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Wireless Automation System Based on Accessible Display Design

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Abstract— with recent advancements in electronics market the development trend is leaning towards deploying intelligent, convenient and remote systems. The aim is to monitor and control devices from a central point. In this paper we present a economically feasible yet flexible and secure Accessible Interface based remote monitoring and control system applicable at different levels including houses, offices, hospitals, multiplexes etc.. The system is designed to be economically feasible with variety of devices to be controlled. This paper illustrates the design of an accessible interface for monitoring and controlling devices at remote places. The central monitoring and control system discussed in this paper controls the nodes at remote zones. The system provides flexibility to add nodes at a later time after setup. The communication mode used in this system is wireless and follows Zigbee protocol.

Index Terms—Remote monitoring, user Interface, remote zones, Zigbee.

INTRODUCTION

With rapid advancements in computer technology and with the emergence of high performance embedded processors the electronics market is undergoing a revolution. Embedded Systems are now becoming a part of people's life beginning with smart phones that help them to stay intact with the digital world to embedded web servers that are capable of interconnection digital devices. At the same time, the rapid development in Internet Technology made internet based remote monitoring increasingly common. As with the growing needs for automation of appliances and maintaining a network that can monitor and control these appliances, it is a major challenge to develop a cost effective and reliable system.

The system discussed in this paper provides a solution for embedded system access through Accessible interface with which we can remotely access, monitor and maintain remote appliances conveniently. The solution is based on Embedded Technology. The system provides user with an Accessible Interface through which the devices can be centrally monitored and controlled [1]. This intelligent system may be a luxury item for many people but it is also necessary to invest efforts in designing an accessible interface that provides the flexibility of usage for users with disabilities.

The communication module is the key element for automation systems. Wireless communication is mostly preferred for designing of remote systems. There are various types of wireless communication media out of which Zigbee is most prominent for remote control systems [2] and [3] Zigbee has become one of the promising technologies in home networks and is attracting major attention in electronics market with its specification suite for networking, security and application software layers using low power, low data rate communication technology based on IEEE 802.15.4 standard for personal area networks. This system uses Zigbee as wireless communication module to transmit data to remote location through Accessible Interface. This system uses S3C2440A (ARM 920T) as its core on which the Accessible Interface is implemented.

SYSTEM DESCRIPTION

Accessible User Interface

An Accessible interface is a user interface that provides ease of access to persons with disability. The aim of accessible interface is not the creation of exclusive spaces for people with disabilities which could be a form of discrimination but rather to develop systems that can be used by everyone. Also it is possible to notice that works on user interface for automation systems are very specific, addressing significant type of impairment. The project assistive housing [6] focuses on elderly comfort allowing home automation through television set and remote control interface. Another work proposes touch screen based interface for people with limitations in upper and lower limbs[7].Other solutions based on image processing, gesture based control system[8] that controls home appliances based on hand gesture recognition. The user interface developed in this system is designed using Qtcreator Integrated Development Environment (IDE) for Qtopia cross development platform deployed on ARM platform (S3C2440A). The interface provides a touch screen control through which remote devices can be accessed. The choice of touch screen interface is based on two factors: the wide spread use of touch based mobiles and PDAs and considering that most of the disabled persons have locomotion difficulty. The design adopted in this system is inspired from quadrant approach proposed in [1]. The GUI layout offers simplified label buttons to identify the appliance to monitor and control. The status of the appliance can be known with the help of labelled button disable/enable. If the device is in "on" state the label is disabled and vice versa. This offers flexibility to the user with monitoring and control done at the same instant.

System Architecture

Here we propose the setup of Central Monitoring and Control System that is standalone, cost effective, reliable. The whole system setup is divided into three zones as follows:

- Remote zones
- Central Monitoring & Control System
- External peripherals connected to Central Monitoring & Control System.

The remote nodes are connected to sensors and devices to be controlled. The Central Monitoring System is the heart of the System and it feeds the input received from sensors to the Accessible Interface and it sends commands to the remote zone to operate the peripherals as shown in Fig.1 (a). An 8051 micro controller is placed in each zone and it acts as Remote Terminal Equipment (RTE). The external peripherals and sensors at remote zone are connected to 8051 micro controller. The Central Monitoring and Control System communicate through Zigbee interface to control the peripherals at remote location. If something undesirable happens at the arbitrary zone the Central Monitoring System would alert the administrator by means of Short Message Service (SMS) through GSM module connected to it. The USB camera continuously monitors the remote zones and sends the frames to the for live monitoring.

