Project Report On

IoT Postbox

Submitted by

Akshay Sharma (13IT106)
Chetan Harithas (13IT110)
Kishan Sagathiya (13IT216)

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Dr. Geetha V.
Dept of IT, NITK Surathkal

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Details of Project Group

Name of the Student	*Register No.*	*Signature with Date*
1. Akshay Sharma	13IT106	
2. Chetan Harithas	13IT110	
3.Kishan Sagathiya	13IT216	

Name of Project Guide: Dr. Geetha V.

Signature of the Project Guide:

Place: NITK, Surathkal

Date:

Abstract

In an age of Twitter, Facebook, and text messaging, a physical mailbox may seem like a relic of the dead (letter) past, but postal theft is still a big problem and people still get annoyed at fruitless journeys to the curb. The smart Internet of Things postbox is a 21st century variation on the old switch-and-doorbell mailbox alert setup that not only lets you know when the post arrives along with a nice picture, but is also intended to combat theft. The IoT-postbox is used to detect new letter in postbox. When a new letter in the postbox is detected the device sends an e-mail to the user with its picture as an attachment. It uses rechargeable, solar powered power-bank as the power source. Raspberry Pi, a low power, small, ARM powered computer is used and its power consumption is optimized.

Keywords: embedded, Internet of Things, Home Automation

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1. Introduction

The Internet of Things (IoT) is an environment in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet. The concept may also be referred to as the Internet of Everything.
The number of connected devices on the IoT network will be huge. One estimate says that the number will be nearly 40 billion, which is approximately 30 devices for each and every active social network user in the world. That is actually a conservative estimate. Another analyst predicts that “trillions of sensors” will comprise the IoT.

The quantity of data being collected and analyzed in and through the IoT will be huge. No one can predict this “ginormous data” volume reliably, but we frequently see articles that mention zettabytes, yottabytes, brontobytes, and even as high as geopbytes. For example: it is already true that sensors on a single Boeing aircraft jet engine can generate 20 terabytes of data per hour.
The economic impact and benefits of the IoT will be very large. Some of the benefits of IoT are:

- Tracking behavior for real-time marketing
- Enhanced situational awareness
- Sensor-driven decision analytics
- Process optimization
- Optimized resource consumption
- Instantaneous control and response in complex autonomous systems.

Associated with these benefits (and others) are the major driving forces that are pushing us at an increasing pace toward full IoT development and deployment. These forces include (at least) the following 8 motivating factors:

1. **Ubiquitous networks** – personal wi-fi on your mobile phone and on every other device. Everyone (and everything) wants and needs to be connected.
2. **Connected computing** – we want all of our devices, phones, televisions, music players, vehicles, etc. to keep track of what we are doing, viewing, reading, and listening to as we move through our day, from place to place – the handoffs from device to device are already happening.
3. **Ubiquitous sensors** – on everything. It is already here – the Internet of Everything and the wearables revolution.
4. **Intelligence at the periphery of the network** – Jim Gray, the visionary database guru from Microsoft, envisioned smart sensors acting as a mini-database with embedded machine learning algorithms. Here is how he said it (10 years ago): “Intelligence is

moving to the periphery of the network. Each disk and each sensor will be a competent database machine."

5. **Analytics-as-a-Service** – the API and App economies are already vast and growing – this enables any "thing" to "do something interesting" as long as it can connect to an API or invoke an App that performs a network-based service. The "thing" is a data generator and/or collector that also learns from, makes predictions, and maybe even takes data-driven actions in response to the data that are collected (through the versatility and convenience of an App or API call).
6. **Marketing automation** – mobile customer engagement, geolocation, Apple's iBeacon, etc. are all creating a network of knowledge about customers' locations, intentions, preferences, and buying patterns. Of course, this degree of location-based knowledge needs to strike the right balance between user privacy and the timely delivery of useful products and services to that user.
7. **Supply Chain Analytics** – delivering just-in-time products at the point of need (including the use of RFID-based tracking). Essentially, everything is a customer (including machines, automobiles, manufacturing plants, ATM machines, etc.), and the IoT is monitoring, watching, and waiting for a product need to arise.
8. **Aging workforce** - There is a huge hiring gap in manufacturing, which is pushing toward more automation, robotics, M2M (Machine-to-Machine), machine log mining, 3-D printing, predictive and prescriptive analytics in the machines that are doing that work for us. As the classic rock song "2525" predicted would happen in the year 5555: "some machine is doing that for you."

