An Internet Based Interactive Embedded Data Acquisition System for Real Time Application

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***Abstract*— We present the principles of a low operational-cost but flexible Internet-based data-acquisition system. The main core of the system is an embedded hardware running a light weight C code. The embedded device communicates through General Packet Radio Service (GPRS), send data to main FTP server, which makes it accessible from anywhere in the world. In addition, GPRS provides a bidirectional real-time data transfer allowing interaction. A novel approach is introduced to minimize the operational costs while operating with a large amount of data.**

I. INTRODUCTION

Internet is the fast becoming vehicle for integrated multimedia (voice/video/graphics/data) communications. Internet technologies have become a discipline in themselves. The Internet Protocol (IP) continues to dominate as a standard for global communications, and other Internet standards are quickly emerging to offer quality of service on the Internet. The wide spread popularity, acceptance and usage of these technologies has presented an opportunity to research and development engineers as well as information technology service providers to develop and provide value added services.[1]
Once a GPRS connection has been established, queried data can be relayed to the client via a central server. Direct communication, on the other hand, enables access to only relevant information in the embedded system by preprocessing the data. The embedded system should also handle the web services. This eliminates the need for a central server and reduces the amount of data sent from the remote unit since only the queried data will be transferred. [3]

- To design, develop and test embedded based system which will partially eliminate the necessity of web server.
- The embedded system need to handle the web services, for this, assigning an IP addresses for embedded system. Developing Comparable optimal efficient system in terms of allowing direct interactive bidirectional communication.

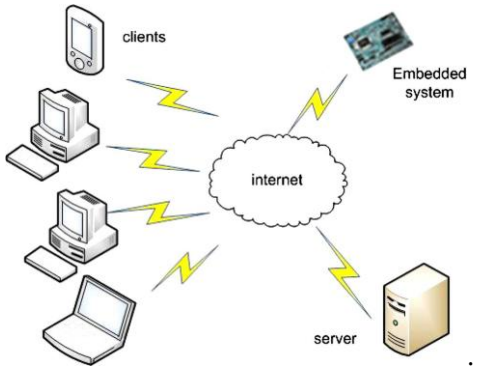

Fig.1 General Diagram of Data Acquisition and Control System

A. *Motivation*

Complexity of well established server success of the Web has proven the value of sharing different types of data in an autonomous manner. The number of Web users, servers, and total Internet traffic has been growing exponentially in the past 5 years. The scale of Web usage is stressing the capacity of the Internet infrastructure and leads to poor performance and low reliability of Web service.

Furthermore, recent studies indicate that server mean time to failure (MTTF) is 15 days, thus a client accessing 10 servers may experience a failure every 36.4 hours. Such a failure rate is not acceptable for many important Web applications such as live streaming and online stock trading. [4]

B. *Project objectives*

The overall objective of this project is to design web server in embedded system to acquire the Images. The details of objective are as follows.

- The Image should be directly transferred through GPRS to the client; the embedded module is set to send the image on an FTP server.

As a part of project, different stages in the architecture will be designed. This architecture will be then executed by using embedded kit. So eventually image acquisition using embedded web server can be done.

II. THEORY & CONCEPT

A. *The proposed system*

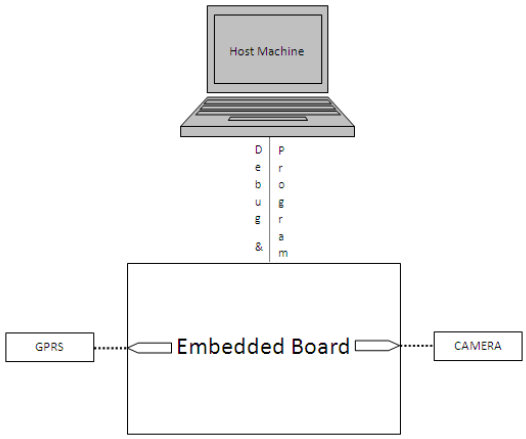

Fig. 2 The block diagram of embedded system with camera attached

In the proposed technique, a GPRS-based portable low-cost image-acquisition system, which can establish a reliable bidirectional connection for image-acquisition is presented shown in fig 2. The proposed system uniquely reduces the cost occurring from frequently requested data and eliminates the need for a well-established server. The system uses a dummy (FTP) server for static information, thus optimizing the transfer of large data. The user can directly log in and interact from anywhere in the world through a web server built into embedded device in real time. This system eliminates the need to maintain an additional server in order to minimize the operational cost while operating with large amount of data like Image.

