utilization, operational enhancements and dynamically remote-managed fleets. Fleet tracking is scalable by design and interfaces with the logistics industry's leading back-office systems [3].

Rising fuel costs constantly challenge fleet operators to maintain movement of vehicles and monitor driver behavior to avoid delaying traffic conditions by either, combining deliveries, reconfiguring routes or rescheduling timetables. This aims to maximize the number of deliveries while minimizing time and distance. Escalating oil prices are increasing costs for many businesses, particularly those with large vehicle fleets, adding a powerful financial impetus to the search for fuel efficiencies. Implementing real-time vehicle tracking as part of a commercial company's mobile resource management policy is essential for comprehensive operational control, remote driver security and fuel savings.

II. SYSTEM STRUCTURE

2.1. Basic Structure of System

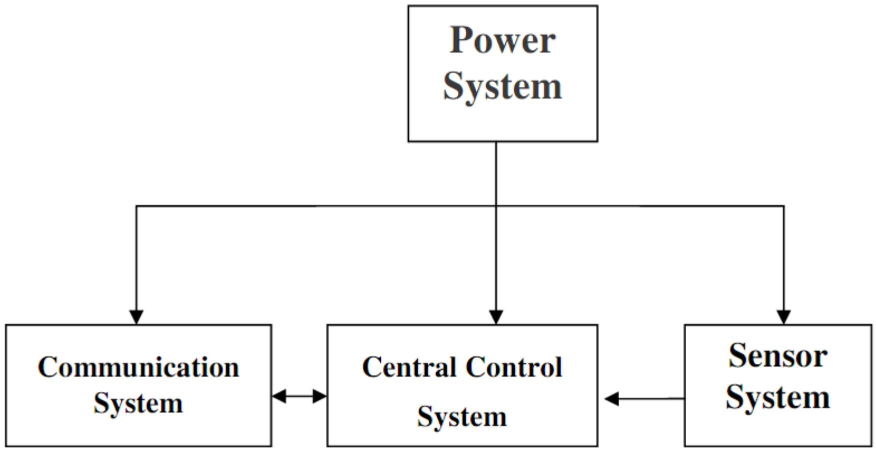

Figure 1 Basic Structure of system

Basically the system is composed of central control system, communication system, sensor system and power system. The system structure is shown in figure 1.

2.1.1 Communication System

System can communicate with remote server through three ways. The first channel uses radio transceiver through RS232 interface; the second one is the optical fiber communication system which can transmit serial data signals by RS485 interface and cameras' video image at the same time. The last one uses wireless sensor net (WSN) to exchange information while a WSN node is attached to the server. When WSN is used, WSN's nodes should be deployed along with the vehicle properly and communication distance can be extended greatly.

2.1.2. Sensor System

Sensors system is composed of fuel level sensors. i.e. reed switch

2.1.3. Power System

The central control system is powered by DC power supply with proper specifications. The communication system i.e. GPS and sensor system are also powered by this power supply.

2.1.4. Central Control System

This is the heart of the monitoring system. It consists of microcontroller with appropriate interfacing with other devices. It performs all the control actions required for proper operation of all the system.

2.2. Structure of a unit

The unit is placed inside the vehicle to sense the fuel level at various time instances and it also tracks the vehicle with help of GPS. To achieve these things the system is equipped with reed switch sensors along with signal conditioning circuits and microprocessor as main building blocks of our system.

