Simple and Efficient Method of Image Acquisition using Internet for Real Time Application

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Abstract*: The availability of low-cost integrated General Packet Radio Service (GPRS)/Global Positioning Systems (GPS) modem has enabled the development of a low cost, portable embedded web server. In this paper a simple and efficient embedded web server is developed. To develop embedded web server installation of operating system on embedded board is eliminated. To check the efficiency of the system instead of taking data, image is acquired as image contain bulky data. As embedded board is having its own IP address the need of well established server is eliminated. In addition the system allows home or company owner to remotely monitor their home or company by using internet. This system can also be utilized by security firms, defense organizations to locate troublesome spot in residential neighborhood and compound.*

Keywords: Embedded system, GPRS, Internet, Image Acquisition, Real time.

1. Introduction

World Wide Web, wireless communication tools and gadgets are being extensively utilized by the youth via social networks, smart phone and GPS technologies. 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.

Several systems using Bluetooth, Infrared (IR), Zigbee used for wireless communication has the limitation of range, also, real time applications for image transfer present today are not interactive in nature, as Image contain large amount of information that requires much storage space, large transmission bandwidth and long transmission times. Image acquisition systems with remote accessibility are in great demand in secured area application. In some applications, a single person can monitor and even interact with the ongoing work from a single base station where unmanned devices that will acquire data and relay the data back to the base [1]. Data collection for post processing on a vehicle's position for an advanced traffic survey is discussed in [2].

A network monitoring system for home automation and intelligent home appliance control system [3] have also been proposed. Zigbee–based technology has been used in local monitoring and controlling of home appliances within homes. For example, Zigbee-based remote information monitoring devices for smart homes and home automation systems were developed and reported [4]. Monitoring and protection building electrical safety system utilizing ZigBee was also presented [5]. The above wireless local range monitoring systems have been extended to a wider remote range using GSM/GPRS networks and wireless TCP/IP based communications [6, 7].

Although these are well-built systems that serve the purpose for a specific task, the user cannot interact with the system. Another unidirectional data transfer is presented in [8], which uses the Global System for Mobile Communications (GSM): a popular wireless choice for connectivity between the data-acquisition units and clients. There are also several systems that allow data to be remotely accessed. As a solution to wireless data collection through the Internet, General Packet Radio Service (GPRS) is a popular choice in several applications. A surveillance system based on GPRS [9] has presented a solution to the data-acquisition problem for remote areas.

A long-distance data-collection system for the Earth tide gravimeter, collecting information on temperature, humidity, atmospheric pressure, etc., is designed with GPRS using a hardcoded static Internet Protocol (IP) address [10]. These systems use GPRS without concerns about minimizing the cost of data transfer. Similar types of Internet-based systems, such as those in [11]–[12], are designed to gather a bulk of data before serving them upon request. In these applications, data are compiled in a central server and are then served to the clients via the Internet. Interaction with embedded PC is also important issue published in [13].

The traditional data acquisition system present today which transmits Image uses GPRS connection. The queried Image can be relayed to the client via central server. Using central server to relay the acquired Image has some disadvantages. First the server act as a relay, no direct bidirectional communication between client and embedded system can be established. In addition it requires server software and maintenance which increases operational cost of the system. Therefore central server shown in figure 1 has to be eliminated for a real time system.

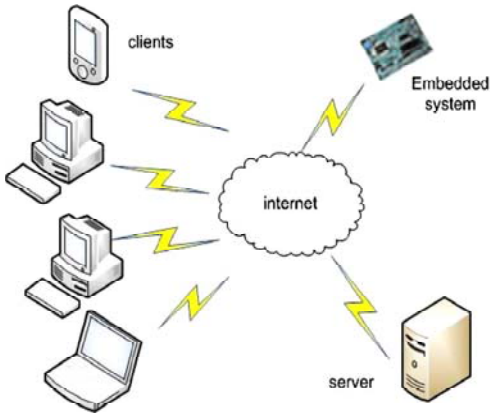

Figure 1. General Diagram of Data Acquisition and Control System

The similar type of idea present today has a reliable bidirectional Point-to-Point Protocol (PPP) link for real-time control via a GSM network is formed. However, there is still no effort to minimize the operational costs (including the costs to transfer a large amount of data like Image). In addition, this system is based on an industrial PC, thus making it an expensive solution.

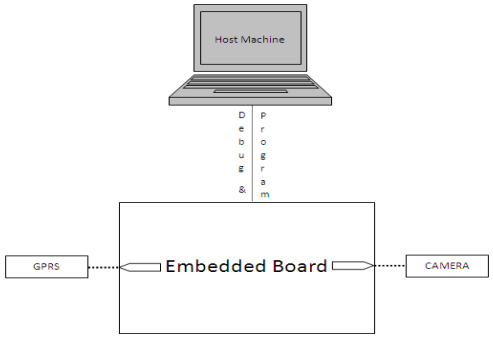

Figure 2. The block diagram of embedded system with camera attached

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. 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 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

2. System Requirements

An Internet-based Data Acquisition systems present today fail to transmit Image. Even if they have to transmit it, Images are compiled in a central server and are then served to the clients via the Internet. A person that needs to access any Image must first access the server. An indirect access to the Image-acquisition unit makes the system unattractive for real-time control applications, where direct interaction with the system is desirable. The need to maintain an additional server will also increase the setup cost and the cost to maintain the acquisition systems, such as regular maintenance cost, system updates, etc. Therefore, the central server has to be eliminated for a real time system.

