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A Cost Efficient Model for Vigilance and Control of Devices using Internet of Things (IoT) and Raspberry Pi

Rumana Badar
BE(CSE)
Anjuman College of
Engineering and Technology
Nagpur, (MS), India
email-id : rumana.badar@gmail.com

Prajakta Ramteke
BE(CSE)
Anjuman College of
Engineering and Technology
Nagpur, (MS), India
email-id :prajaktaramteke7@gmail.com

Prof. Kamlesh Kelwade
Associate Professor, CSE
Anjuman College of
Engineering and Technology
Nagpur, (MS), India
email-id : kamleshacet14@gmail.com

Abstract- In today's scenario the data is transferred over network without requiring human to human or human to computer interaction. This paper proposes a cost efficient system designed to control of the devices and alerting from heavy damages to be caused due to fire, using the power of Internet of Things and a palm sized microcomputer called the Raspberry Pi. Together they give the user remote access to hardware, set safety mechanisms that alert users automatically, as well as communicate with other things over the Internet. We have implemented a Smart System that allows users to control lights and also provide a special help feature (by blinking lights in emergencies). These lights can be accessed from any part of the world and there is a common website interface for all customers that allows login and then provides their particular URL from the database which allows access to lights of their house. This allows commercialization of the concept at a mass scale and yet remains cost- efficient. The system also sends alerts in case of a fire to the user via Gmail, SMS and Social Media like Twitter and Facebook and contacts the fire department for help. This is done through recipes created with IFTTT. The language of choice is Python, which is the default environment of Raspberry Pi.

Keywords- *Smart Automation, Internet of Things (IoT), Raspberry Pi, Remote Safety Communication, IFTTT*

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I. INTRODUCTION

In this designed model, we have introduces a smart automation model has the capacity to take data from the physical world and communicate it to the users or take the necessary actions. Such a system can be implemented using the concept of Internet of Things which connects daily life objects via the Internet to allow sharing of data. While this has been implemented at grand scales for smart cities, we propose a system which is affordable and can be used in buildings and homes and customized according to needs. This is possible due to the Raspberry Pi, which has the power to control many appliances wirelessly. Hence the common man can now afford a more interactive, cost efficient and environmentally beneficial system in their offices, homes, malls, other public places, etc.

II. LITERATURE REVIEW

The paper focuses on 3 things, 1. The Internet of Things, 2. The Raspberry Pi, 3. Interfacing and Programming a Smart Automation System as a part of implementation.

1. THE INTERNET OF THINGS(IoT)

A. The concept

The Internet of Things, also known as, IoT is the connection, interaction and interdependence of a wide range of devices over the Internet. This allows these objects to communicate with each other and with people. Smart objects play a key role in this concept. These are objects, which use sensors for embedded communication and information exchange and hence are digitally upgraded. An example of smart objects implementing Internet of Things would be a heart rate monitor that informs the user and doctor of abnormal activities and guides the patient during a heart attack. Mark Weiser first put the concept of IoT forward in the early 1990's. The term Internet of Things was popularized by Auto-ID center at MIT in 1999. It had begun to design & propagate RFID infrastructure. In 2002, its co-founder & former head Kevin Ashton was quoted by Forbes as saying, "We need an Internet of Things, a standardized way for computers to understand the real world."

B. The applications

Basically IoT allows a data passage between the physical world and the virtual world. This can revolutionize the utility of objects in daily life. Table-1 shows some potential IoT applications. Hence these new capabilities that things offer open up fascinating prospects and application possibilities. This also leads to a need for proper underlying technology and an infrastructure for an Internet of Things that is efficient, scalable, reliable, secure and trustworthy.

C. *Scope*

The Internet of Things is considered as the next IT revolution, wherein the interconnection between devices will create a smart environment. According to a survey done by Gartner Inc. the number of connected devices will cross 4.9 billion in 2015 and the whole Industry of IOT is expected to support total services spending of $69.5 billion in 2015 and $263 billion by 2020.