For this application, we are using **Raspberry Pi 3**. The **Raspberry Pi** is a credit card–sized single-board computer. All models of Raspberry Pi feature a Broadcom system on a chip (SOC) which include an ARM compatible CPU and an on chip graphics processing unit GPU (a VideoCore IV). CPU speed range from 700 MHz to 1.2 GHz for the Pi 3 and on board memory range from 256MB to 1GB RAM. Secure Digital SD cards are used to store the operating system and program memory in either the SDHC or MicroSDHC sizes. Most boards have between 1 and 4 USB slots, HDMI and composite video output, and a 3.5mm phono jack for audio. Lower level output is provided by a number of GPIO pins which support common protocols like I2C. Some models have an RJ45 Ethernet port and the Pi 3 has on board WiFi 802.11n and Bluetooth.

1.1. Scope of the Work

The objective of this project is to build and deliver a smart postbox (IoT postbox) that enables home automation.The IoT postbox would sense and mail that it receives and instantly notifies the owner via email or text message (a message over the Internet).

1.2. Product Scenarios

This project lies under the IoT scenario **Social Sensors**. Affiliated by IEEE, this scenario allows more and more people to monitor important parameters in their home or in their surrounding environment. This project can be called as a **Home Automation** project which will make people's life easy by notifying them about their mail in the post-box as soon as it is delivered, so that people don't have to go and check again and again if they have got a post. They will also get a picture of the mail, as their email attachment, so that they will know if they have received a mail which they were expecting/not expecting. Also they will know that the mail is stolen if they have got a notification but couldn't find the mail in the box.

2. Requirement Analysis

2.1. Functional Requirements

- The device should be able to detect, whenever a new post arrives.
- The web camera attached to the Raspberry Pi should take a picture of the mail from the top. (This will let the user know about the sender of the mail etc.)
- The device should be able to notify the user about the new post via an email with an attached pic of the post.

2.2. Non-Functional Requirements

Since to build such a device we need to check whether the box contains a post or not at any moment, the device should always be switched on and located at some remote location. Due to economical reason this device should work efficiently with low power consumption. Some power saving tips for Raspberry Pi are:

- Avoid unnecessary peripherals
- Shut the USB Hub in Raspberry Pi
- Down-clock the Core
- Turn off video output (HDMI)

3. System Design

3.1. Design Goals

- The project should be easy to setup and easy to use.
- Components should not be very costly and should be easily available.
- The project should fully solve the purpose of the application.

