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An Internet of Things Framework for Automation and Remote Control of Home Appliances

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ABSTRACT: Internet of Things devices communicates with each other without need of human-to-human interaction nor human-to-computer interaction. Such systems can work cognitively and make decisions without human involvement.Internet of Things when implemented properly can solve a wide range of global problems such as natural disasters, pollution and even manage home appliances wirelessly. Home automation is carrying out the common processes of home appliances without the need of human interaction. This paper makes home automation a reality using raspberry pi and a mobile phone that remotely controls home appliances from the internet. A Home automation mobile application and an automation website scriptalso been developed for implementation of the internet of things framework.

KEYWORDS*:* Internet of things, Raspberry pi, Home automation, Remote control, Smart Home, Android application

I. INTRODUCTION

Internet of Things is making devices smarter with the help of other devices. It is formed by a large network of connected devices where devices can interact and share information with each other [1]. It allows sensing and remotely controlling objects which bridges the gap between the physical world and computer-based systems. With the help of this paper, any home appliances that don't havethe capability to connect to the internet can be brought online. Anyone in United States can control a device they possess in India with the help of this internet of things framework. Through this automatic control of windmills, automatic control of solar panels, street lighting in rural areas, and control of cameras in forests or even much bigger global problems can be solved.

Figure 1: Uses of Internet of things in a household

The different applications of an internet of things framework in a household can be seen inFigure 1. It can be used in household for Closed-circuit television (CCTV) monitoring, temperature monitoring, water level monitoring, home security, automatic lighting, connectivity and many other practical applications. With the advancement of Internet of Things all the devices can provide useful information, such as a temperature sensor connected to the raspberry pi can offer a real-time temperature variation of the location it is placed and this data can be captured and stored for knowing

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the temperature variation or for doing some useful work such as when the temperature reaches a particular range, the raspberry pi can either switch off or on the ceiling fan connected to it. The possibilities of this paper and its applications are endless.

Figure 2: Advantages of internet of things for home automation

Figure 2 shows the key advantages of the implementation of the internet of things for home automation [2]. It makes your life more comfortable as it can control home appliances remotely as well as save electricity by automatically switching off appliances when not in use. Authentication layer is used for implementing security for your appliances.
Raspberry pi is a single board computer that has the same size of a credit card [3]. This is possible since raspberry pi uses SoC (System on Chip technology) which integrates all components of a computer into a single chip. It can be plugged directly into a monitor using HDMI (High-Definition Multimedia Interface) cable and can connect to any device such as keyboard, mouse. The most useful feature of the raspberry pi is GPIO (General Purpose Input Output) pins. GPIO pins can be controlled by the user at run time from raspbian, the operating System for raspberry pi or remotely through an internet of things framework.
Raspberry pi-2 delivers six times more the processing capacity as of previous models [4]. This means it can handle a lot more tasks faster than the older models. Raspbian is an OS developed specially for raspberry pi, which has around 35000 packages and pre-compiled software included for ready to use along with raspberry pi. It has an HDMI video output port which can play 1080p videos with no lag. Since it has low power requirements, it can also be powered up by batteries. The most useful feature of raspberry pi is the GPIO pins due to its ability to be controlled by the user at run time. Various input and output devices can be controlled with GPIO providing a feature our home computers cannot provide to the end user. This means the user can control the flow of data using GPIO. Due to its small size, it is highly portable and can be used in extremely low and high temperatures.

II. MATERIALS AND METHODS

Internet of things framework requires the following hardware's mainly a raspberry pi board, a Wi-Fi USB adapter, 4 channel electric relay board, General purpose input output (GPIO) cables, jumper wires, 5 volts 2 amperes micro USB power adapter, 4 GB Class 6 Micro SDHC card, HDMI cable, HDMI supported monitor, mouse, keyboard.
A Raspbian operating system for raspberry pi and software tools like android SDK, eclipse, android emulator, android development toolkit, VNC viewer, Google webiopi, wiringpi are required.
Programming languages such as Java, Hypertext pre-processor (PHP), Python and open technologies such as Representational state transfer application programming interface (REST API), CURL and server by Apache are used for developing this framework.
Connect power adapter to raspberry pi and install Raspbian operating system. Connect electric relay using jumper wires to the GPIO port also the 3V3 power pin to the electric relay. Install Apache server, server script, wiringpi on raspberry pi and internet of things android application on android device.