B. *Image acquisition system*

System architecture: To satisfy above requirement the system is designed to have two sub systems; a Home Server (HS) and Monitoring Server (MS) center.

- The Home Server:

It consists of TCP/IP enabled GPRS, Embedded Board and Camera. The embedded system used in this work is simple ARM Board where no need of installing operating system likes Linux. Hence complexity is reduced. Arm board used having two serial ports. One serial port is used for camera interfacing and another serial port used to connect GPRS modem.

The camera used is low voltage CMOS image sensors that provide full functionality of a single chip SXGA (120*160) camera. It provides full-frame, sub-sampled or windowed 8- bit/10-bit images in a wider range format, controlled through the Serial Camera Control Bus (SCCB) interface. Finally GPRS used with built in TCP/IP protocol. It is tri-band GSM/GPRS engine that works on frequency of EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. [4]

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. Here, the bottleneck is the camera; hence, the speed of data transfer can further be improved by using a camera with a faster sampling rate. The client initiates the camera control script, which eventually takes a snapshot. The embedded board receives the data from the camera port then stores them into the FTP of filegenie.com through GPRS. [5]

- Monitoring Server:

Fig 3 shows the monitoring Server is located at the monitoring firm service provider center(s) (e. g. security firm or civil defense). The filegenie is the web site where data can be saved by signing in to that site. Instead of installing FTP on a separate PC, or to have a separate web site the image data is sent to FTP of filegenie. So www.filegenie.com is working as a monitoring server. For prototype model it provides 20 MB data to be saved freely. As VGA camera is used the size of the image is between 1 to 2 KB hence total no. of Image can be saved is 1000. Hence it is sufficient to take data for five days. Then data can be saved and deleted from filegenie to take new data. For 65 Rupees it gives the data storage capacity of 7000MB which are used to save data up to 30 days that is why system is optimal. The need for static IP is also removed at the server side and client side. [4]

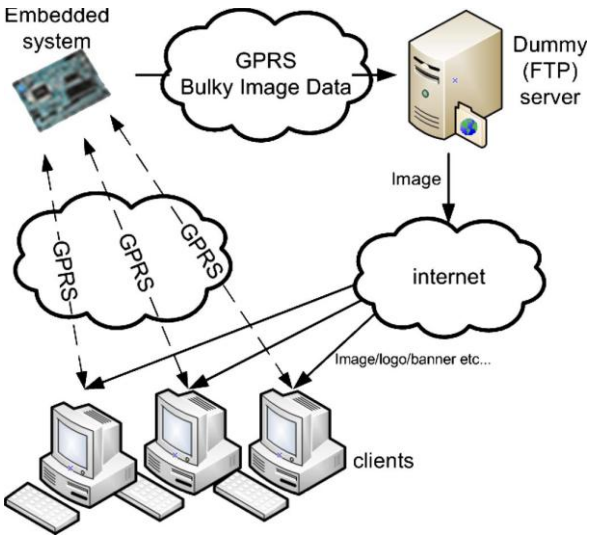

Fig. 3 Image acquisition system

C. *System component*

Each of these servers is briefly described below in fig. 4 Client Server Interfacing

HTTP Server: The HTTP server is a standard Web server that allows clients to connect over the Internet or through a GPRS network. The system is currently using an open source server.

Database Server: An open-source database server is used to save the image data into ftp server.

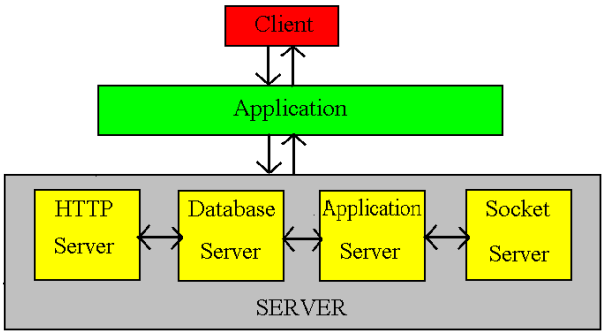

Fig. 4 Client Server Interfacing

Application Server: The Application Server serves as the glue between the HTTP server and the other servers including the

Database Server: The system used an open-source Application server.

