

Centralized Automation for Domestic Application

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Abstract-Proposals are made to design and build Intelligent home, meeting the modern requirements satisfying most living standards of consumers. Easy handling of selected home appliances in the house by switching ON or OFF from any room is provided in the system. Real home automation requires domestic appliances that can communicate with each other in a sophisticated enough way to deliver real benefits to the householder. The 3.2 inch TFT display with touch screen is used for the user interface which provides all the information about the current status of the sensors along with date and time. Moreover, remote control of these selected appliances is designed using 2.4 GHz wireless network in which all units have unique identity. The remote also have single button profile selection as per consumer requirement. The electrical energy requirements of the house are efficiently used by monitoring the presence and temperature. Saving of electrical energy by this unit is maximized by automatically switching off the lights and fans when no person is present in the room. Furthermore, water level controller is included in the system. Fire alarm unit is also added in the system that also turns on the electronic valves to extinguish the fire. The RFID interface is provided as a key for door interface. All these sensors and wireless units are interfaced with high speed ARM 7 microcontroller.

Index Terms— Arm7, Touch Screen, TFT, RFID, Wireless.

I. INTRODUCTION

Home automation activities are becoming increasingly important nowadays in providing more comfort, security and energy efficiency for the home residents. Reports are available in the past concerning the development of devices and units needed for implementing the smart home [1]. Each implementation deals certain aspects of automation satisfying partial requirements of the consumers. This project deals with the design of home automation apparatus satisfying almost the complete requirements of automation needed for comfortable stay and pleasant living in a house. Use of 65k color TFT display for user interface gives the ease of operation to the user. The display shows the various parameters like Current date, time, temperature, currently switched on appliances and many other things. Using various kinds of sensors like temperature and presence detection helps in utilizing the electrical energy efficiently, as lights are used only when the person is present in the surrounding otherwise turned off.

The use of intelligent water level controller helps in completely destroying the loss of water and it also finishes the need of manual turning on and off of the water pump. RFID key are used to access the door lock. The 2.4 GHz wireless remote is used to control the electrical appliances containing the different profile buttons. The fire sensors are used to prevent from fire hazards which also provide signals

to electronics valves. The master unit of the system is using high speed arm7 microcontroller LPC2148 running on 60 MHz to operate and respond to the peripheral units as good as in real time. The other subunits in the system are featured AVR microcontrollers ATmega8. All these subunits are connected to the master unit with 2.4 GHz wireless link and have unique identity in the system. An mp3 decoder unit is provided with 20 watt amplifier for entertainment purpose. MP3 decoder unit accepts the command from infrared remote this unit is also capable of playing FM radio. The unit contains USB hub for mass storage device that accepts any USB mass storage device formatted with FAT/FAT32 format. MP3 decoder supports mp3 and wma file formats. A PS2 keyboard is provided as user interface to the system to change the system parameters like time, mood lighting groups and programming alarms. Functionality of certain relays can also be changed.

II. SYSTEM OVERVIEW

Wireless network enable a variety of use cases, as illustrated in Fig. 1. A non-exhaustive list of examples are provided below [5],

A. Appliance control

A light can be controlled from any room, which reduces the need for new wired connections. Lights can also be activated in response to a command from presence detector unit. As the manual switches are replaced with the relays that are turning on at the zero crossing of the AC mains cycle reduces the startup surges and increases the life cycle of contacts as well as appliances.

B. Remote control

Radio Frequency wireless technology is used for the remote control application which provides the freedom to operate the appliances from anywhere around the 100 meter range. Unlike infrared remote it does not need to be directed towards the receiver.

C. Smart energy

Appliances like lights, fans and water pump may be controlled depending on the information collected by several types of sensors around the house connected wirelessly with the centralized controller. Presence detector units are placed in certain areas such as bathroom and balcony to activate the lights only when it is necessary. Water level controller is placed near the water tank provides the water level information to the centralized controller to automatically turn on and off the water pump.

