Design of an IoT Smart Home System

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Abstract—**This paper basically deals with design of an IoT Smart Home System (IoTSHS) which can provide the remote control to smart home through mobile, infrared(IR) remote control as well as with PC/Laptop. The controller used to design the IoTSHS is WiFi based microcontroller. Temperature sensor is provided to indicate the room temperature and tell the user if it's needed to turn the AC ON or OFF. The designed IoTSHS need to be interfaced through switches or relays with the items under control through the power distribution box. When a signal is sent from IoTSHS, then the switches will connect or disconnect the item under control. The designed IoT smart home system can also provide remote controlling for the people who cannot use smart phone to control their appliances Thus, the designed IoTSHS can benefits the whole parts in the society by providing advanced remote controlling for the smart home.**

The designed IoTSHS is controlled through remote control which uses IR and WiFi. The IoTSHS is capable to connect to WiFi and have a web browser regardless to what kind of operating system it uses, to control the appliances. No application program is needed to purchase, download, or install. In WiFi controlling, the IoTSHS will give a secured Access Point (AP) with a particular service set identifier (SSID). The user will connect the device (e.g. mobile-phone or Laptop/PC) to this SSID with providing the password and then will open the browser and go to particular fixed link. This link will open an HTML web page which will allow the user to interface between the Mobile-Phone/Laptop/PC and the appliances. In addition, the IoTSHS may connect to the home router so that the user can control the appliances with keeping connection with home router. The proposed IoTSHS was designed, programmed, fabricated and tested with excellent results.

Keywords— internet of things, microcontrollers, smart home

I. INTRODUCTION

In the Kingdom of Saudi Arabia, the elderly people represent 8% and the special needs people represent 7% of the society[1], [2] These two part of the society are facing a real problems with the common conventional methods of controlling the appliances inside the home (i.e. switches). Based on our survey, we concluded that the people who are interested in controlling their home appliances remotely are as following: 79% among the special needs people, 91% among the elderly people and 88% among the normal people. Therefore, the data we collected from the survey indicates the importance of providing a solution which is realistic, durable, cost-efficient, and simple in use and installation.

Nowadays, internet is everywhere, each home have its own WiFi Network, everybody has a smart phone. Which these enhancement achieved to the humanity, opened the door to a new terminology called IoT (Internet of Things). IoT is the networking of physical devices embedded with electronics, software, sensors, actuators and network connectivity that enable these objects to collect and exchange data [3-10]

To overcome the aforesaid problems the *Design of IoT Smart Home System* is proposed. This system also provide remote controlling for people who cannot use smart phone to control their appliances such as some of the special needs people and uneducated elderly people.

II. THE BASIC SCHEME

The basic scheme for the proposed IoT Smart Home System (IoT SHS) is shown in Fig-1. which is intended to be a product of small in size, easy in control and cost efficient. It is targeting the whole parts in the society by providing advanced remote controlling for the home appliances.

It uses WiFi and IR technology according to the standards for remote controlling of the appliances. Normally in each room there's Lights, Air Condition, Fan and Plugs which are very essential in each room in any house which our product is capable to hold them. This product will not make change in the room electrical distribution lining, everything will be kept

as it is, but only the relays will be connected in series with the switches or plugs in the distribution box.
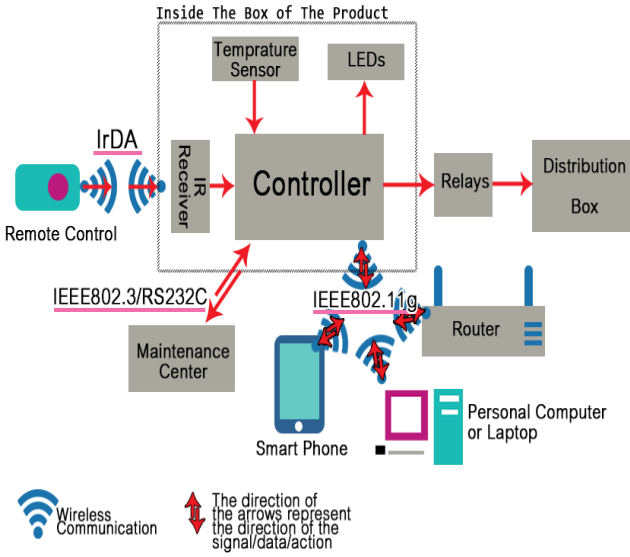

Fig. 1 The Basic scheme for the proposed IoT Smart Home System.

