2015 President's Cup – Final Report

Real-time Display for Machine Status

Team members

LIU, Xinzhu (EEGBM)

DUAN, Yangyang (BCB)

LIU, Yuchen (ECE)

CHEN, Zhiyu (QFIN)

KAO, I-hsuan (PHYS)

CUI, Yunpeng (ECOF)

LI, Mengyuan (CIVIL)

Supervisor

Prof. David Rossiter (CSE)

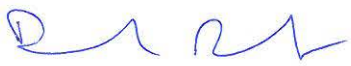

Table of Contents

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 our team initiated this project, aiming to provide hall residents a convenient way of checking laundry status and improve the efficiency of washing machines. We use vibration sensors to collect data and upload it onto our real-time display website through the local computer. Residents can check the website though their laptops or mobile phones, plan early and save time.

2. Introduction

2.1 Overview

Our project was initiated in 2014 summer with 7 people in total. All 7 team members are HKUST year 2 students without little programming and engineering skills before hand. And this is an interesting and diverse team because all members are from different majors: EEGBM, BCB, ECE, QFIN, PHYS, ECOF and CIVIL.

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. We believe the root cause is the inefficient allocation and use of the washing machines rather than the quantity. So we initiated this project, inspired by the concept of IOT "Internet of Things", 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 for us we decided to develop our 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

2.3 The need for such a project

To investigate the need for this system, we made a draft version of website and researched the students' needs. We found that this function is highly appreciated by respondents (Figure 1.1 and Figure 1.2), with very optimistic results and zero pessimistic response. And this is also a common

need for residents of each hall (Figure 1.3).