D. Security and safety

Advanced security systems can be based on several sensors (e.g., smoke detectors and motion sensors, temperature switches) for detecting possible risk situations that trigger appropriate actions in response. Different types of alarms like Fire alarms and Burglar alarms can be triggered in response to these sensors.

III. STRUCTURE OF THE WIRELESS SYSTEM

Wireless network consist of a centralized controller and peripheral devices (sensors). The centralized controller acts as a master in the system and has address “00” in the network. Each peripheral device has their own address. Whenever a peripheral device wants to communicate with the centralized controller it sends the data packet via 2.4 GHz wireless RF transmitter. The data packet consist of six bytes out of which first three bytes are address bytes of respective device and remaining three are of data. Fig 2. Shows the communication between centralized controller and devices.

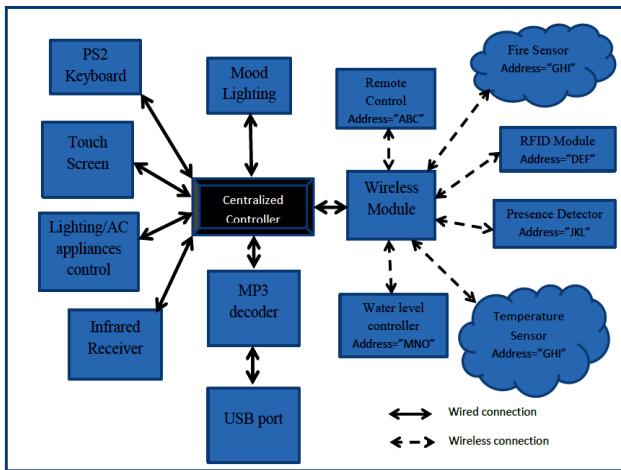


Fig 1. Peripheral Device and Network Topology

IV. SYSTEM WORKFLOW

The 32 bit ARM controller is heart of the centralized processing unit is running on 60 MHz. Higher speed allows serving the request from peripheral devices as good as in real time. Main program of the software is as shown in the Fig 2. The Real Time Clock (RTC), Touch Panel and Wireless trans-receiver unit are working on interrupt and their interrupt service routines are as shown in Fig 3,4, 5 respectively.

LPC 2148 is capable of handling 4 external interrupts EINT0, EINT1, EINT2 and EINT3. EINT0 is connected to the clock pin of the ps2 keyboard whenever the key is pressed the clock pin changes its state which results in interrupt, EINT0 interrupt service routine receives the key from keyboard and perform the predefined action for the key. Only the keys that are used in the program will be accepted all the other keys will be ignored. EINT2 is connected to the touch unit of the touch screen, whenever the activity is detected on the screen this pin goes low which results in the interrupt, EINT2 interrupt service routine accepts the xy coordinates as

shown in the flowchart. The coordinate values are filtered with the digital median filter before accepting and only valid set of coordinates accepted and served all the other sets will be ignored. EINT3 is connected to the wireless trans-receiver unit. Whenever the data from any of the peripheral device is received by the unit this pin goes low. EINT3 interrupt service routine receives 6 bytes in all the packets out of which first 3 bytes contain the address of the peripheral device. ARM microcontroller first identifies the device and then data is decoded to perform particular operation. Along with these external interrupts on more interrupts is used to uptake the time on the display screen. The RTC updates the time every second but interrupt is programmed to occur every minute. All these interrupts are used to handle the nested interrupts so that no interrupts coming from the peripheral devices to be served. Some delay might occur while one or more devices ask for attention but device will be attended for sure. The key data coming from the ps2 keyboard might be received incorrectly when another interrupt occurs during keyboard ISR.