The relays will be normally connected, this is because if any fault occurs to the IoT SHS (i.e IoT SHS not working), the loads will be under control by the conventional switches and the plugs will be electrically fed. When a signal is sent from IoT SHS, then the relays will be disconnected, which by this approach, the appliances are being controlled effectively.

Controlling the appliances is done through remote control which uses IR and WiFi. Our proposed design will allow any device capable to connect to WiFi and have a web browser regardless to what kind of operating system it use, to control the appliances. No application program is needed to purchase, download, or install. In the remote control there will be a buttons which are reserved to each relay or appliance, and also a single button to turn all the appliances off by one press.

In WiFi controlling, the product will give a secured Access Point (AP) with a particular SSID. The user will connect the device (e.g. mobile-phone or Laptop/PC) to this SSID with providing the password and then will open the browser and go to particular fixed link. This link will open an HTML web page which allowing the user to interface between the Mobile-Phone/Laptop/PC and the appliances. In addition, the product may connect to the home router so that the user can control the appliances with keeping connection with home router and keep enjoying with internet connection while controlling the room appliances. The red arrows represent the direction of the signal that provided from or to the controller. The blue waves symbol represent the wireless connection between the devices (either WiFi or IR). For WiFi wireless communication, the standard IEEE802.11g is used, for hardwired communication an IEEE802.3/RS232C is used and for Infrared communication an IrDA standard is used.

The *controller* is WiFi based microcontroller, which is like the heart of the system which control all elements connected to it. *Temperature sensor* is provided to indicate the room temperature and tell the user if it's needed to turn the AC ON or OFF. *LEDs* is provided to show the status of the switches (relays) which this will give information to the user to know which is ON and which is OFF. *IR receiver & remote control* is provided to allow the elderly, special needs people and people who are cannot use the smart phone, to control the switches with more comfort way to them. The *Relay* is acts as switch but unlike the conventional one. When a signal is sent form the controller to the relay, the relay is switched. The Relays are connected to the distribution box, which is the box that include the all lines of the lights, AC and fan.

The Microcontroller can either acts as an Access Point (AP mode) or Station mode. AP mode allow the smart phone to connect with the controller through a local network (Intranet). Station mode will allow the controller to connect to the router. By connecting to the router, the user can enjoy accessing to internet in his smart phone and in same time he can control his appliances without signing out from the home router. The *Maintenance Center* is used for updating the software of the Controller, or fixing the software problems. It's normally a computer which communicate with the microcontroller through *USB to UART converter*. This converter uses the standards IEEE802.3 or RS232C. These two standards provide three important port needed to allow the communication between the Controller and the computer. These ports are *Tx* (Data Transmit), *Rx* (Data Receive) and *GND* (Signal Ground).

III. THE DESIGN AND IMPLEMENTATION

The modules and interfaces of the proposed IoTSHS are shown in Fig-2. The WiFi based Microcontroller ESP8266 has been used which hass HIGH logic +3.3V, LOW logic GND and V_{CC} +3.3V [10].
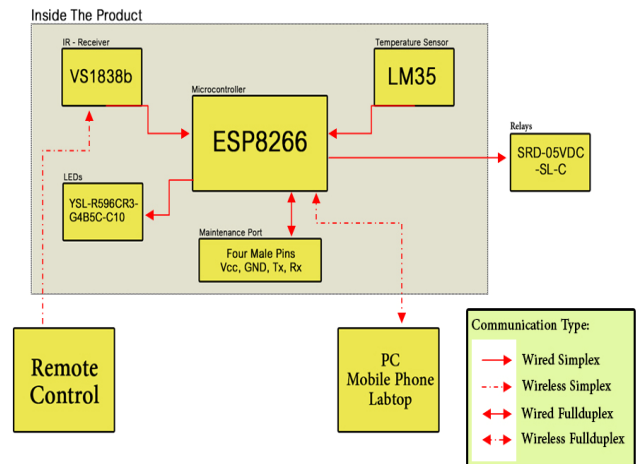

Fig. 2 The modules and interfaces of the IoTSHS.

To monitor the room temperature a low-cost temperature sensor LM35 with $0.5C^o$ ensured accuracy at $+25C^o$ is interfaced with the WiFi based Microcontroller ESP8266 It is rated for full -55^0C to $+150^0C$ range [11]. An IR receiver VS1838b is also interfaced with microcontroller for the elderly people who do not use the smart mobile phone. The other interfaces are relays (SRD-05VDC-SL-C) [12], LEDs and maintenance port which includes four male pins viz., V_{CC}, Ground, T_x and R_x terminals. The mobile or PC/Laptop are to be interfaced through WiFi on the microcontroller. The complete circuit diagram of the IoTSHS is given in Fig. 3.