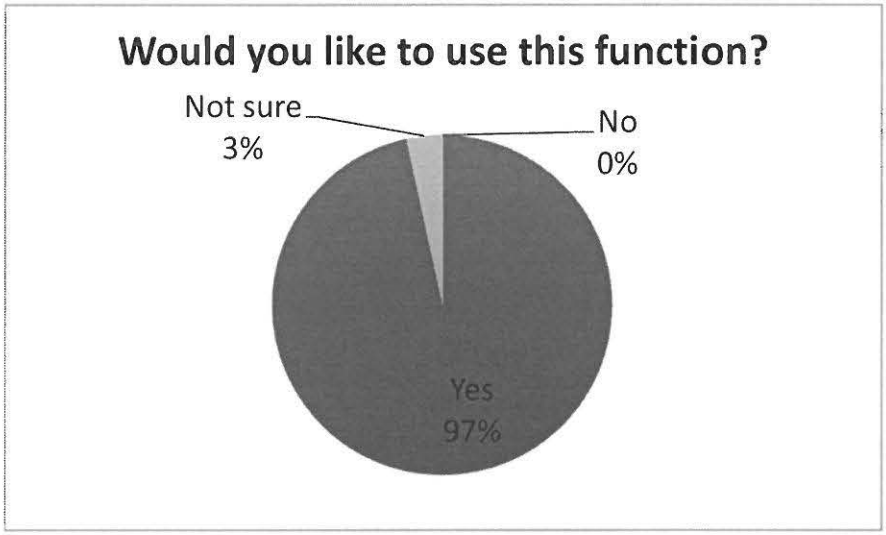

Figure 1.1

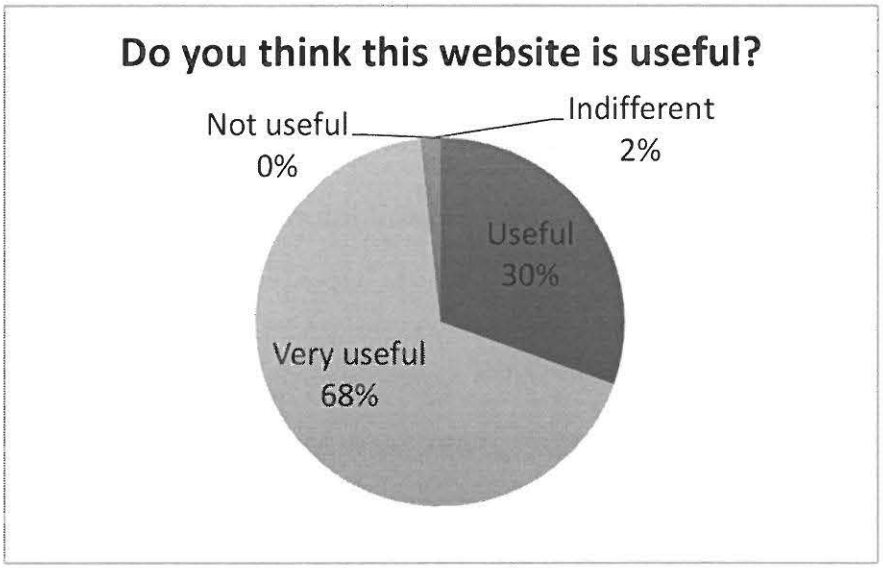

Figure 1.2

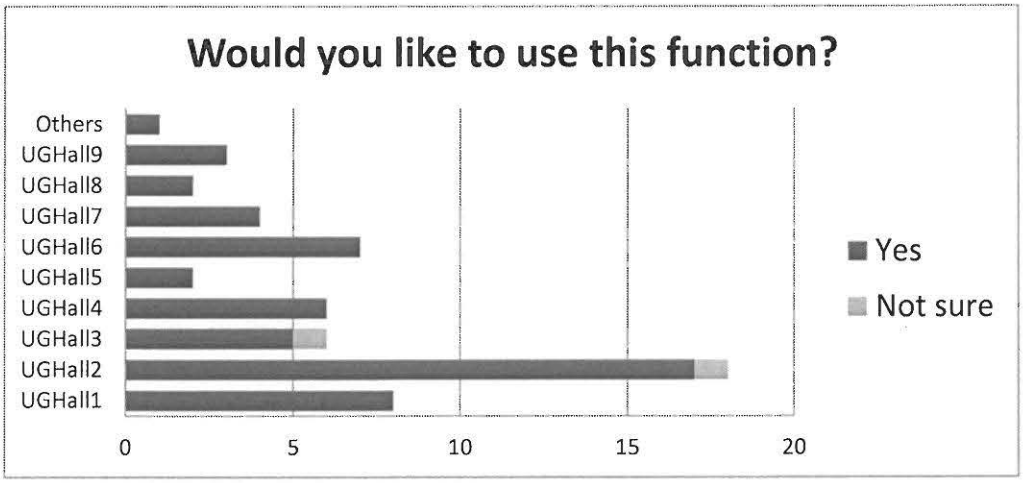

Figure 1.3

3. Methodology and related information

3.1 Project data flow overview

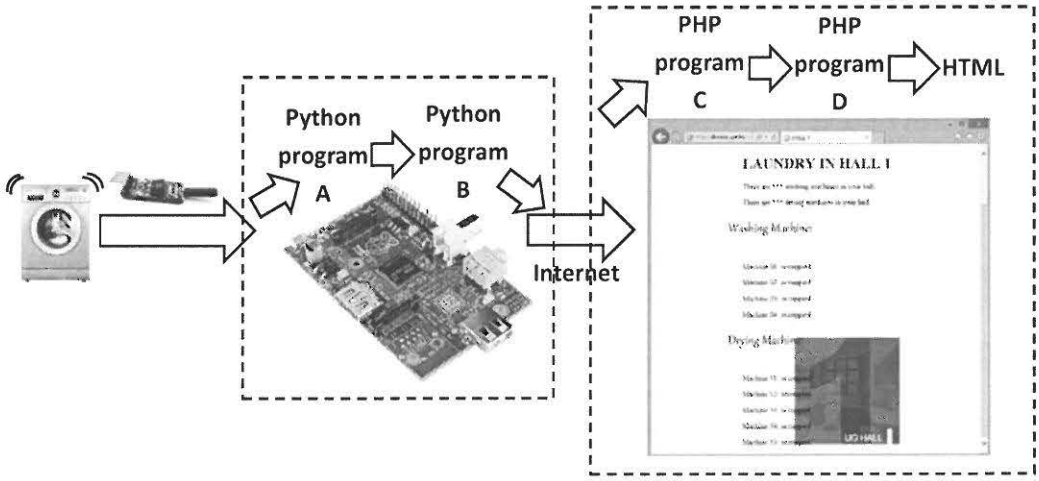

Figure 2 Data flow from washing machine to website

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. We use html, CSS and JavaScript 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: SW 1801P

