THE HONG KONG
UNIVERSITY OF SCIENCE
AND TECHNOLOGY

COMP4971 – Project Report

Project Title:

Raspberry Pi System
For
Detecting Machine Status

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1. Abstract

Many students have been complaining there is no available laundry machine at peak time and it is difficult to check the availability of machines unless go to the laundry room. Thus this project is aiming to provide hall residents a convenient way of checking laundry status and improve the efficiency of washing machines. The project is mainly reply on a Microcontroller called raspberry pi, together with vibration sensors to collect data and upload it onto real-time display website so that residents can check the website though their laptops or mobile phones, plan early and save time. This project explains the technical implementation in detail, the logic behind and demonstrate the final project outcome.

2. Introduction

2.1 Background

Quite a number of HKUST hall residents have complained that there are not enough washing machines on campus. During the busy hours, they may carry heavy laundry baskets up and down stairs while find all the machines occupied. It may even take them several journeys to finally find an empty one. The root cause is the inefficient allocation and use of the washing machines rather than the quantity. So this project, inspired by the concept of IOT “Internet of Things”, is hoping to create a free information disclosing and accessing platform to increase the efficiency of public facilities.

2.2 Objectives

Because this is a common need in UST and washing machines are relatively convenient to reach thus this project is to develop checking system based on washing machines, then adjust and apply it to more fields in the future. Here are the objectives of our project.

- Improve the efficiency of usage of washing facilities
- Help students find available machines and manage their washing schedule
- Improve the Hall living satisfaction level
- Develop a pilot project for potential future business

3. Methodology and related information

3.1 Project data flow overview

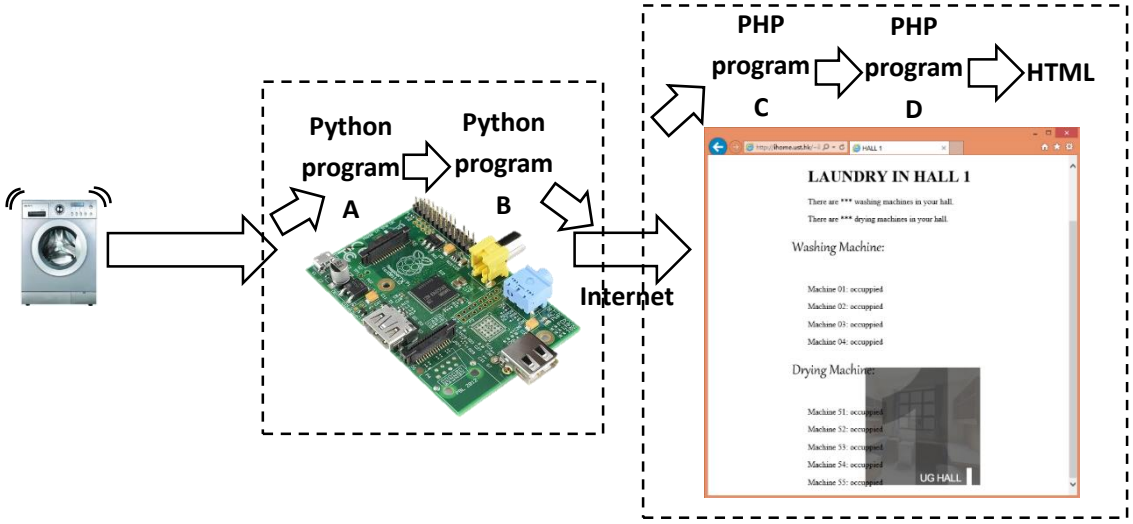

Figure 1 Data flow from washing machine to website

3.2 Hardware and software employed

As a prototype for the real time display, our project provides the real time availability status of the laundry machines in residential halls through online platform. Two main parts, electronics and website building, are considered in this project. The basic mechanism of the electronics part is the signal transition and forwarding. Vibration sensors, whose inputs are stick to the laundry machines, are used to collect the electronic signals when the machines are under working. Subsequently, the signals are forwarded from the outputs of the sensors to the single-board computer, Raspberry Pi. A database is programmed in Raspberry Pi with Python language to collect and record the electronic signals and translate them in the form of text file, which is more suitable for website programming. After that, the data in Raspberry Pi are transmitted to the ihome server through on-campus Wi-Fi where the website is built. Html, CSS and JavaScript are used to design, skeleton and frame the body of the website. PHP animates the website and acts as the medium between the database and the display site to transit the change from the signal to the website. For residents, they just need to check the website to get the availability status for the particular machine and then decide whether to go to wash their clothing or not. Similar sensor system may be applied to other public areas like parking lots and communal bathrooms etc.

