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Green Public Computer Lab using Single-Board Computer and Interactive Computer Reservation System.

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***Abstract*—Public computer lab is very common in college and university. The main cost for maintenance lab is the power cost. In our university, the public computer lab consume more than 40kW·h per day. The earlier study found that most cost comes from a major part: Some users don't shut down the computer after their usage. In this study, we use a low-power single-board computer (Raspberry Pi 2) for interactive kiosk providing computer reservation system and temporary storing the student usage, the VM-Based server providing RESTful web service, and embedded software on the client for shutting down the idled computer. The study found the new reservation system can decrease energy consumption up to 44.32%, lower staff's maintenance time, fair of sharing limited computer resource, and student usages are record accurately. (*Abstract*)**

Keywords—Green Computing, Public Computer Management, Web Service, Raspberry Pi

I. INTRODUCTION

The public computer free lab is often found in many education institutes and other public places. One of the main maintenance cost for this type of lab is electricity cost, mostly come from turned on computer in the lab. The early investigation, we found that more than 50% of turned on computers are idle with no one using them. This is mainly caused by un-shutdown computer after usage of students.

Furthermore, according to Thai Computer Crime [1] act enforce every users must identify themselves when using computer and the provider have to record the usage as log or store in database for at least 6 months.

At first, our university's computer lab used the traditional logbook for recording the ID of students who were using computer in our lab. Each student who wants to use the computer in the lab has to sign-in every time. However, this method was sluggish and showed large number of human errors.

We have gathered electricity bill and the slowness of the recording usage issues. The new system is designed for electronically record the student ID who are using computer, automatically shut down the idle computer, and fairly share the computer resource among students. A low-power interactive kiosk is designed using Raspberry Pi [2, 3] and touch screen monitor.

This paper is organized as the following: the Raspberry Pi hardware and interactive kiosk concept are explained in Section II. Next, the system design and experiment setup are detailed in Section III. The experimental results are shown in Section IV, and finally, the conclusion and future works are described in Section V.

II. RELATED WORKS

A. Raspberry Pi

The Raspberry Pi is a credit card size single-boarded computer with built in graphic processor and network interface. It draws only approximately 2W of electricity but its computing performance is very efficient. There are many applications of Raspberry Pi. For the example, in [4] use Raspberry Pi for Bluetooth communication with touch screen interface, authors of [4] found that the communication is accurate and reliable. Moreover, it also used for building low-cost and power-efficient cluster like in [5], the author built 300 nodes cluster with Raspberry Pi and this cluster only use 25-30A per 24 nodes for computation.

In this paper, we use Raspberry Pi 2, Model B with 900MHz Quad-Core ARM CortexA7 CPU as an interactive kiosk. This kiosk is using touchscreen monitor and connected with barcode scanner for user authentication.

B. Interactive Kiosk

In present, the usages of interactive kiosk are found in many public places. Especially in the education institutes, museums, and airports. They provide useful information and some services to the users. The integration of touchscreen monitor makes the interactive kiosk more useful and more interesting [6].

The usage of interactive kiosk is found in many works, such as in [7]. The authors use interactive kiosk in the museum for providing 3-D display of items to visitors. Moreover, the works in [8] developed the interactive map controlled with pointing gesture.

III. The Design of New System

This section consists of two designs. First, we designed low-power interactive kiosk which deployed in front of the lab. The students who want to use the computer in the lab have to make reservation before use or his/her computer will repeatedly shut down. Next, the client background process (as known as "Windows service") which installed on every computer in the lab. The small program will keep polling on server to check if the computer is reserved.

A. Interactive Kiosk

The newly designed interactive kiosk is low-powered interactive kiosk which uses Raspberry Pi 2. We use Pidora Linux for the operating system installed on Class 10 SD-Card on Raspberry Pi 2. The Raspberry Pi 2 will provide web browser for computer reservation system which fetched from a web server on a virtual machine.

The reservation system is based on touchscreen monitor input. The students have to authenticate themselves using the barcode on their student ID card. The data between web browser of Raspberry Pi 2 and the server is exchanged by using JSON data and HTTP POST request in RESTful fashion (Fig.1).

Fig. 1. Barcode-based authentication screen.

After the authentication, the system will show available computer and status of each computer in the lab. Students may reserve computer they want (Fig.2).

