Mobile Embedded Hybrid Approach for Surveillance and Remote Controlling

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***Abstract*—** The importance of remote observation and controlling has been rapidly increased in recent years due to the evolution of mobility. Since mobile phones have become pre dominant at present, quite ubiquitous and increasingly sophisticated, the integration of the mobile phone and a surveillance system becomes more meaningful. This research explored possible ways of implementing such system over existing mobile phone infrastructure without any other third party service providers. However, this reveals the important of integration of mobile phone and embedded system over generic interface such as USB. Additionally, it addresses the design and the implementation of such home security system. It reveals about challenges that occurring while using several technologies simultaneously though they individually work properly. Further it converses about importance, limitations and challenges of synchronizing several functions together such as reading and writing via serial port of a microcontroller and using SMS and MMS listeners together. Moreover it discusses about challenges of debugging embedded program and pit falls of Simulators. It also explained platform and framework limitations such as limitation of memory, incompatibilities of interfacing digital circuits, limitations of AT commands, J2ME security restrictions, limitations of peer to peer video streaming, and feature dependency of mobile phones. However, possible solutions for them such as poling, synchronizing, interleaving, multithreading and level conversion are also discussed. Results conclude that data loses may occur because of buffer over follows due to concurrent usage, and miss synchronization. Besides responsiveness of the system is highly depend on the mobile network. It varies from seconds to few hours. Possible future enhancements such as interrupts routines, wireless communication like ultrasound and Bluetooth with their possible security concerns are discussed. However, this method connects software richness and mobility of mobile phone with the hardware connectivity of embedded system. Thus the derived system gain advantages of both.

***Keywords*—** *Mobile Computing, Embedded Systems, Surveillance*

I. INTRODUCTION

Remote observation has been widely using today; especially in places where humans can hardly reached or too risky to be in. For example geographical explorations such as deserts, volcano and deep sea, astronomical explorations like pathfinder rover to the mars, wildlife explorations, distance bomb disposals, etc. Besides, it is also been used to distantly monitor medical conditions, workplace theft, fraudulent or corrupt activity, home and vehicle security. However monitoring an activity may not be enough. In most cases remote controlling goes together with remote observation. Hence, over the decades people have been trying to implement such systems in different ways.

II. RELATED WORKS

Bing-Fei et al. have implemented such a system by interfacing GSM module to an embedded system [2]. They have been able to transmit a video stream as a sequence of low quality JPEG images over the GSM network. The main drawback of this method is that is not extensible. In other word, it does not adjust according to the bandwidth of the network. MariuszWzorek et al. have developed a GSM based Unmanned Aerial Vehicle [4] with video streaming. However, it was an expensive solution which cannot be applied to solve public matters. Arturo Palau et al. have implemented a GSM based remote control system without remote observation [1]. Michael Bramberger et al. have developed a smart camera for traffic surveillance [5]. Khiyal et al. have tried SMS based remote controlling system to automate home appliances [3]. Further, security alerts have also been implemented. However, it doesn't support remote observation.

III. PROBLEM STATEMET

Assume an owner is away from his home, maybe he is in abroad, no one at his home. He is worrying about the security of his home. He wants to pretend as he is at the home, especially at night. He wants to switch on, off lights, TV or any other device such as siren, etc. Further he would like to get security alerts for suspicious

activities such as someone enters to his home or open his secrete cupboard. Furthermore he would like to see a picture of that particular place to conform the status.

IV. METHODOLOGY

This solution consists of four main components namely sensors and actuators, embedded system, host mobile device and a client mobile device. First three are connected to each other weirdly and the last two uses regular mobile connection.

A. Sensors and Actuators

This part consists of set sensors such as door sensors, IR sensors, thermal sensors and set of actuators such as mortars, alarm, lights, and relays. Sensors are used to capture the relevant event in the environment where the user wants to observe. Sensors are picking up signals from the surrounding and trigger the microcontroller accordingly. The microcontroller decides the necessary action based on its perceptions. However, these sensors can be digital or analogy. Digital sensors are directly connected to the port B of the microcontroller and Analogy sensors can be converted to digital or directly connected to port A. Actuators are used to perform various functions such as ON or OFF lights, TV or alarm, operate a door or gate, etc. Simply the system can operate any electronic or electric device. Opto couples have used to isolate the low voltage components from the high voltage ones. These actuators are connected to the port C and D of the microcontroller. However the port A is kept free for future use. Currently each port is capable of handling eight devices separately, but can be extended to 256 easily.

B. Embedded system

This part consists of an embedded system which powered by a PIC16F877A microcontroller. In fact this is the heart of the whole solution. PIC micro C is used to program the embedded system. Interrupt handlers trigger the relevant routine soon they receive signals from the sensors. If it needs to alert the remote mobile client, it sends the alert to the host mobile device which is connected to its serial port. It uses standard AT commands to communicate with the mobile device. On the other hand it receives commands from the remote client through the same line. The Watch-dog timer of the PIC handles the possible deadlocks of the embedded system. Figure 1 shows the basic configuration of the microcontroller.

