

Smart Home Automated Control System Using Android Application and Microcontroller

Mohamed Abd El-Latif Mowad, Ahmed Fathy, Ahmed Hafez

Abstract— Smart Home System (SHS) is a dwelling incorporating a communications network that connects the electrical appliances and services allowing them to be remotely controlled, monitored or accessed. SHS includes different approaches to achieve multiple objectives range from enhancing comfort in daily life to enabling a more independent life for elderly and handicapped people. In this paper, the main four fields for SHS which are, home automation and remote monitoring, environmental monitoring, including humidity, temperature, fault tracking and management and finally the health monitoring have been considered. The system design is based on the Microcontroller MİKRO C software; multiple passive and active sensors and also a wireless internet services which is used in different monitoring and control processes. This paper presents the hardware implementation of a multiplatform control system for house automation and combines both hardware and software technologies. The system results shows that it can be classified as a comfortable, secure, private, economic and safe system in addition to its great flexibility and reliability.

Index Terms— Home automation, Android Applications, Arduino card, security, home appliances, Bluetooth, Android

1 INTRODUCTION

Smart home is an emerging concept that attracts the synergy of several areas of science and engineering. A lot of research has been going on for more than a decade now in order to increase the power efficiency at the consumer level of the power management systems. Smart Home is the term commonly used to define a residence that integrates technology and services through home networking to enhance power efficiency and improve the quality of living [1]. Smart house is not a new term for science society but is still far more away from people's vision and audition. This is because although recent various works has been done in designing the general overview of the possible remote access approaches for controlling devices or in cases simulating the smart house itself and designing the main server the design and implementation of an off-the-shelf smart house remote control application has been limited to simply the computer applications and just in cases mobile and web applications development. The "smart house" technology is one realization of home automation ideals using a specific set of technologies. It's a house that has highly advanced automatic systems for lighting, temperature control, security, appliances, and many other functions. Coded signals are sent through the home's wiring to switches and outlets that are programmed to operate appliances and electronic devices in every part of the house. Smart home appears "intelligent" because its computer systems can monitor many aspects of daily living. Smart house can also provides a remote interface to home appliances or the automation system itself, via telephone line, wireless transmission or the internet and android application, to provide control and monitoring via a smart phone or web browser. The growing numbers of elderly population and increasing life expectancy have brought enormous challenges to many

aspects of human life, especially in health and healthcare. According to the United Nations online database [2], currently the percentage of elderly population is 7.6% which is projected to rise as high as 16.2% in 2050. Home automation becomes more advantageous for safety, security. An embedded board physically connected all home automation devices and through integration with a personal computer (PC) based web server, provided remote access to the system [3]. This paper presents smart house controlled by various micro controller systems. The designed system consists of five parts which are connected to both MİKRO c and Arduino software. The first sub-system in SHS is a while review on the system. The second sub-system is the security systems that includes a fire alarm system used in announcing the outbreak of a fire and working to extinguish it remotely, and burglar alarm system that signals the occurrence of a burglary. The third sub-system is lighting control system (energy saving) which includes the internal house lighting, and the ceil lighting outside the house. The fourth sub-system is the remote control system for house controlling. The fifth sub-system is the temperature sensing system for air conditioner. SHS has been designed and implemented through two interfaces which are, computer and remote control unit interfacing. Computer device that provided with microcontroller software is the main controller unit for all systems in the house. It receives data from house sensors, process information and updates data for the different systems, and transmit controlling signal to house systems and switching output devices. Microcontroller makes the ability to monitor the important system operations. Users can also control the different systems abilities, and chose the best required system. Also remote control interfacing is available to control some applications in the SHS.

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2 SHS Overview

Smart home appliance is an interface between the remote control with its mobile or remote control and a home reliever. For each device, in order to accomplish this interface design process was taken using the micro controller and arduino for controlling some application in the home manually by using a remote control and automatically through different sensors. Each system application will be discussed. The block diagram of complete SHS is shown in figure-1. We use a different types of micro controllers which are (PIC30f4013-PIC 16f627A-PIC12f652- PIC18f, arduino), secondary connectivity between remote or smut phone and micro controller is established through (RF wireless and Bluetooth) modules. The two previous modules can be connected either to micro controller or arduino. A specific android application has been designed such that diffrenet home electronic devices can be controlled using a smart phone remotely.

