

Home Automation Systems - A Study

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Abstract

- Measure to avoid the wastage of electrical energy due to the inability to access the appliances all time. [20]
- These system can make use of a host of communication methods.
- Different controlling devices and configurations can be found in existing systems.
- An android application, is used to instruct a Raspberry pi, which is the main control centre in a particular home and is connected to each of the switch boards in every room of the house.

Motivation

- To conserve energy
- To help differently-abled people access appliances
- Accident prevention and management
- Economic gains
- Security
- Convenience

Existing Systems

Broad classification of systems:

- GSM Based
- Bluetooth Based
- Phone Based
- Zigbee Based
- Wireless Systems
- Mixed Type

GSM Based Home Automation System [1][5][6][7]

- 3 ways - GSM, voice, Internet
- GSM control uses SMS messages and AT commands
- Internet based control uses server and database, transfer done by a PC
- Voice commands are unstable and not tested enough.
- Integrated modem

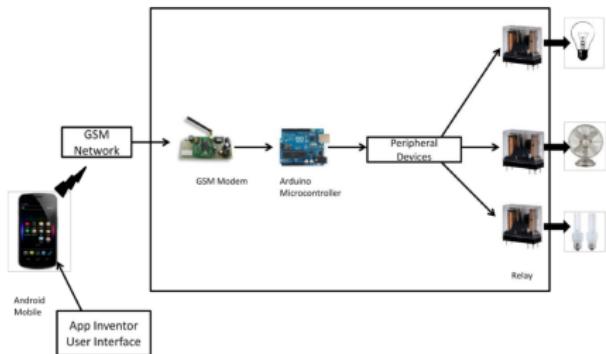


Figure : GSM System

Disadvantages

- Lacks reliability
- SMS delivery issues
- Cost of using SMS
- Not real time

- Attached Bluetooth Module
- Relays attached to Bluetooth board ports used for control
- Works when the user is within range
- Advantages: High Speed, Security
- Drawbacks: Limited range, long time for device discovery, real time access

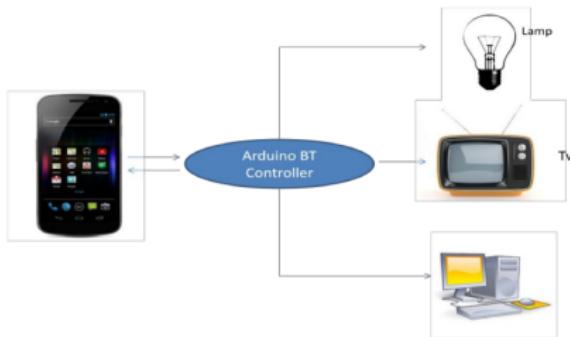


Figure : Bluetooth System

Phone Based Home Automation System [17]

- Makes use of the dual tone multi frequency used in telephone lines (DTMF)
- Phone line ringing detected by to authenticate user
- Keypad keys pressed and tone used to control device
- Drawback: Device number limited to number of keys in keypad - 12

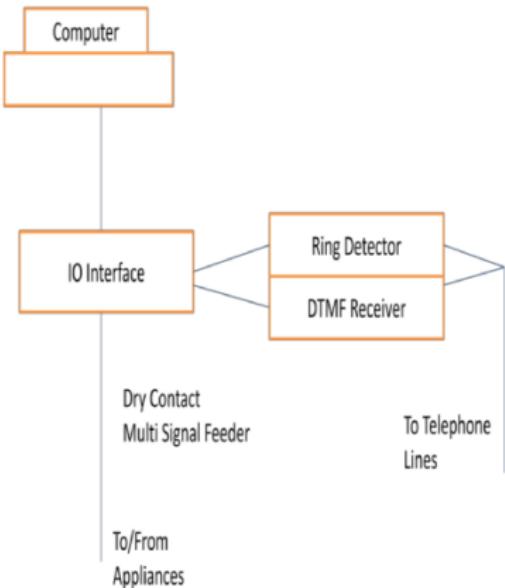


Figure : Phone Based System

- Similar to Bluetooth
- Fairly new technology
- PIC microcontroller and voice commands used for controlling devices
- Zigbee used for transmission of the command to another PIC microcontroller
- Relays used for control
- Drawback: Limited range of Zigbee, hinders remote access, voice recognition has added overheads

