SBC-based Home Automation System

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Abstract-"**Intelligent House" term means all sorts of home automation systems for maintaining and controlling home appliances. There are many home automation systems available in market for controlling electronic appliances in house. The system will give basic functionality like turning the home appliances ON/OFF such as fans, tube-lights as well as security for LPG leakage. It will take care that all these appliances are automated. For the security from LPG leakage, a system is required to give alarm. For this purpose, the system will send E-mail/SMS to the user mentioning the state of appliances and activity performed by the system. Also, the interaction between the user and the system will take place for controlling the state of appliances through E-mail.**
The aim of designing a home automation application using computer is to enable user to monitor and control the appliances remotely. Considering the cost and space issues of computer system, it will be beneficial to use single board computer system such as Raspberry Pi, so that one can build the automation using open source technologies with compact design.
Key Words – **Raspberry Pi, Home Automation, LPG leakage**

I. INTRODUCTION

Home automation means the control over any or all electrical devices in either our home or office. [1] There are various types of home automation systems available worldwide. These sorts of systems are generally designed and purchased for variety of purposes. In fact, one of the major problems in the area is that these different systems are neither interoperable nor interconnected. [2] There are different issues involved while designing a Home Automation System. The system should also provide a user-friendly interface on the host-side, so that the devices can be easily setup, monitored and controlled. [3] In smart home systems, the internet is also used to ensure remote control. Since many years, the internet has been widely used for the processes such as browsing the pages/websites, searching required information, chatting, downloading, installation, etc. As the new technology is developed rapidly, monitoring, controlling services have been started to be served along with the internet as an instrument providing interaction with machinery and devices. [4] The system can be used in several places like banks, hospital, labs and other sophisticated automated system, which dramatically reduced the hazards of unauthorized entry.[3] The main reason to

develop this system is to save time and man power along with maintaining security and convenience.[1]
The paper proposes a SBC-based Home Automation System through E-mail/SMS.
The Raspberry Pi is a fully featured micro-computer squashed onto a circuit board measuring approximately 9cm x 5.5cm. The Raspberry Pi is the work of the Raspberry Pi Foundation, a charitable organisation. It's supported by the University of Cambridge Computer Laboratory and tech firm Broadcomm.
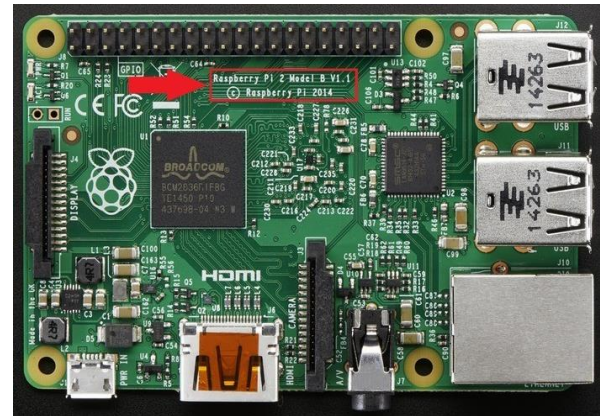

Fig. 1 Raspberry Pi

It has Arm7 Quad Core Processor powered Single Board Computer running at 900MHz. Supported Operating Systems (OS) are:

- Linux based OS
  - Fedora
  - Raspbian
  - Debian
  - ArchLinux
  - Ubuntu Mate
  - NOOBS
- Windows based OS

II. SYSTEM CONFIGURATION

Fig. 2 describes the configuration of the proposed system. For the proposed system, the processing unit chosen is Raspberry Pi because of its user friendly features and economic benefits.