List of items used in this project:

a. Raspberry Pi B+
b. Vibration sensor: MPU6050
c. Display Screen (TFT color monitor 17.4cm*11.4cm*3.3cm)
d. Breadboard

e. DuPont Wire
f. Multimeter (UT33D)

3.3 Determine engine status

After consulting the university residential department and the security department, our initial and easiest idea to get the engine data which is the data inside the card payment machine has been declined due to students' privacy concern. Another direct way to getting data which is to change the washing machine internal electric path so that it could send the data upon usage also failed to be accepted considering unnecessary risk of breaking down the machine.
Thus external sensors are used for the reason of safety and accuracy.

3.4 Sensor selection process

Sensors are the core part of this project, serving as the data importer. The selection of sensors is vital considering the accuracy and stability. A few options have been considered before the final conclusion, such as camera (too much burden for school network), electric sensors (too expensive), heat sensors(inaccurate). In the end, vibration sensors are selected to meet all the criteria.

3.5 Vibration sensor

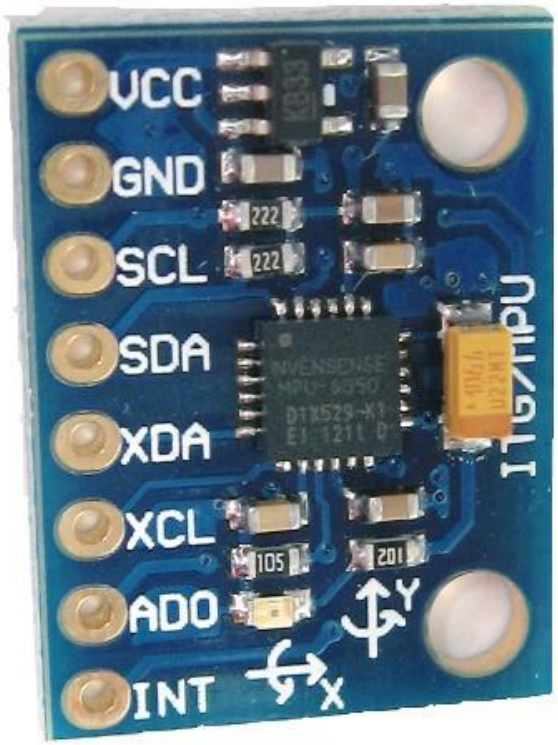

Figure 2 Vibration sensor: MPU 6050

MPU6050 （Figure 2） is a three dimensional vibration sensor, giving out the gyro data (x, y, z) and the acceleration data (x, y, z). If to use the vibration data, the most applicable place worth researching is the in water pipe and the thinnest side wall of the machine and these are the places intended for the sensors to be stick on. Also in order to get the most relevant data, complete Six set of data are gathered throughout a path of five minutes stable machine state, a complete cycle of laundry and another five minutes stable machine state. Afterwards, when visualize the data across time dimension. It has been find that gyro y dimension is most sensitive to the end fast spinning phase (Figure 3) while the acceleration sum of x, y and z dimension is most sensitive to the in water phase (Figure 4). Thus these two set of data are the selected data to be analyze later on to determine the status of the machine.

