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\*\* CodeChix PiDoorbell - Home Automation with RaspberryPi using GPIO

\*\* codechix.org - May the code be with you...

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\*\* License: Apache 2.0

\*\* Version: 1.0

\*\* Project/Library: PiDoorbell - Handout for Tutorial

\*\* Description: Akkana Peck & Rupa Dachere's writeup based on notes from

\*\* Rupa Dachere's PiDoorbell CodeChix Hacking sessions

\*\* Recordings and testing information provided by Deepa Dhurka,

\*\* Serpil Bayraktar and Rupa Dachere

\*\* The FAQ text file in the GitHub PiDoorbell/Docs repo has

\*\* exhaustive steps for each section

\*\* Assumptions: You know Python and Linux basics. And you like to fiddle

\*\* with hardware.

\*\* Testing: N/A

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Hardware Parts List:

* Raspberry Pi (you provide) and power supply

(preferably 1 amp or better)

\* SD card loaded with Raspbian and other required software (see below)

\* HC-SR04 ultrasonic rangefinder

\* Solderless breadboard

\* Jumper wires: 4 male-female, 2 male-male

\* Resistors: 1 360 Œ© (or optionally 2), 1 470 Œ©

\* LED (optional)

\* USB to TTL Serial Cable for Rpi, OR ethernet cable

(for RPi-laptop communication)

Optional:

* Camera for RPi: either USB webcam (Logitech C310 or C270) or

Pi Camera. C310 and Pi Cam have been tested.

\* USB wi-fi dongle

\* Cell phone (for text alerts)

Software

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Installed on the Raspberry Pi:

\* Raspbian (Wheezy or comparable distro),

\* Pip (python-pip), pyserial, python-rpi.gpio, python-twitter (https://code.google.com/p/python-twitter/),

\* git, raspistill, fswebcam, ffmpeg (might have to download and compile from ffmpeg.org)

\* Twilio Python SDK (pip install twilio)

\* Dropbox Uploader script (https://github.com/andreafabrizi/Dropbox-Uploader)

\* PiDoorbell repository, installed via: git clone https://github.com/codechix/PiDoorbell

On your laptop: Some means of communicating with the RPi. Either a program like screen plus drivers for a USB-serial device (most Linux systems and some Mac systems have this already), or a way of using IP masquerading over an ethernet cable.

First step: connect to the Raspberry Pi

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Without a monitor and USB keyboard, there are two ways of talking to a Raspberry Pi: over a serial cable, or over ethernet.

Using a serial cable lets you see boot messages and works even when the Pi has a networking problem.

Using ethernet takes more setup, but may be easier on some Macs.

Option 1: Connect with Serial Cable

Linux already comes with a driver that will work for the serial cable.

On Mac, you may need to download and install a driver first. You can get

Them here: http://sourceforge.net/projects/osx-pl2303/

If using Lion or Mountain Lion or later OS X, try this

driver: http://changux.co/osx-installer-to-pl2303-serial-usb-on-osx-lio

Accept all defaults when prompted by the installer.

Now wire up the serial cable as shown.

The black wire goes on the third pin from the corner; the white wire goes

next to that,

and then the green.

DO NOT USE THE RED WIRE!

If you do, the Pi will try to get power from that wire (over the USB)

which conflicts with getting

its power from its micro-USB power plug. Just leave that wire hanging

free.

Once the serial cable is connected to the Pi, plug the USB end into your

laptop.

Then run this command:

Linux: screen /dev/ttyUSB0 115200

Mac: screen /dev/cu.PL<something> 115200

The <something> part (on Mac) will vary, so use the Tab key after PL and

let it autocomplete.

If you have trouble, you might have better luck by running Linux under

VirtualBox/Fusion. Make sure you

select the ‚Äúconnect to Linux‚Äù option when connecting the USB to the

Mac.

To exit screen: C-A C-\ (where C- is Control on Linux, Command on Mac).

You can use any other program you prefer for talking to a serial port:

minicom, etc. The device ID may

be something other than /dev/ttyUSB0, depending on your OS.

Once you have a connection established, you should be able to plug in the

Raspberry Pi's power supply

and see boot messages.

Option 2: Connect with Ethernet Cable

Connect the two ends of the ethernet cable to the Pi and your laptop.