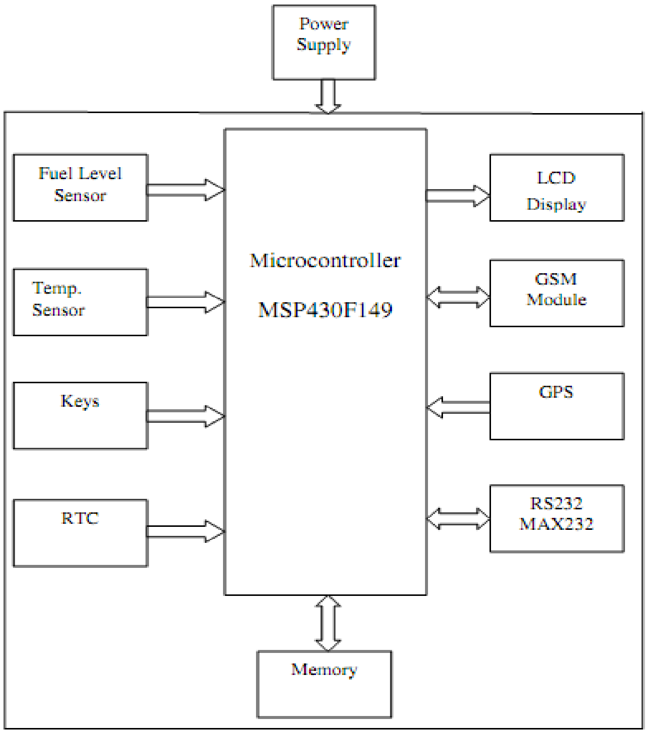

Figure 2 Block Diagram

The Microprocessor is the heart of our system. Microprocessor is the electronic device which contains processing Power, memory and IO ports to interact with different connected devices. In this system microprocessor is the brain of system which stores the status of fuel level in a fuel tank and position of vehicle. The system is powered by DC power supply with proper specifications. This supply can be provided from batteries. Fuel Sensors 1 and 2 i.e. reed switches will be used to sense the quantity of fuel filled and quantity of fuel consumed and notify microcontroller about the level of fuel in the fuel tank. Fuel sensor 1 is placed at the inlet of fuel tank, as the disk of flow meter rotates, due to the magnet present on the disk it will make and break the reed switch, so square pulses will be available as an input to the microcontroller. By counting these pulses and multiplying it by a flow factor we will get exact amount of fuel filled.

Fuel sensor 2 is placed at the outlet of fuel tank, as the disk of flow meter rotates, due to the magnet present on the disk it will make and break the reed switch, so square pulses will be available as an input to the microcontroller. By counting these pulses and multiplying it by a flow factor we will get exact amount of fuel consumed. From this we can exactly calculate the amount of fuel present inside a tank.

These different logs of fuel filling and consumption are stored in the memory. The GSM module is interfaced to the microcontroller. By sending different commands to GSM module placed in a vehicle unit, owner can get the information of different logs and location of vehicle stored in the memory. So that owner can keep the record of fuel and track of the vehicle accurately and continuously. This will help the owner for effective fleet management.

III. SYSTEM IMPLEMENTATION

3.1. Reed Switch Circuit

A magnetic field (from an electromagnet or a permanent magnet) will cause the reeds to come together, thus completing an electrical circuit. The stiffness of the reeds causes them to separate, and open the circuit, when the magnetic field ceases. Another configuration contains a non-ferrous normally-closed contact that opens when the ferrous normally-open contact closes. Good electrical contact is assured by plating a thin layer of non-ferrous precious metal over the flat contact portions of the reeds; low-resistivity silver is more suitable than corrosion-resistant gold in the sealed envelope.

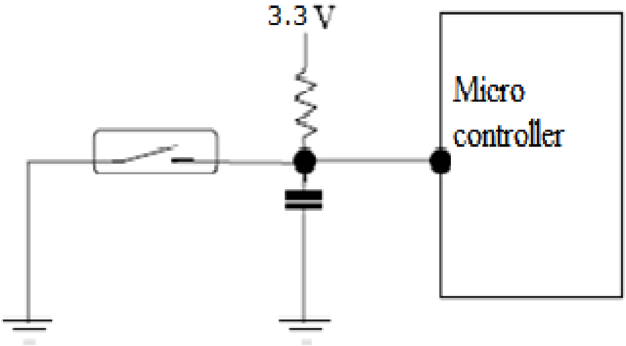

Figure 3 Interfacing of Reed Switch to controller

There are also versions of reed switches with mercury "wetted" contacts. Such switches must be mounted in a particular orientation otherwise drops of mercury may bridge the contacts even when not activated [2].