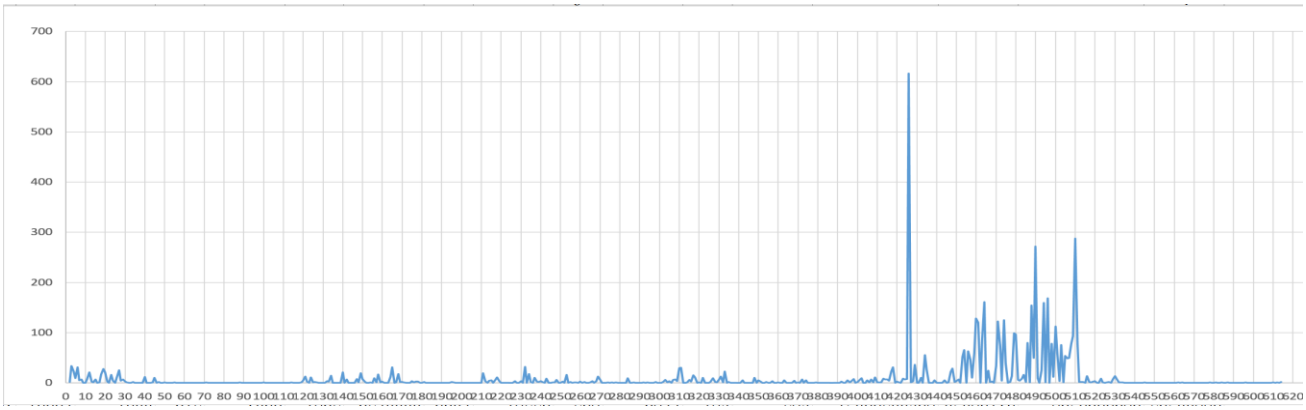

Figure 3 Gyro y dimension

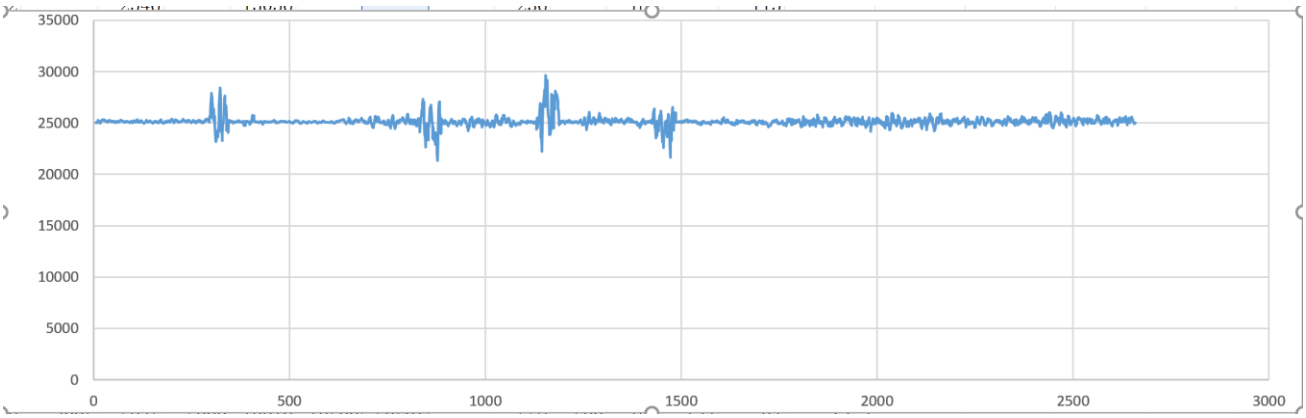

Figure 4 Acceleration sum of x, y and z dimension

Vibration sensors are selected based on three concerns. (Figure 2) Firstly, vibration sensors are relatively cheap. Because the status of each washing machine needs to be collected independently, it is very important to control the cost of sensors, which will be of large quantity, so that the total price will be acceptable and attractive to be widely used. Secondly, vibration sensors are mechanically easy to understand hence, user friendly. Users can adjust it and repair vibration sensors on their own and little technical knowledge will be needed. Last but not least, vibration sensors can perfectly avoid one significant concern of users: privacy. Because no video or photos are collected, other users cannot view the clothes nor know the users through this website and the information of each user will be perfectly protected.