The basic idea behind real-time processing is that the embedded system is expected to respond to the queries in time. Real time should be fast enough in the context in which the system is operating and reliable as well. As the number of client increases the Image will directly be served through GPRS repeatedly, causing a linear increase in response time. In this case, the connection time is proportional to the amount of data to be transferred through GPRS.
The system should have advantage in terms of allowing bidirectional communication and reducing overhead, which can be virtually important for some real time application viz. remote area monitoring system. In this project the embedded system is accessible via web server built into the device which eliminates the need of central server and also improves system performance when number of clients accessing the same data simultaneously. The functional and nonfunctional requirements for the proposed systems are as follows:

Functional Requirements:

- Monitoring of curfew area should be possible for security purposes.
- Monitor the house in case children's are staying in it.
- Offices can be monitored by their owner from anywhere in the world.
- It should help to notify security service providers or the Civil Defense Department/Security firm with the emergency so they can take immediate action.
- In addition to the Internet, home owners shall be able to check the status of the houses by sending an SMS to the modem, the modem shall reply by indicating the status of the house.

Non-Functional Requirements:

- Reliability of the system; the system should be highly
- reliable during the time of its functionality.
- High accuracy of the system; the system should provide
- an accurate status.
- Availability and accessibility: The system shall be able to
- function on a 24/7 basis.
- The system shall take a maximum of one hours to be
- installed.
- The system must be secure; only the home owner can get
- response from the modem at home or the security service
- providers or the Civil Defense and others.
- User friendly: The web interface shall not take more than ten minutes to learn.
- Low power consumption: during the operation of modems at home, the modem should only be in high power modem when a valid trigger is received otherwise it is in the sleeping mode.
- The system as a whole should not cost more than USD
- 200 to buy and install, and should not take more than USD 20 to maintain and operate during one year of the time of its operation.

3. Image Acquisition System

3.1 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 Sever consist of TCP/IP enabled GPRS, Embedded Board and Camera. The monitoring Server is located at the monitoring firm service provider center(s) (e. g. security firm or civil defense)

The embedded system used in this work is simple ARM Board where no need to need of installing operating system like Linux. Hence complexity is reduced. Arm board used having two serial ports. One serial ports 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 (1280*1024) 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. Out of two serial ports one is connected to ARM board and other can be used for other application.

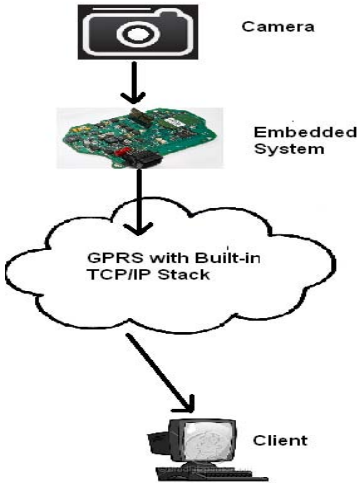

Figure 3: The image acquisition system

3. 2 System Software

Each of these servers is briefly described below:

- 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.

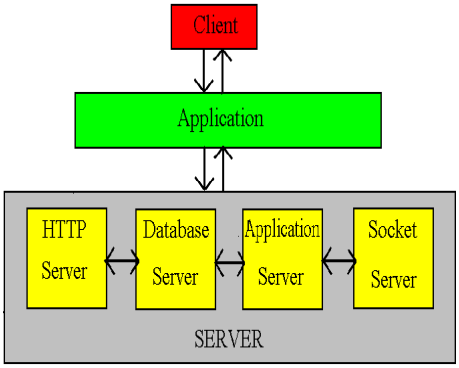

Figure 4. The MDSS Center Software Architecture

- Database Server: An open-source database server [19] is used to profile homes and record homes' statuses. Figure 6 shows the entity relationship (ER) diagram for the current database server.
- 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 a customized multi-threaded sockets server. This server waits for the H-GATE to open a sockets connection. For each client socket connection, it connects to the database server and updates the status.

3.3 System Flowchart

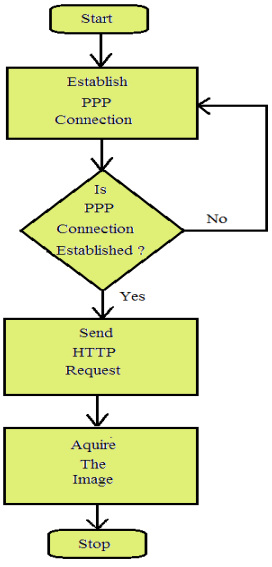

Figure 5. Manager code operational principles.

The software running on the embedded system at the highest level is named the manager code, which will be explained in Section IV 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 flowchart of this code is given in Fig. 5, representing a sample operation of the GRPS unit. The periodic operations and routine tasks are organized by a Home Server. If a new data-access application is considered in future developments, its program can easily be added to the Home Server as a periodic operation.

4. System Operation

For this sample application, a complementary metal–oxide–semiconductor camera with a built-in JPEG codec controller chip has been chosen. 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. 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 Flash memory externally added onto the embedded unit.

Figure.6. Image acquired by the client.

5. Conclusion

Finally by specifying IP address to the GPRS it can be accessed from anywhere in the world. The simplicity is retained by not using complex embedded board. Instead of taking data the efficiency is checked by acquiring image as image is bulky data. Modifications can be done by just giving the miss call to GPRS board which will reply with the image on the client mobile. If instead of image if data has to acuire then ARM board can be removed and GPRS with built in operating system with input/output port can be used.

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