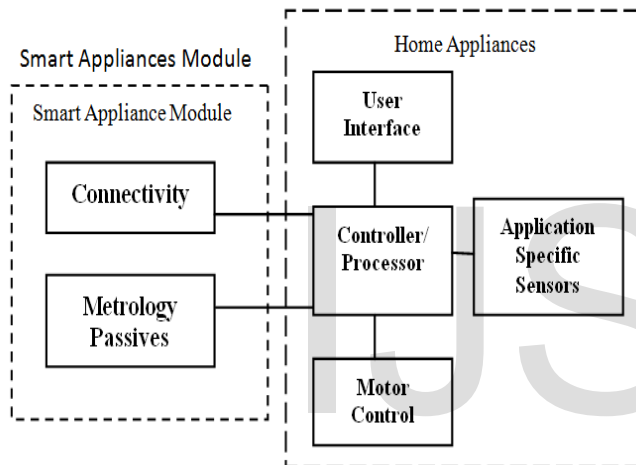


Fig-1 Block Diagram of Complete SHS

A. Microcontroller

PIC microcontroller can be used as the „brain to control a large variety of products, in order to control large devices. It is necessary to interface or connect them to the microcontroller. We have used PIC16F877 which is 8 bit, RISC type, 40 pin IC. This PIC will differ from other PICs because of the features like 10 bit, 8 channels inbuilt ADC, inbuilt PWM, one 8 bit USART, three timers [4]. The microcontroller communicates with the bluetooth module through its TX and RX pins. The serial control command send through the smart phone is received by the bluetooth module and processed by PIC microcontroller. The corresponding port pins are enabled to switch on appliances. 12MHz crystal connected between pins 13 and 14 along with two 33pF capacitors providing the basic clock frequency to microcontroller.

B. Arduino Board.

Arduino is a tool for making computers sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used

to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or communicate with software running on your computer. There are many other microcontrollers and microcontroller platforms available for physical computing. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino is also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems.

Arduino UNO

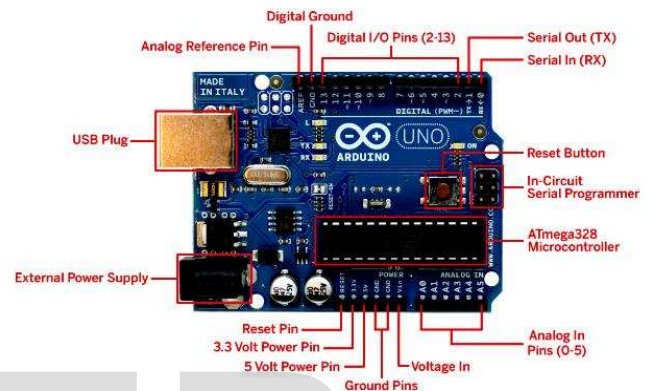


Fig.2 Schematic Arduino Uno Front

Arduino UNO is a microcontroller board it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

C. Android

A Smart phone is a mobile phone based on a mobile operating system, with more advanced computing capability and connectivity than a feature phone. Android is a software stack for mobile devices that includes an operating system, middleware and key applications. Android, by simple definition, is an operating system for many mobile phones. Android is a customizable platform that can look and feel very different on every different handsets. Android gives us tools for creating apps that looks great and take more advantage of the hardware capabilities available on each device. Android is mainly based on Linux operating system which uses java- like languages for running applications. The main purpose of using android is to send the control signals from smart phone through bluetooth. [3]

D. Bluetooth

Bluetooth was selected as our way of communicating mobile with a central system. Bluetooth module receives the data serially in RS232 format from controller and sends it to wireless network. For interfacing it with microcontroller we need to build the circuit because Bluetooth module understands data in RS232 standard and controller understands data

in TTL format. So we need to design circuit to make these two compatible with each other. Bluetooth module we are using is LM400 from LM technology. LM400 is designed to provide Bluetooth 2.0+EDR function on small form factor. Bluetooth function is based on CSR blue core 4-EXT Bluetooth system, which implements the full speed class 1 bluetooth operations with full seven slave piconet support [4].

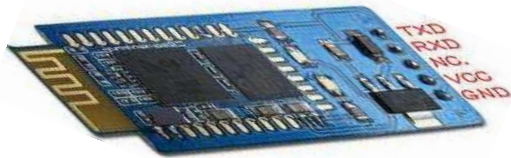


Fig.3 Bluetooth Module

3 Smart Home Security Systems

Here is a simple and compact security alarm system to protect your home/shop and valuables. The circuit is built around a tiny microcontroller chip PIC12F675. Besides, a ready-made Passive Infrared (PIR) module is integrated with the alarm system for reliable human-motion detection. The built-in passive infrared sensor detects human movement by sensing temperature changes over the scene, and works even in the total darkness [5]. Human body heat moving across the scene will trigger the PIR sensor, and the trigger signal will be sent to the control circuit instantly. As the output of the alarm system can be connected to external lamps or alarm sirens, these devices will be instantly activated upon the detected motion. As a result, the intruder who entered the guarded area, even in total darkness, will instantly be exposed. Note that PIR sensor can be used not only for detecting motion in the darkness, but it can even be used effectively in daytime where it may produce much less false alarms compared to other motion detection mechanisms. Here, the PIC12F675 works as a "logic interface" between the detection device and the alarm actuator. Also we use the arduino for security application so it can provides both control and integration of security systems and also the potential for central locking of all perimeter doors and windows. Security cameras can be controlled, allowing the user to observe activity around a house or business right from a monitor or touch panel. Security systems can include motion sensors that will detect any kind of unauthorized movement and notify the user through the security system or via cell phone.



