Boston University
Electrical & Computer Engineering

EC463 Senior Design Project

First Prototype Testing Plan

Ecobin

by

Team 9
Ecobin

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Required Materials

Hardware:

- Raspberry Pi 3 B+ (with 32GB SanDisk SDHC Class 10 card)
- Raspberry Pi Camera Module v2
- PIR Motion Sensor
- LED Strips (12V, 0.9W)
- LED diodes (green, red, white)
- 12W Power Adapter (Pi3)
- 12DC Power Supply (LED Strips)
- Transistor (BJT PN2222A)

Software:

- Python 3 scripts:
    - Capture photos in JPEG format
    - Object recognition
        - Tensorflow
        - Keras
        - Numpy, Scipy
    - Signal handling
        - Raspi GPIO

Set Up

The equipments and setup are divided into two parts: the Raspberry Pi with the camera for hardware; image capturing and image recognition Python scripts for software. A computer acts as processing cloud server. Peripherals such as the motion sensor and the Pi camera are attached to the Raspberry Pi. If the Passive Infrared Motion Sensor (PIR) detects an object, it transmits a 3.3V signal to the Raspberry Pi via the Pi's GPIO pins. This trigger signals the Pi to turn on the LED strip to illuminate the bin, and capture an image using the camera. After that, the Pi will forward the image to a simulated server. Within the simulated server, a Python script, powered by the Keras API and the pre-trained VGG model, identifies object in the image. (Keras is an open source high level neural network library which allows for efficient and fast prototyping and experimentation.) The server then communicates with the Pi and then a signal is sent to the LED which in turn lights up green(if recyclable) and red(if trash).

Pre-testing Setup Procedure:

Server side:

1. Enable ssh connectivity with the Raspberry Pi with the command *ssh pi@*ip_address**
2. Enable sftp connectivity with the Raspberry Pi with the command *sftp pi@*ip_address**
    i. Make sure that the sftp environment is in the correct working directory. (ie. *cd Desktop*)
3. Run the python script, *keras_test_individual.py*

Raspberry Pi side:

1. Ensure that the background is clear
2. Run the python script, *ecobin.py*

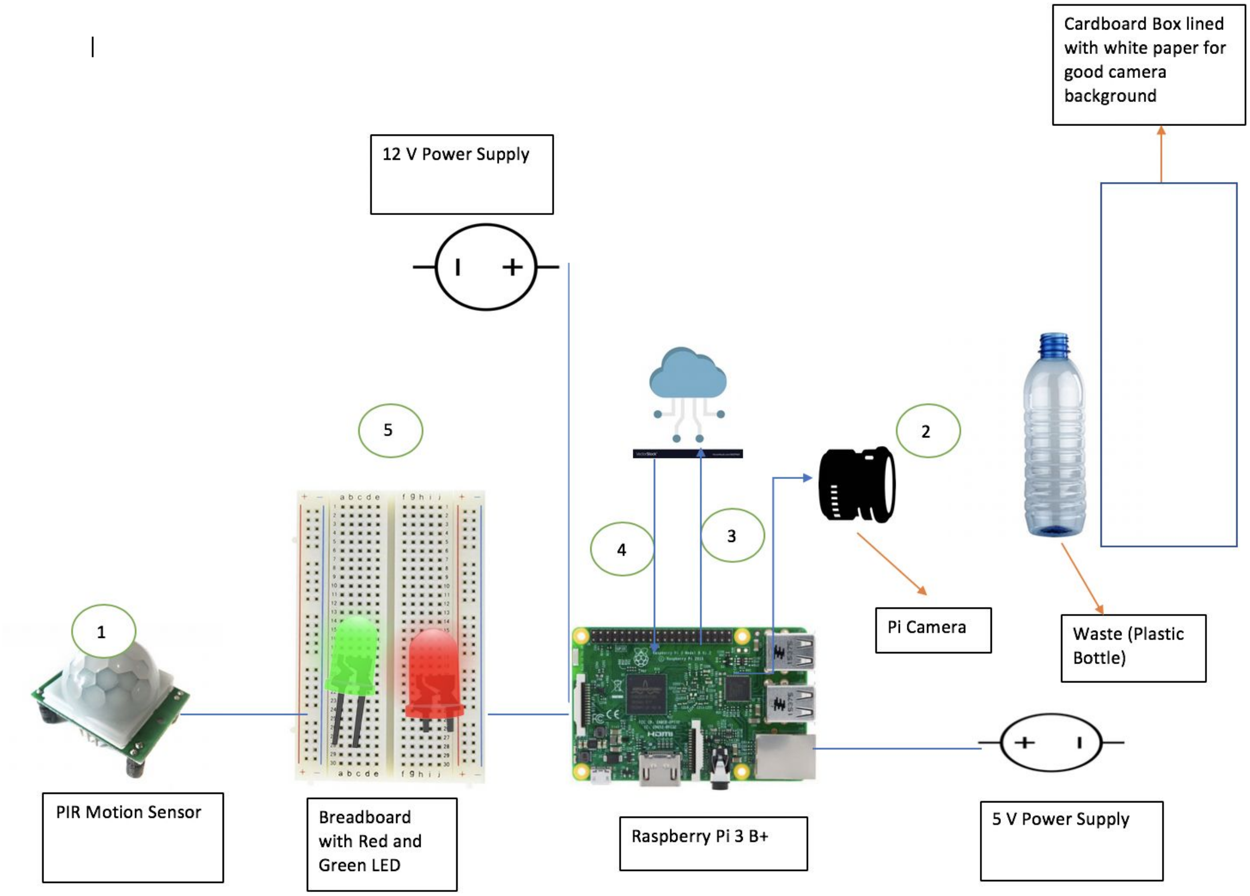

Figure 1: Illustration of Setup and Process Flow

Testing Procedure:

1. Place an object on the detection platform(cardboard box), and wave hand over PIR motion sensor.
2. Image of trash is captured by the Raspi camera
3. The image is processed in the simulated server, in this case, a computer.
4. [Computer] - Through sftp, enter the following commands
    i. *get trash.jpeg* ← Sends object image to the computer from the pi
    ii. *put code.txt* ← Sends detection results to the pi from the computer
5. The computer sends the results back to the Pi, the Pi shows the result through the red(trash) and green(recyclable) LEDs.

Measurable Criteria

The criteria for successful running and output is as follows:

I. The Raspberry Pi should successfully capture an image and output name of the captured image on to the terminal

II. On the breadboard, there is a Red LED and a Green LED. The Red LED should light up if the system detects “Trash” and the Green LED will light up if it detects a “recyclable” object. The object is able to be identified and sorted into these two overarching classification because we categorised common objects into two separate lists and once the object is detected and identified, it searches the list to match the object to a classification.

III. If there’s motion above the PIR motion sensor, the Raspberry Pi should successfully take a photo of the object.

IV. The Raspberry Pi should successfully classify whether an object is recyclable with **75%** accuracy.

Score Sheet

Object	Category	Correct? (Y/N)
Result →		%

Hardware Pinout

Pi3 Pin #	Usage/Description
2	5V Power -> PIR Vcc
6	Ground -> PIR GND
11	GPIO 17 -> PIR Out
3	GPIO 2 -> White LED diode
5	GPIO3 -> Red LED diode
7	GPIO 4 -> Green LED diode
13	GPIO 27 -> LED strips