3.2. Interfacing Diagram

The interfacing circuit consists of Microcontroller (MSP430F139), two fuel level sensors, RTC, memory connections, 16×2 LCD, GPS and GSM module.

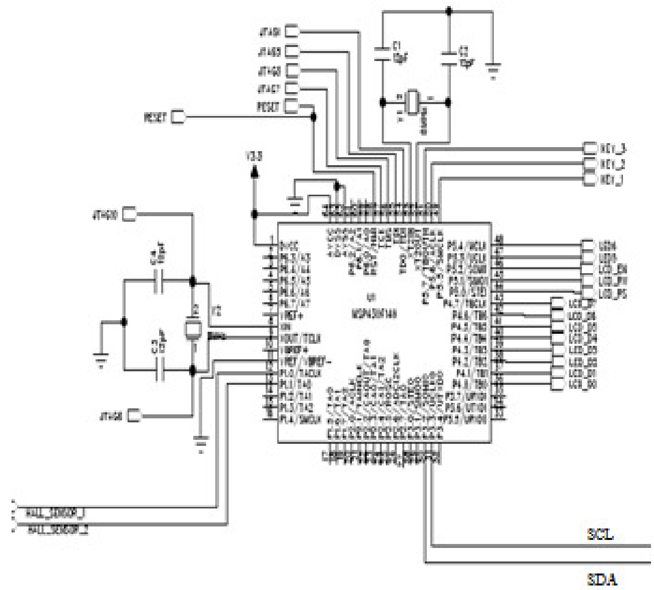

Figure 4: Interfacing circuit

The proposed system is of two communicating processes, p1 and p2, along with a shared memory. In addition to the controller-based system, the GPS antenna play significant role. The memory block of the microcontroller-based design is replaced by hardware entity controlled by the I2C.

3.2.1. Process I

This process has to deal with the message received from the GPS. The default communication parameters for NMEA (the used protocol) output are 9600 bps baud rate, 8 data bits, stop bit, and no parity. The message includes information messages as shown in Table 1.
$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000*18
$GPGLL,…$GPGSA,…$GPGSV,…$GPGSV,…
$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13
309.62,120598,*10, GPVTG,…$GPMSS,…$GPZDA,…

From these GPS commands, only necessary information is selected (i.e. longitude, latitude, date, and time). The data needed are found within the commands RMC and GGA; others are of minor importance to the Controller. The position of the needed information is located as follows:
$GPRMC: **<time>,** <validity>, **<latitude>,** latitude hemisphere, **<longitude>,** longitude hemisphere, **<speed>,** <course over ground>, <date>, magnetic variation, checksum [5], [6].
$GPGGA, **<date>,** latitude, latitude hemisphere, longitude, longitude hemisphere, <GPS quality>, <# of satellites>, horizontal dilution, <altitude>, Geoidal height, DGPS data age, Differential reference, station Identity (ID), and check sum. This information is stored in memory for every position traversed. Finally and when the vehicle reaches its base station (BS), a large number of positions is downloaded to indicate the route covered by the vehicle during a time period and with a certain download speed.
The sequential behavior of the system appears in the flow chart of Figure 5. Initially, a flag C is cleared to indicate that there's no yet correct reception of data. The first state is "Wait for GPS Parameters", as mentioned in the flow chart, there's a continuous reception until consecutive appearance of the ASCII codes of **"R,M,C"** or **"GGA"** comes in the sequence. For a correct reception of data, C is set (i.e. C= "1"), indicating a correct reception of data, and consequently make the corresponding selection of parameters and saves them in memory. When data storing ends, there is a wait state for the I2C interrupt to stop P1 and start P2, P2 download the saved data to the base station (BS). It is noted that a large number of vehicles might be in the area of coverage, and all could ask for reserving the channel with the base station; however, there are some predefined priorities that are distributed among the vehicles and therefore assures an organized way of communication. This is simply achieved by adjusting the time after which the unit sends its ID when it just receives the word "free"[3].