3.2. System Architecture

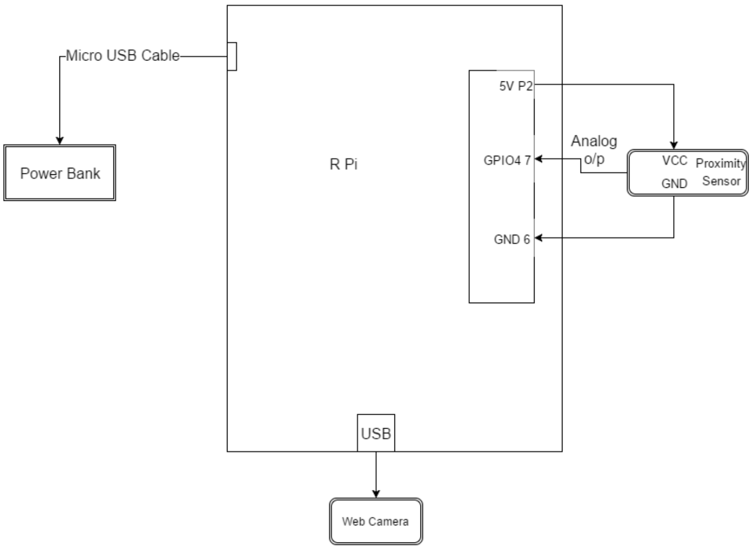


Figure 1: Project Schematic

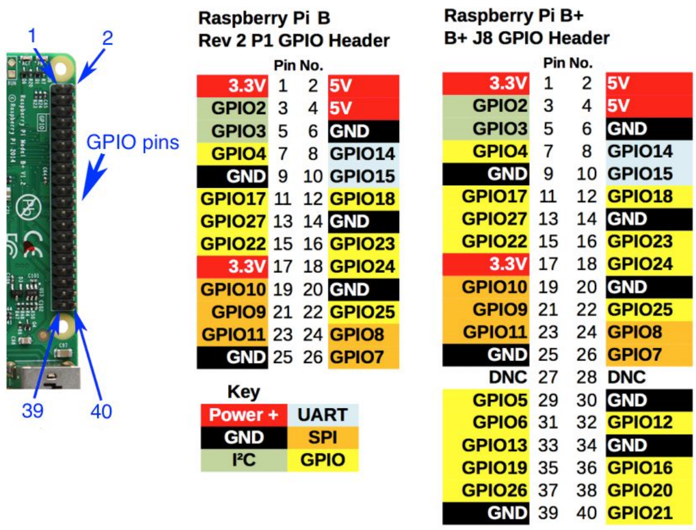


Figure 2: Raspberry Pi GPIO

3.2.1. Hardware components

- Postbox to receive mail.
- Raspberry Pi + SD card loaded with Raspbian Wheezy OS powered USB hub with a 5V power supply.

(a) Sensor off state (b) Sensor on state

Figure 3: Proximity Sensor

- Solar Powered External power-bank to power Raspberry Pi. (Would be better if it is dust and heat proof)
- Network connection or USB wifi dongle for the Pi for Internet connectivity.
- Webcam to take a picture of the mail as soon as it is delivered. (We used I-ball C2.20 face to face web-camera)
- Some connection to the Pi GPIO - IDC connector, ribbon cable and jumpers.
- Resistors and LED
- Infrared Transmitter and Receiver to make a proximity sensor

Figure 4: Web Camera

3.2.2. Software

- Terminal Emulator to set up an SSH connection with Raspberry Pi (Tera-term has been used in our project)
- SMTP Client library for Raspberry Pi
- IFTTT library to send emails
- feedparser python package to access Google mail API.
- GPIO control package for Raspberry Pi. (SMBUS)
- Webcam image saver for Raspberry Pi. (fswebcam)

3.3. Raspberry Pi 3

1. **Hardware** - The Raspberry Pi is a series of credit card–sized single-board computers. The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.

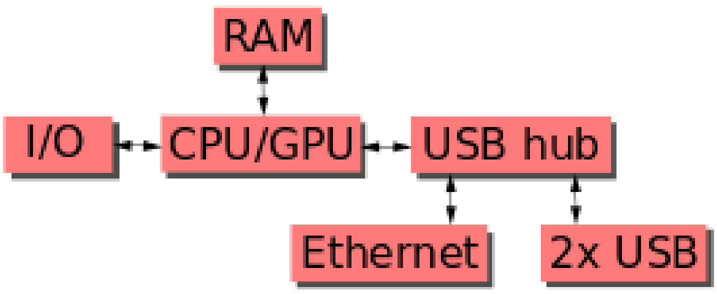


Figure 5: Raspberry Pi Block Diagram

2. **Processor** - The Raspberry Pi is based on the Broadcom BCM2835 SoC, which includes an 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU), and RAM. It has a Level 1 cache of 16 KB and a Level 2 cache of 128 KB. The Level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible. The Raspberry Pi 2 uses a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.
3. **RAM** - The Raspberry Pi 2 and the Raspberry Pi 3 have 1 GB of RAM. The Raspberry PI Zero has 512 MB of RAM.
4. **Networking** - The Raspberry Pi 3 is equipped with 2.4 GHz WiFi 802.11n and Bluetooth 4.1 in addition to the 10/100 Ethernet port.
5. **Peripherals** - The Raspberry Pi may be operated with any generic USB computer keyboard and mouse.