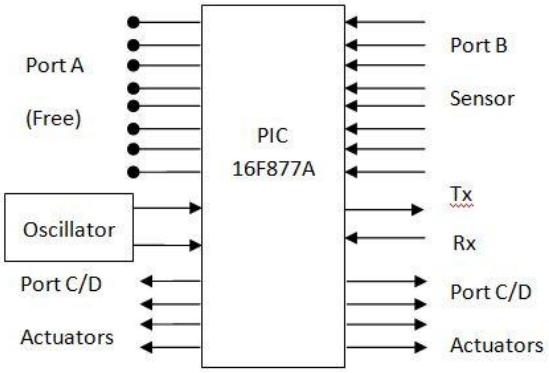

Figure 1. Microcontroller connections

C. Host mobile device

The host mobile device provides communication service to the embedded system. The advantage of using a mobile device for the communication rather than a GSM module is that it can provide extra services to the embedded system. For example it can use its video camera, processing power, storage, Bluetooth facilities and other software to extend its capabilities. This device along with the embedded system is kept at the place where the security it needed.

D. Client mobile device

Client mobile application is built using J2ME. Figure 2 shows the main components of the application.

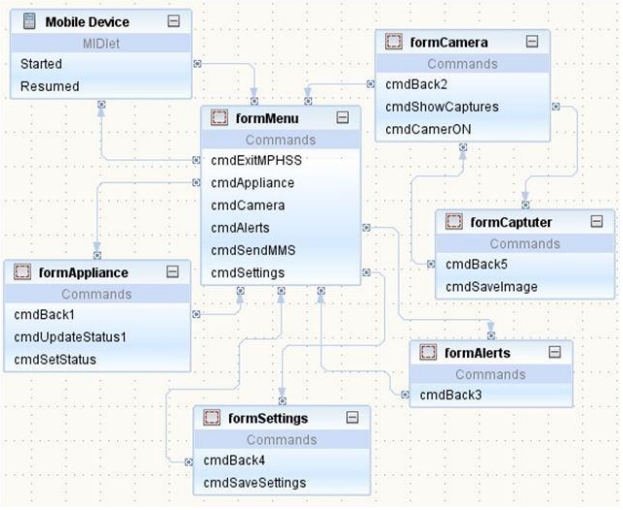

Figure 2. Main Components of the Mobile Application

Basically it facilitate mobile user to receive security alerts, view or store real time visuals, and remotely operate any preconfigured device through his mobile phone. He can monitor the current status of the device

and change it if necessary. Figure 3 shows a screen capture of the mobile application.

Figure 3. Mobile Application

Real time monitoring and recording is also facilitated by the system. Host mobile device captured visuals and stream to the client device as a video call. Figure 4 shows the screen capture of recoded videos.

Figure 4. Secure camera of the system

Further, the user can configure the system to send security alerts to a desired number such as ambulance service, fire brigade or police. The flexibility is he can do all these configurations through his mobile application without reprogramming his embedded system.

V. RESULTS AND DISCUSSION

One of the main objectives of this research is to gain high degree of mobility to the remote controlling and distance monitoring. Wireless communication is the obvious solution for this. However with the use of well-established existing mobile infrastructure, this objective was easily achieved. Because, the mobile users can travel anywhere in the world with the same system. Further this saves money a lot since the only requirement is a simple mobile connection. On the other hand the solution only depends on the mobile service provider. No installation, configuration, hosting or maintenance cost is needed. Solution is almost works as plug and play manner; any device can be connected to the system easily and no high-tech knowledge is needed to plug it. Further users can install client application on their own mobile phone if its supports Java. Thus, user does not need to carry any extra device. Another objective was the adoptability to the network condition. Since the inter module communication needs simple text message passing, it works well even under the worst network conditions. However the quality of the visuals depends on the least resource among the mobile network and the mobile devices. In other words quality depends on the bottleneck. However, the system can dynamically adapt to the environment; when there are more resources, the quality of the service is high. Another concern was the power consumption rate and the stand by time. Since both mobile devices and embedded systems are well design to consume less power, the stand by time of the solutions is more than 24 hours. Usually a wireless communication consumes more energy and it is more vulnerable to attacks compared to a wired network. Thus wired connections are used among the sensors, actuators, mobile device and the embedded system to save the power. Moreover, it assures the security of the communication. Major drawback of the solution is the high uncertainty of the message delivering time. It varies from one second to few minute, possibly couple of hours. However the solution has successfully able to utilize the software richness of the mobile devices and the hardware integration of the embedded system to provide real time distance monitoring with remote controlling.

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