Configure your laptop's ethernet address to be 192.168.2.1/24:

On Linux, type: ifconfig eth0 192.168.2.1/24 up

On Mac, use 'network' settings in 'System Preferences' and configure

Manual IP address

Your Pi has been pre-configured with a static IP address on its ethernet

port. Note the IP address,

then try to log in to your Raspberry Pi using ssh:

ssh pi@<your-pi's-IP-address>

Of course, you can use an ssh client like putty if you prefer.

You can even port-forward X to run remote windows (ssh -X pi@<ip address>)

if you're already

familiar with how to do that, but that's beyond the scope of this

tutorial.

Either Way: Now Set Up Wi-Fi

The Raspberry Pi uses the file /etc/network/interfaces to configure

networking.

You'll need to edit that file as root (using sudo). You can use any editor

you're familiar with,

but if you aren't familiar with any on the Pi, pico is probably the

easiest to work with.

First make a backup of it:

sudo cp /etc/network/interfaces /etc/network/interfaces.sav

Then edit it:

sudo vi /etc/network/interfaces

There should be a stanza for eth0 already there. Leave it in place, go to

the end of the

file (add a blank line if needed), then type one of these, depending on

the conference wi-fi we're using:

Open wi-fi (no password):

iface wlan0 inet dhcp

wireless-essid "network-name-goes-here"

wireless-mode managed

WPA/Secure wi-fi, with password:

auto wlan0

allow-hotplug wlan0

iface wlan0 inet dhcp

wpa-ssid ‚Äúnetwork name‚Äù

wpa-psk ‚Äúpassphrase‚Äù

Save the file and exit the editor. Then, back in the Pi's shell, restart

networking:

sudo service networking stop; sudo service networking start

Now test networking by trying to ping an outsite site:

ping www.codechix.org

If that doesn't work, you may need to stop andstart networking again, or

possibly even reboot.

2. FUN: Using GPIO: Blinking an LED

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2a. Wire Power and Ground

You'll be using the Raspberry Pi's GPIO header.

The first step is to wire up power and ground to your breadboard.

On a solderless breadboard, the strips along the edges of the board ‚Äì

labeled with red and

blue ‚Äì are generally used for power (red) and ground (blue).

On the Raspberry Pi's GPIO header, the pin in the corner gives you 5 V

power ‚Äì the power

supply the RP is getting from its power input.

The third pin from the corner, in the outer row, is ground. (There are

several other pins

that can provide ground, if you need more than one. But since we're using

a breadboard that's not a problem.)

Use male-female jumpers the female end of each jumper fits over the Pi's

GPIO pin, and

the male end plugs into the breadboard. If possible, use red for power and

black for ground.

2b. Wire up the LED

An LED has one leg longer than the other. The longer leg should be

connected to power, the shorter

one to ground. But you need a small value resistor in the circuit so you

don't burn out the LED.

Use your 360 Œ© resistor for this. It's the one with red and orange bands.

In the middle part of the breadboard (between the power/ground strips),

each line of 5 is wired together.

So with this wired up, the current flows from the Pi to the red power

strip, to the long pin of the LED,

through the LED, through the resistor, out to the ground (blue) power

strip of the breadboard, and out

to the Pi's ground pin.

If your Pi is plugged in and running, the LED should light up as soon as

you finish connecting the wires.

3. Connect the LED to a pin you can control

It's not much fun to have an LED always on.

So instead of connecting the long pin to the breadboard's power rail,

connect it to pin 18 of the Pi's GPIO header.

The pin numbering on the GPIO header doesn't make any sense, so you should

always check a reference to figure

out which pin is which. And worse, there are two different incompatible

ways of numbering the pins. We'll

be using the ‚ÄúBCM‚Äù numbering system. BCM pin 18 is the 6th pin from

the corner on the outer row.

The LED should be off now. Try running the led.py script. You'll have to

run it as root: only root can

access the Raspberry Pi's GPIO pins.

sudo python led.py

Your LED should start blinking.

You can edit led.py and adjust the sleep times.

GPIO Pin Diagram

Take a look at the diagram showing all the pins on the Raspberry Pi's GPIO

header (PiDoorbell/Docs/rpi-gpio.jpeg).

Warning: some pins may vary between different Pi versions.

Hooking up the sonar rangefinder

The HC-SR04 distance sensor emits a sound pulse, then measures the time it

takes for the sound to return.

Same principle as bats, dolphins or submarines.

The HC-SR04 has 4 pins. If you point the sonar horns away from you, the

pins are, from left to right:

Gnd (ground), Echo, Trigger, VCC (5 V power).