TABLE I. Potential IoT applications identified by different focus groups of City of Melbourne Citizens

2.THE RASPBERRY PI

Areas	Potential applications
Traffic management	Intelligent transportation through real-time traffic information and path optimization
Infrastructure monitoring	Sensors built into infrastructure to monitor structural fatigue and other maintenance; accident monitoring for incident management and emergency response coordination
Healthcare	Triage, patient monitoring, personnel monitoring, disease spread modeling and containment - real-time health status and predictive information to assist practitioners in the field, or policy decisions in pandemic scenarios
Emergency services, defense	Remote personnel monitoring (health, location); resource management and distribution, response planning; sensors built into building infrastructure to guide first responders in emergencies or disaster scenarios
Crowd monitoring	Crowd flow monitoring for emergency management; efficient use of public and retail spaces; workflow in commercial environments
Water	Water quality, leakage, usage, distribution, waste management
Building management	Temperature, humidity control, activity monitoring for energy usage management, Heating, Ventilation and Air Conditioning (HVAC)
Environment	Air pollution, noise monitoring, waterways, industry monitoring

A. The concept

The Raspberry Pi is a series of credit card-sized single-board computers developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. But now it has become a favorite for "Do It Yourself" projects due to its powerful capabilities and affordability ($35). It's a capable little microcomputer that can be used for many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high-definition video. The models of raspberry pi currently available are model A, model B, model B+ and the latest model Raspberry 2(with Windows functionality)

We have used Raspberry Pi model B+ that was the latest available in 2014.

B. Additional Hardware Resources Compatible To Raspberry Pi

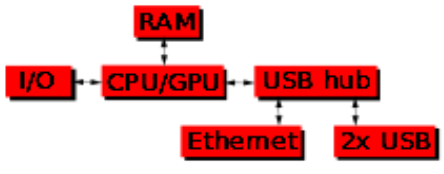

Figure 1. Port available

In Figure 2, for model *A, B, A+, B+*; model *A* and *A+* have the lowest two blocks and the rightmost block missing (note that these three blocks are in a chip that actually contains a three-port USB hub, with a USB Ethernet adapter connected to one of its ports).

In model *A* and *A+* the USB port is connected directly to the SoC.

On model *B+* the chip contains a five point hub, with four USB ports fed out, instead of the two on model *B*.

Other features of the Pi are:

1. Processor:
The design is based around a Broadcom BCM2835 SoC, which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and 256 Megabytes of RAM.

2. *GPIO*:
One powerful feature of the RASPBERRY PI is the row of GPIO (general purpose input/output) pins along the edge of the board, next to the yellow VIDEO out socket.

3. Wi-Fi Adapter
Wireless USB adapter is needed for connecting raspberry Pi and remote desktop and internet without any wires hassle.

4. SD card
The SD card is installed with an O.S of your choice such as NOOBS, DEBIAN, etc. We use as Raspberry Pi's operating system "Raspbian Wheezy" which comes with all the features we require. The design does not include a built-in hard disk or solid-state drive, instead relying on an SD card for booting and long-term storage.

5. Ethernet cable
In this project an Ethernet cable is used to connect the Raspberry Pi with the computer for programming.

