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Design of Event Data Recorder Using Microchip PICs

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Abstract: Vehicular security, tracking and collision avoidance techniques are gaining focus in the automobile industry. Event Data Recorders (EDR) are the key elements in implementing tracking and fault analysis. A reliable EDR analyses crashers better, , enhances security and logistic tracking, fault tracing and settles insurance claims quicker. Thus EDR has gained a significant place in the automobile trade. This work aims to design an EDR prototype for vehicular security and tracking in a multiprocessor environment employing Microchip PICs.

Keywords: Event Data Recorder, MCU, Vehicular Security, tracking.

I. INTRODUCTION

Event Data Recorder (EDR) is a device installed in automobiles to record information such as vehicle tracking, fighting frauds [4], crashes or accidents. EDRs are special-purpose multiprocessor systems that are integrated into different environments to gather the event data for analysis. Hence they are reactive systems that continuously interact with the surrounding [1]. Key features of EDR are parallel operation, communicating via message passing and responding on time to critical events. In addition, the components can be heterogeneous hosting various signaling, different communication protocols and topology. Performance evaluation and modeling based on the global state of information in these systems are tedious since they are designed to make autonomous decisions on resource sharing and scheduling.

The characteristics described above indicate the design of distributed heterogeneous embedded systems requires careful attention in choosing the hardware for various communication and message protocols. Cost, support and, hardware (integration with different standards) and software compatibility are the major factors that decide the selection. Ref [5] proposes complex architecture based on functional decomposition of the communication process. Three blocks are strongly interlinked. The first block addresses the basic function, which is steering the vehicle, managed by the onboard computer. The second block concerns the duties related to traffic management and additional services for the driver and passengers. This function is developed by the specific computer. The last block is dedicated to the security of communications and the privacy of the driver and passengers.

This paper focuses on employing low-end microcontrollers from microchip to design an EDR in a multiprocessor environment. We employed two communicating processors to acquire various sensor data using GSM connectivity. Microchip currently offers high performance and versatile 8-bit to 32-bit microcontrollers along with digital signal controllers, which range from the low-cost 8-bit Baseline family to the sophisticated powerful dsPIC® DSCs [2]. 8-bit MCUs, include the PIC10, PIC12, PIC16 and PIC18 families, offer the designer a range of choices with variations in performance, memory and pin count. Baseline products offer a 12-bit instruction set covering 6 to 40-Pin and up to 3 kByte program memory or 2k instructions with a basic peripheral set including comparators and analog-to-digital converters.

The response time, power consumption, temperature range (the CPU can withstand) and immunity towards shock and vibrations are the major factors considered while choosing the processor. PIC 16F628 and PIC 16F887 are suitable candidates from PIC16 family. Flash based, 8-bit CMOS microcontrollers with nanoWatt technology, operating frequencies range of DC to 20 MHz, having power saving sleep mode and watchdog timer and, supports Universal Asynchronous Receiver Transmitter (UART) and I2C.

II. SYSTEM ARCHITECTURE

The system consists of a master controller module built on a high-performance RISC CPU 16F887, –40-pin flash-based, 8-Bit CMOS and a slave 16F628 microcontroller from Microchip as shown in Figure 1. The Master module is responsible for acquiring information from all the sensors except GPS. The GPS data is acquired by the slave 16F628 through UART and communicated to the master. The master is equipped with facility to interface up to 15 sensors;8 sensors have been implemented to acquire temperature data of engine, distance to the nearby vehicle, wetness of the road, shocks (impacts), tilt and distances to the nearby automobiles. The hardware UART in the master is multiplexed and shared between the GSM and a host PC.

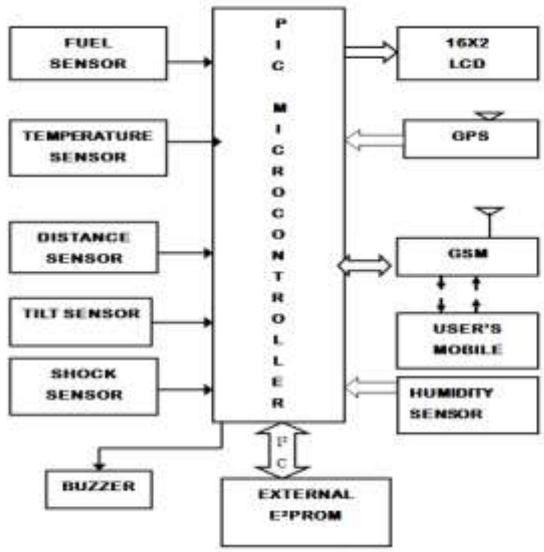

Figure 1: the block diagram of the EDR

The master acquires the information from the sensors in a Roundrobin way and compares with standard threshold values and backups. The performance and signaling from sensors vary based on the quality; few sensors need to be assigned higher priority. For this study 8 sensors and a GSM modem were integrated into the master which includes temperature, humidity, speed, distance to the nearby vehicle (collision avoidance), tilt sensing and shock sensor. The slave acquires the GPS data and calculates the speed, and sends the information to the master through software UART. Provision to attach 16x2 character LCD display to master and slave has been incorporated for verification and debugging.