We'll connect power and ground, and wire Trigger to BCM pin 23, Echo to

pin 24. Those are the 5th and

6th pins from the audio connector end of the GPIO header on the outer row.

There's one snag: the HC-SR04 runs on 5V, while the Raspberry Pi's GPIO

pins can only handle 3V

(even though it has a 5V power pin). We can compensate for that by using

two resistors as a

‚Äúvoltage divider‚Äù to convert 5V to a level the Pi can handle.

Remember, your 360 Œ© resistor is the one with the orange and blue band.

Try not to get the resistors

backwards, and be sure to connect the 470 Œ© to ground, not power. Too

much voltage on a GPIO pin could

potentially damage your Pi!

Controlling the Rangefinder

To control the HC-SR04, we need to turn the Trigger line high briefly,

then turn it low again. The Echo line goes low. When the sound pulse

returns, the Echo line goes high. So we just need to time how long it takes to

go from low to high.

The HC\_SR04.py script does just that. When you have everything wired up,

run it as root to see if everything's

working:

sudo python HC\_SR04.py

If everything's okay, you'll see it print repeated lines measuring the

distance in front of it. Try putting

your hand or some other object in front of it and see if the distance

changes.

If you don't see repeated printouts, double-check your wiring. It's

amazingly easy to find yourself one pin off,

or with the Trigger and Echo pins reversed.

Once all the rangefinders are working, we can move on to the real

PiDoorbell logic, in pidoorbell-recognizer-gpio.py.

PiDoorbell Recognizer Script

pidoorbell-recognizer-gpio.py is the main script that incorporates the

sensor, camera (photo + video),

uploading of files and notifications in the form of SMS and Tweets.

It needs to be run as root (because it needs access to GPIO). It can take

several arguments:

pidoorbell-recognizer-gpio.py -h will list them all.

For initial testing, run it like this:

sudo python pidoorbell-recognizer-gpio.py -i -local

-i specifies interactive mode, so you can see verbose messages about what

it's doing. -local keeps it

from using any web services while you're still getting everything hooked

up.

In interactive mode, you should see a steady stream of messages as it

reads distances from the rangefinder.

Try putting your hand or another object in front of the sensor to trigger

it.

By default, the script considers anything from 0 to 30 inches to be within

its target range, and an object has

to remain there for at least 5 seconds before it reacts. These values are

set near the beginning of the script

and are easy to change.

Additional flags that pidoorbell-recognizer-gpio.py supports are:

-latency specifies the time the script waits for photos/videos to be

uploaded to Dropbox. Default is 20s.

You might need to tweak this depending on network latency.

-pic\_mode specifies whether to take a video (1) or photo (2). Default:

photo(2).

-mode specifies the notification service to use: "sms" or "tweet" or

"all". Default: "all".

Taking photos or video of your visitors

The recognizer can take a photo if you have a camera on your Raspberry Pi.

That can be either a USB webcam

that works with fswebcam and ffmpeg, or the Raspberry Pi camera module

attached to your Pi.

Ffmpeg and fswebcam are optional software, not installed by default, so

they need to be installed:

apt-get install fswebcam libv4l-0 v4l-utils

When capturing video, ffmpeg is used.

apt-get install ffmpeg

You might need to compile from source: http://ffmpeg.org

RaspberryPi Camera Module

The Pi camera module doesn't use the normal Linux video framework, so it

needs its own programs: raspistill

and raspivid (which should already be installed as part of package

libraspberrypi-bin), or, ideally, a Python

module called picamera which isn't installed by default:

apt-get install python-picamera

By default, the recognizer will try to take a still photo using fswebcam

if it finds a USB camera, or using the

pi camera module if one is installed. With a USB camera, you can shoot a

10-second video instead (video isn't

supported yet for the pi camera) by passing -pic\_mode 1 as an argument to pidoorbell-recognizer-gpio.py.

These photos should be created in the dropbox-pidoorbell subdirectory of

your source directory (where you're

running the script). You may need to create that directory.

Adding Dropbox, Twilio, Twitter

Install the dropbox api: pip install dropbox

Open an account at https://www.dropbox.com/home

Get your API Key and Secret at:

https://www.dropbox.com/developers/apply?cont=/developers/apps

You can use an App Name like pidoorbell-yourname, or whatever you like.

Run dropbox\_uploader.sh. You will be asked your app key and secret.