1. GSM Module: GSM stands for Global System for Mobile. It is used in RPiHAS to send notifications to user via SMS and E-mail.
2. Relay Switch of Electric Home Appliance: The state of switch is changed using relay such as turning ON/OFF. This status is sent to Raspberry Pi via RF Transceiver using relay.
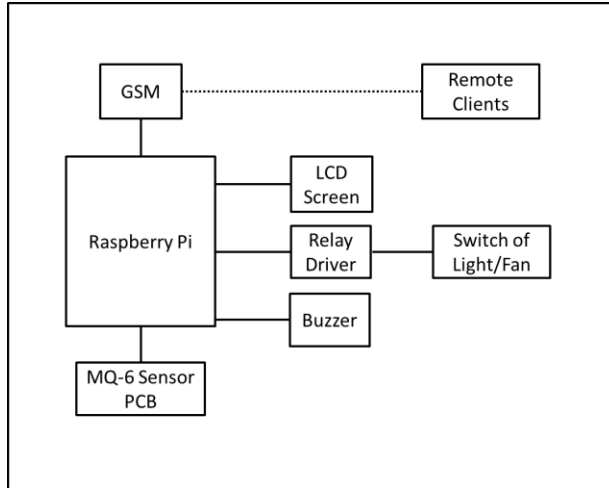
Fig. 2 Layout of proposed system configuration

3. LCD Screen: It is used to display standalone application designed to monitor and control the devices.

4. LPG Sensor MQ-6 & Analog to Digital Convertor (ADC): MQ-6 is a sensor which detects LPG leakage. It has high sensitivity to LPG, iso-butane and propane. It has long life. It outputs analog signal and hence, ADC is required, so that RF Transceiver can transmit it to another RF Transceiver mounted on Raspberry Pi.

5. Remote Clients: Remote clients are the devices such as laptop, cellphone and tablet. These are used to receive notifications and control devices remotely.

III. METHODOLOGIES

1. Algorithm to validate subject of E-mail:

Step 1: Initialize the RPiHAS i.e. Log into Home account dedicated to Raspberry Pi for device interfacing.

Step 2: RPiHAS starts the process of reading email received from user.

Step 3: Check if subject of email is valid or not.
   a) If valid, then perform the algorithm to change device status mentioned below.
   b) If invalid, then send error message to user.

Step 4: RPiHAS waits for 1 second interval to read new mail.

Step 5: Continue to step 3. [5]

2. Algorithm to change device status:

RPiHAS receives command to change status, then

Step 1: Check current status of device and command received for device.
   a) If both are same, then send acknowledgement to user via E-mail as well as SMS.

b) If both are different, then perform action as per command received and send acknowledgement to user via E-mail as well as SMS.

3. Administrative Modules:
a) User / Admin Login
   In this module, user is going to login to the Home Automation System by providing User ID and Password. The user can provide E-mail login or system login to start application. The login has maximum three attempts to enter into the system. If the user is not able to login into the system within 3 attempts then system will lock the application and terminate automatically.

b) Status Module
   In this module, user can view the status of system whether the device is ON or OFF. If the device is ON, then status will show "Active" and the controlling button will show opposite sign of state. If the device is OFF, then status will show "Inactive" and the controlling button will show turn ON image sign. If the LPG Leakage is detected then system will buzz an alarm and the alert image sign on the screen. The console is provided for showing the status of devices i.e. it is ON or OFF. Also, it will save the log of the same.

c) Device Administration Module
   In this module, Admin can add devices or remove devices. There are two fields available to Add/Remove device information, Device Id and Device Name. There are three buttons: Add, Remove and Reset. If user inserts the details of the device then system will automatically check whether the device is connected to the system or not and then add it to system. If user inserts value and presses Remove button, then system will check if the device is already connected to system, if it so, then it will be disconnected and removed from the system and will give message. The reset button resets the input boxes to fill-in the fresh information.

d) Logout Module
   In this module, the user can end the session by clicking on Logout button.

e) Help Module
   This module shows how to use the Home Automation System application effectively on the Linux platform and also contain Developer Information.

IV. SYSTEM DESIGN

To model the functional requirements of the system, use case diagrams are intended. It shows a set of use cases and actors and their relationships. It is

considered as the start point of software design. The following figure shows the use case diagram of the system from the end-user's perception.
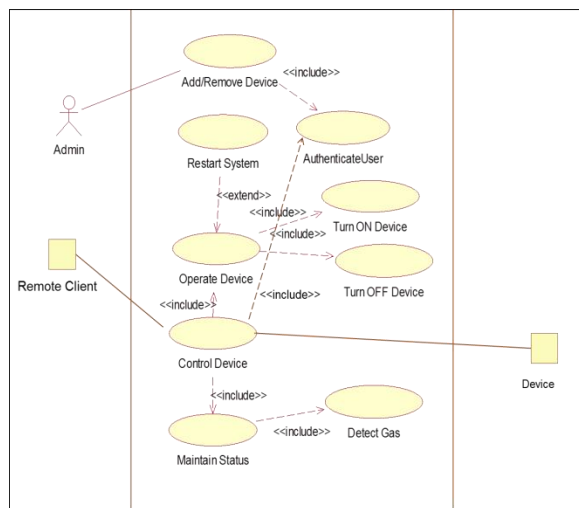

