UNIVERSAL ANDROID REMOTE CONTROLLER: AN IoT BASED SMART HOME AUTOMATION SYSTEM

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Abstract: Smart home automation technology is an application of IoT. Using this, controller is used to control home devices or appliances (inside or outside) in a smart home. With numerous connected devices and appliances, there is a difficulty in operating as complexity increases due to various controllers comprising of several buttons and is not User-friendly. It is also noticed that complicated formats and functions used for controlling home appliances may produce large transmission messages e.g., eXtensible Markup Language (XML) messages, for these kind of things a universal remote console are constructed to increase the convenience of the smart home control system. On the other hand, with unnecessary, nonfunctional, and even useless functions or buttons appear on the screen of the controller, a higher probability of incorrect operations may be generated when controlling appliances. The idea of universal remote controller (URC) is introduced to integrate multiple functions of home devices or appliances into a single remote controller. A unique intelligent universal remote controller (Command-Based, Voice-Based) is designed in order to simplify these problems and resolve the issue of multiple remote controllers. A sensor based technology is used to create a Wireless Home Automation System (WHAS) where devices are controlled and managed by sensors (LDR, Gas, Temperature, Humidity etc.,) and a URC. Sensors are used to control a device or appliances and can also generate an alert upon the detection of abnormal conditions. The proposed system is implemented in a mobile phone device which supports Android operating system which has several open source Universal Plug-n-Play libraries useful for development and implementation of UI. Therefore, the device or appliance can be automatically detected via a network (Wi-Fi) and a UI is dynamically generated from descriptions and properties of the device or appliance. An android smart phone device is used as a Universal Remote Controller (URC) for controlling all the devices or appliances in and around the home area.

Keywords: *IoT, Smart Home, Sensors, Wi-Fi, Android.*

I. INTRODUCTION

Internet of Things (IoT) [1] is a technology that connects all things and the Internet in smart spaces. By implementations of intelligence with sensing devices, IoT has been widely applied to different fields, such as smart homes [2], [3]. The application fields in smart homes [4] incorporate smartness into home areas for comfort, safety, security, healthcare, and energy conservation [5], [6]. The need for comfort and a convenient life are especially important in smart homes. Thus, home automation is one of the most essential and critical components for the IoT-based smart home technology. Home automation systems are used to control home devices or appliances in smart homes and provide automatic remote control inside or outside homes [7].

Fig 1: Home automation system

Nevertheless, although remote control provides convenience and ease of use, some major problems require consideration and improvement, such as how to provide an intuitive and user-friendly remote control scheme in IoT-based smart homes [8].

II. RELATED STUDIES

Currently, the majority of devices and appliances in smart homes are equipped with a remote controller, which includes a number of buttons and wireless transceivers [9]–[11]. This setup provides higher operational complexity around the space with numerous devices or appliances. Thus, the idea of the universal controller (URC) is introduced to integrate multiple functions of home devices or appliances into one single remote controller [8], [12]–[13]. Nevertheless, various functions and buttons of a URC results in more complicated operations, the problems of intuition and user-friendliness remain. Numerous solutions are proposed to develop URCs with a liquid crystal display (LCD) screen, networking capability, and several techniques [10]–[13]. Typical techniques for these types of URCs include *universal plug and play* (UPnP) and *universal remote console specification of the alternate interface access protocol* (AIAP-URC). Built in with these techniques, the device or appliance can be automatically detected via a network [8]–[11], and a UI is dynamically generated from descriptions and properties of the device or appliance [11]–[12].

Because these techniques facilitate control setting and increase the ease of control, intuition and user-friendliness can be improved. Although the UPnP technique discovers devices around a specific space [18]–[21], multiple instances of the same type of devices or appliances are frequently located in this specific area, e.g., lights/lamps. Therefore, these lights/lamps are displayed on the screen of the controller; the mapping and correspondence between the device's UI and the actual device may confuse users. The kind of control systems is not sufficiently intuitive and user-friendly to users.

A. Wisdom families in housing as a platform using the integrated wiring technology, network communication technology, intelligent family-system design scheme of safety technology, automatic control technology, audio and video technology to integrate the household life related to facilities., schedule to build efficient residential facilities and family affairs management system, enhancing the Home Furnishing safety, convenience, comfort, artistic, and realize environmental protection and energy saving of residential environment.

Smart home is reflected under the influence of Internet of things. Through the technology of the Internet of things, smart home connects all kinds of family devices together(such as audio and video equipment lighting, curtain control, air conditioning control, security systems, digital cinema system, video server, shadow cabinet system, network appliances etc.). Providing home appliance control, lighting control, telephone remote control, remote control, anti-theft alarm, indoor and outdoor environmental monitoring, HVAC control, infrared transmitting and various programming timing control function and method. Compared with the ordinary family, smart home is not only the traditional living

functions[3], also have building, network communication, information appliance, equipment automation, set system, structure, service, management as an efficient, comfortable, safe, convenient, environmentally friendly living environment, provide a full range of interactive information. Smart home help families and the outside to keep the exchange of information flow, optimize people's way of life, to help people manage time effectively, enhance the safety of the Home Furnishing life, even for a variety of energy cost savings.