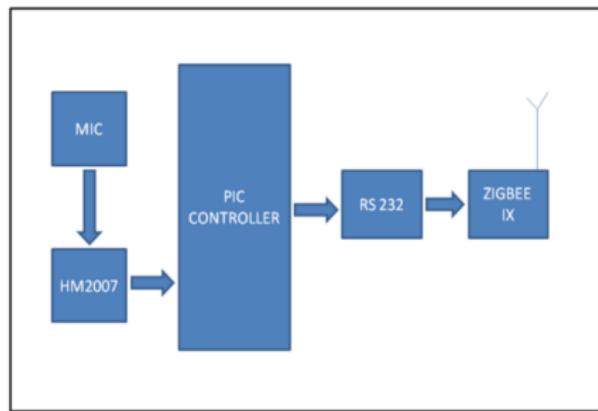


Figure : ZigBee Based System

- Wireless communication techniques
 - infrared, radio waves
- Arduino board along with Wi-Fi communication
- Home PC is a server and android smart phone used for communication
- PC controls the Arduino board
- Wi-fi used for internet access
- Radio waves - larger range
- Disadvantages:
 - Spectrum availability
 - Interference
 - Security

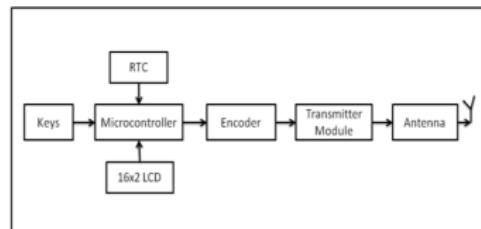


Figure : Wireless System

- Combination of GSM, Bluetooth, Zigbee
- UI in an android application, which takes voice input and converts to textual commands
- SMS command sent to the phone at home
- This command is transferred by Bluetooth
- Command further transferred by Zigbee
- Offers remote access capability
- Drawbacks: multiple controllers , expensive

Basic Comparison

System	Primary communication	Remote access	Number of devices	Cost	Speed	Real time
GSM	SMS messages	Access from anywhere in the world	Unlimited	High cost due to SMS charges	Slow due to SMS delivery issues	No
Bluetooth	Bluetooth and AT commands	Restricted to Bluetooth range- 10 meters	Unlimited	Low cost	Fast due to proximity	Yes
Phone based	Phone lines	Anywhere with a phone line	12 due to 12 frequencies of DTMF	Low cost	Fast	No
ZigBee	ZigBee and AT commands	Around 10 meters	Unlimited	Low cost	Fast	Yes
Wireless	Radio, infrared or other waves	Depending on range and spectrum of waves used	Unlimited	High cost due to licensing and other spectrum issues	Slow due to interferences	Yes