Table 1: The parameters sent by the GPS

NMEA	Description
HPGGA	Global Positioning system fixed data
GPGLL	Geographic position-latitude/longitude
GPGSA	GNSS DOP and active satellites
GPGSV	GNSS satellites in view
GPRMC	Recommended minimum specific GNSS data
GPVTG	Course over ground and ground speed
GPMSS	Radio-beacon Signal-to-noise ratio, signal
GPZDA	fPPS timing message (synchronized to PPS)

3.2.2. Process II

As mentioned earlier, the Base station is continuously sending the word "free", and all units within the range are waiting to receive it and acquire communication with the transceiver. If the unit received the word "free", it sends its ID number, otherwise it resumes waiting. It waits for acknowledge, if Acknowledge is not received, the unit sends its ID number and waits for feedback. If still no acknowledgement, the communication process terminates, going back to the first step. If acknowledge is received, process 2 sends Interrupt to process 1, the latter responds and stops writing to memory.

3.2.3. Memory

The suggested memory blocks are addressed by a 12-bit address bus and stores 8-bit data elements. This means that the memory can store up to 4 KB of data. The memory controller navigates the proper memory addressing. Multiplexers are distributed along with the controller to make the selection of the addressed memory location and do the corresponding operation.

3.2.4. Communication Protocols: I2C and UART

The I2C bus is a serial, two-wire interface, popularly used in many systems because of its low overhead. It is used as the interface of process 1 and process 2 with the shared memory. It makes sure that only one process is active at a time, with good reliability in communication. Therefore, it writes data read from the GPS during process 1, and reads from memory to output the traversed positions into the base station. The Universal Asynchronous Receiver Transmitter (UART) is the most widely used serial data communication circuit ever. UART allows full duplex communication over serial communication links as RS232. The UART is used to interface Process 1 and the GPS module from one side, and Process 2 and the Base Station (BS) from the other side.