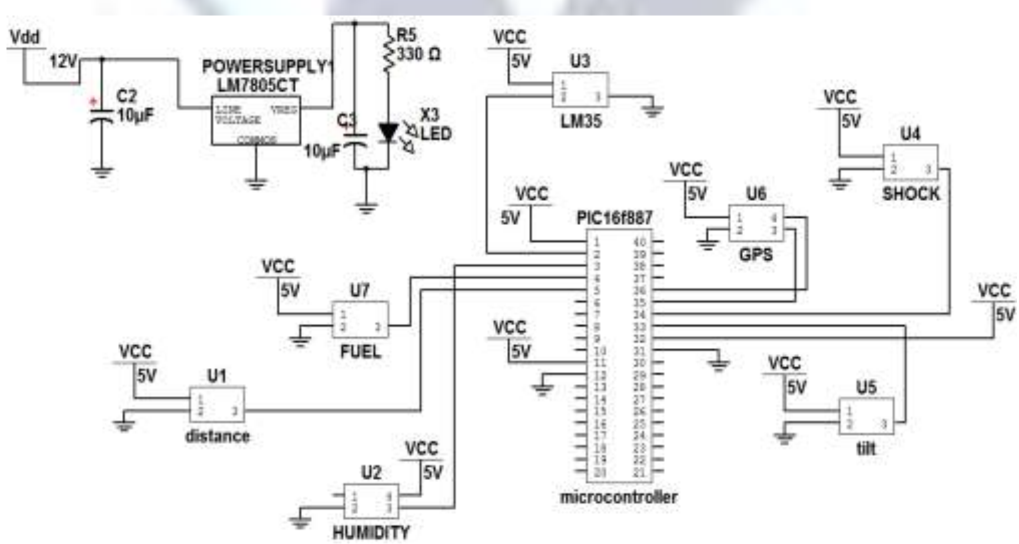

Figure 2: Circuit of sensor interface to the master

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A detailed sketch of the sensors and GPS interface with the master is depicted in Figure 2. The slave is based on 16F628 microchip processor dedicated for acquiring the GPS data and calculating the speed of the vehicle. Ultra high sensitivity (-165dBm), 22 tracking/66 acquisition-channel GPS receiver, which supports WAAS/EGNOS/MSAS/GAGAN, NMEA protocols is being used and equipped with internal back-up battery, one serial port, embedded patch antenna 18.2 x 18.2 x 4.0 mm and ready pin for UART interface, TTL 5V and can operate at a temperature range of -40 to 85o C. The slave is programmed to acquire data from the GPS module through the serial port as shown in Figure 3.