Figure : Basic Comparison

Our System

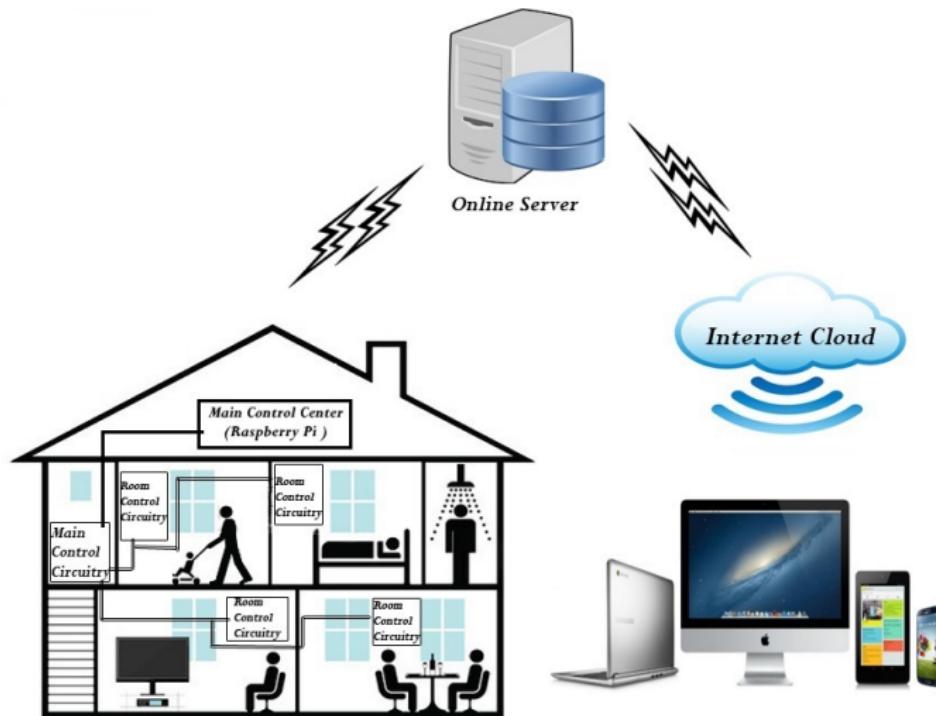


Figure : Proposed System

System Functions

- Control of appliances using the Raspberry Pi
- Mechanical control of the appliances using physical switches simultaneously
- An android application as the interface to the system allowing toggling of the devices
- A database that will store the current ON/OFF status of the device

Components Used

- Raspberry Pi
- Relay Board
- Two-Way Switch
- Multiplexer/De-Multiplexer
- Flip-flop
- Control Device
- Appliances

Main Modules

Raspberry pi

- Command Centre that acts as a web server using a module called CherryPy
- Python program that controls devices
- Responds to calls from User
- Calls the server to update its database when the device state is modified

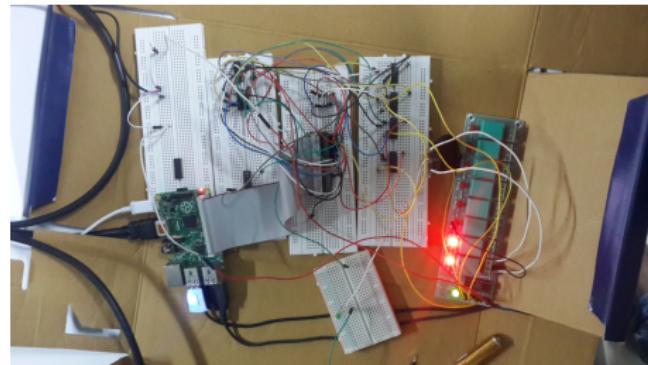


Figure : Raspberry pi

Main Modules

Control Circuitry

- Connected to the devices
- Consists of
 - Relays
 - Multiplexers
 - Flip-flop
- Responds to calls from User
- Allows mechanical and software control of Appliances

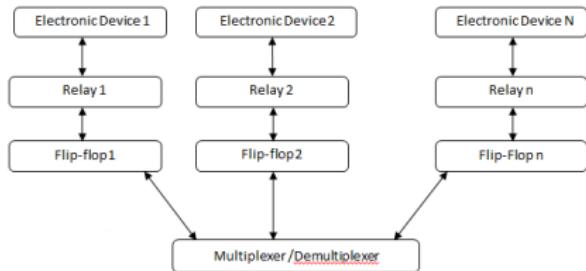


Figure : Control Circuitry

Android Application

- Simple GUI for users/clients.
- Connects to the internet via Wi-Fi, GPRS, etc.
- Sends commands to the Pi Server through the
- Centralized web server
- Uses JSON messaging protocol
- Asynchronous communication
- Real time status reports
- Register with Pi server and Web server

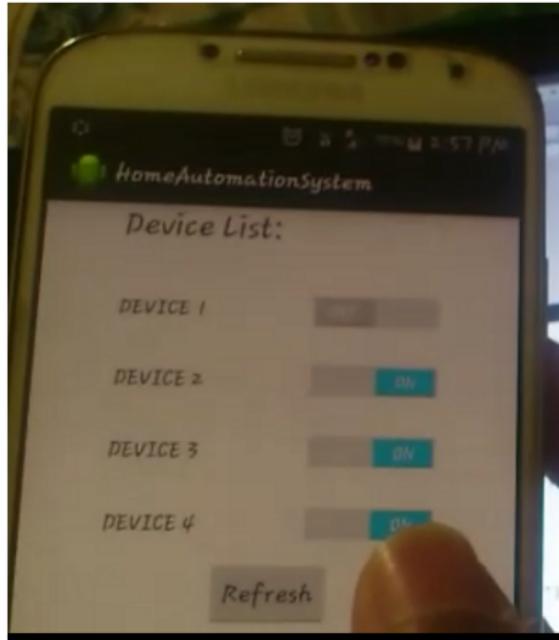


Figure : Android App

- Single centralized web server on the cloud
- Dispenses commands/messages to the raspberry pi
- Exposes an API for access by an Android app
- Maintains database consistency
- *Technologies used:* PHP, MySQL, Cherry Py, Apache Server