The designed double sided PCB is shown in Fig. 4. The layout of each component is designed based on the dimensions provided in the datasheet of each component. The red colored lines are top-side copper in the PCB, the blue colored lines are bottom-side copper in the PCB and the Pink links are both-sided copper on the PCB. The Autodesk fusion 360 was used to design the design the container box. Once the complete circuit is assembled on the designed PCB the microcontroller was programmed using USB to UART converter.
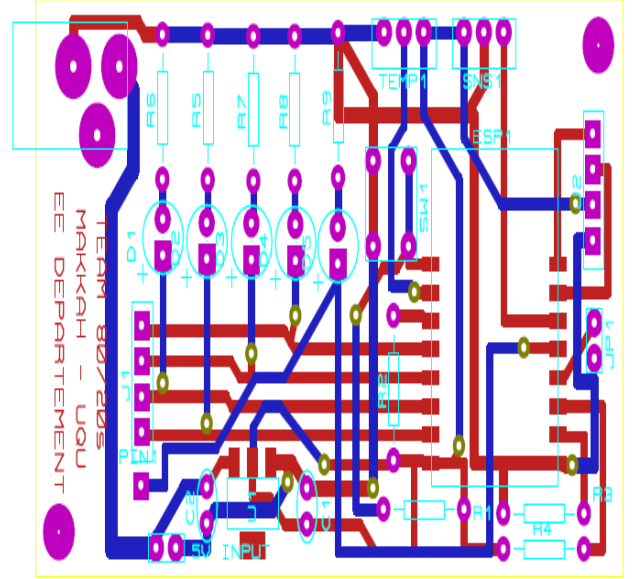

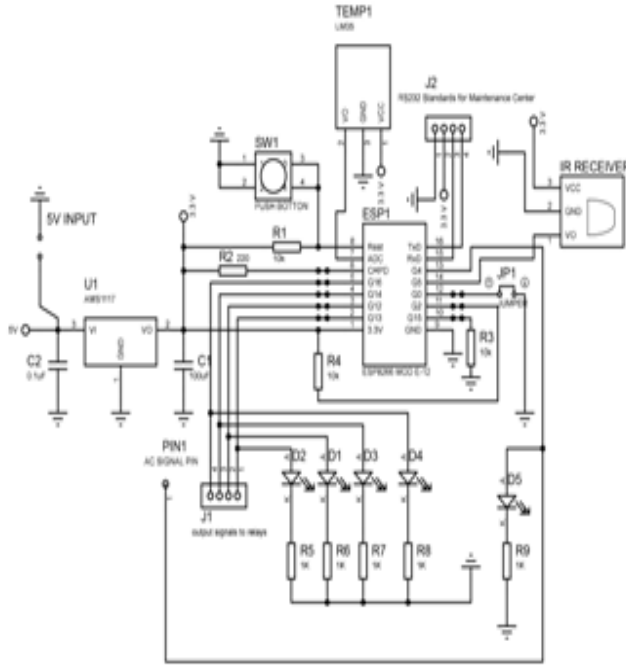Fig. 4 The designed PCB of the IoTSHS.

Fig. 3 The circuit diagram of the designed IoTSHS.

IV. STRUCTURE OF THE CONTROLLING WEB PAGE

The structure of the controlling web page is shown in Fig.5, The home page includes three main things:
- Select your home WiFi network,
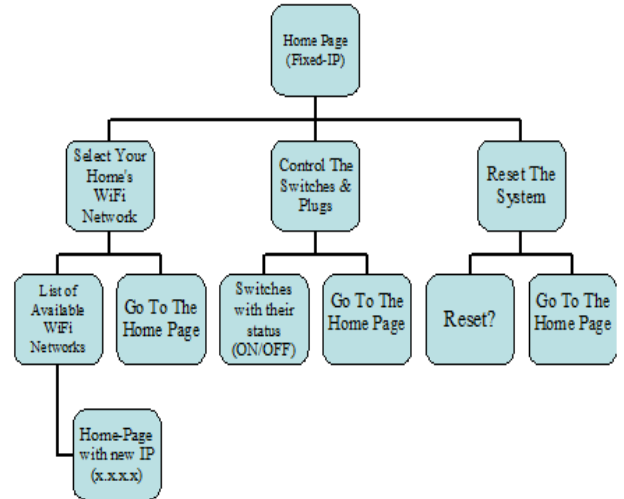- Control switches and plugs,
- Reset the system.