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

3.3.1 Vibration sensor

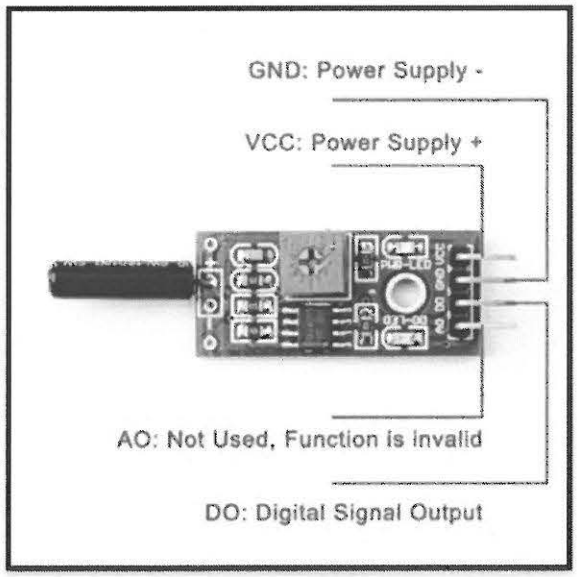

Figure 3.1 Vibration sensor: SW 1801P

We choose vibration sensors based on three concerns. (Figure 3.1) 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 so they are users 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.

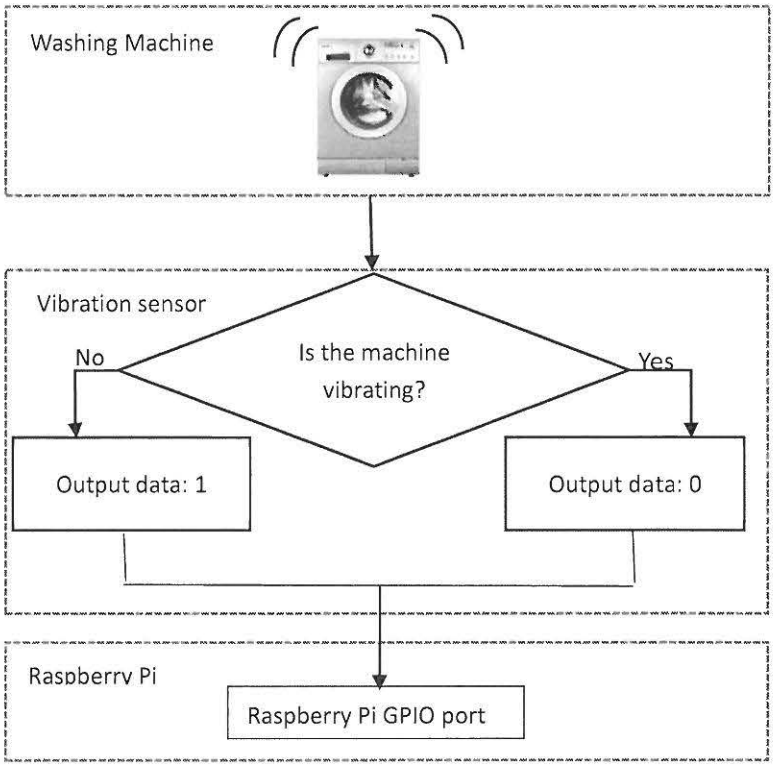

Figure 3.2 Data flow through the vibration sensor

3.4 Data transformation

3.4.1 Raspberry Pi

We chose Raspberry Pi (Figure 3.3) because it's both functional satisfying and efficient. 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.