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III. RELATED WORK

Various research was carried out in the home automation. In [5], the problems and challenges faced by smart homes using Internet of things are discussed as well as the solution to overcome them. In [6], a home appliances monitoring as well as controlling system were implemented. In [7] a web of things application framework for smart homes was proposed. In [8,9] has various models for web connectivity and energy conservation in home automation. [10] is an implementation of the Internet of things for monitoring and control of home appliances. In [11] home automation using Ethernet and Bluetooth is presented. In [12] a smart meter to reduce the power consumption of home appliances is proposed. In [13] social networks are used for authentication in home automation. In [14] home automation is controlled through email.

IV. PROBLEM IDENTIFICATION

Today, most home appliances are semi-automated, be it a washing machine that perform the different tasks such as rinsing, spinning, drying of clothes automatically. But there isn't a programmed way to control the power function i.e. power off and power on of the electrical appliance. Most people forget to switch off light or fan when they leave the room. If everyone remembers to switch off home appliances when not in use, imagine how much electricity can be saved, which leads to lower electricity bills, lesser power cuts, lesser scarcity of electricity, lower global warming and a greener planet.

In this paper, anyone can control home appliances wirelessly from anywhere in the world. An Android mobile application has also been developed which helps to manage home appliances from your mobile phone including advanced power saving options.Moreover, with the advent of mobile phones and its high importance in our everyday life, it can replace our electrical switch boards too.

V. EXISTING SYSTEM

There are many home automation systems available to the consumers, but they are less efficient and less cheap in terms of cost. Moreover,these systems can handle only specific type of home appliances like there are thermostat devices which can only monitor the temperature, moreover the commercial products are expensive and often ask to pay more per component. Manufacturers have used different protocols such as Ethernet, ZigBee and Z-Wave which are propriety protocols and are incompatible with each other. Existing systems [15] have either used a Bluetooth module for wireless communication which has a range of 30 metres only and Ethernet modules which requires wired connection between the home appliances which often is very inconvenient due to the positioning of home appliances in various corners in a home. So there is a need for a system that can pick far signals, highly economical, flexible as well as easy to use

VI. PROPOSED SYSTEM

In this paper, an Internet of things framework to control home appliances wirelessly using a mobile phone and a tablet is proposed. This framework uses Wi-Fi protocol, which is the most reliable and widely used protocol for communication. Unlike existing systems, the proposed system can pick signals from anywhere, irrespective of the position of the appliances. An Android application has been developed for mobile phones and tablets. A server script has also been developed for the server running within raspberry pi.

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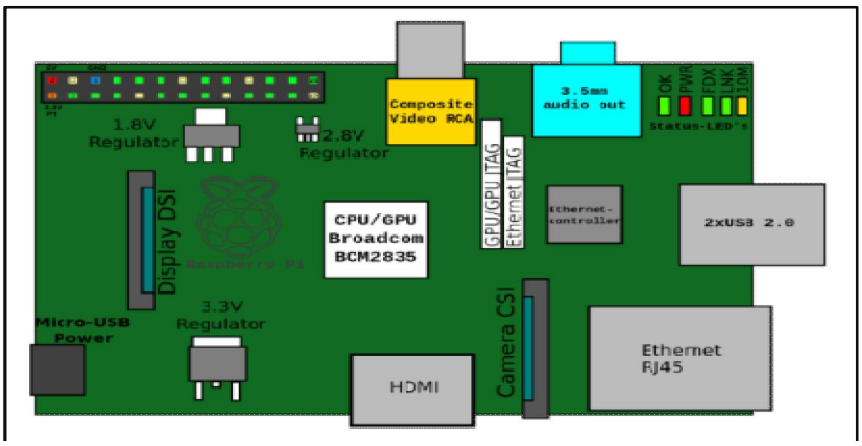