Fig. 5 The structure of the controlling web page.

By pressing *Select your home's WiFi network* a new page will come with list of WiFi SSIDs available around, the user can select his home WiFi network to connect the product with home router. By doing this the user don't have to sign out from his home router to control his appliances. A new link (192.xxx.xxx.xxx) related to the router is provided to access to the product though router. The second choice in the home page is *Control The switches & plugs*. In this section, the user will interface with his appliances (ON/OFF). A temperature readings is provided to let the user know if it's needed to switch the AC ON or OFF while he is outside the room.

The last choice is *Reset the system*. This choice is provided to turn all the appliances OFF at same time. *Go To Home Page* choice is provided in each page. This is because the browser deals with the links. Each choice represent a link, when any choice is pressed, a link of that choice will be saved in the browser. When a *Back* button provided by the browser is pressed, the previous link will be chosen!. This is become danger for the appliances which causes instability of the switches in the system. Therefore, we provided this button to return to the home page safely. Fig-6 shows the proposed web-page in the mobile phone. The Fig. 7 shows the complete circuit on PCB packed in the designed case.
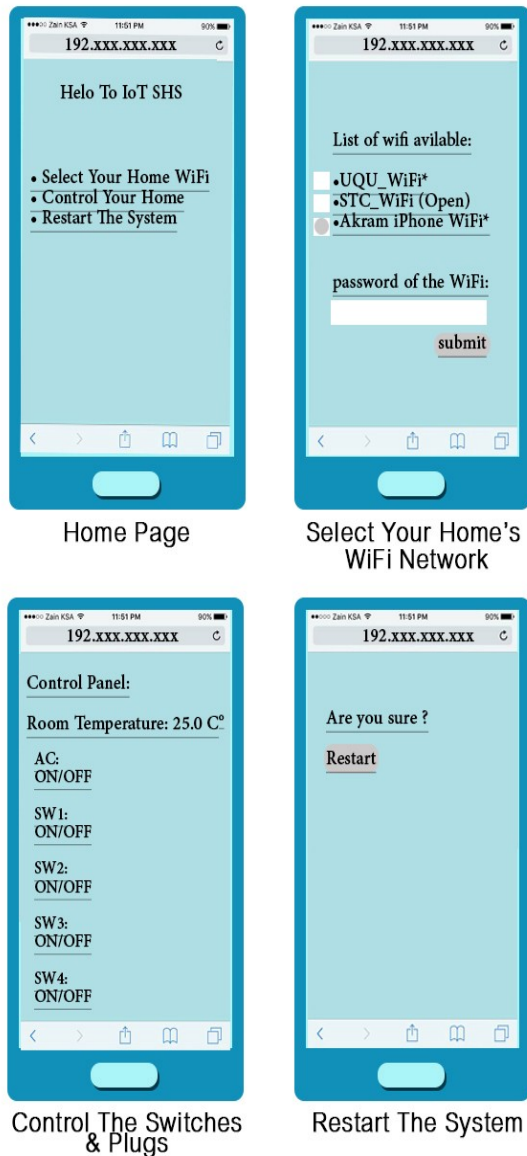

Fig. 7 The end product of the Designed IoTSHS.

V CONCLUSION

This community-based design (IOT SHS) is implemented due to its importance of serving different parts of the society. This design covered the needs of normal, elderly and special needs people. By applying this design, we are joining the technology with the society in advantage to achieve the welfare of the society.

An IoT Smart Home System (IoTSHS) is designed which can provide the remote control to smart home through mobile, infrared(IR) as well as with PC/Laptop. The controller used to design the IoTSHS is WiFi based microcontroller. Temperature sensor is provided to indicate the room temperature and tell the user if it's needed to turn the AC ON or OFF. The designed IoTSHS is to be interfaced through relays with the items under control through the power distribution box. When a signal is sent from IoTSHS, then the relay will connect or disconnect the item under control. The designed IoT smart home system can also provide remote controlling for the people who cannot use smart phone to control their appliances Thus, the designed IoTSHS can benefits the whole parts in the society by providing advanced remote controlling for the smart home.

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Fig-6: The proposed web-page.

with home router. The proposed IoTSHS was designed, programmed, fabricated and tested with excellent results.

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