Sockets Server: The Sockets Server is used to connect for each client socket connection; it connects to the database server and updates the status. The built in TCP/IP GPRS will take care of it.

D. System Algorithm

The software running on the embedded system at the highest level is named the manager code, which will be explained with a sample implementation. In the design, the Home Server controls the execution of application and is triggered once all the components of the operating system are up and running. The system can be also accessed by FTP server instead of HTTP server. The FTP used here is only for data storage and to maintain the server.

Fig. 5 shows the algorithm of system.

1. Initialize LCD and both UART0 and UART1 at baud rate 9600 bps, 1 start bit and 1 stop bit.
2. Initialize sim900 module.
3. Synchronize camera by sending command {0xAA, 0x0D, 0x00, 0x00, 0x00, 0x00};
4. Initialize camera by sending command {0xAA,0x01,0x03,0x07,0x09,0x03};
5. Get snap shot of camera by sending command {0xAA ,0x03 ,0x00, 0x00, 0x00, 0x00};
6. Set size of image by sending command {0xAA,0x03,0x08,0x00,0x02,0x00};
7. Get Picture by sending command {0xAA, 0x0E, 0x04, 0x00, 0x00, 0x00};
8. Initialize ftp communication with username and password for our specific account.
9. Push above image byte by byte to FTP server.

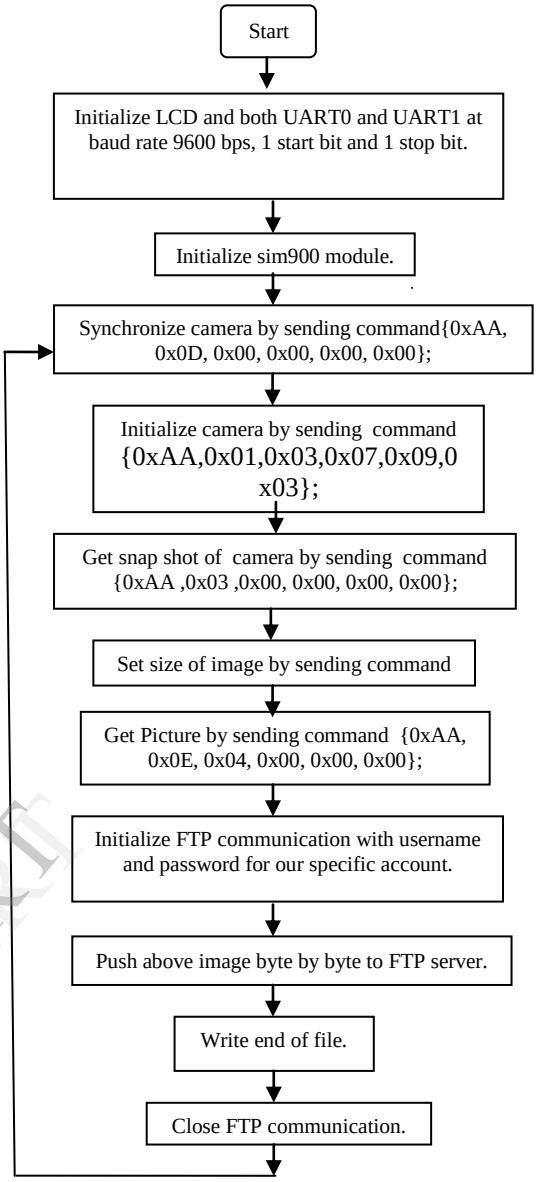

Fig. 5 Algorithm of the system

III. ARM ARCHITECTURE & DESIGN TOOL

A. LPC 2148

The LPC21448 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high- speed flash memory ranging from 32 KB to 512 KB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

B. *µCAM 7725 Serial Camera*

Capture JPEG Images and send them via RS 232 UART interface. This serial camera module makes it very easy for ARM controller circuit to add image capture function for various applications. The uCAM (microCAM) is a highly integrated serial camera module which can be attached to any host system that requires a video camera or a JPEG compressed still camera for embedded imaging applications.