A snapshot of the Web Server Database

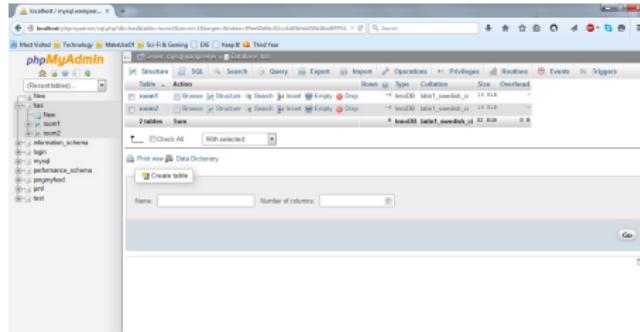


Figure : Web Server for House

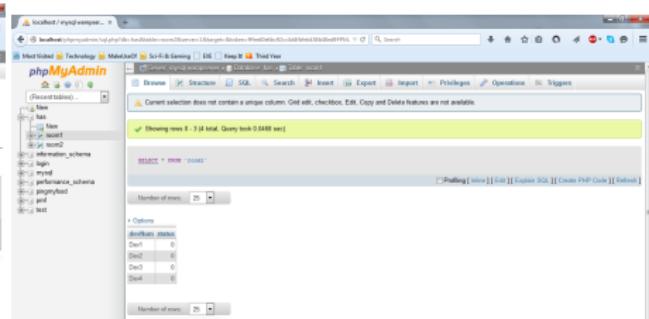
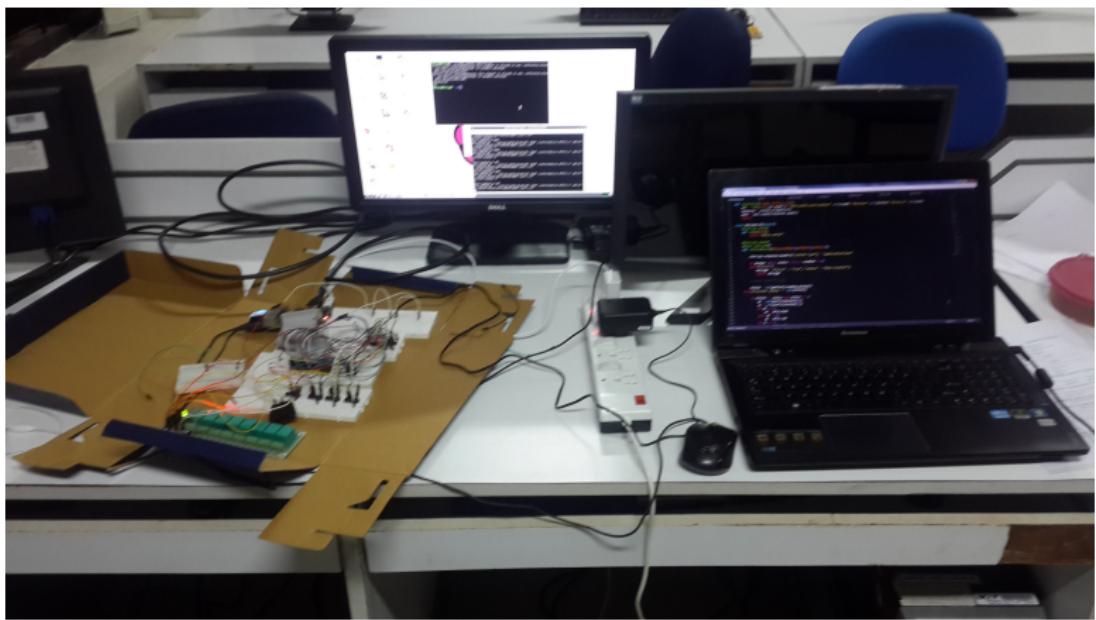