3.6 Data transformation

3.6.1 Raspberry Pi

Raspberry Pi is selected (Figure 5) because it's both functional satisfying and efficient considering it has its own operating system available for download (e.g.: Raspian) compared to Arduino. For example, python program could directly be used rather than C language, original embedded Wi-Fi application rather than Wi-Fi module to be installed, embedded GPIO port rather than to configure port construction on oneself. Raspberry Pi contains a reasonable CPU and both Ethernet and USB ports. Raspberry Pi is also relatively cheap, around 250 HKD, so it will be cost-efficient, with each hall laundry room share a same computer.

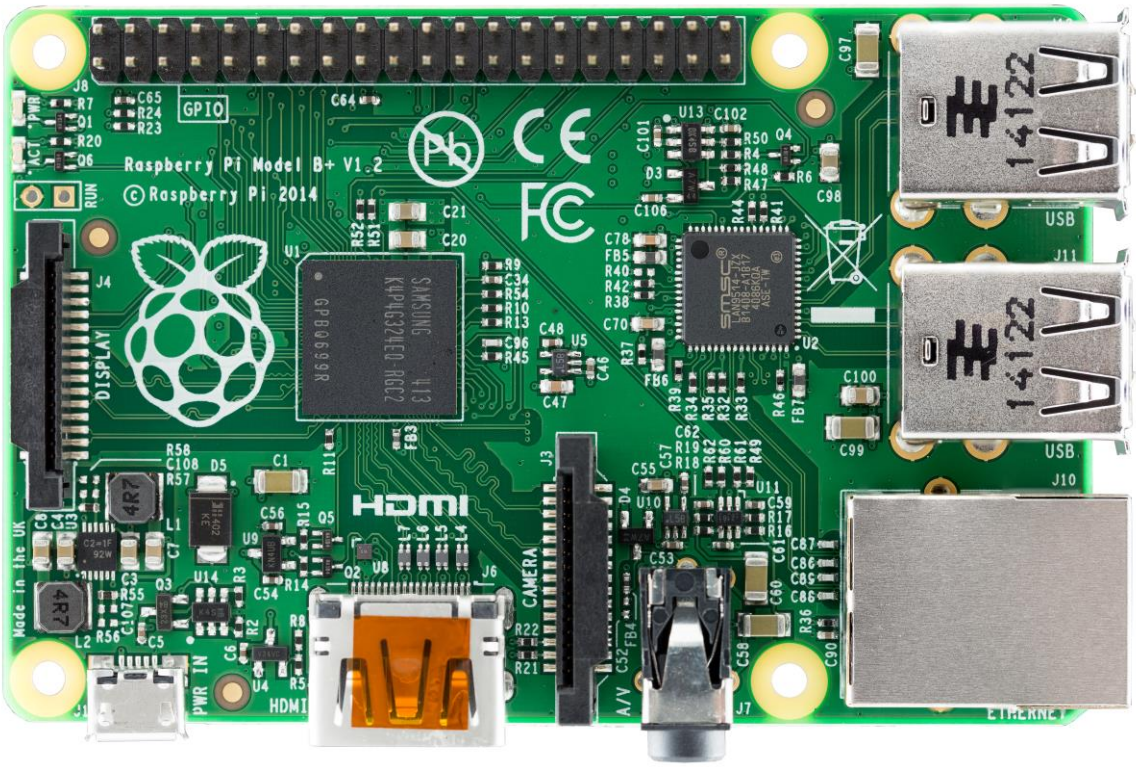

Figure 5 Raspberry Pi

Sensors use the SDA module on Raspberry pi to communicate to the CPU and AD0 are used to switch between different sensor's data income.