6. **Video** - The video controller is capable of standard modern TV resolutions, such as HD and Full HD, and higher or lower monitor resolutions and older standard CRT TV resolutions.
   The Pi 3's GPU has higher clock frequencies 300 MHz and 400 MHz of different parts that in previous versions ran at 250 MHz.
7. **Real-time clock** - The Raspberry Pi does not come with a real-time clock, which means it cannot keep track of the time of day while it is not powered on. As alternatives, a program running on the Pi can get the time from a network time server or user input at boot time.

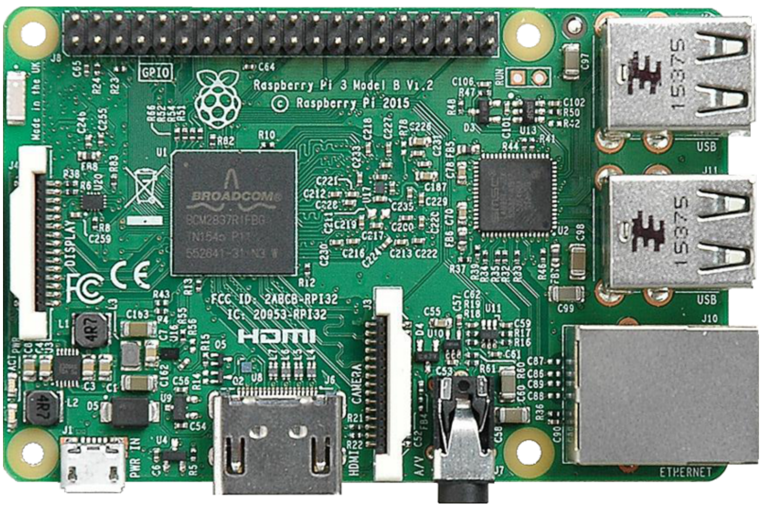


Figure 6: Raspberry Pi 3

3.4. Detailed Design Methodology

The project is built on a Raspberry Pi which is a credit-card sized single board computer. A new letter in the postbox or at someones' door step is detected using an infrared emitter and receiver pair making up a proximity sensor.(illustrated in fig). The Raspberry Pi can be powered by any 5V power source via micro USB. The source of power could be mains supply or a power bank or battery with a 5V USB outlet. The Raspberry Pi along with the IR transmitter-receiver and the web cam are mounted inside the postbox in case of an external postbox or are mounted at a suitable location close to a door (In case the mail delivery happens at ones door step) .

The R-Pi is continuously waiting for new mail. Once new mail is detected using the proximity sensor the board's program is set in motion. The board uses the attached web cam to take a picture of the freshly received email. The R-Pi then logs in to the pre-configured email id (a gmail account from which the R-Pi can send mails from) to access the Google mail API. It uses Gmail mailto API and sends an email to the owner (whose email ID or IDs may be configured on by connecting to the board) with an attachment containing the web-cam captured image of the new mail taken by the web-cam.

The Raspberry Pi uses the ifttt(IF This Then That) tool to send emails.