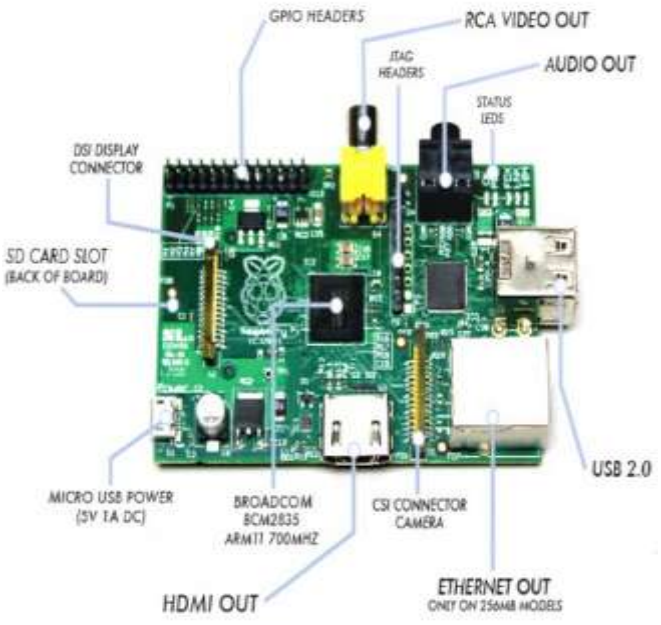

Figure 2. Raspberry Pi with labeled parts

III. IMPLEMENTATION

A. *System Setup*

The Smart Automation Model is unique and we have implemented in many ways. Our first concern was to make this system commercially viable. This would require one common interface for all our customers to log in to. We have also provided tunneling to the local server so that this system is usable from anywhere in the world, via the Internet.

Our second task consists of a fire alert system that not only alerts the specific user but also necessary authorities, like the fire department, and sends notifications to specified Gmail account, SMS to phone and updates status on Facebook and Twitter.

B. *Initialization of Raspberry Pi*

- We installed a collection of operating systems called NOOBS from which we used Raspbian Wheezy.
- We chose Python as the coding language as it is compatible with all sensors.
- The Raspberry Pi needs to be connected to a router with an Internet connection.

Module – I Controlling Light System

The objective of Module-I is to be allow users to control their lights of the house from anywhere in the world. For this we have provided a common web portal for all customers through which they can log in to their specific lights control pages. The database contains their usernames, passwords and URL to their lights control page.

The webpage itself contains three buttons for each light fixture. Currently we have connected to one LED light fixture. Secondly we have provided a special HELP button that users, especially elders and women, can use to make the lights strobe and warn neighbors of required help.

The advantage of using a web portal rather than an android app is that users can control lights using any device which has a browser and a net connection. Hence it is not restricted.

There are three buttons on the webpage:
ON- switches the light on
OFF- switches the light off
HELP- Makes the light blink in intervals of 10s until OFF button is clicked.

1. *Hardware components used in module-I setup*

- Raspberry Pi Model B
- SMD 5050 RGB LED strip(waterproof) with 12V charger and remote control
- 5V channel relay module
- Connecting wires
- 1 pair male and female DC Power Jack Adapter Connector plug

2. *Software Configuration of Module-I*

We installed the following software on the Raspberry Pi SD card:

- Local Apache server
- MySQL
- PhP
- Additional python libraries.

3. *Connections*

The LED strip is connected to the relay module which in turn is connected to the 12V power supply and the Raspberry Pi GPIO pins (General Purpose Input Output). Figure 3 shows the connections.

Figure 3. Connection for Module -I

4. *Testing and Results of Module -I*

The table 2 shows the speed of the application and figure 4 shows the result that we observed.

TABLE II. Testing for controlling lights module

Serial No.	Time taken for Light On	Time taken for Light Off
1	40 ms	50ms
2	50ms	1s
3	40ms	40ms
4	40ms	40ms

Figure 4. Light switches ON

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Module – II Fire Detection and Alerting System

The main objective of this phase is to be able to detect a fire and immediately notify the respective authority and city fire station. If a fire starts in the vicinity and no one is there, the building is able to notify the fire authorities via the Internet. A notification pops up on the website of the fire department as well as Raspberry Pi sends notifications to the user via email, SMS. There is no time wasted, waiting for human response!

First of all the Flare the Flame sensor will detect the fire if it occurs and when the output pin becomes high of fire sensor then Raspberry Pi with the help of IFTTT.com sends the notifications to the fire department as well as informs user through email and SMS. Raspberry Pi also updates the status on Twitter & Facebook.

1. *Hardware components used in module-II setup*

- Raspberry Pi Model B
- Flare the Flame sensor
- Connecting Wires
- Wi-Fi router (with Internet connection)

This flame sensor module could be used to detect fire or other lights with wavelength at 760 nm ~ 1100 nm. This module can be powered with 3~5V and can work with Raspberry Pi.