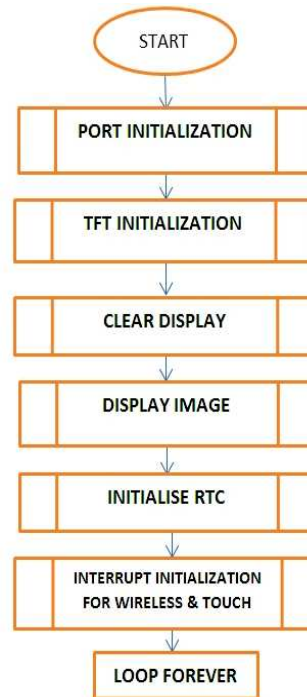


Fig. 2. Main Program Flow

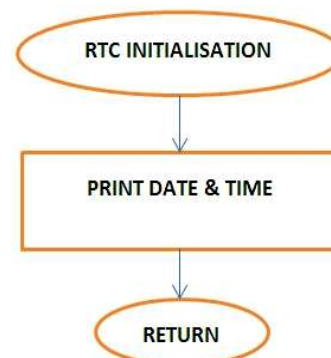


Fig. 3. RTC ISR

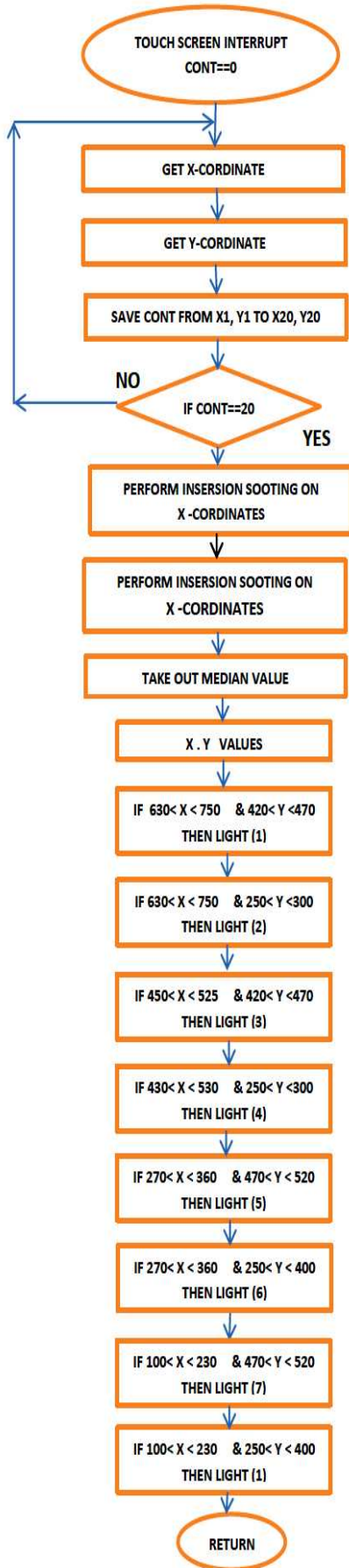


Fig 4. Touch Screen ISR

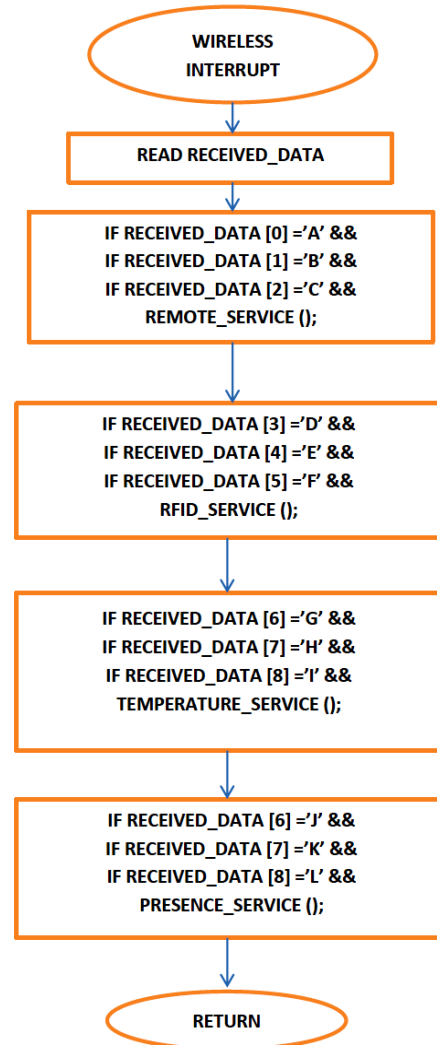


Fig 5. Wireless ISR

V. EXPERIMENTAL DATA

TABLE I. Pheripheral Device and Their Priority

SR NO	DEVICE	CONNETION TYPE	PRIORITY	PACKET SIZE
1	FIRE/TEMPERATURE	WIRELESS	I	6 BYTES
2	REMOTE CONTROL	WIRELESS	II	6 BYTES
3	TOUCH SCREEN	ADC	III	6 BYTES
4	WATER LEVEL CONTROLLER	WIRELESS	IV	6 BYTES
5	BURGLAR ALARM	WIRELESS	V	6 BYTES
6	PERESENCE DETECTORS	WIRELESS	VI	6 BYTES

Table 1 shows device priority tabel during communication between centralized controller and pheripheral devices its connection type. Priority is decided depending on the security, safety and considering the daily routine of the domestic use[4].

VI. EXPERIMENTAL RESULT

Fig 6. shows the TFT screen display. At the bottom of the display current date in mm/dd/yyyy format and temperature in degree celcius. Time is updated after every 1 minute. Temperature is updated as given by temperature sensig device wirelessly nearly after every 3 seconds.



Fig. 6. TFT Screen Display

Fig. 7. Another snap of display is shown the red blocks indicate the turned on appliances and blue blocks indicates the off appliances. The block color is updated as per appliance's state. No matter if it is turned on via touch screen or wireless remote or any other sensor. It also indicates the presence sensor status in the area and the person used the RFID card.