The intelligent Home Furnishing as a kind of new industry is a leading period and growth period of the critical point. The market consumption concept has not formed. But with the further implementation of intelligent Home Furnishing market popularization, to foster the um of consumer habits, the consumption potential of intelligent Home Furnishing market must be huge. This industry prospects are bright. Because of this, domestic intelligent Home Furnishing excellent production enterprises attach more and more importance to research on the industry market, especially the thorough research to the enterprise development environment on the customer and the change of customer demand trend. A large number of outstanding domestic intelligent Home Furnishing brand becoming the leader of this industry rapidly and gradually. So far, intelligent Home Furnishing in the China has experienced nearly 12 years of development. From the original dream, to today's real into our life, it has experienced a difficult process.

B. Remote controller can be developed with considering of following issues:

Using available communication channels, PC as the main server and an emergency controller. MCRC (channels + control devices) can be classified into the three main categories such as: a.Internet (PDA, SP, Web page) b.GSM modem and PC), Telephone lines (DTMF and microcontroller)

Local control unit of MCRC: The local control unit of MCRC [2] contains a PC and two microcontrollers. The duties of control unit are: Receiving commands from user, detecting and interpreting this command, sending the result to devices and informing the user by feedback signals.

C. This investigation presents an agent-based smart (ABS) home system that automates home-service operations. The ABS[8] home system comprises three subsystems, namely user interface, home gateway, and home functionality. ABS home users can request services with handheld devices through an ABS user interface, and receive them through an agent cooperation mechanism. This investigation has designed three agents and implemented them in the agent platform: the manager agent schedules the service processes; the service agent manages service requests, and task agent executes service operations. With home-functionality subsystems including location servers, message centers, and multimedia centers in ABS homes, services are conveniently provided, efficient, and comfortably manipulated. The Universal Plug and Play[1]-[8] feature adopts IP network technology to control, manage and transfer data among functionality devices in ABS homes. The proposed service-scheduling mechanism provides services that are conveniently provided, efficient, and comfortably manipulated. This study presents an implementation of the ABS home system to illustrate the feasibility of the proposed architecture. The study also presents a performance evaluation to

demonstrate the effectiveness of the proposed mechanism.

Therefore, the proposed control system always displays one control user interface of a single device. These details help us to achieve the purposes of the intelligent universal remote control system for home appliances.

III. PROPOSED SCHEME

Here, the comprehensive system architecture and its primary components are discussed in Section III-A and Section III-B and Section IV describes the detailed workflows of the proposed Universal Android Remote Controller. The key features of the device control profile (DCP) are presented in this:

A. *System Architecture*

In this project we required operating voltage for ARM controller board is 12V. Hence the 12V D.C. power supply is needed for the ARM board. This regulated 12V is generated by stepping down the voltage from 230V to 18V now the step downed A.C voltage is being rectified by the Bridge Rectifier using 1N4007 diodes. The rectified A.C voltage is now filtered using a 'C' filter. Now the rectified, filtered D.C. voltage is fed to the Voltage Regulator. This voltage regulator provides/allows us to have a Regulated constant Voltage which is of +12V. The rectified; filtered and regulated voltage is again filtered for ripples using an electrolytic capacitor 100µF. Now the output from this section is fed to microcontroller board to supply operating voltage.

In this proposed scheme, all the sensor values are collected by microcontroller and are displayed in the LCD. Based on the sensor values the devices will be controlled. If the room temperature is increased the DC fan will automatically on. If gas is detected motor is powered ON. If LDR value is low then the bulb will automatically on through relay. The information related to device status and the sensor values will be updated in the Wi-Fi connected devices. The mobile must have an app called "connection terminal" and the mobile must be paired with the Wi-Fi module. The devices in kit can also be controlled by giving commands through Wi-Fi module.

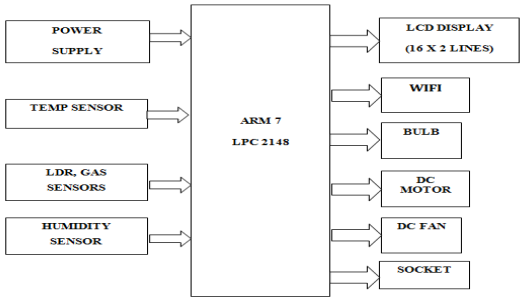

Fig 2: Block diagram

B. *Components of Kit*

Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written. **ARM7TDMI:** ARM is the abbreviation of Advanced RISC machine, it is the name of a class of processors and is the name of a kind technology too. The RISC instruction set, the related decode mechanism are much simpler than those of the CISC designs. **Liquid-crystal display:** LCD is a flat panel, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock.