3.6.2 *Python*

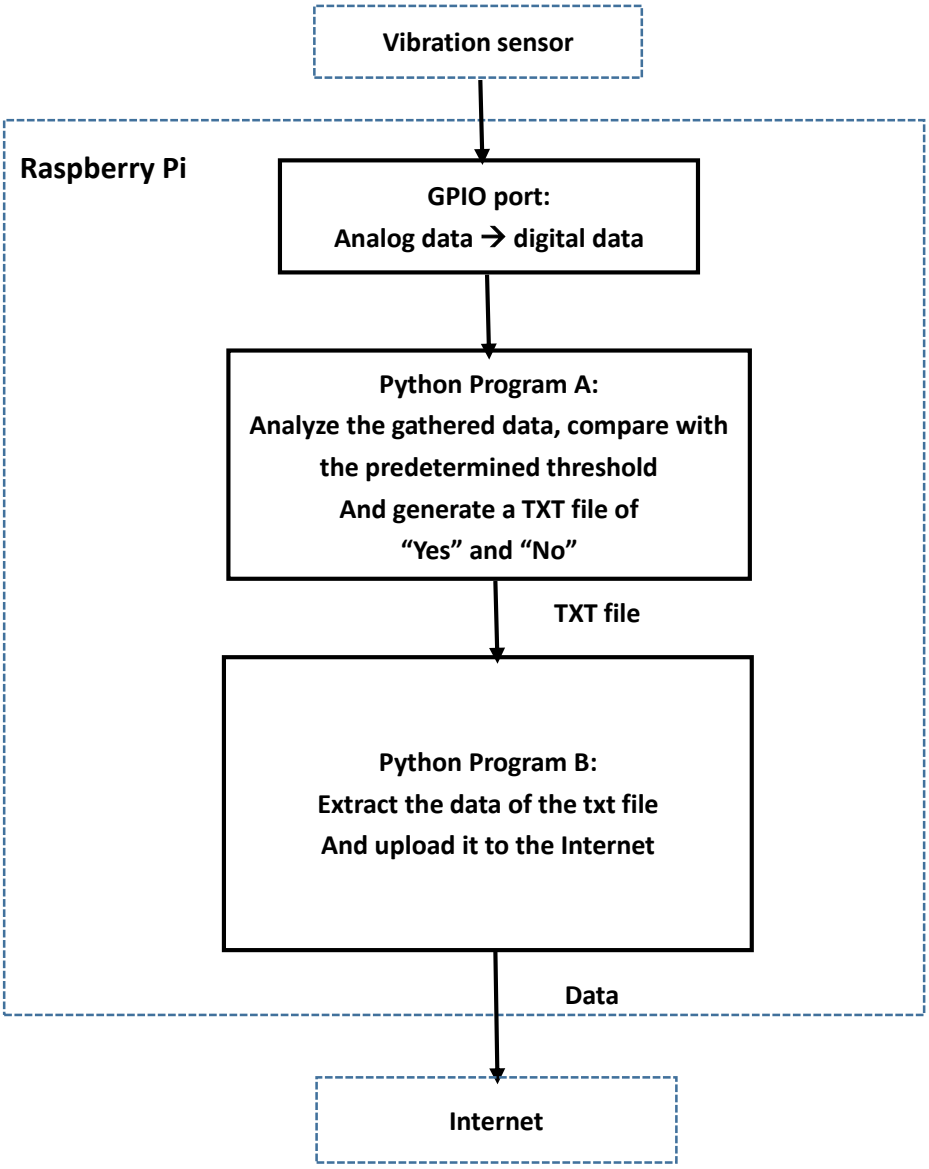

Figure 6 Python programs

3.6.3 *Internet related program*

Different languages are used for different parts in this project. For example, Python program for data collection and uploading, running on Raspberry Pi and html, CSS, JavaScript are to build the website. Besides these, PHP is to construct the database on the website.

3.6.4 *PHP*

As Python Program B upload the data from the TXT file that Python A has generated. One PHP file called Program C (Figure 7) receive the numerical data and generate a TXT file on the Internet, saved in a server. Another PHP file, program D (Figure 7) read the TXT file that's on the Internet and display it on the browser.