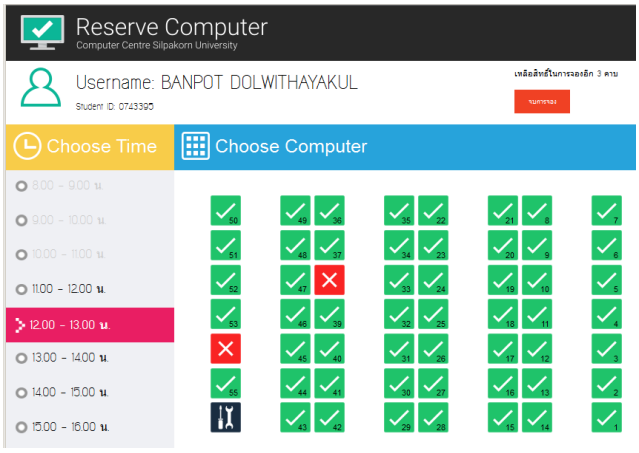

Fig. 2. Reservation and computer status display screen.

B. Client Background Process (as a Windows' Service)

All of computers in the lab are using Microsoft Windows from Windows 7 to Windows 8.1. To integrate and control every computer in the lab, we need to develop a lightweight program which can be run as a Windows service. The flow of newly develop program is illustrated as Fig.3

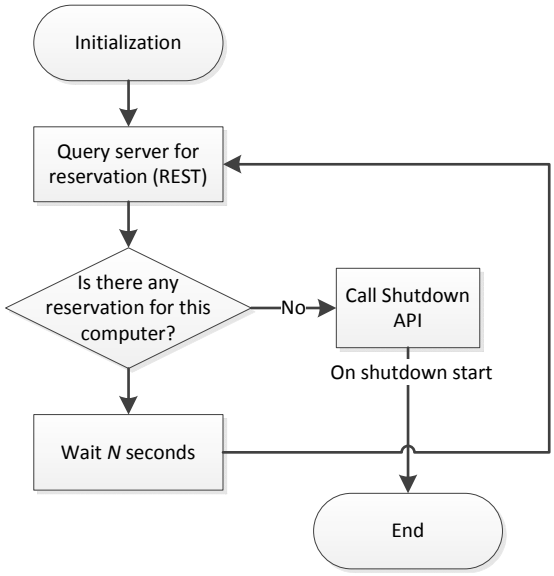

Fig. 3. A simple and lightweight background service on clients.

We developed the program using Microsoft Visual Studio Express 2012.

First, the program automatically initializes itself when the booting of client is finished (delayed start). Next, the program makes a connection to web server through REST API and query if it's reserved. If there is a reservation, it will keep polling on web server every *N* seconds (*N*=30 for this implementation). Otherwise, it will shutdown itself through Windows API. Each reservation length for 2 hours.

This client process will keep the computer shutdown when there is no reservation. When the reservation is about to end, program will popup a window to warn and ask if user will

make another reservation. From our observation after installed this background process, there is no idle turned on computer without user in the lab anymore.

The summarized of interactive kiosk, server, and clients is illustrated as Fig.4

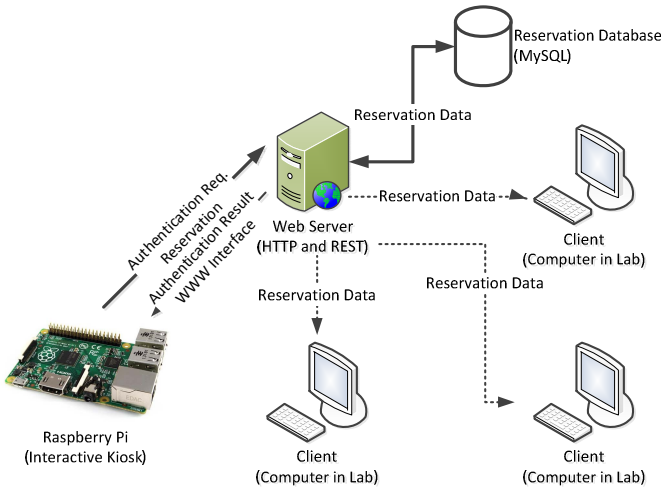

Fig. 4. Reservation and computer status display screen.

IV. Experimental Results

In this section, we measured both qualitative results by collecting satisfactory score and quantitative results by measuring power consumption of the lab by randomly installed the small power meters on 10 computers in the lab. The results are as the following:

A. Power usage of the computer in the lab.

The power consumption is measured by power meter. We installed 10 power meters on 10 random computers in the lab for 30 days. The total number of computers in the lab is 60. The computer usually turned on from Monday to Saturday (8.30am – 8.00pm).