Now test the uploader:

$ ./dropbox\_uploader.sh

# App key:

<copy here from the website>

# App secret:

<copy here from the website>

# Permission type, App folder or Full Dropbox [a/f]: a

> Token request... OK

Then open the following URL in your browser, and allow Dropbox Uploader

to access your DropBox folder:

https://www2.dropbox.com/1/oauth/authorize?oauth\_token=8NGlM1Cj8205nC5w

(this is a sample - you will receive a different URL for authentication

when the script runs.)

Twilio

Install Twilio SDK on the Rpi: pip install twilio

Open an account at https://www.twilio.com

Your account SID and TOKEN are in your Account Settings

ACCOUNT SID <>

AUTH TOKEN <>

Update PiDoorbell/sms\_auth\_info.py file with Twilio, Dropbox, and Twitter account info.

It should look like:

# Twilio authentication credentials

# The values should be in double quotes, i.e., "xyz"

account\_sid = <Your Twilio account secure ID>

auth\_token = <Your Twilio authentication token>

# Dropbox app key and secret from the Dropbox dev site

# The values should be in single quotes, i.e., 'xyz'

DB\_APP\_KEY = <Your Dropbox application key>

DB\_APP\_SECRET = <Your Dropbox application secret>

DB\_ACCESS\_TYPE = 'app\_folder'

#Twitter authentication credentials

# The values should be in singl quotes, i.e., 'xyz'

twitter\_auth\_key = <Your Twitter authentication key>

twitter\_auth\_secret = <Your Twitter authentication secret>

twitter\_access\_key = <Your Twitter access key>

twitter\_access\_secret = <Your Twitter access secret>

Putting it all together

With Dropbox and Twilio all set up, run the PiDoorbell code:

pi@raspberrypi ~ $ sudo python pidoorbell-recognizer-gpio.py -i -mode sms

Then put your hand or an object in front of the sensor ‚Äì you should see

messages like:

\*\*\*\*\*\* DETECTED AN OBJECT AT -- 9.44145122999 -- INCHES \*\*\*\*\*\*

Then it should take a photo (if you have a camera), upload it to Dropbox,

and send you an SMS!

Example output:

pi@raspberrypi ~/pycon2014/pidoorbell $ sudo python pidoorbell-recognizer-

gpio.py -i -mode sms

latency is 20 pic\_mode is 2 local\_mode is False notification mode is

sms

206.71170739

Distance: 206.7 inches

206.725658952

Distance: 138.9 inches

138.930726795

Distance: 3.6 inches

3.5506725086

\*\*\*\*\*\* DETECTED AN OBJECT AT -- 3.5506725086 -- INCHES \*\*\*\*\*\*

Distance: 3.4 inches

3.4369136191

\*\*\*\*\*\* DETECTED AN OBJECT AT -- 3.4369136191 -- INCHES \*\*\*\*\*\*

Distance: 3.8 inches

3.7873124627

\*\*\*\*\*\* DETECTED AN OBJECT AT -- 3.7873124627 -- INCHES \*\*\*\*\*\*

Distance: 3.4 inches

3.39881512309

\*\*\*\*\*\* DETECTED AN OBJECT AT -- 3.39881512309 -- INCHES \*\*\*\*\*\*

Distance: 3.4 inches

3.36500941536

\*\*\*\*\*\* DETECTED AN OBJECT AT -- 3.36500941536 -- INCHES \*\*\*\*\*\*

Taking photo with fswebcam ...

--- Opening /dev/video0...

Trying source module v4l2...

/dev/video0 opened.

No input was specified, using the first.

--- Capturing frame...

Corrupt JPEG data: 3 extraneous bytes before marker 0xd7

Captured frame in 0.00 seconds.

--- Processing captured image...

Writing JPEG image to './dropbox-pidoorbell/visitor-photo-2014:4:3-19:51.jpg'.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* UPLOADING TO DROPBOX: \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

latency is 20

* Uploading "/home/pi/pycon2014/pidoorbell/dropbox-pidoorbell/visitor-

photo-2014:4:3-19:51.jpg" to "/visitor-photo-2014:4:3-19:51.jpg"... DONE

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* SENDING SMS WITH URL:

https://www.dropbox.com/s/4vhv709udzm2zyn/

visitor-photo-2014%3A4%3A3-19%3A51.jpg

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Appendix: References and Thanks

This handout, all the code, slides, and other materials for this workshop

are available on GitHub:

https://github.com/codechix/PiDoorbell.

This tutorial is run by members of Bay Area CodeChix, a nonprofit

organization for educating, mentoring and promoting women engineers and

developers: http://codechix.org

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