Figure 3: Raspberry pi printed circuit board(PCB) diagram

The printed circuit board diagram of raspberry pi [16] can be seen in Figure 3. Raspberry pi has Ethernet port, HDMI port, USB ports, and GPIO ports. Input and output devices such as circuit boards, sensors can be connected through GPIO ports, so they are most useful ports of raspberry pi. Araspberry pi electronic boardis used along with a relay board module to connect physically to the electrical appliances.An Android application is used to interact with raspberry pi through wireless network. If raspberry pi is connected to the internet using Weaved application, then the home appliances can be controlled from anywhere in the world where there is internet connectivity [17].

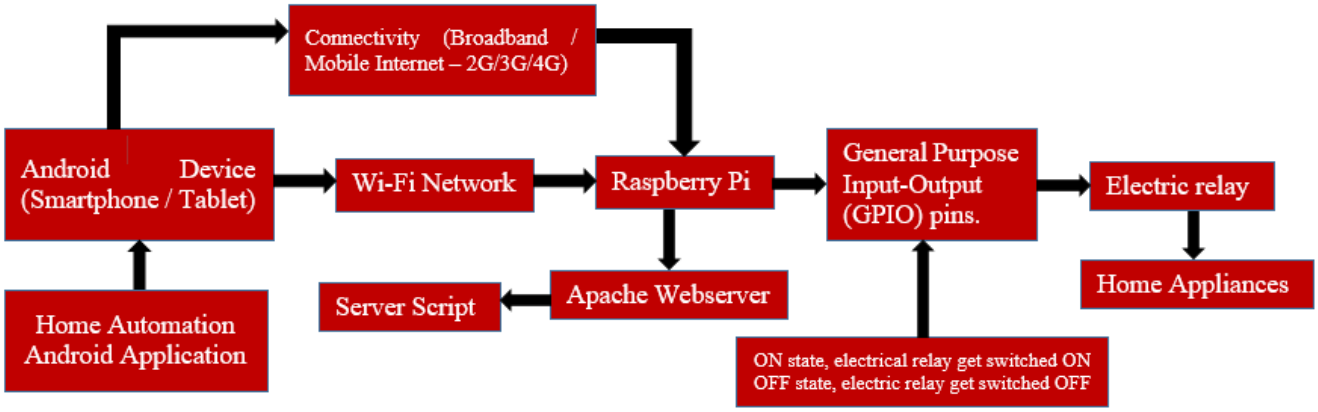

Figure 4: Proposed Internet of things framework

Figure 4 shows the proposed internet of things framework. It is an ideal framework for automation and remote control of home appliances. The android device sends the request to off/on the home appliance through Wi-Fi/Connectivity which is captured by raspberry pi that processes the requests and sends the command to switch on the corresponding GPIO port. The electric relay connected to that GPIO port gets switched on, which turns on the home appliance.

VII. METHODOLOGY

A. Technical Specifications

The main concept in this paper is to build an internet of things framework that can automate and remotely control home appliances. To build a home automation system the following basic components are required

- Raspberry pi board
- Electric relay board
- 802.11n Wi-Fi adapter

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- Android smartphone or tablet