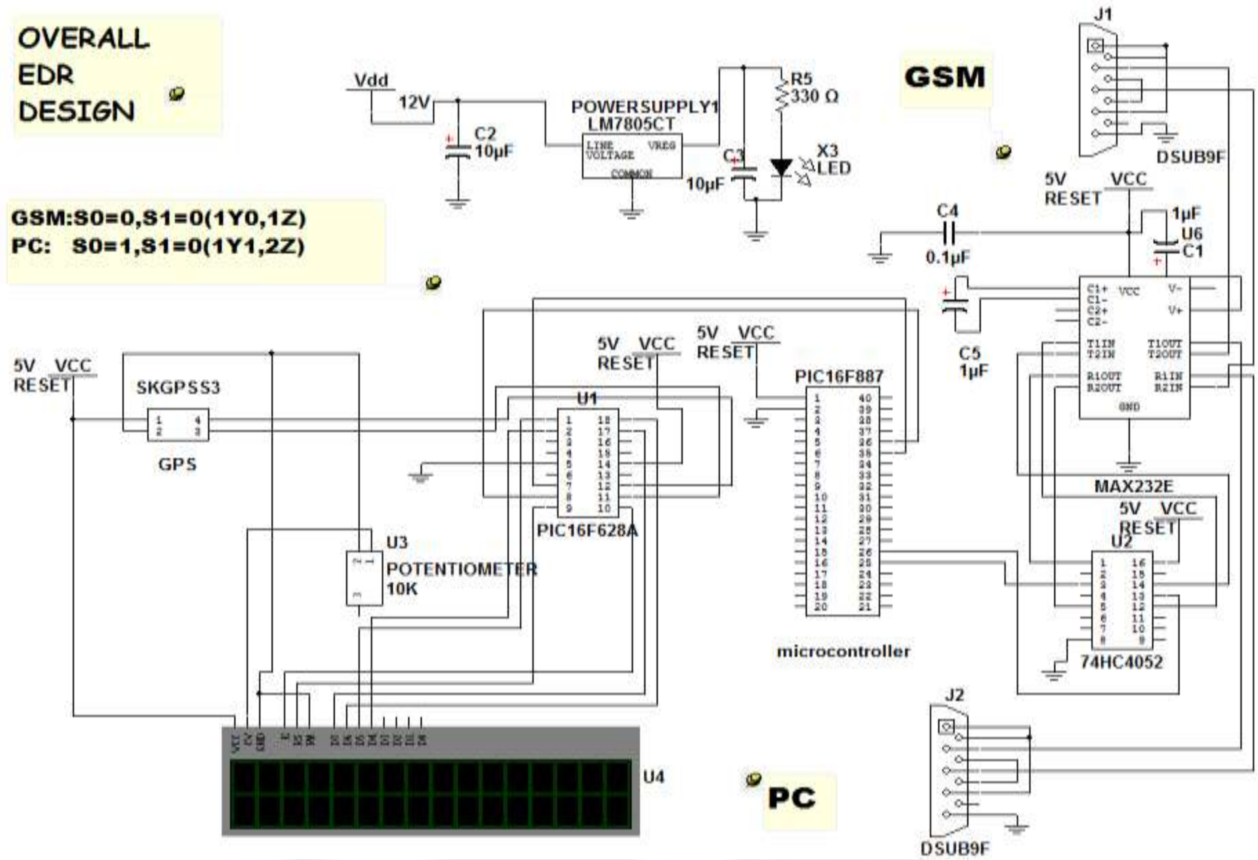

Figure 3: Circuit of EDR prototype

GSM and host computer are connected to the PIC 16F887 through MAX 232 and a multiplexer 74HC4052. The signals S0 and S1 choose between the GSM and host computer.

III. SYSTEM SOFTWARE

The system software was developed in Microchip HI-TECH C compiler. The HI-TECH C Compiler for PIC10/12/16 MCUs is a free-standing, optimizing compiler. It supports all PIC10, PIC12 and PIC16 series devices, as well as the PIC14000 device and the enhanced Mid-Range PIC® MCU architecture [8].

An experimental software has been designed to test the hardware as shown in Figure 4. Power-on initializes the both master and slave followed by initializing UART, software UART, LCD, I2C, GPS, GSM and checks for the sensor functionality. Any acquired value beyond the limits prompts error messages. Round-robin scheduling is followed, the simplest scheduling, to grab the information to test the sensor integrity. Once the integrity test is completed, different levels of priority can be assigned to each sensor according to the time-critical events. The sensor information can be verified using the LCD provided with master and slave, and the data can be displayed in host computer through serial port. The data collected are formed into frames and written to the EEPROM or to any data backup devices as the provision is provided attach backup storage. Each data is subjected to threshold verification to identify emergency events. In case of any emergency the GSM modem alerts the pre-configured mobile with an SMS (short messaging service). Tilt- and shock-sensors are incorporated into the module to emulate heavy shocks representing accidents.

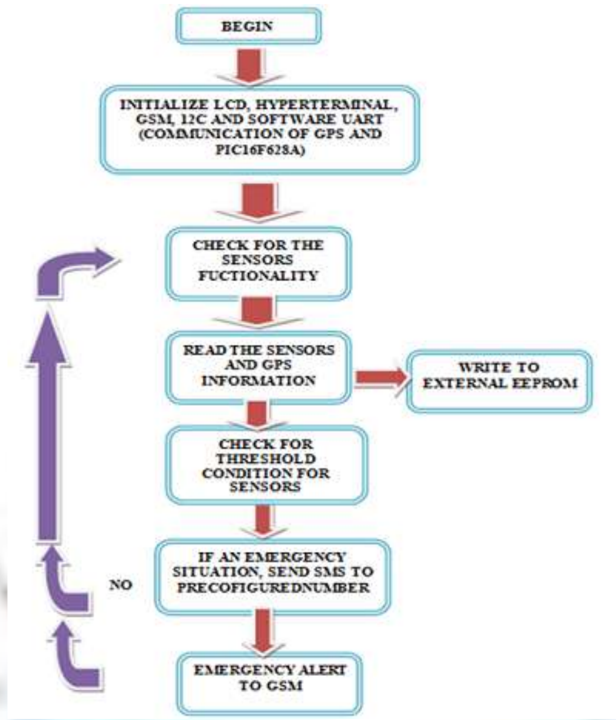

Figure 4: Program Flow Chart

CONCLUSION

Design of an EDR prototype is presented using programmable ICs and HiTech C from Microchip. Most of the current hardware in the market is implemented using digital signal processing (DSP) and higher-end processors, which make them cumbersome for prototyping. The low power consumption, high re-configurability at the circuit level and ease of programming make this system an ideal candidate for prototyping.

The performance of the system can be enhanced by developing software that takes into account all time-critical events (real time kernel) or adopting real-time kernels such as µC/OC-II [3], FreeRTOS. FreeRTOS is a small-footprint, portable, preemptive, open source, real-time kernel that has been designed specifically for use on microcontrollers [9]. FreeRTOS is free, even for use in commercial applications, and does not pose any risk to proprietary software or intellectual property. Low-cost commercial licenses are available under the OpenRTOS™ brand for applications that require professional software licensing to ensure the integrity and support of commercial products.

ACKNOWLEDGMENT

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