ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.7

A Universal Remote Control System for a Smart Home Appliance

Manasa K N[1], Sowmya B[2]
Assistant Professor[1, 2]
Department of CSE
Sambhram Institute of Technology, Bangalore, India

Abstract:
Smart home is a field that can be represented with the help of Internet of Things(IOT). On a day to day basis we use numerous appliances and devices which could be controlled and coordinated with the help of a remote control system. Here we are introducing a universal control system for home appliances which enables easy and interactive accesses by pointing it to the targeted device. The result shows, that the universal remote control system is a useful and suitable control system for a smart homes which are IOT based. These appliances can also be controlled using a smart phone equipped with infrared, IR universal serial bus(USB) dongles and also using some open source universal plug and play(UPnP) libraries. According to this mechanism only one device can be controlled at a time using IR remote control system, pointing to the targeted control box.

Keywords: IOT, Remote Control System, UPnP, USB Dongle, Device Control Profile, Smart Home, IR

I. INTRODUCTION

Internet of things is a technology which is used to study a group of interconnected objects that gathers and exchanges data with each other using sensors of a size of a rice grain. With the intelligence of these sensors IOT has its wide range of applications such as [1]Smart homes [2]Smart city [3]Smart Farming [4]Healthcare [5]Smart Industry [6]Energy Conservation and many more. The process of home automation is to control the various home appliances using a central control system. The need for comfort and convenient life are extremely important for a smart home and remote control system provides these with an ease.

The goal of this paper is to develop a universal remote control system for home appliances with a user friendly interface. The devices/appliances are automatically detected by the remote control system when it is pointed to the targeted device and the UI is displayed on to the user friendly display of control system, which helps users to control and monitor the targeted appliances in IOT based smart homes. A design of a finite state machine is used as a model to indicate the various state of a device and the dependencies among the states. To decrease the bandwidth consumption we are using a multiple bit string formatted control codes that represents the controlled operations.

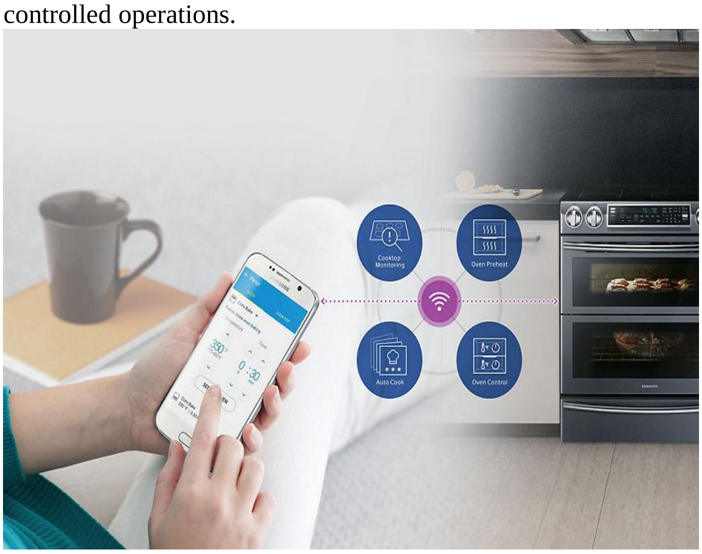

Fig.1: Proposed control system to control a micro wave oven

Fig.1 shows an example for controlling a microwave oven. In this a remote controller is a mobile phone, a oven can be controlled by pointing to a control box of a oven. Control process of the oven includes two state dependencies. First, the oven is powered off it can only be powered on by pressing the power button. Second, when the oven is in sleep or natural mode, the temperature button has no effect since the temperature is automatically adjusted. By considering the state dependencies only the relevant functional buttons are displayed on to the screen of the controller.

II. EXISTING SYSTEM

Most of the current appliances are equipped with a remote controller, with numerous buttons which are highly complex, therefore it is efficient to use a universal remote controller which handles multiple appliances. Appliances can also be controlled using voice command due to environmental noise the command maybe miss interpreted by the controllers. On the other hand many unnecessary, non functional and useless buttons may cause incorrect operations while controlling the appliances. Hence to avoid inactive and non functional buttons we use sate dependencies of the appliances to control them. For example, when a micro wave oven is powered off, the only functional button that is needed is power on button. When oven operates in the moderate mode the remaining buttons are inactive. It is also noticed that complex formats and functions of XML messages to communicate with the targeted appliance consumes more bandwidth then the proposed scheme.

III. PROPOSED SYSTEM

A. System Architecture

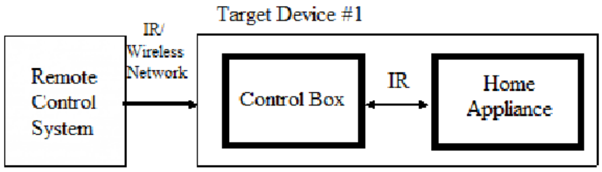

Fig 2. System architecture of control system

The system architecture consists of two parts 1) the number of targeted devices embedded within control box which interacts with remote control system and 2) Remote control system.