Raspbian, the official operating system for raspberry pi is installed and configured [18]. An Apache web server isinstalled to run the server script in raspberry pi. A Wi-Fi adapter is attached to raspberry pi and configured for creating a Wi-Fi network. To the 3V3 power pin of the raspberry pi, the electric relay power source pin is connected with the help of jumper wires. Ground pin of the raspberry pi is connected to the electric relay ground terminal using jumper wires. Relay board pins is connected to General-purpose input/output (GPIO) pins of the raspberry pi. GPIO helps to control the relay using terminal commands.
An android device can control the home appliances attached to raspberry pi. The android user has to install the android application in a smartphone or tablet and then connect to the broadcasted Wi-Fi network. Android app accesses the server script by sending Hypertext Transfer Protocol (HTTP) GET request to control the GPIO pins which in-turn switches off / on the relays [19]. Server script in-turn sends wiringpi commands, a module for GPIO access to the shell to either turn off/on the GPIO pins. Weaved module is used for controlling the home appliances from anywhere in the world. Wi-Fi Protected Access Protocol (WPA2) is used for securing the wireless network formed by Wi-Fi adapter.
The Android app sends GET request through Wi-Fi network to the server and then the PHP handlers within the server processes the request and perform the functions by the server script, then the server script in-turn sends commands to the raspberry pi to change the state of GPIO. GPIO has two readable input values either high=1 or low=0. The relay can be turned on / off through digital signals without the need of traditional switch boards.Relays are electrically operated switches [20], when the input is high, the LED glows and the home appliance attached to it is also switched onand vice-versa.

Figure 5: An electric relay board

An electric relay board with LED's of relay glowing when connected to raspberry pi is seen in Figure 5. When the GPIO port of the raspberry pi is switched on, current passes through and device connected the corresponding GPIO port gets switched ON. Here 2 electric relays connected to 2 GPIO ports were switched on, hence the indicator on two of the GPIO port is glowing. The other 2 GPIO port was switched OFF, hence their LED's do not glow.

B. Android application

- Power Saving Mode for automatic switching off light during daytime. This is useful if the user forgets to turn off home appliances such as tube-light or fan, it switchesoff automatically.
- Auto Mode for automatic switching off / on electrical appliances during daytime or night-time. This is useful when the building lights switched on during the night will automatically be turned off when it is 6 am in the morning, so if the person wakes up late or forgets to switch off, android app will manage itself and no power would be wasted.
- SQLite database has been used for storage of home appliances data and its switch state.
- Separate button for each GPIO pin of raspberry pi, hence the user can control each appliance individually.
- Representational state transfer (REST) application programming interface (API) support is included in the application [21]. It can perform HTTP GET and POST requests to control the GPIO pins of raspberry pi.

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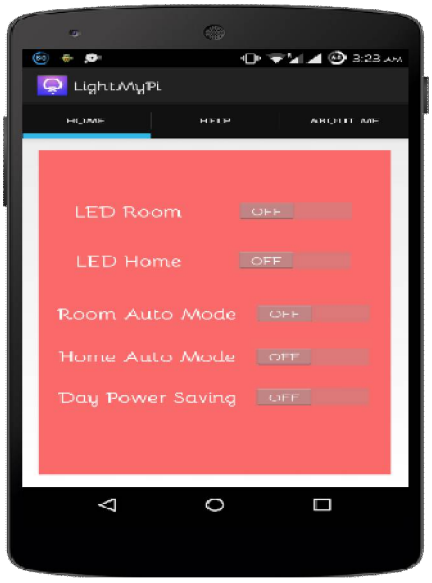

Figure 6: Home automation android application

Figure 6 shows the android application to control and automate home appliances. This application has special buttons for LED home, LED room, room auto mode, home auto mode and day power saving mode. When room auto mode is switched on, lighting appliances in room gets switched off automatically from 1 am to 6 am. In home auto mode, all lights outside the home gets switched on automatically from 6 pm and switches off at 6am automatically. When day power saving mode is on, all lights and heavy power consuming appliances gets switched off from 8 am to 6 pm automatically.

C. Server script

A server script is made for controlling GPIO pins through the REST API. It is hosted on an Apache serverrunning in raspberry pi. It utilizes the wiringpi GPIO access library written in C language to perform the tasks. It sends wiringpi commands directly to the raspbian shell. It can read and write all the GPIO pinstates, both off and on. GET request of REST API are used for accessing the server script from android devices. This way the GPIO pins can be controlled directly without the need of secure shell (SSH) access.

