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Wireless Embedded Data Acquisition System for Mobile Applications

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ABSTRACT: *This paper presents an interactive way to acquire the parametric data of moving application using of GPRS services. The total system is incorporated in the mobile application like car, bus etc. The embedded system is designed with the help of microcontroller and user interface devices. The acquisition of the present parameters of the system/ environment/ vehicle is recorded with the help of different types of sensors and their signal conditioning units. The system is connected to the global internet network by the use of GPRS services and therefore the recorded data can be accessed from any remote locations having the internet access. With the use of different sensors the Wireless Embedded Data Acquisition System (WEDAS) is capable of being used with any type of mobile applications.*

Keywords*: GPRS Embedded System, Data Acquisition System, Microcontroller, Wireless Network, Internet.*

I. INTRODUCTION

There are many of the data acquisition systems are designed, developed and are currently using efficiently in the different application areas. Most of these systems having the connectivity to the fixed terminal application and hence incorporates the wired communication for remote monitoring and control. SCADA system is a finest example within them. But in case of the application area where the system is not stationary and continuously moving at different location the task of the acquisition of data becomes a bit complex. This paper presents an effective way to acquire the data from the relatively far distance, continuous moving system with the help of GSM and GPRS network. The continuous connection with the mobile system is therefore done with wireless equipments which enable the data monitoring and control simple.

Fig 1: Conceptual dataflow diagram of the System

II. WIRELESS CONNECTIVITY WITH GPRS

Different wireless communication devices are present with their own advantages and disadvantages, out of which the General Purpose Radio System (GPRS) finds the suitable solution. The moving vehicles having the wireless network connected with the GSM subscriber network which also provides the GPRS services for data communication and opens the global internet doors open to communicate with the world. The conceptual diagram of the communication flow is shown in fig.1. With the internet enabling feature the user can access the mobile system parameters from anywhere in the world through the PC. The multiple mobile devices can be accessed by accessing their respective IP addresses which can be static or dynamic depending on the GPRS service provider.

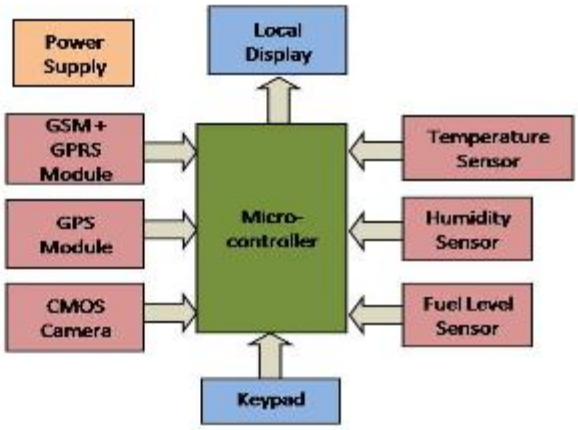

Fig 2: Functional block diagram of the System

III. MOBILE DEVICE ARCHITECTURE

Mobile devices are equipped with the WEDAS each for individual continuously monitoring the respective parameters of the mobile device. The parameters like Temperature, Humidity, Fuel Level and the speed and position of the mobile device are common; along with them special parameters like atmospheric pressure, present traffic conditions can also be possible to acquire. The basic functional block diagram of the system is shown in the figure 2.

The microcontroller is the heart of the system which handles all the tasks of data acquisition, GPRS connection establishment, and data transfer. The system is designed with 8-bit, low power PIC18F67J60 microcontroller from Microchip having 11 ADC channels of 10-bit, one UART channel and 39 I/O pins. It is having 25MHz speed, 128K Flash program memory and 3808 bytes of SRAM data memory which is enough to store the HTML pages required to send to the user to view the preset status of the parameters through web browser.

3.1 Sensors

The microcontroller is connected to the various input and output devices; LCD and keypad are provided with GUI in the software to provide the aid of local visualization and setting adjustment for the user in the mobile device. The data acquisition from the various sensors is done by the internal ADC of the microcontroller. The temperature sensor LM35 is used having voltage output linearly calibrated with temperature as 10mV/C is connected to one of the ADC channels. The Humidity sensor SY-HS-220 gives the voltage output with respect to the present % relative humidity in the environment in the mobile device. The humidity calibration is done with the help of the %RH Vs Voltage waveform graph provided by the manufacturer. The system also reads the current fuel level state of the vehicle with the help of resistance varying float sensor calibrated with the tank size of the vehicle.

By the implementation of the GPS receiver the system is able to monitor the present position of the mobile devices. The GPS module extracts the longitude; latitude and speed parameters directly from the signals acquired from the GPS satellites and hence needs the open to sky placement; normally on the roof top of the vehicle. The CMOS camera attached to the system aids to capture the live images of the present traffic conditions. These images are stored in the RAM of the microcontroller and sent to the remote user upon request. This enables the critical condition resolve awareness of the mobile device by the remote user. The communication with the camera is established over an RS232 communication protocol using an asynchronous package transfer method.

Instead of these sensors the user can accommodate the other sensors as per the need. It is also possible to control the particular parameter by controlling the conditions by output devices locally configured to operate upon the desired conditions and set points.

3.2 Communication Devices

There are also several systems that allow data to be remotely accessed. GSM and GPRS are developed for cellular mobile communication. As a solution to wireless data collection through the Internet, General Packet Radio Service (GPRS) is a popular choice in several applications. A GPRS modem is connected to the microcontroller with the serial port. It works at 900/1800/1900 MHz operating frequencies. A PPP daemon (PPPD) is used to manage the PPP network connections between the client and the embedded module. The PPPD is responsible for setting up the GPRS parameters, such as the connection speed and compression. To directly access an embedded system, the IP address of the embedded device should be made available to the client side.