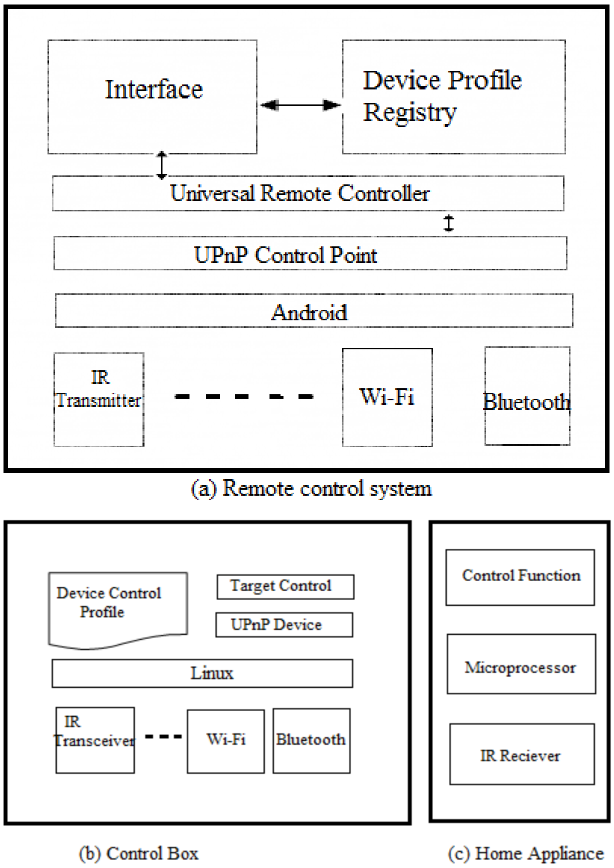

Fig 3. Software stack of Remote Control System, control box and target device.

- **Interface** according to the current state of the targeted device a UI is created.
- **Device Profile Registry** the information about the current state and dependency between each state of the current targeted device is stored in registry.
- **Universal Remote Controller** it is the main component of remote control system which analyzes the current state of the device and receives device control profile (DCP) from the targeted device .
- **UPnP Control Point** it transmits the control commands to the targeted device. UPnP control point is a set of protocol that enables networked devices to discover each other and to establish a communication between them.
- **Communication Interfaces** communication between Remote control system and the targeted device takes place using IR, Wi-Fi, Bluetooth and Zigbee.

Remote control system which controls target device is composed of two parts [1]Control Box [2]Home appliance. The functions of control box are detailed as follows

- **Device Control Profile(DCP)** Appliances can be controlled by remote controller by transmitting the messages. Using the XML complicated message control format the bandwidth consumption increases. To solve this problem DCP uses multiple bit string encoding scheme and finite state machine. The finite state diagram to represent state transition for controlling the oven is illustrated in the Fig 4.
- **Target Control** generates DCPs and transfers the corresponding DCPs to the URC control of the remote control system.
- **UPnP Device** communicates with the UPnP control point of the remote control system and the received UPnP commands are executed.
- **Linux Platform** it is the operating system platform of the control box.
- **Information communication interfaces** it uses IR transceiver to receive a detected signal from the remote control system when it is pointed to the IR transceiver of the control box. Zigbee, Wi-Fi, Bluetooth can also be used as communication means.

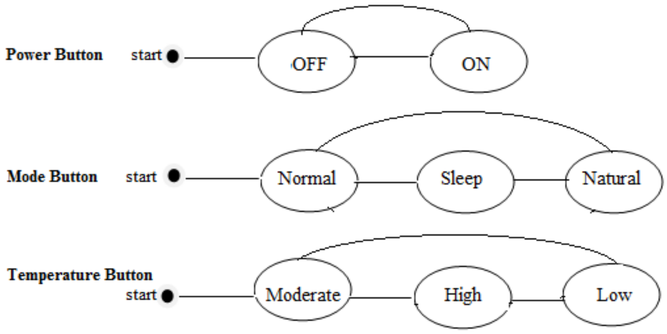

Fig 4. Finite states of a Microwave Oven's control function

Fig 4 illustrates an example of state transitions for controlling a microwave oven with three buttons. By using FSM only the states that are relevant for control flow can be represented in UI. The control process includes two state dependencies. First, the oven is powered off it can only be powered on by pressing the power button. Second, when the oven is in sleep or natural mode, the temperature button has no effect since the temperature is automatically adjusted.

Bit-strings	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
Function Button						Temperature	Mode	Power
Status parameter	Low	Moderate	High	Natural	Sleep	Normal	On	Off

Fig 5. Function buttons and status parameters of a Microwave oven represented in bit-vector forms

The bit string encoding scheme is a more flexible design which includes all possible operational states. In Fig 5 two rows that is representing function buttons and status parameters have to be declared in DCP header. The transition state of the oven can be transferred to FSM after the encoding process and is represented in bit string formats as in Fig 6 and is treated as a control operation.