VIII. RESULTS

The proposed internet of things framework can be used for automation and remote control of home appliances. All home appliances can be connected to the electric relay board and can be controlled by the GPIO pins of the raspberry pi. The proposed android application can be used to control the home appliances wirelessly with a range of 100 meters, which is 3.34times more efficient than existing systems that uses Bluetooth or Ethernet for connectivity.The data transfer rateof the proposed system is 10 times faster than existing systems.WPA2, the strongest encryption standard is used for securing the network Raspberry pi can operate stably in temperature as low as -70°C to high as 80°C [22], hence it can withstand a wide range of environmental conditions better than any other system can withstand. The proposed internet of things framework takes as less as 0.5 second to process the input and perform the desired output, where the location of the home appliance has no impact on the time taken for the output.

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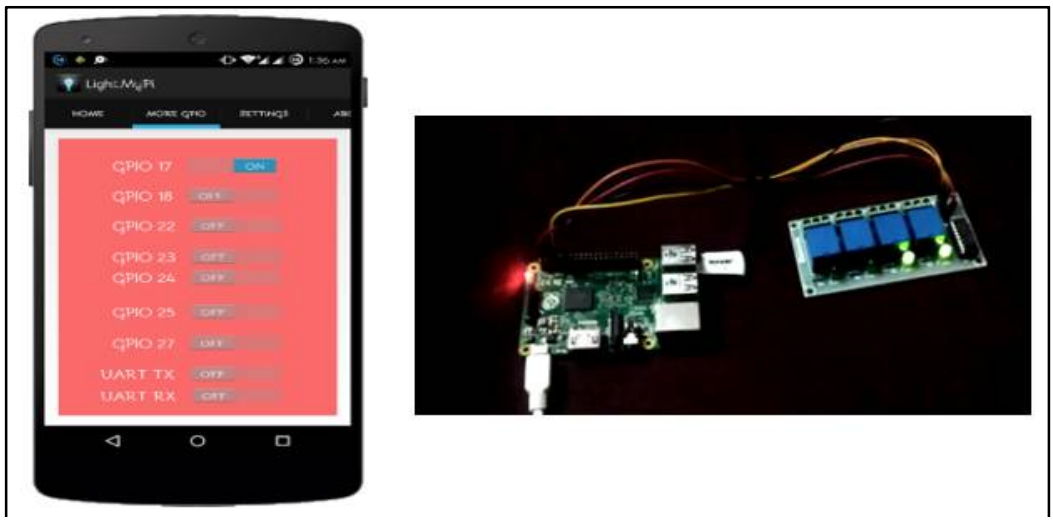

Figure 7: Home automation system in active state

Electric relay in working mode can be seen in Figure 7. It isconnected to the raspberry pi's GPIO pins. Any home appliance connected to the electric relay starts functioning when the relay LED is on. When the GPIO button in the android application is pressed, LED of the electric relay starts glowing. LED of the electric relay is in glowing since the raspberry pi has processed the switch on request from android application.

IX. CONCLUSION WITH FUTURE SCOPE

The proposed internet of things framework is highly efficient and is 10 times better than existing systems. This framework can be used to control and automate any home appliances, non-dependent of its physical location. This can also be implemented in electronic products so that the consumer can control the appliances from android phone or tablet and automatically switches off when not needed.

About 37% of the carbon emissions is from electricity. As global warming is increasing due to increasing carbon emissions, this internet of things framework can be used to save electricity, which can reduce up to 10% of carbon emissions [23].

Applications of this framework are home appliance control, remote surveillance, pollution check, prediction of natural disasters like earthquakes, and volcano eruptions, and can keep a track of the icecap melting 24 hours and 7 days with sensor data and further perform data mining that can give us a new understanding and know the future of our earth.

