Abstract

Embedded systems are becoming ubiquitous and are adopting more complex structures and sophisticated algorithms. Embedded systems with remote data access features help to make it better observable, controllable, flexible and efficient. Use of off-the-shelf technologies for integrating remote access features in embedded system not only offers distinct advantages of reduced cost and development time but also diminishes issues of interoperability, scalability and ambiguity in use. This thesis evaluates and demonstrates use of various off-the-shelf technologies for remote access in embedded systems with emphasis on mobile communication technologies, namely GSM and GPRS, for long rage and Bluetooth technology for short range.

The thesis presents design and implementation of two applications based on GSM short message service (SMS) technology for educational institutes. GSM based auto-responder, which is one of the applications presented, is an inquiry response mechanism that allows parents or any stack holders to remotely access student's information 24x7 on their mobile phones through SMS request. Second application presents design of customized bulk SMS system that allows institute to easily send SMS to large number of students with each message containing information relevant to individual student. Complete design of both the applications, that includes database management, GSM communication and interactive GUI, is designed in MATLAB. Experimental results are presented.

The thesis also reviews GPRS technology for remote data access. Various options for using GPRS network are presented and evaluated. A systematic approach for incorporating this technology in an embedded system is explained. Use of this technology for remote data access is illustrated
through design of a laboratory set-up for remote patient monitoring. The design successfully demonstrates transmitting simulated ECG signal over GPRS network to a remote monitoring station connected to internet. The set-up designed consist of ARM7 based LPC2148 microcontroller and GPRS modem on transmitter side and TCP/IP socket designed in MATLAB on receiver side. Experimental results of implemented system are presented.

The thesis also reviews the emerging domain of smart grid and discusses role of remote access technologies in establishing advance metering infrastructure (AMI) for smart grid. Discussion on basic functionalities of AMI and required infrastructure is presented along with review of DLMS/COSEM standards for AMI. Concept of demand-side management (DSM) program in smart grid is discussed and its importance is explained. Various techniques that can be used in design of a home area network (HAN) based home energy management system (HEMS) are studied and a comparative analysis is presented.

The thesis proposes the need of a smart add-on device that will enable dumb in-home equipments to be part of HAN and to match the requirements of HEMS. The proposed concept is implemented in form of a wireless multi-channel plug-in type data logger that allows real time monitoring of energy consumption in various in-home equipments on a central monitoring system. The design is based on AVR ATmega32 microcontroller with CS5460A based module for energy measurement, Bluetooth module for wireless communication and GUI based application for central monitoring. Operational accuracy of the system has been verified using standard industrial grade load analyzer. Experimental results are presented.