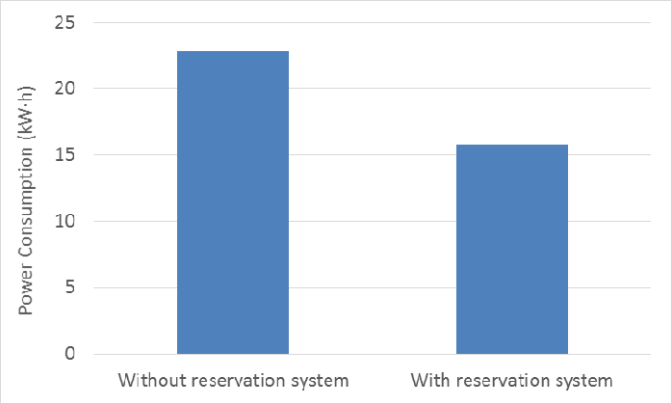

Fig. 5. Power consumption of computer subjects in the lab (10 computers), 21" LED monitor included.

From Fig.5, the results obviously show the decreasing of power consumption after deploying interactive kiosk and installed the client service program. The new system can save approximately 44.32% of power by shutting down the idled computer in the lab.

B. Power usage of the interactive kiosk.

The power consumption of the interactive kiosk is also measured. We measure the power consumption of Raspberry Pi 2 and desktop computer when they are working as an interactive kiosk. The power consumption of touchscreen monitor is included. The results are displayed as Fig.6

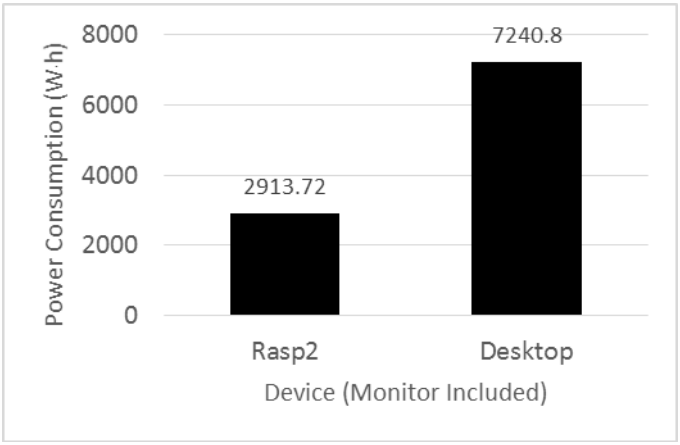

Fig. 6. The comparison of power consumption of the Raspberry Pi 2 (Rasp2) and Desktop computer working as interactive kiosk.

From Fig.6, the power consumption kiosk using Raspberry Pi 2 is 59.75% less than the kiosk using a small desktop computer.

C. Satisfactory Score of Users

The satisfaction score of users is collected by a popup a set of multiple choice questionnaires after the reservation process at kiosk is completed and the questionnaire apply once per user. The satisfaction score is ranked from 1 to 5 and the results are shown on Table I.

TABLE I. Satisfactory Score of Users

Question No.	Satisfactory Score		
	Question	***Average***	***S.D.***
1	The new system is useful and want to use the new system.	4.40	0.49
2	The new system can decrease the time for signing in into the lab.	4.66	0.48
3	Useful for sharing limit number of computer resource among students.	4.82	0.40
4	The kiosk is convenient and easy to use.	4.80	0.39
5	Overall satisfication	4.01	0.51

The Table I show that most users understand about sharing limit computer resource by reservation system (Score=4.82)

and feel that the interactive kiosk is convenient and easy to use (Score=4.80).

V. Conclusion and Future Works

The new computer reservation system is designed for public free computer lab in education institutes. The new system shut down the idle computer in the lab (computer without reservation) which can significantly lower electricity bill. Moreover, our system also record the student ID and usage time of students according to the enforcement of Thai Computer Crime act.

Most students can faster sign-in to the lab and fairly share computer resource among other students through the interactive kiosk and touch screen. The results from the online questionnaire show the kiosk is easy to use and more convenient than traditional paper-based sign-in.

The lab managers can now easily manage the usage record and print the usage report for reference when need.

The average power usage for the computer lab is decrease by 44.32% or approximately USD 549.5 per year.

However, the system need further study in term of reliability and lifetime of Raspberry Pi working as a kiosk and our new system has barcode-based authentication which may be easily faked or fraud. We are integrating the face-detection module as second factor authentication in very near future.

Acknowledgment

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