The module has an on-board serial interface (TTL or RS232) that is suitable for a direct connection to any host micro-controller UART or a PC system COM port. User commands are sent using a simple serial protocol that can instruct the camera to send low resolution (160x120 or 80x60) single frame raw images for a quick viewing or high resolution (640x480 or 320x240) JPEG images for storage or viewing. The uCAM comes in a compact form factor with a built in lens and a 4-wire connector that provides easy access to both power and serial data.

While communicating with COM Port of microcontroller the Tx pin of camera is connected to the Rx pin of controller. The Rx pin of camera is connected to Tx pin of controller. The Ground pin is common camera and controller. Finally power supply is provided to both camera and controller.

C. *IPC 2000 ISP flash overview*

In-System programming (ISP) is a method of programming and erasing the on-chip flash or RAM memory using the boot loader software and a serial port. The part may reside in the end-user system. The flash boot loaders provide an In-System Programming interface for programming the on-chip flash or RAM memory. This boot loader is located in the upper 8 KB of flash memory; it can be read but not written to or erased.

IV. SYSTEM DESIGN & IMPLEMENTATION

A. *Serial Communication:*

- RS-232 Level Converter

Usually all the digital ICs work on TTL or CMOS voltage levels which cannot be used to communicate over RS-232 protocol. So a voltage or level converter is needed which can convert TTL to RS232 and RS232 to TTL voltage levels. The most commonly used RS-232 level converter is MAX232. RS-232 communication enables point-to-point data transfer. It is commonly used in data acquisition applications, for the transfer of data between the microcontroller and a PC. The voltage levels of a microcontroller and PC are not directly compatible with those of RS-232, a level transition buffer such as MAX232 be used. [6]

B. *GPRS Interface*

GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/1800 MHz the Modem is coming with RS232 interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The onboard Regulated Power supply allows to connect wide range unregulated power supply. Using this modem, one can make audio calls, SMS, Read SMS; attend the incoming calls and internet through simple AT commands. [2]

C. *µCAM OV7725 Interface*

Fig. 5 shows the Camera connected to controller, the uCAM has a dedicated hardware UART that can communicate with a host via this serial port. This is the main interface used by the host to communicate with the module to send commands and receive back data. [2]

The primary features are: Full-Duplex 8 bit data transmission and reception through the TX and RX pins. Data format: 8 bits, No Parity, 1 Stop bit.

- Auto detects Baud rates from 14400 baud up to 115200 baud.
- Selectable Baud rates up to 1228800 bps.

1. Camera
2. Connecting Camera

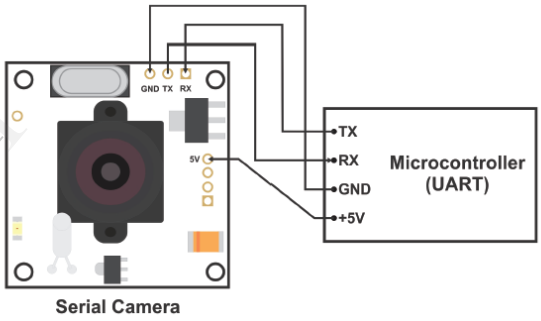

Fig. 6 Camera connected to controller

3. After initializing the camera get picture to have a snapshot Getting Snapshot by giving the proper command

V. CONCLUSION

In this application, a low-cost, Internet-based data acquisition and control system has been designed and implemented that should find interest from researchers. The Compared with other applications, this system has advantages in terms of allowing direct bidirectional communication and reducing overhead, which can be vitally important for some real-time applications. The operational costs have been reduced by relinquishing the storage of large data to an FTP server on the Internet. The system is designed to support both static and dynamic IPs. A method to distribute the IP information has been developed. This cost-minimization effort is a big concern for mobile systems using wireless communication methods and has not been discussed before. The overall cost advantage of the system in terms of the components used makes it an attractive choice for data-acquisition applications. The power demand of the device is still in the process of being improved by putting the attached devices into sleep mode at times when they are not in use to conserve power.

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