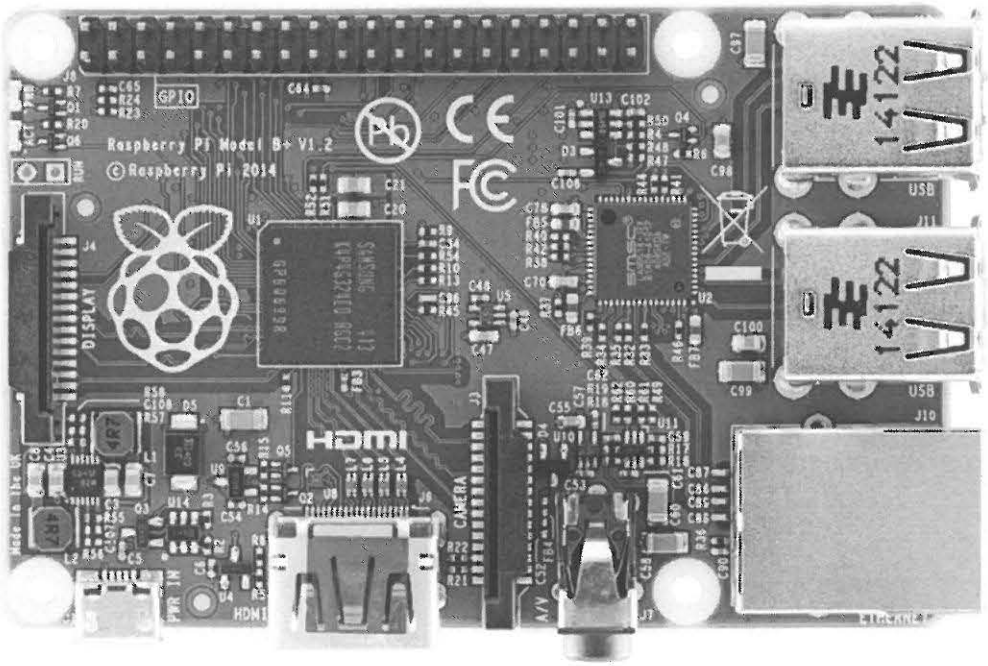

Figure 3.3 Raspberry Pi

3.4.2 Python

The output of the vibration sensor is either 1 when still or 0 when vibration. However, when implementing in real life, for the occasional cases that someone may accidentally kick the machine or the adjacent machine is vibrating fiercely, the output of the vibration sensor may not be what we

desired it to be. Therefore, a Python program, which is called program A (Figure 4.1) is written to take the summation S(t) of the most recent 100 sample n which is taken every 0.3 seconds.

$$S(t) = \sum_{i=t-99}^{t} n_t$$

A threshold T is set beforehand according to real situation. The Python program will record "Yes" to a txt file when the sample summation is less than the threshold (S(t) <= T →vibrating) and record "No" when the sample summation is larger than the threshold (S(t) > T →still).

This txt file will be uploaded to Internet by text format by another Python program, program B (Figure 4.1).