TABLE III. Specifications of the Fire Sensor

Product Name	Flame Sensor Module
Output Channel	1
Power Supply	3.3/5V
PCB Board Size	32 x 14mm/ 1.3" x 0.55" (L*W)
Hole Size	3mm/ 0.12"
Material	Electric Part
Net Weight	3g
Package Content	1 x Flame Sensor Module

2. *Software Configuration for Module-II*

- Install SSMTP.
- Register in IFTTT.com to send notifications and SMS.
- Setup Gmail account (rsvpiot@gmail.com) specifically for Raspberry Pi to use.
- Setup an unofficial Fire Department Facebook page.
- Python libraries for coding in Python.

IFTTT is a web-based service that allows users to create chains of simple conditional statements, called "recipes", which are triggered based on changes to other web services such as Gmail, Facebook, Instagram, and Craigslist. IFTTT is an abbreviation of "If This Then That" IFTTT can automatically automate web-application tasks, such as posting the same content on several social media.

3. *Connections*

The fire sensor is connected to the Raspberry Pi as follows:

- VCC of fire sensor connects to Pin1
- GND of fire sensor connects to Pin6
- Data pin connects to Pin 10

Figure 5. Connection for Module -II

4. *Testing and Results of Module -II*

The table 4 shown below shows the speed of the application and figures 5,6,7,8 show the result that we observed.

a. *Sending an E-mail*

When Fire is detected by the Fire Sensor the application uses SSMTP to send a mail to a Gmail account. For this we have predefined the id of the sender, receiver and and the sender's password as well as the Gmail server. Hence a notification saying "FIRE!! Contact necessary authorities" is sent.

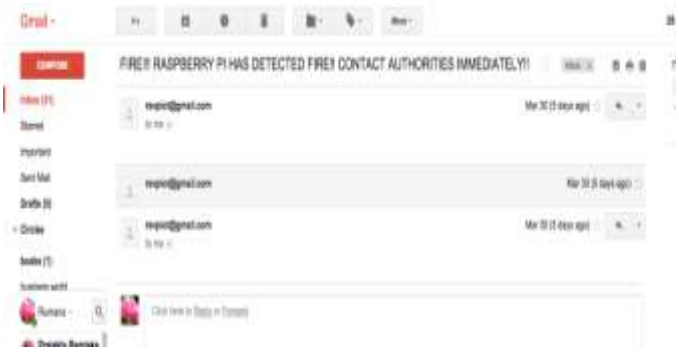

Figure 6. Notification received in Gmail account from Pi

b. *Sending SMS*

We created an IFTTT recipe which checks the Gmail inbox if there is a mail from the Raspberry Pi, in this case it is rsvpiot@gmail.com. This id is specifically used only for sending Fire notifications. Hence the recipe is triggered and an SMS is sent to the specified phone number.

TABLE IV: The time required by Raspberry to send mail and different recipes to work

Serial No.	Time at which application triggered	Time when Mail sent	Time when mail received	Time when fire department Facebook page notified	Time when SMS received	Time when Facebook status updated	Time when Twitter status updated
1	3:53am	3:54	3:54	4:11	4:10	4:30	-
2	3:56am	3:56	3:56	5	4:10	5	5
3	7pm	7:01	7:01	7:25	7:35	7:30	7:37
4	7:02pm	7:03	7:03	7:26	8:17	8:15	-
5	8am	8:01	8:01	8:10	8:21	8:12	8:20

c. Sending notification to fire department

We envision that for each locality's Fire Department we can have a Facebook page or group of which all the locality residents are members. If there is a fire, the Fire Department is notified without the need of a middleman to communicate to them and other neighbors are also notified.

Hence we created an IFTTT recipe that checks for mail by rsvpiot@gmail.com and gets triggered to send a predefined message mentioning the premise of the user to the Fire Department page.

Figure 7. Notification sent to Fire Department Facebook page

d. Updating status on Twitter and Facebook

We created two other recipes to send status updates to our Twitter and Facebook accounts whenever a Fire notification is sent to our gmail account by the raspberry pi.

Figure 8. Updating status on Facebook page

Figure 9. Twitter status updated using recipe

CONCLUSION

Hence we conclude that the proposed model for vigilance and control of devices, allows interacting remotely to household appliance and application sends alert to fire department by using the power of Internet of Things and Raspberry Pi.

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