LDR: LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits.

Gas sensor: They are used in gas leakage detecting equipments in home & industry, for detecting of LPG, i-butane, propane, methane, alcohol, Hydrogen, smoke. The Rs of the sensor is obtained through effected voltage signal output of the RL which series-wound. The relationship between them is described:

Rs\RL = (Vc-VRL) / VRL

Humidity sensor: Humidity sensor is a device that measures the relative humidity of in a given area. It can be used in both indoors and outdoors. These are available in both analog and digital forms. These are converted into the digital format via an ADC process which is done by a chip located in same circuit.

Temperature sensor: A thermistor is a type of resistor whose resistance is dependent on temperature. The TMP103 is a digital output temperature sensor in a four-ball wafer chip-scale package and is capable of reading temperatures to a resolution of 1°C.

DC Motor: DC motor relies on magnetic law. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of coil.

Fig 3: Sensors: a. LDR b. Gas c. Temp d. Humidity

Wi-Fi: Wi-Fi is a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. Wi-Fi is a trademarked phrase that means *IEEE 802.11x*. To connect to an access point, computers & devices must be equipped with wireless network adapters and is supported by many applications and devices including video game consoles, home networks, mobile phones and other types of consumer electronics.

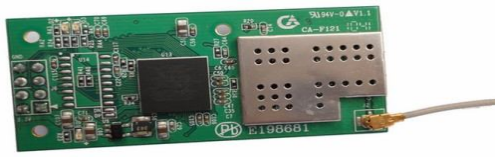

Fig 4: Wi-Fi Module

VSD03 is the new third-generation embedded UART-WIFI modules studied by VSD TECH. It is an embedded module based on UART serial, according with the WIFI wireless WLAN standards, it accords with IEEE802.11 protocol stack and TCP/IP protocol stack and it enables data conversion between the user serial and the wireless network module. Through this module, traditional serial devices can easily access to the wireless network. Its main features include:

Interface:

- 2*4 pins of Interface: HDR254M-2X4
- The range of baud rate: 1200~115200bps
- RTS / CTS Hardware flow control
- single 3.3V power supply

Wireless

- support IEEE802.11b / g wireless standards
- support range frequency: 2.412~2.484 GHz
- support two types of wireless networks:
    - Ad hoc and Infrastructure

- support multiple security authentication mechanisms:
    - WEP64/WEP128/TKIP/CCMP
    - WEP/WPA-PSK/WPA2-PSK
- support quick networking
- support wireless roam

IV. SYSTEM IMPEMENTATION

The system development kit has the components such as ARM 7 board, Wi-Fi modem, DC Fan, DC Motor, Bulb and LDR, Gas, Humidity, Temp sensors.

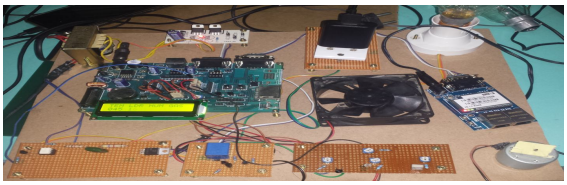

Fig 5: System development kit

In this project we required operating voltage for ARM controller board is 12V. Hence the 12V D.C power supply is needed for the ARM board. After LCD initialization & interfacing to microcontroller, commands & data to LCDs with a time delay are sent in order to display alerts upon detection from sensors. When sensors detect any abnormal conditions, they immediately give alerts on LCD display screen and a buzzing noise is generated from the buzzer. To illustrate abnormal conditions like high humidity, high gas, high temperature and low light intensity variations are also displayed, then a need for device automation arises. The devices can be automated in two-ways either by text-written (command-based) or speech recognition (voice-based).

If room temperature is increased, gas is detected then DC fan and motor will automatically on respectively. If LDR sensor detects low value then bulb will automatically on through the relay. The information related to device status and sensor values will be updated in the Wi-Fi connected devices. The mobile must have an app called “connection terminal” and be paired with Wi-Fi module and be controlled by giving either commands or speech recognition.

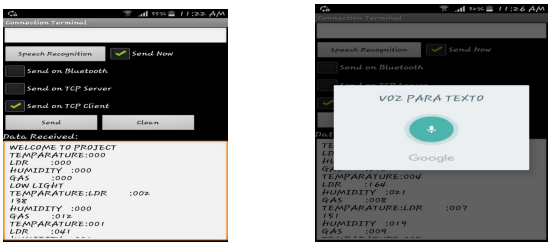

Fig 6: Two-ways of device automation

DC Motor: When an increase in humidity, alert on LCD display and buzzing sound are generated and notification is sent to Wi-Fi connected device and can be controlled by sending commands like “@MON*” & “@MOFF*” to switch on/off Dc motor.