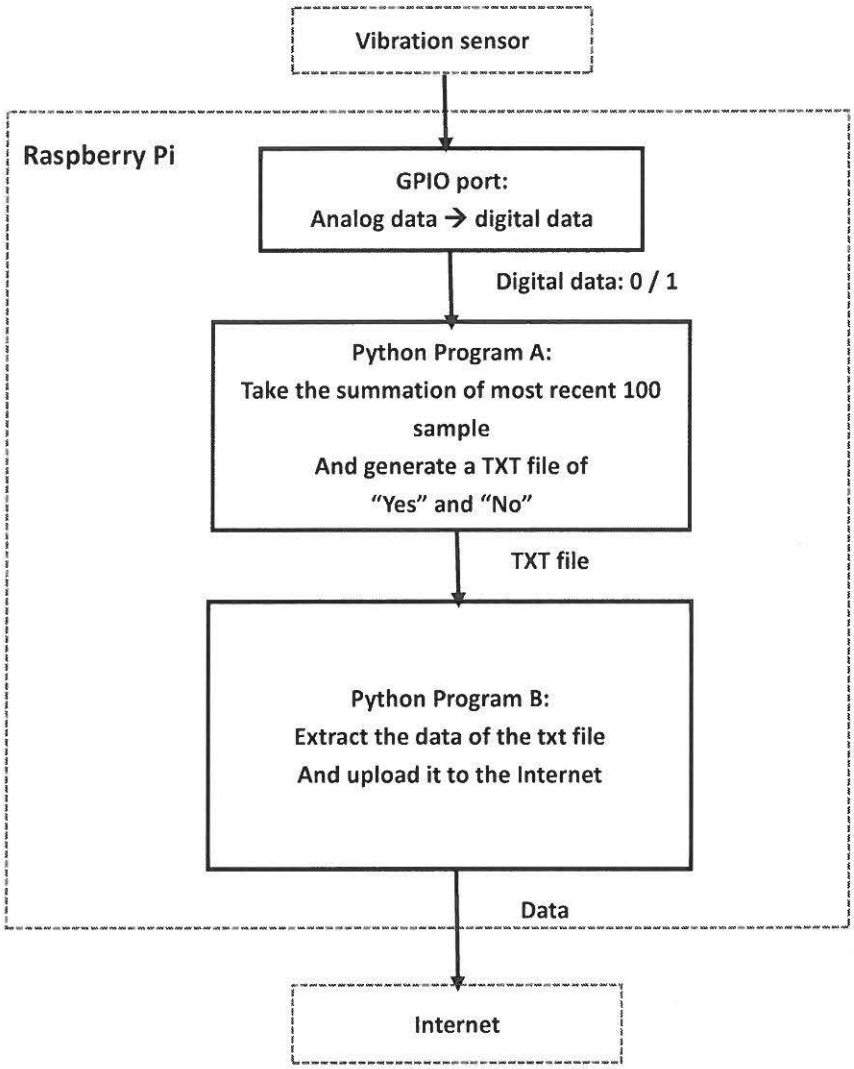

Figure 4.1 Python programs

3.4.3 Internet related program

We used different languages for different parts in this project. For data collection and uploading, we used python and run it on Raspberry Pi. And we used html, CSS and JavaScript to build the website. Besides these, we also used PHP to construct the database on the website.

3.4.3.1 PHP

As Python program B upload the data from the TXT file that Python A has generated. One PHP file what we called Program C (Figure 4.2) receive the data and generate a TXT file on the Internet, serving as a server. Another PHP file, program D (Figure 4.2) read the TXT file that's on the Internet and display it on the browser.