REFERENCES

[1] Lu Tan and Neng Wang, "Future internet: The Internet of Things," 3rd International Conference on Advanced Computer Theory and Engineering(ICACTE), Chengdu, pp. V5-376-V5-380, 2010.
[2] "Advantages of internet of things", https://cloudplugs.com, 11 September 2016.
[3] "Raspberry Pi - Teach, Learn, and Make with Raspberry Pi", https://www.raspberrypi.org, 11 September 2016.
[4] "Raspberry Pi 2 Model B",https://www.raspberrypi.org, 11 September 2016.
[5] P. P. Gaikwad, J. P. Gabhane and S. S. Golait, "A survey based on Smart Homes system using Internet-of-Things," Computation of Power, Energy Information and Communication (ICCPEIC), 2015 International Conference on, Chennai, pp. 0330-0335, 2015.
[6] D. Wang, D. Lo, J. Bhimani and K. Sugiura, "AnyControl -- IoT Based Home Appliances Monitoring and Controlling," Computer Software and Applications Conference (COMPSAC), 2015 IEEE 39th Annual, Taichung, pp. 487-492, 2015.
[7] A. Kamilaris, V. Trifa and A. Pitsillides, "HomeWeb: An application framework for Web-based smart homes," Telecommunications (ICT), 2011 18th International Conference on, Ayia Napa, pp. 134-139, 2011.
[8] A. Razaque, P. Oddo, F. H. Amsaad, M. Sangavikar, S. Manchikatla and Niraj, "Power reduction for Smart Homes in an Internet of Things framework," 2016 IEEE International Conference on Electro Information Technology (EIT), Grand Forks, ND, pp. 0117-0121, 2016.

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[9] K. Moser, J. Harder and S. G. M. Koo, "Internet of things in home automation and energy efficient smart home technologies," 2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC), San Diego, CA, pp. 1260-1265, 2014.
[10] D. Pavithra and R. Balakrishnan, "IoT based monitoring and control system for home automation," Communication Technologies (GCCT), 2015 Global Conference on, Thuckalay, pp. 169-173, 2015.
[11] K. Mandula, R. Parupalli, C. A. S. Murty, E. Magesh and R. Lunagariya, "Mobile based home automation using Internet of Things (IoT)," 2015 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT), Kumaracoil, pp. 340-343, 2015.
[12] R. K. Deore, V. R. Sonawane and P. H. Satpute, "Internet of Thing Based Home Appliances Control," 2015 International Conference on Computational Intelligence and Communication Networks (CICN), Jabalpur, India, pp. 898-902, 2015.
[13] D. A. Gupta, C. Y. N. Dwith and B. A. V. Ramakanth, "Wireless Home Automation using social networking websites," Advanced Computing and Communications (ADCOM), 2014 20th Annual International Conference on, Bangalore, pp. 12-15, 2014.
[14] S. Jain, A. Vaibhav and L. Goyal, "Raspberry pi based interactive home automation system through e-mail", ICROIT India, February 2014.
[15] D. Sunehra and M. Yeena, "Implementation of interactive home automation systems based on email and Bluetooth technologies," 2015 International Conference on Information Processing (ICIP), Pune, pp. 458-463, 2015.
[16] "Raspberry Pi PCB Layout", http://www.mobilerobots.pl, 11 September 2016.
[17] H. Lamine and H. Abid, "Remote control of a domestic equipment from an Android application based on raspberry pi card", STA 2014, Hammamet, Tunisia, December 2014.
[18] E. Upton and G. Halfacree, Raspberry Pi user guide, NJ: John Wiley & Sons, pp 50-170, 2012.
[19] Z. Mednieks, L. Dornin, G. Meike and M. Nakamura, Programming Android. Sebastopol, Calif.: O'Reilly, pp 60-150, 2011.
[20] P. Scherz and S. Monk, Practical electronics for inventors, NY: Tab Books, pp 340-410, 2013.
[21] B. Phillips, B. Hardy, C. Stewart and K. Marsicano, Android programming, GA: Big Nerd Ranch Guides, pp 90-130, 2013.
[22] S. McManus and M. Cook, Raspberry Pi for dummies, NJ: John Wiley & Sons, pp 220-290, 2013.
[23] "Home Automation, IoT Could Cut Energy Consumption 10 Percent", https://www.cta.tech/News/Press-Releases/2016/May/Home-Automation,-IoT-Could-Cut-Energy-Consumpt-(1).aspx, 11 September 2016.

BIOGRAPHY

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