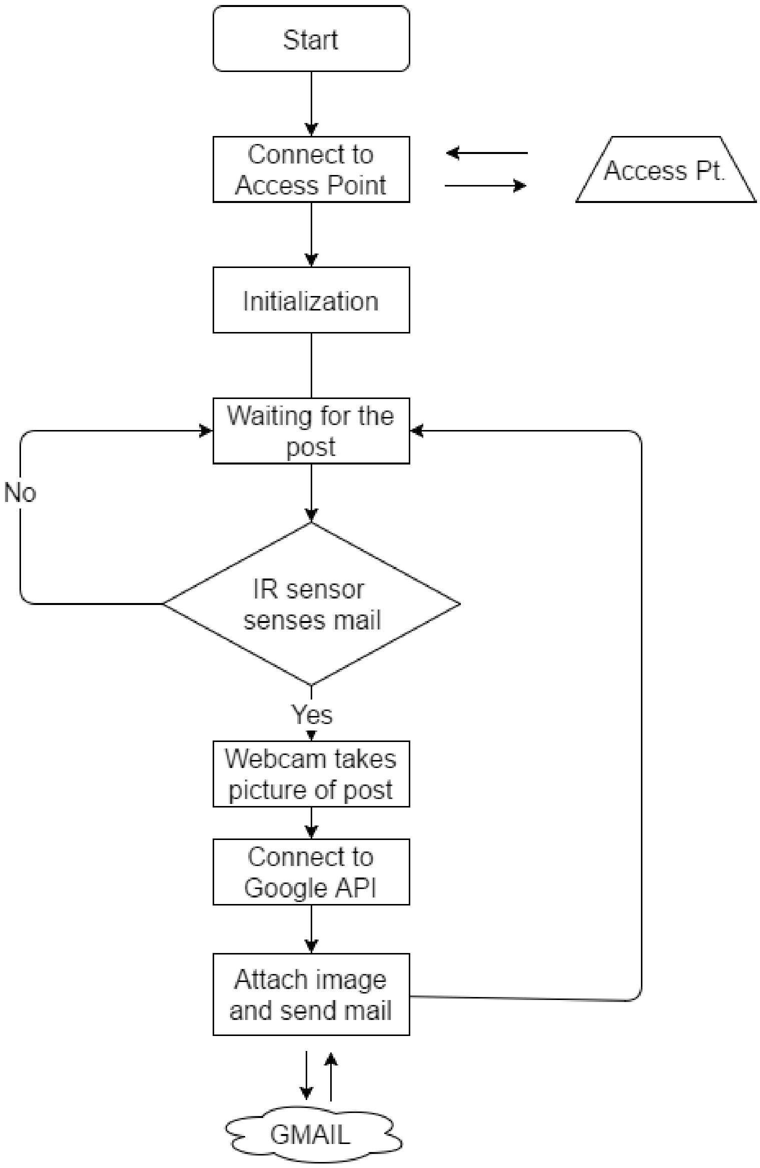


Figure 7: Working Cycle

4. Work Done

4.1. Development Environment

- The Raspberry Pi primarily uses Linux-kernel-based operating systems.The ARM11 chip at the heart of the Pi (first generation models) is based on version 6 of the ARM. The primary supported operating system is Raspbian, although it is compatible with many others. Raspbian OS is used for this project.

- Raspbian is a debian based operating system optimized for the Raspberry Pi hardware. The Raspbian comes with over 35,000 packages, pre-compiled software bundled in a format for easy installation on the Raspberry Pi.

- Tera term, a terminal emulator, is used to set up an SSH connection with the Raspberry Pi. This is then used to control the Raspberry Pi and the input and output devices it is connected to.

- Python 2.4.7 is the programming language used to write programs to run on R-Pi.