A GPRS connection with unlimited duration of connectivity is charged only for the data package transfers and adopted in several mobile remote control/access systems. GPRS becomes a cost-effective solution only if the data transfers can be optimized. Once a GPRS connection has been established, queried data can be relayed to the client via a central server. The basic idea behind real-time processing is that the embedded system is expected to respond to the queries in time.

It is also having the GSM communication facility. GSM is used for the voice and message communication whereas GPRS is used for data communication. This system is configured to be virtually online at all times in a GSM network.

IV. SOFTWARE FOR SYSTEM WORKFLOW

The microcontroller is responsible to act as the synchronizer between reading the sensor values, establishing the communication between the client and host and transfer the data to the client upon the request. The microcontroller periodically scans all the sensors sequentially and keeps eye on the client connection or data requests. It measures the temperature and humidity information from the LM35 temperature sensor and SY-HS-220 humidity sensors and keeps the last 50 records to its RAM FIFO. The old records pushed out by the new records and the client will always get the latest information about the situation. The present fuel level is also read periodically but only single record of it will be preserved.

The camera acquires bulk image data; therefore, it is a good module to demonstrate the effectiveness of the system. It compresses and transfers the image from the camera to the serial port. The communication with the camera is established over an RS232 communication protocol using an asynchronous package transfer method. Before taking a snapshot, the camera is synchronized by sending an appropriate number of synch data packages. After the synchronization, both the embedded board and the camera wait until they receive an acknowledgement from the other side before sending another request or data. This protocol is executed in an average of 3.4 s for each picture, which can be considered as an adequate rate for most applications. The embedded board receives the data from the camera port then stores them into the RAM.

The GPS module used in the application is an serving the NMEA format raw data with a simple communication protocol operating on one of the serial ports. The program transfers the selected GPS data to the memory after compiling a bulk of raw data. Useful information is parsed from these raw data within the embedded system by detecting the starting points of the NMEA data as reference points while reading into the serial buffer. The microcontroller starts a periodic operation of acquiring the raw data from the GPS module and sending the qualified GPS data to the Flash memory. In order not to exceed the Flash memory limit, the newest GPS data are exchanged with the oldest data using the memory as a FIFO buffer. This provides up-to-date GPS data to be available at the FIFO upon request from client.

V. CONNECTING WITH THE INTERNET

To directly access an embedded system, the IP address of the embedded device should be made available to the client side. A static (hard-coded) IP could be used, or the remote device should initiate a connection by reporting its IP. This choice is quite straight forward and simple. Although the usage cost remains unchanged, it requires a static IP setup by the service provider and involves monthly recurring costs. The static IP is preferred for its simplicity in designing a system; however, its overhead may be impractical. The other choice is to use a dynamic IP assigned through a Dynamic Host Configuration Protocol (DHCP) server of the GSM provider for every connection established. However, this IP needs to be known by any client requesting an access to the embedded server. This can be solved by the Short Messaging Services (SMS) protocol. The client will send an request message to the system to inform its Dynamic IP. The Embedded system replies with the IP address in the SMS format. On reception of SMS with IP address of the host device client can easily communicate with the host device using the web browsers. Only upon the reconnection to the GPRS will change the IP address and need to be resent to the client and client will reinitiate the connection procedure.

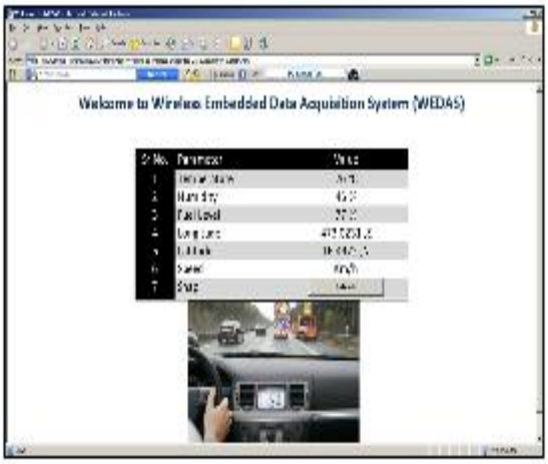

Fig 3: Snapshot of webpage displaying the web parameters

VI. RESULTS

Due to the necessity of using pure html code due to web server limitation in embedded systems, the generation of the pages through CGI scripts is simple yet informative. In addition, a temperature measurement integrated circuit with a very low cost temperature measurement chip (namely, DS1620) is used to collect ambient temperature in certain time intervals at an accuracy of 0.5 ◦C. This chip is attached to the parallel port of the embedded board. A daemon is initiated at boot time to sample and display the temperature every 30 s for a time interval of 15 min.The output graph generated for temperature is shown in Fig. 14. This enables the user on the client to constantly monitor the temperature. Fig. 15 shows a snapshot displaying the altitude information. The embedded system is accessible via a web server built into the device.

VII. CONCLUSION

We propose a GPRS-based portable low-cost data-acquisition system, which can establish a reliable bidirectional connection for data-acquisition. The proposed system uniquely reduces the costs occurring from frequently requested data and eliminates the need for a well-established server. The system uses a SMS services to exchange the dynamic IP address information. The user can directly interact with the embedded device in real time without the need to maintain an additional server. The system is modularly built, allowing different modules to be added. In addition, it is flexible to accommodate a wide range of measurement devices with appropriate interfaces