Figure : Web Server for Room

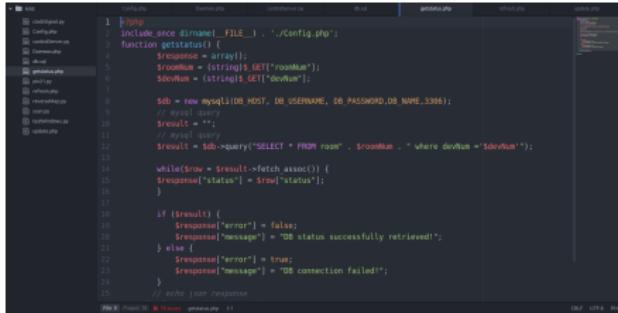
Overall Working

- User connects to the Online Web Server through the API with the Android app
- The user selects the room and device to be switched on
- The JSON message is communicated to the Web server
- The web server issues a command to the Pi server and the respective device is toggled on, and it simultaneously updates the DB
- Asynchronous updates take place simultaneously

Overall System's Snapshot

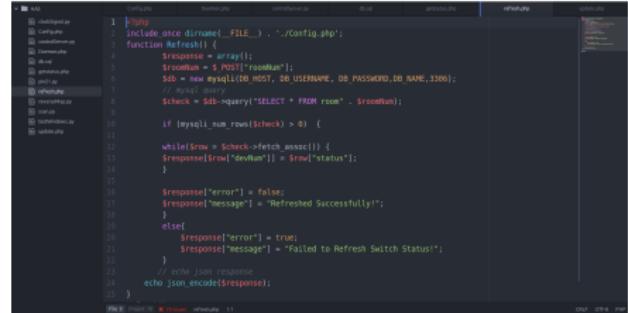


Code Snippets



```
1 //php
2 include_once dirname(__FILE__) . '/Config.php';
3
4 function getstatus() {
5     $response = array();
6     $rownum = (string) $_GET["rownum"];
7     $devnum = (string) $_GET["device"];
8
9     $db = new mysqli(DB_HOST, DB_USERNAME, DB_PASSWORD,DB_NAME,3306);
10
11     // mysql query
12     $result = "";
13     $rownum = "";
14
15     $result = $db->query("SELECT * FROM room" . $rownum . " where devnum = '$devnum'");
16
17     while($row = $result->fetch_assoc()) {
18         $response['status'] = $row['status'];
19     }
20
21
22     if ($result) {
23         $response['error'] = false;
24         $response['message'] = "DB status successfully retrieved!";
25     } else {
26         $response['error'] = true;
27         $response['message'] = "DB connection failed!";
28     }
29
30     // echo json response
31 }
```

Figure : Code Snippets



```
1 //php
2 include_once dirname(__FILE__) . '/Config.php';
3
4 function Refresh() {
5     $response = array();
6     $rownum = $_POST["rowNum"];
7     $db = new mysqli(DB_HOST, DB_USERNAME, DB_PASSWORD,DB_NAME,3306);
8
9     // mysql query
10     $check = $db->query("SELECT * FROM room" . $rownum);
11
12     if (mysqli_num_rows($check) > 0) {
13
14         while($row = $check->fetch_assoc()) {
15             $response[$row['devName']] = $row['status'];
16         }
17
18         $response['error'] = false;
19         $response['message'] = "Refreshed Successfully!";
20     } else {
21         $response['error'] = true;
22         $response['message'] = "Failed to Refresh Switch Status!";
23     }
24
25     // echo json response
26     echo json_encode($response);
27 }
```

Figure : Code Snippets

We have locked this entire system of ours with the Indian Patent office by filing a provisional specification titled, "*Universally Compatible and Accessible, Software Controlled, Expandable Home Automation System, for Energy Conservation and the Differently-Abled*", 5729/CHE/2015, Filed on October 26, 2015.

Conclusion

- We have presented the design and implementation of a home automation system that allows users to remotely access and control the power supply to the various devices at their home and thereby preventing wastage of energy.
- The system using a Raspberry Pi as the control system has been implemented.
- The detailed working has been presented.
- Aim of energy conservation can be fulfilled.

Scope for future work

- ① Implementation of the system at a greater scale .
- ② Integration of sensors such as light sensors and motion sensors with the system to automate the application environment.
- ③ Detecting and updating the database on manual operation has not been implemented, although a conceptual design is available.

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