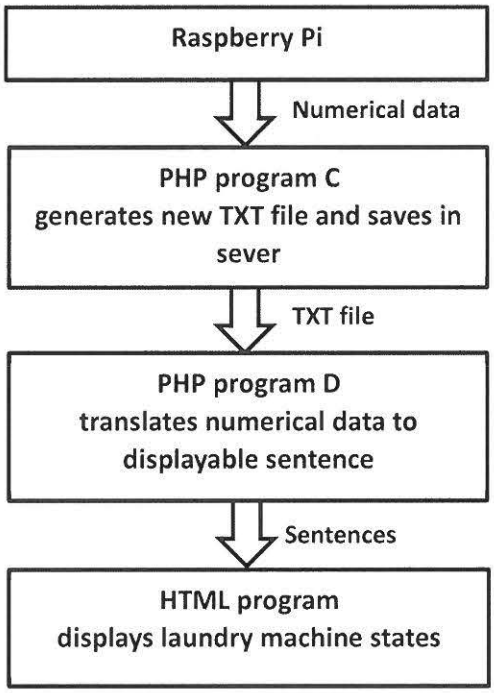

Figure 4.2 PHP & HTML programs

4. Demonstration

Data flow

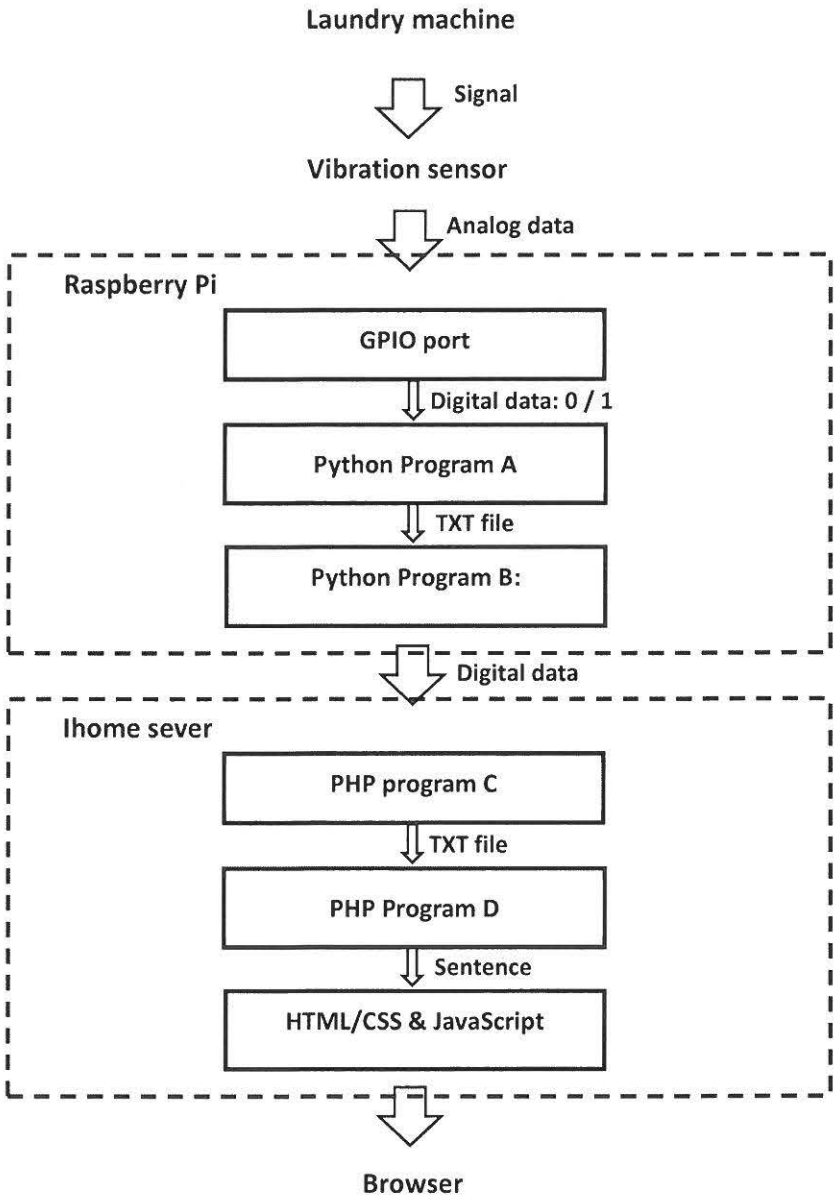

Figure 5 Data flow from washing machines to online display

5. Possible future implementation

5.1 Online booking function

We have considered to add online booking system on the website. However, this function may need to access users' personal information, such as student name or ITSC account. This may draw privacy concerns and may lead to problems. So the team decided to postpone this plan until get proper solutions regarding the issues.

5.2 Potential market

This monitoring and display system can be applied to a wider market. Only by changing the way data collected, this status display service will be suitable for various potential costumers. Taking parking lot as an example, we can use ambient light sensors to collect the parking status of each spot and upload it onto our website, which will offer drivers and managers a direct view. Restrooms will be another potential and privacy will be protected under our method since we use none-camera sensors. For all these markets, our company provides a cheap upgrade service without complex modification and reassembling and no privacy or safety concern will be included.

6. Conclusion

Many residents have been complaining the insufficiency of campus laundry machines. So we initiated this project "Real-time display for machine status" to solve this problem. Our team used vibration sensors, Raspberry Pi and multiple programing languages 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. This product can also be put into market and widely used in public restroom, parking lots and other public zones.

7. Individuals' contribution

General Manager	LIU Xinzhu
Vibration sensor and Raspberry Pi implementation	LIU Xinzhu, LIU Yuchen
Python program	CHEN Zhiyu
PHP Program	KAO, I-husan, DUAN Yangyang
Website design	LI Mengyuan, LIU Yuchen
Market research & Promotion administration	CUI Yunpeng
Final Report	CUI Yunpeng

Promotion material design	DUAN Yangyang, LI Mengyuan
General public contact of Student Housing and Residential Life Office	LIU Xinzhu
General public contact of ITSC Office	CHEN Zhiyu
Main contact representative of supervisor	KAO, I-husan, LIU Xinzhu
Material Purchase	LIU Xinzhu, LIU Yuchen, LI Mengyuan

8. References:

[1] Raspberry Pi: http://en.wikipedia.org/wiki/Raspberry_Pi Date accessed: Dec.1st, 2015

[2] Laundry view: http://www.laundryview.com/lvs.php Date accessed: Oct. 20th, 2015

[3] Vibration sensor: http://www.lxxtech.com/electronic-modules-p380.html Date accessed: Jan.3rd, 2015

9. Appendix

Details of Authors					
# 1 Author					
Full Name	LIU, Xinzhu	ITSC			
Student ID		*Major*	EEGBM	*Year*	2
Email			*Mobile No*		

# 2 Author					
Full Name	DUAN, Yangyang	ITSC			
Student ID		*Major*	BCB	*Year*	2
Email			*Mobile No*		

# 3 Author					
Full Name	LIU, Yuchen	ITSC			
Student ID		*Major*	ECE	*Year*	2
Email			*Mobile No*		

# 4 Author					
Full Name	CHEN, Zhiyu	ITSC			
Student ID		*Major*	QFIN	*Year*	2
Email			*Mobile No*		

# 5 Author					
Full Name	KAO, I-hsuan	ITSC			
Student ID		*Major*	PHYS	*Year*	2
Email			*Mobile No*		

# 6 Author					
Full Name	CUI, Yunpeng	ITSC			
Student ID		*Major*	ECOF	*Year*	2
Email			*Mobile No*		

# 7 Author					
Full Name	LI, Mengyuan	ITSC			
Student ID		*Major*	CIVIL	*Year*	2
Email			*Mobile No*		