4. Demonstration

4.1 Data flow

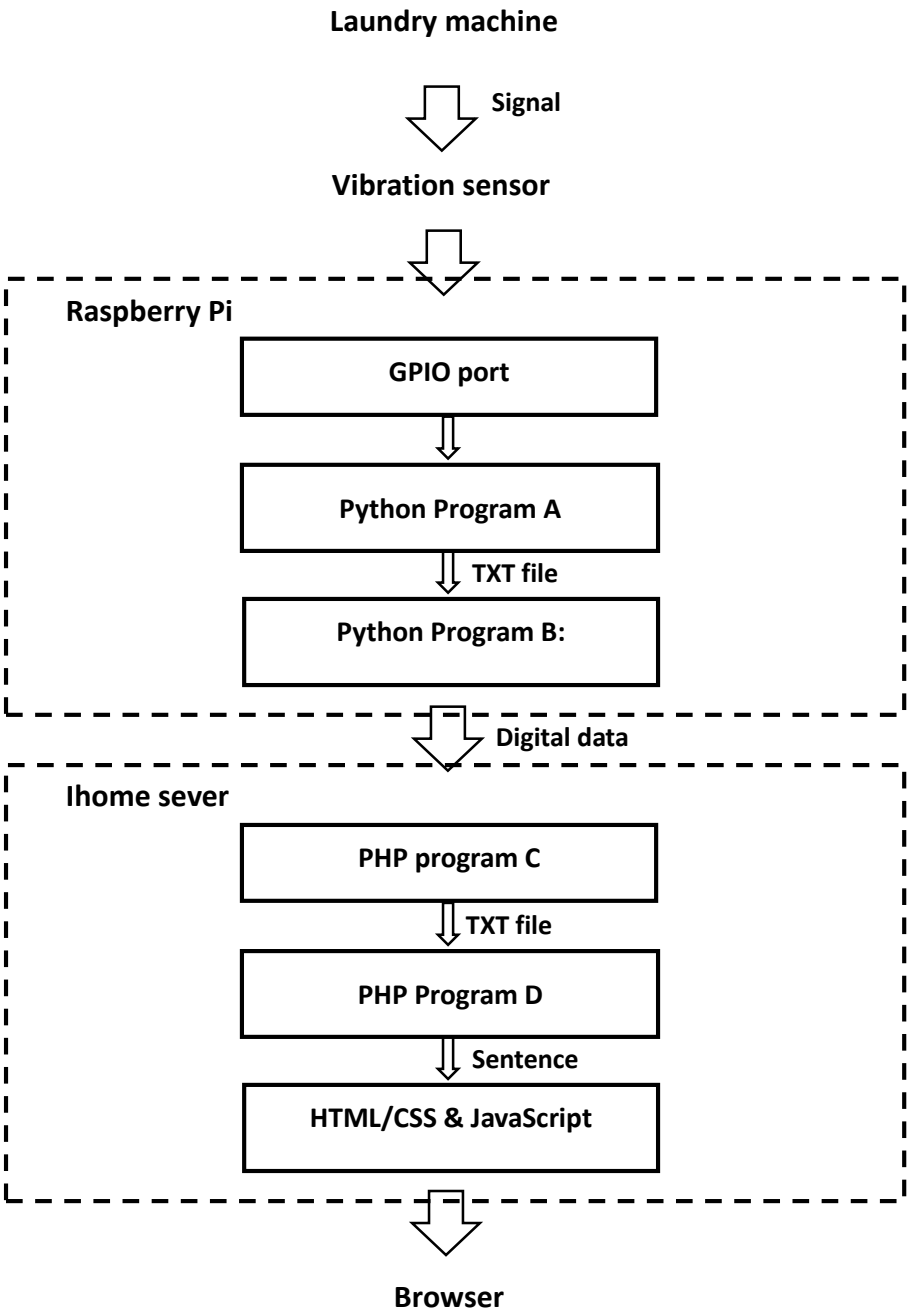

Figure 7 Data flow from washing machines to online display

4.2 Video demonstration link:

https://drive.google.com/open?id=0BxFCNcjSg22hd25BSENpNkpQOXc

5. Conclusion

Many residents have been complaining the insufficiency of campus laundry machines. And this project is founded to solve this problem. Vibration sensors, Raspberry Pi and multiple programing languages are used and succeed to detect the washing status of machines accurately and upload it online for on-time display. This whole system is cheap in cost and is easy for administrators' operation and fixing. No reassembling of machines will be needed and this system offers the perfect protection of users' privacy.

6. References

[1] Raspberry Pi: http://en.wikipedia.org/wiki/Raspberry_Pi Date accessed: Jun.1st, 2016

[2] Laundry view: http://www.laundryview.com/lvs.php Date accessed: May. 20th, 2016