4.2. Screen-shots and Results

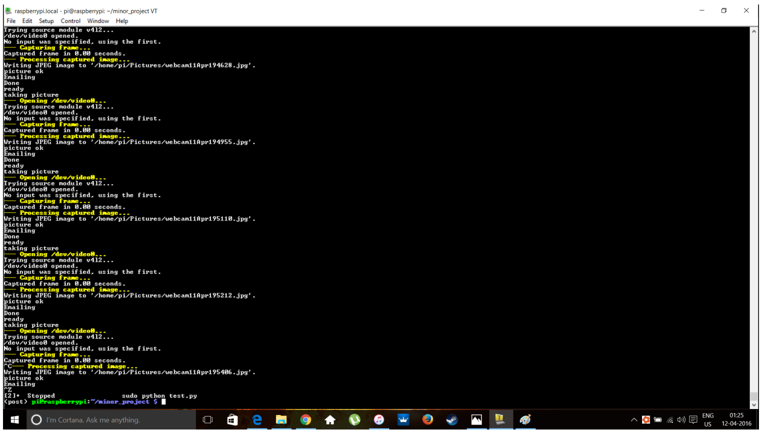


Figure 8: Raspberry Pi terminal while running program

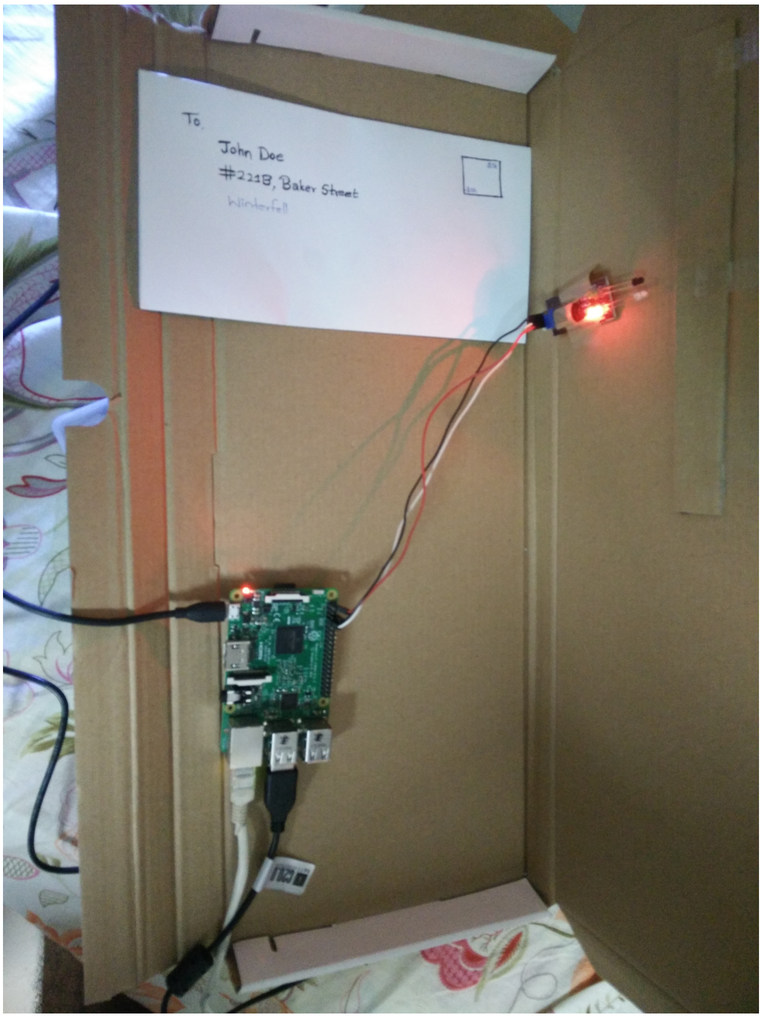
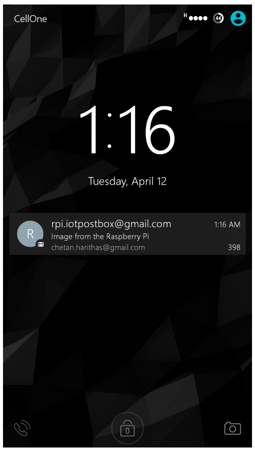
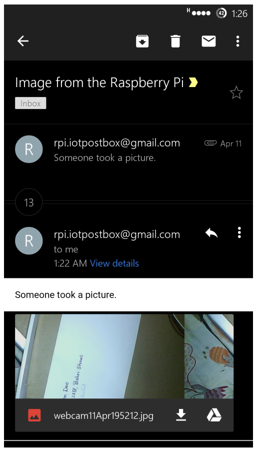


Figure 9: Project Setup for Demo



(a) Email Notification on phone



(b) Email sent by Raspberry Pi

Figure 10: Email from R Pi

5. Conclusion and Future Work

IoT is an evolving field with a wide variety of applications and research scope. A lot of new ideas to automate our daily life and make it more comfortable, are being proposed everyday. This project was done to show one of the applications of home automation using an R-Pi and a few other components. Raspberry Pi can be used to do a large variety of IoT projects when used along with suitable components.
This project was taken up as our **Minor Project** course project of Information Technology department and was successfully completed under the guidance of **Dr. Geetha V**.
For future work some more features like monitoring the postbox 2x7 and keeping track of number of mails in the box as well as history (time and picture) of the mails can be recorded and showed on a cloud server.