The remote nodes have three types of executable elements namely:

- Sensors
- Webcam
- Electric Equipments

Fig.1 (b) describes the elements at the remote zone. The sensors feed the input to central monitoring and control system. Webcams sends the live feed as frames for monitoring. Electrical equipments are executable elements controlled from the central zone.

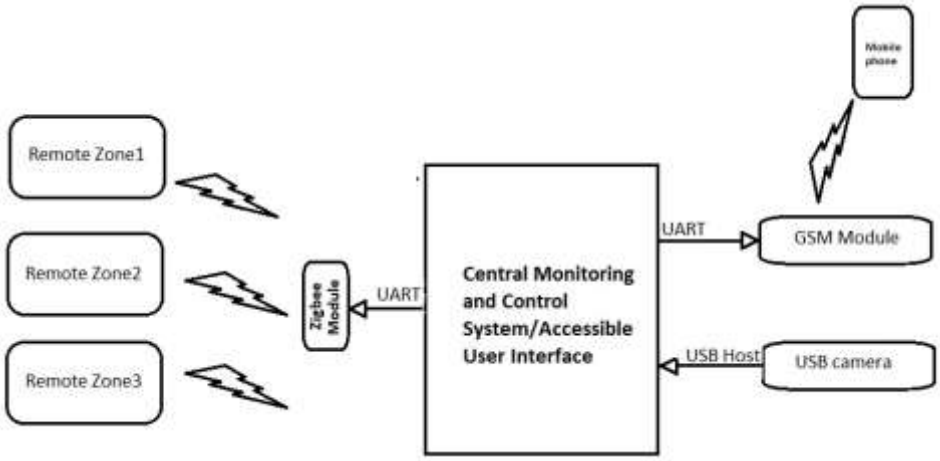

Fig. 1. System architecture of central monitoring and control system

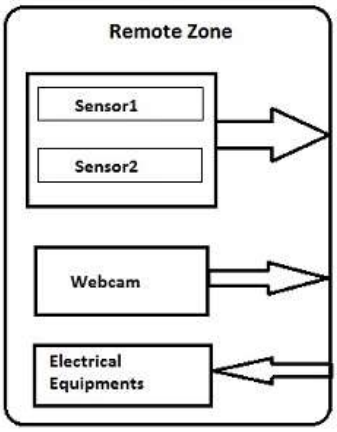

Fig. 1(b). Structure of remote node

SYSTEM DESIGN

Hardware Design

The general hardware structure for central monitoring and control system is based on ARM processor (S3C2240A) as shown in Fig.2.The choice of ARM9 processor is because of their low cost and low power consumption. The Board operates at the frequency of 400 MHz with 64MB SDRAM, 64 MB NAND Flash. The board operates with 5V external supply with working voltages of 3.3V, 1.8V, 1.25V generated on board. The S3C2440A CPU supports two types of boot modes: booting from NAND flash and booting from NOR flash. An UVC compatible web cam is used for video surveillance. The Ethernet interface uses a Davicom DM9000 chip. The three serial ports are led out on CON1 (UART0), CON2 (UART1), and CON3 (UART2). UART0 is also connected to RS232 level converter. There are four ADC channels connected to GPIO header (CON4). It also has a four wire resistive touch interface. Xbee 2.4 GHz RF-modules operating under Zigbee protocol are used as communication medium. SIM900 GSM module is used for message alerts.8051 micro controller is used as Remote Terminal Equipment (RTE).