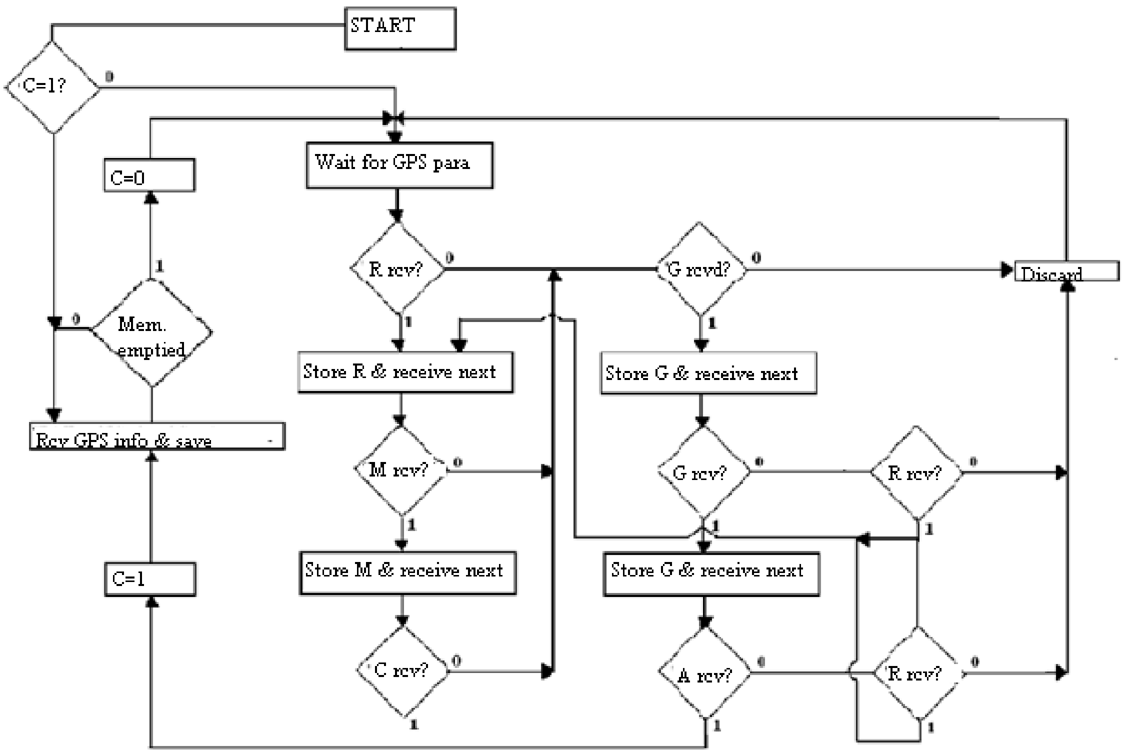

Figure 5. Flow chart governing the main part of the system

IV. RESULTS

The results obtained matched our design goals as the vehicle was tracked with desired accuracy. Fuel quantity was successfully sensed and transmitted over the air up to the required distance.

V. CONCLUSIONS

The advancements in low power designs in Electronics have allowed us to undertake his work which involved the use of Texas Instruments ultra low powered MSP430 series microcontroller. Instead of using the conventional methods like use of popular 8051 series microcontroller and having a complex application we went for a simple application but with a modern technology involving the usage of MSP430 microcontroller. The software was written by keeping in mind standard software engineering practices like modularity, code reuse and portability. Most of the C language functions, especially written for LCD interface are fully portable and can be reused for any other microcontroller platform with little or no change at all. The MSP430 specific code is also optimized for efficient execution.
Our project is a growing application in transportation field. Many new features are being added to enhance the monitoring and tracking operations using recent technologies. Our attempt is to design the best prototype for the same. The system will help the owner of vehicle who is at remote location to perform the tasks of detecting the fuel theft and tracking the vehicle accurately and continuously. Many factors of transportation system are considered. It can work into various environments. The data can be read at the central server by using RS232 protocol.

VI. FUTURE WORK

There are numerous opportunities to extend or continue this work. First and foremost the number of vehicle units can be increased to more than one depending upon the scale of fleet. Some JAVA application can be developed in the mobile itself so that information about altitude and longitude can be directly located on the Google map. A single centralized remote monitoring server can be established by using a personal computer for large scale real time data acquisition. The electronics can be made truly ultra low powered by using a LCD module that runs on 3.3V instead of 5.0V and keeping the microcontroller in sleep mode most of the time. Further miniaturization of the PCB size can be made by using smaller, surface mounted IC packages like TSSOP.

VII. HARDWARE PICTURE

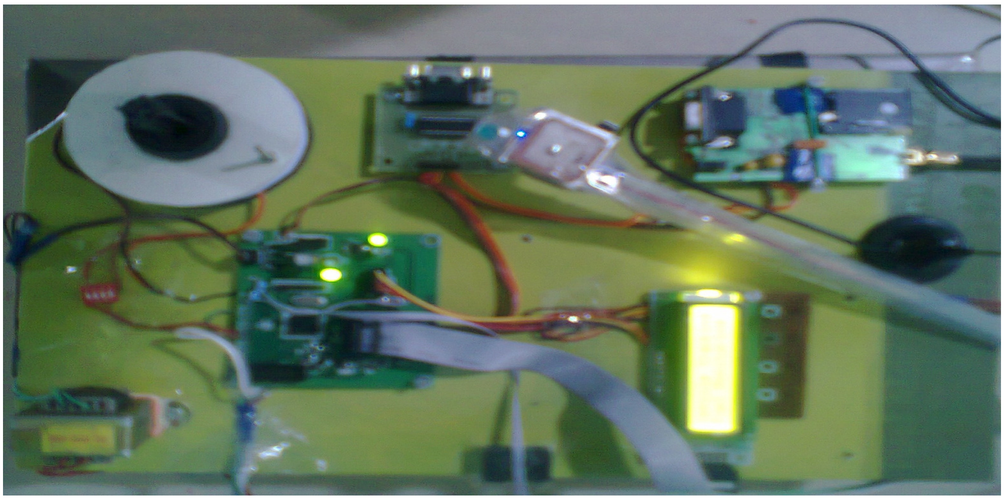

Figure 6. Real picture of hardware

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