Fig.4 SHS Alert Message

4 Smart Home Lighting Control Systems

Smart home lighting control systems is shown in figure.5



Fig.5 Smart Home Lighting Control Systems

At this section user will be able to control the light in SHS by two different ways by smart phone or by PIR sensor automatically if we talk about using smart phone it will be on/off option or dimmer. Dimmer are devices used to vary the brightness of a light, by decreasing or increasing the RMS voltage. It is possible to vary the intensity of light and speed of fan by using a number of types of dimmers. Modern dimmers are built from silicon controlled rectifier (SCR) instead of variable resistor, because they have higher efficiency. Since silicon controlled rectifier switches between a low resistance "ON" state and a high resistance "OFF" state, it dissipates very little power compared with the controlled load. Dimmer circuit is based on SCR control circuit which is used in lightning control and fan speed control. This section mainly discuss about the hardware construction of mai control board. Arduino UNO is chosen due to its capability to perform the both serial and USB features to establish the bluetooth and USB connection to the android application. Light sensor module is chosen because it is the low cost 2-in-1 modules. For the bluetooth module, low cost bluetooth module is chosen to establish the bluetooth connection between main control board and smart phone. The electrical current is directly connect to the main control board whereby it separates the regulator and relay circuit. The voltage regulator is constructed by common reliable regulator circuit which consists of transformer, rectifier and regulator. 5V and 3.3V DC output is regulated in order to fulfill the voltage needs of the specific components in the main control board. Moreover, the low voltage activating switches will replace the existing switches the ease of installation is taken into account for this system. The system is designed to directly install beside the electrical switches on the wall. The installation of this system eliminates the complex wiring reinstallation and overhead wiring on the wall. The existing switch connection is connected and controlled by the relay circuit inside main control board. Furthermore, multiple control boards can be installed in home. Bluetooth master device in PC/laptop is mostly able connect up to 7 devices. With these simple and low cost components, the main control board can be constructed in pretty small size but still performs the strong functions and features of the system. The application is designed in Android version 2.2 (Froyo) with API level 8. The application is designed in low API level so that the devices with higher version are compatible with it. Figure-6 illustrates the android GUI tested on smart phone.

with Version 4.0.4 (Ice Cream Sandwich). The interface is simple to use, user can simply touch on the icon to turn on/off the appliances after connected to the Window GUI or direct to the main control board.

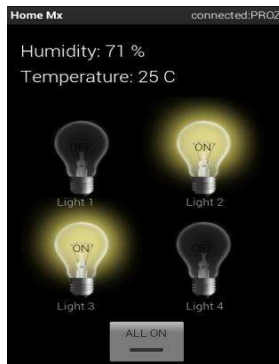


Fig.6 Android Main Control GUI

Figure-7 illustrates the interface of Android GUI selecting bluetooth device. User can connect directly to main control board (BlueBee) or connect to PC/laptop (PROZ) by bluetooth connection.



Fig.7 Android Bluetooth Connection Interface

5 SHS Remote Control System

Currently one of the existing issues that are associated to smart home applications are the fact that in a home with all sorts of automated application, there will be too many remote controls or monitoring terminal, if the user installed a range of proprietary applications from different providers [6]. There is also the fact that the access range to remotely control these devices are limited by either length of cables or wireless network coverage in a personal area network. It is a widely known fact that an important example of wireless technology application is the mobile phone technology. So ; we use RF wireless module with a remote control of pic16f & Bluetooth module with the smart phone. We use our remote control system for controlling two main applications first application is a garage door open and close. The second application is a curtains control but the remote of curtains is used only for switching between two modes (sleep mode, active mode) this modes is mainly depend on an outside sensor for sun light detection. Garage door remote control is shown in figure-8.



Fig. 8 Garage Door Remote Control

Second a curtains control but the remote of curtains is just for switching between two modes (sleep mode, active mode) this modes is mainly depend on an outside sensor for sun light detection. The outside light sensor is shown in figure.9



Fig. 9 Outside Light Sensor

6 Smart Home Temperature Sensing System for Air Conditioner

At this section we will control the home temperature automatically by using a special temperature sensor which is the LM35 sensor is used. It has an output voltage that is proportional to the Celsius temperature. It has low self heating capability, suitable for remote applications, low cost due to wafer level trimming, operates from 4 to 30v, low impedance output in this case. At this project we use this sensor in the kitchen for mentoring & control the room temperature & use a special option which is lcd which user can read the temperature and smoke level in kitchen also to be a visual alarm if this level of temperature or smoke will make a fire or if there is already a fire in the kitchen also we use the temperature sensor to measure the outside temperature in order to compare it with the given temperature to the system to control the air condition according to user comfortability. The outside temperature sensor is shown in figure-10.



Fig.10 Outside Temperature Sensor

So; if room temperature goes very high or low it can be automatically adjust the fan/AC as per the temperature.

7 Conclusions

In this paper the design and implementation of a control and monitor system for smart house has been established. Smart house system (SHS) consists of many sub-systems that controlled by Microcontroller software as a main controlling system. Also, SHS was supported by remote control system as a sub- controlling system. The system is also connected to a wireless bluetooth technique to monitor and control the electronic house equipments from anywhere in the world using both Arduino and micro controller.

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