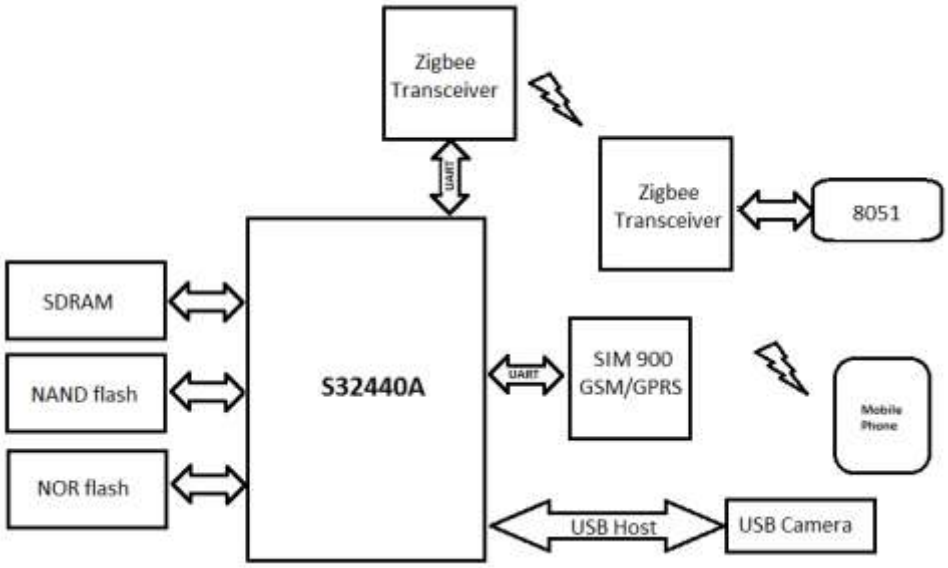

Fig. 2.Hardware structure of the system

Software Design

The software development process includes: the establishment of cross compiler, creation of root file system, transplantation of boot loader, porting embedded Linux kernel, design of Accessible Interface using Qt creator IDE. ARM Linux gcc is used as cross compiler. Host system uses Ubuntu 12.04 for development and target system uses embedded Linux as operating system. Linux is used as it is open source kernel and can easily be transplanted to the requirements of Embedded Systems. The software framework for the system is shown in Fig.3.

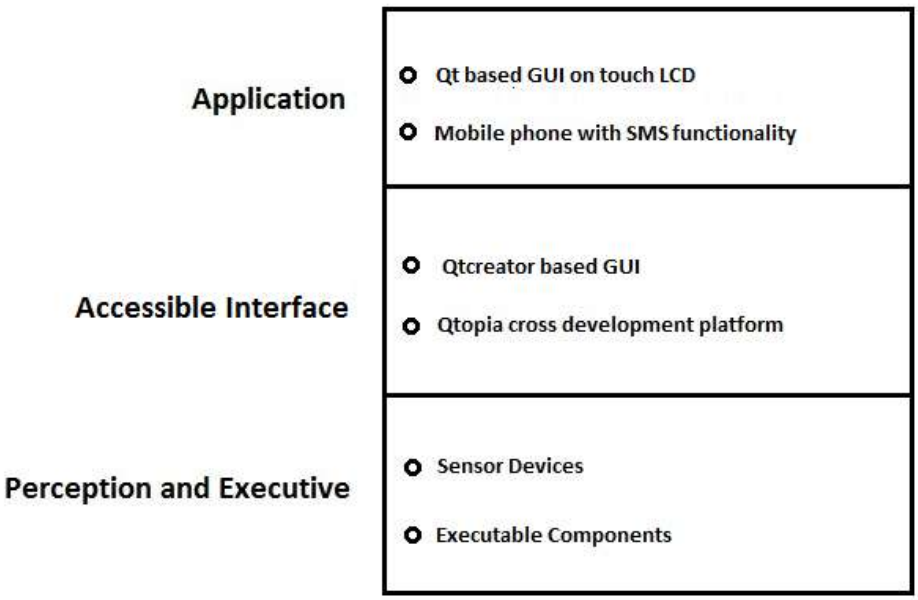

Fig. 3.Software framework of the system

SYSTEM REALIZATION

Accessible Interface based Control System

The Accessible Interface allows administrator to control devices at remote zone. The Accessible Interface design is achieved using from Qtcreator for Qtopia cross development platform. Qtopia is a graphical environment for Linux on mobile phones, handheld PC or multimedia and embedded devices. Qtcreator uses C++ compiler from GNU compiler connection on Linux. Device drivers are written in C++ language.

The central monitoring and control system has three UART interfaces. UART0 uses RS232 for communication with host computer.UART1 uses TTL to connect with Xbee 2.4GHz RF-module. Xbee transceivers use Zigbee protocol to communicate with remote microcontrollers. UART2 uses TTL to connect with SIM900 GSM/GPRS module. MAX232 IC used as level converter from TTL to RS232 as shown in Fig.6. The central monitoring and control system has a touch LCD interface as shown in Fig.5. The device drivers are written for LCD interface on Qtopia platform. The user interface allows the administrator to select a remote zone to access the devices with ease.

At remote zone 8051 microcontroller is used control peripherals and to feed the input from sensors to central monitoring and control system. Depending on the sensor feedback obtained the warning or alert message is sent to administrator using SIM 900 module.

A remote zone can be monitored with the help of USB hub that connects various USB cameras placed at each remote zone. The zones can be monitored through by connecting to USB hub. V4Linux drivers installed in the central monitoring and control system allows us to capture frames from the USB camera and display it on the LCD interface.

Zigbee Addressing

Xbee 2.4GHz RF-modules used in this system operate within ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other. They have the indoor range of about 30m. Xbee module can be viewed as modem as it mainly uses UART to communicate with the main board. Xbee modules communicate through AT command mode. Each module has a unique device ID through which they establish a single communication channel within ISM 2.4GHz frequency band. The baud rate is set to 9600.