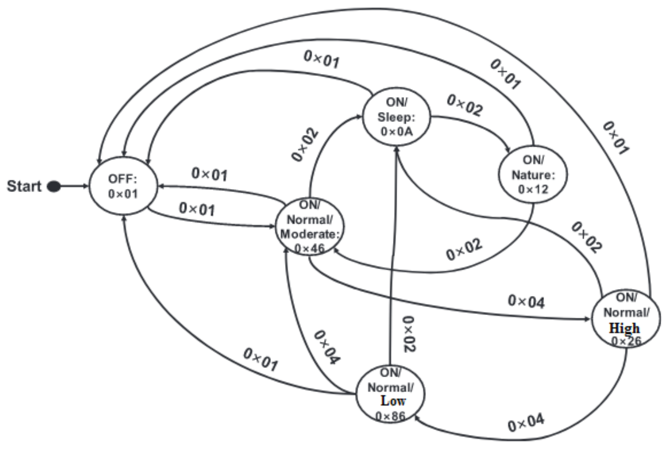

Fig 6. Transition state diagram of Microwave oven operational states as represented in bit strings format.

IV. SYSTEM IMPLEMENTATION

A prototype for microwave oven has been implemented to verify the feasibility of the proposed remote control system.

A. Demonstration of Proposed Prototype

Proposed control prototype have been launched in IoT-based smart homes. The Remote Control system is implemented on a commercial smartphone platform, which is implemented with 1GB RAM, 16GB ROM, Bluetooth, Wi-Fi, and universal serial bus(USB) interface. In addition, all software components such as UPnP Control Point and URC Control are developed based on the Android 4.1 version.

The control box is provided with an ARM7-based development board, which is equipped with 200MHz, 1MB Flash, 64MB NAND Flash, 64MB SDRAM, and 22 general purpose input/output(GPIO) interfaces. The internal software components are implemented based on the Linux 2.4.18 version.

Fig 7. ARM-7 board

The communication between the remote control system and the control box are IR, Bluetooth, and Wi-Fi. The control gateway is provided with 2GB SDRAM, one USB IR receiver, and two USB connectors. USB cable is used to transfer internal data between control gateway and the power line controller, via a power line network the plugs from 1 to 8 are connected to a power line.

B. System Operations and UIs Demonstration

The operational UIs for controlling a oven are shown in Fig 8. A smart phone, which is treated as the remote control system, is picked up, and the be ready signal is sent to the control box, as shown in Fig 8(c). Next, the remote control system receives the DCP from the control box via a Bluetooth or Wi-Fi wireless network after the remote control system is pointed to the control box of the oven. The icon and current state of the oven are displayed on the control screen as shown in Fig 8(b). As the power button is pressed, the state display on the screen of the remote control system is switched to power on. The oven is operated in normal mode with a moderate temperature, as shown in Fig 8(c). After the temperature button is pressed, the oven is operated in natural mode without temperature control function.

(a) (b)

(c)

Fig 8. Andoid user interface (a)Android app icon (b)Home page (c)Setting oven's temperature

C. Bandwidth Consumption Comparisons

The two previous remote control approaches are RF4CE-based approach and an XML-based approach are applied for the comparison with the proposed system. The comparisons of bandwidth consumption are summarised in Table 1. The DCP file size for a oven in the previous XML approach is 885 bytes. For the RF4CE-based approach, which is based on the definition of the consumer electronic remote control frame, the consumer electronic control frame, and the state transmission function, the size of the DCP is 288 bytes for a oven with six state machines. The file size of the DCP of the proposed control system is only 242 bytes.

Table 1: Comparison Of Bandwidth Consumption For

Transmission Data Size	Remote control system	RF4CE-based	Conventional XML
File size of the DCP(bytes)	242	288	885
Size of command set (bytes)	2	2	3
Size of minimum state return (bytes)	2	182	213
Size of maximum state return (bytes)	2	332	378

IV. CONCLUSION

The implementation of the proposed control system is currently limited to IR sensors. More state dependent devices must be identified. Therefore, to control devices with a more precise pointing mechanism, and support an auto discovery mechanism of state dependencies are two possible directions for future research.

REFERENCES

[1] M.javier et al., "From the internet of things to the internet of people", IEEE Int.Comput., vol.19,no.2,pp. 40-47, Mar.2015.

[2] Wang, L.Hu, J.Zhao, "A survey from the perspective of evolutionary process in the Internet of Things," Int. J.Distrib. Sens. Netw., vol.2015, no.9, pp.1-9, jan.2015

[3] https://developer.android.com/studio/index.html

[4]https://developer.android.com/training/basics/firstapp/index.html

[5] https://developer.android.com/training/index.html

[6] K. NarendraReddy (M.Tech), P.Sukumar "Controlling Home Appliances by Using Universal Remote Control System (IoT and Bluetooth) " IRJET volume: 04 issue: 07 , july -2017

[7] H. C. Tadimeti and M. Pulipati, "Overview of automation systems and home appliances control using PC and microcontroller," Int. J. Sci. Res., vol. 2, no. 4, pp. 127–131, Apr. 2013.

[8] G.-J. Horng, C.-K. Lin, C.-H. Tseng, C.-H. Wang, and J.-F.Yang, "An agent-based smart home system and its service- scheduling mechanism: Design and implementation," Wireless Pers. Commun., vol. 78, no. 1, pp. 521–542, Sep.2014.