Fig. 3 Use Case Diagram

1. Actors:
a) Admin
   Admin is a person having an account with a password, can log in on system and operates home appliances remotely by the system. He holds special rights, for example, add/remove device.
b) Device
   Device is a computer embedded home appliance that could be added onto system. Also, it can be configured and operated remotely. Switch is a device which has two states, either *ON* or *OFF*.
c) Remote Client
   Remote Client refers to system that has wireless connection such as Cellphone, Laptop, etc. It can be added onto system, configured with system, and communicate with system.

2. Use-cases:
a) Operate
   Operate is the use-case which provides a service for the users to operate on the devices that are connected to system through remote client. Consider an example, user sends messages for turning ON a switch to system and then system performs the action.
b) Restart/Redo
   Restart/Redo is the use case having an extension of the use case *Operate*. When the system is unable to detect the command that the user sent, to make it function normally either it should detect and fix the error or restart the device and the operation will be conducted once again.
c) Maintain Status

Maintain Status is the use case in which the system keeps a record of the status of all the connected devices. These statuses of devices are updated from time to time. When admin requires the state information of some device through remote client, the system sends the latest state of that device to the remote client that requested.
d) Control
   Sometimes the device may malfunction. The use case *Control* means it can detect malfunctioning by updating the state of the devices, stop it (using operate use case), and inform the admin what happened.
e) Add/Remove Device
   The use case *Add/Remove Device* is a service for the admin to add a device onto the system to be controlled remotely and automatically, as well as remove a device from the system that is no longer to be controlled. When a device is connected to system, both system and the device are configured in order to collaborate with each other.
f) Detect Gas
   The use case *Detect Gas* is function which will automatically give signal to the system after the detection of LPG by sensor MQ-6. This is to provide security from LPG leakage.
g) Authenticate User
   The use case *Authenticate User* is used to check whether the mail received is from valid user.

V. RESULTS AND DISCUSSIONS
1. Compact system: The RPiHAS uses single board computer Raspberry Pi requiring less space. Its size just as same as credit card.
2. Cost Efficient: The Raspberry Pi is cheaper than desktop PCs. Also the sensor used is cheap.
3. Secure: The RPiHAS is secure because it uses email authentication for login to the system as well as validation at every stage of controlling.

VI. CONCLUSION
Raspberry Pi based Home Automation System is needed as being a human, one can forget to turn OFF the home appliances. Hence, to turn them OFF, this type of system is helpful to control them remotely.

Unlike other Home Automation Systems, this system requires less space and it is cost efficient. It is flexible as the standalone application makes it user friendly for monitoring and controlling the appliances.

This system provides security by LPG leakage detection to avoid probable accidents.

Hence to avoid unnecessary power consumption as well as to provide comfort to user, this system is efficient.

VII. ACKNOWLEDGMENT

REFERENCES

[1] Hari Charan Tadimeti, Manas Pulipati, Overview of Automation Systems and Home Appliances Control using PC and Microcontroller, Volume 2 Issue 4, April 2013

[2] Stevens,Tim, The smart office, ISBN 0965708101(1994)

[3] Prof. M. B. Salunke, Darshan Sonar, NileshDengle , SachinKangude, DattatrayaGawade, Home Automation Using Cloud Computing and Mobile Devices, Vol. 3,Issue 2 (Feb. 2013), ||V2|| PP 35-37

[4] Zekeriyakeskin, YunusEmrekocaturk, okanBingol, kubilayTasdelen, Web-basedsmart home automation: PLC controlled implementation, vol 11, NO. 3,2014

[5] 2014 International Conference on Reliability, Optimization and Information Technology-ICROIT 2014, India, Feb 6-8 2014 Raspberry Pi based Interactive Home Automation System through E-mail IEEE, Dept. of Electrical and Electronics Engineering.

[6] http://www.raspberrypi.org