Fig 7: High humidity alert on LCD display

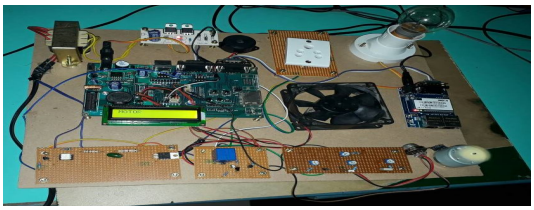

Fig 8: Rotating DC Motor

DC Fan: If there is an increase in gas and temperature levels then alert on LCD display and buzzing sound are generated and notification is sent to Wi-Fi connected device. Then commands like

"@FON*" and "@FOFF*" are sent to switch on/off DC fan. Devices can be controlled when threshold ranges are exceeded.

Fig 9: High gas and temp alert on LCD display

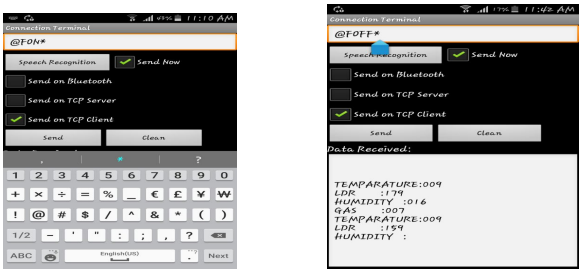

Fig 10: Commands to control DC Fan

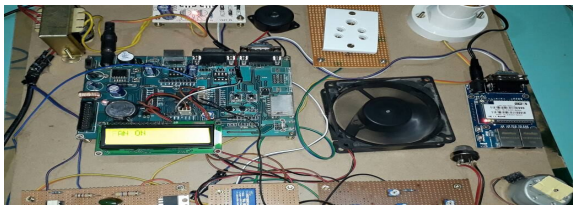
Fig 11: Rotating DC Fan

Sockets: Switch boards & sockets can also be controlled like any other home appliances by using commands like "@S1ON*" & "@S1OFF*".

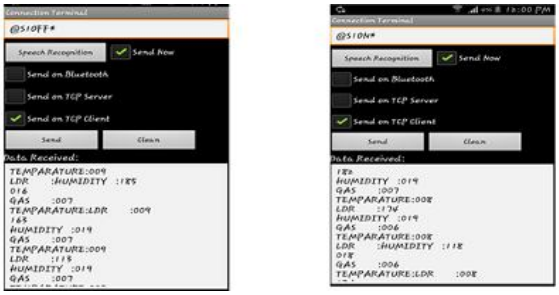

Fig 12: Commands to control socket

Bulb: Using LDR sensor, light intensity mechanism can be monitored & controlled by using commands like "@BON*" and "@BOFF*" to perform switch on/off operations. The light intensities can be varied with commands per se "@B25*" and "@B50*" to increase 25% and 50% light intensity respectively.


Fig 13: Commands to operate & vary Light intensity

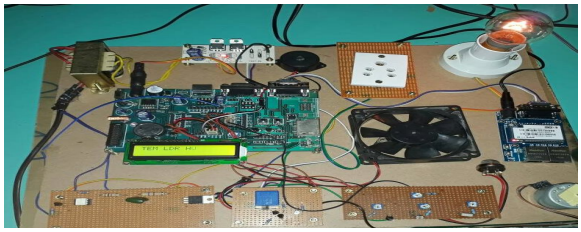
Fig 14: Bulb glows after sending "@B25*" command

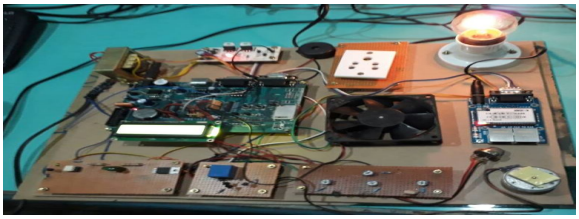
Fig 15: Bulb glows after sending "@B50*" command

V. CONCLUSION

An intuitive control system with a set of user friendly operations, is proposed for controlling connected devices/appliances in IoT-based smart homes. The devices can be operated either by the text-written or speech recognition by a UI. User Interface here is an android based smart phone. Multiple devices can be controlled by using a Universal android remote controller. Using highly advanced IC's and with the

help of growing technology the project has been successfully implemented.

Nevertheless, the implementation of proposed system is limited to only certain devices. For example, if a room is comprised of 3-4 lights then providing unique instance numbers or values to each of it can make work easier. Therefore, to control devices / appliances with a more precise mechanism, and to support auto discovery of abnormal conditions are two possible directions for future research.

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