Fig 7. TFT Screen Displaying Devices Status

Fig. 8. Shows the appliances connect board where lids are used to show the status of the relays. All the high 230volts ac circuits are designed on this board. The board is driven by the serial to parallel converter that contains the 8 bit output for 8 relays. Additional devices can incorporate by increasing the count of relays. Fig 9. Shows the complete over view of centralized automation setup.

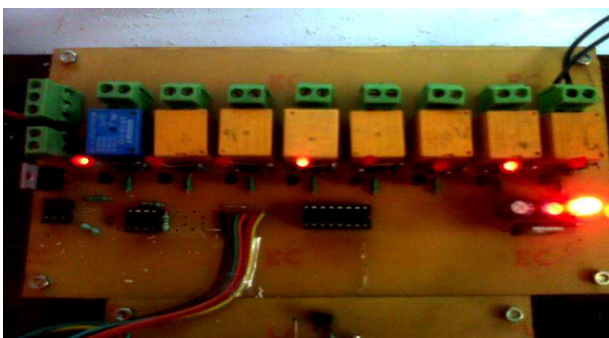


Fig. 8. The Appliances Connect (relay) Board

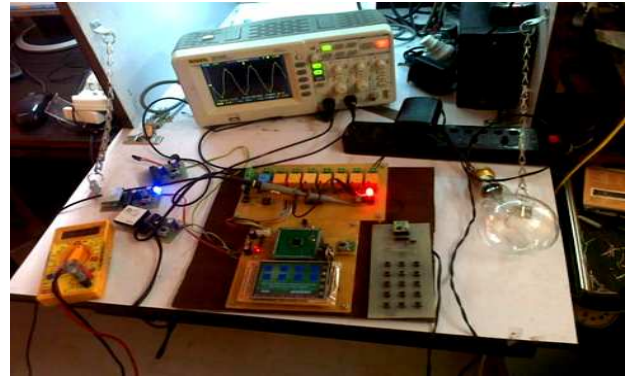


Fig. 9. Over view of proposed system

VII. CONCLUSION

Use of wireless network is significant for centralized control of intelligent home. Home appliances were monitored and controlled via the designed and implemented control panel from any part of the house, use of high speed arm microcontroller helps for serving large number of peripheral devices at faster rates without cross communication. Touch screen and remote control provides easy end user interface. The system also helps to completely avoid the waste of energy because of efficient algorithm implementation. Results show effective use of home appliances with increased comfort to user. Additional devices can also be added without disturbing the main hardware.

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