Zigbee module acts as network coordinator connecting remote nodes with central system. But before making communication Zigbee needs to be initialized. The initialization procedure between Zigbee sensor nodes and Zigbee coordinator is shown in Fig. 4.

Short Message Service

SIM 900 GSM/GPRS module is used to send alerts to administrator. SIM 900 works on 900MHz frequency. The baud rate is set to 115200. This module has an AT command interface that provides the services of GSM call, short message and GPRS net service. It has SIM card slot into which any GSM SIM card can be inserted to avail services. The use of GSM technology allows user to control appliances through GSM commands [3] which has not been proposed in this system but can be designed in future systems of automation.

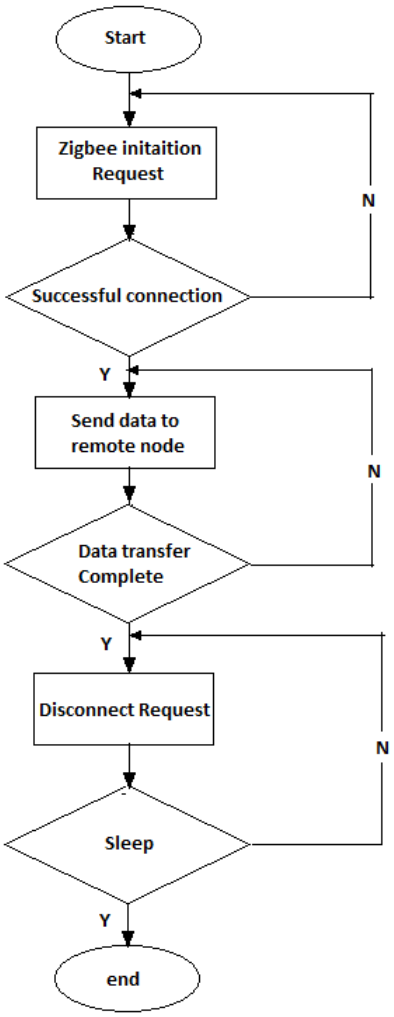

Fig. 4.Zigbee information processing flow chart

INTERFACE DESIGN DIAGRAMS

Fig. 5.Accessible touch interface on Qtopia platform

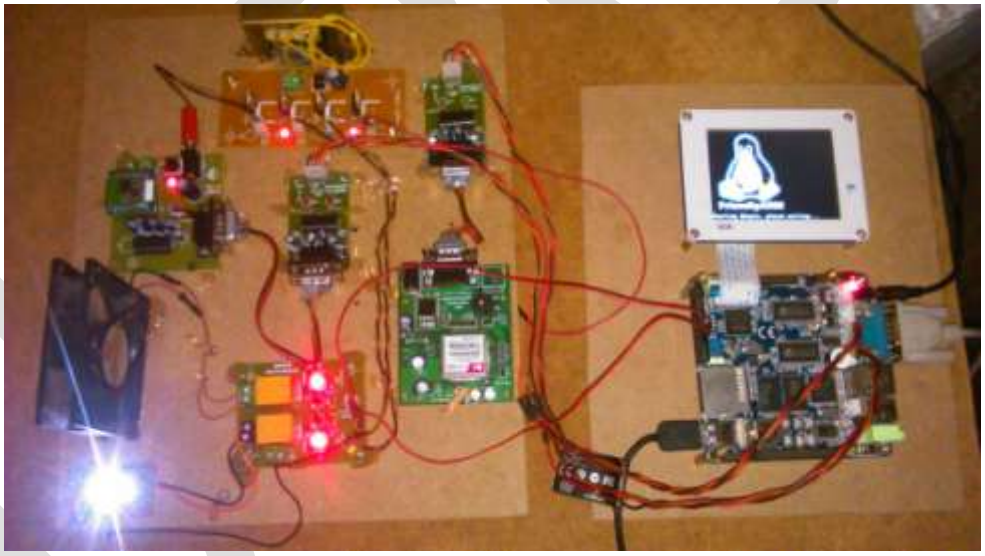

Fig. 6.External peripheral interface

CONCLUSION

The system described in this paper is economically feasible and flexible. The accessible interface is simple and easy to use which does not require any prior knowledge for operation. It addresses the primary objective of accessible interfaces and also serves the purpose of commercial applications. With slight modifications it can be easily applied in various fields such as home automation, industrial control and intelligent appliances. Therefore, it has wide variety range of application prospects and great promotional value. The functionality of system could be further extended

with the help of embedded web server technology that extends the accessibility of system through internet with the help of web browser.

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