Take-away Lab: A New Approach on Embedded System Experiment

Hasnim Harun[1] and Abdullah Mohd Zin[2]
[1]Politeknik Kota Kinabalu, Sabah Malaysia, hasnim@yahoo.com
[2]Universiti Kebangsaan Malaysia, Selangor Malaysia, amz@ftsm.ukm.my

ABSTRACT

In this paper, we try to look into the possibility to make the experiment "Take-away" rather than convensional "Dine-In" lab. One of the Embedded System Design lab experiment for diploma program in Politeknik Kota Kinabalu, Sabah, Malaysia was used. Through observation, most of the Embedded System lab experiment can be done outside conventional lab. It's because the main equipment are only laptop computer, microcontroller (i.e Arduino) and electronic components. All the main equipment to perform lab experiment can be brought back home and the experiment it's self can be done outside of the lab. However, the take-away lab should have some mechanism to alert and inform the lecturer that the lab experiment has taken place and the experiment data can be log for assessment. The design and development of the take-away lab will be explained and discussed. The concept of take-away lab will benefits all stake holders such as institution, lecturer, students and parent in term of efficiency use of space and quality allocated time for students.

Key words : Take-away Lab, Remote Lab, Virtual Lab, E-Learning, Engineering Education

1. INTRODUCTION

Conventionally, learning are done at classroom or in laboratory. However the advances in information technology and Internet make e-learning possible including in the laboratory. However, student learning differ from each other and the learning process depends on how learners get the knowledge. Practical work provides students with the experience they need to help them understand theories taught in classroom. However the increasing number of students and the high cost of equipment reduce practical work in laboratory[1].

To overcome this problem and improve the learning, lab experiment through Internet technology[2] have been develop. This technology offers a new way for engineering education. It also complement traditional teaching and learning methods. The remote lab enable students to perform real experiments through the web and also allow them to correct error with real data analysis. Virtual laboratories however, don't use the real instrument or real data, because they are based on simulations[3].

Remote lab development have advantages like improving the e-learning platforms that require practical activities. It also eliminate time and space constraints i.e accessibility at anytime and anywhere. The experiments are real and run at the real time and can be shared expensive equipment among universities.

2. REMOTE LAB FOR EMBEDDED SYSTEM

Remote Lab are being successfully developed and implemented worldwide. However, to implementing remote lab for the embedded system, require the knowledge of the embedded systems market. The development of systems "from scratch" is not effective. Therefore, one of the important areas to improve the efficiency of embedded systems design is the accumulation of technical solutions for reuse. This reuse of knowledge can be illustrated and implemented in remote laboratories[4]. The disunity of descriptions of already developed components such as hardware, programs, algorithms, implementations etc. hinders their reuse, but the application of remote experiments allows the designer to obtain information about ready hardware/software platforms and components for making decisions on Embedded Systems to use.

There are many different manufacturers of hardware and software platforms: Arduino, Texas Instruments, Parallax Inc., Microchip, Digilent, Raspberry PI, Cyclone. Each platform has a form factor and functionality, so the designer's choice depends on the task[5]. Therefor, the lecturer has to know the platforms exist in the market and be able to make responsible decisions concerning application of a certain hardware- software platform. The information offered does not always allow the right to implement the project.

The learning process in the design process of a remote lab foe embedded system will allow students to
- Perform selection of hardware platforms.
- Develop program code.
- Test compatibility and working capacity of hardware and software parts of the projectable system.
- Check if the devices functions to the specification requirements.
- Observe the experiment result.

Other than remote lab concept, there are virtual lab which offer virtual simulation. For example, it is possible to allocate

simulators for Arduino and others. However, the simulation does not replace real work with the hardware and software[6]. The simulator allows study of only its mathematical model.

Therefore, selecting a remote lab experiment by selecting hardware-software platforms of our choice is an actual task.

3. TAKE-AWAY LAB – A NEW APPROACH ON TAKING LAB EXPERIMENT

Take-away Lab has a slight different from a remote lab. While a remote lab is a lab where a student from a far can take an experiment prepared by their lecturer in institution lab, for take-away lab, the student can bring back home all the experiment components and can conduct the experiment by them self. Lecturer or institution can prepared a set of experiment where a student can borrow to take home.

A mechanism to detect whether the student have conducting the lab experiment will be added to the experiment, so the lecturer can know who have done and who's don't. In this experiment, google drive spreadsheet is being use.
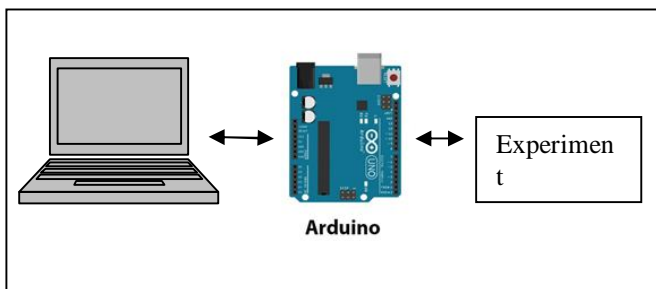

Figure 1: Hardware Requirement

Figure 1 above shows the essential components and the design of the Take-away Lab. And figure 2 below shows the design of take-away lab.
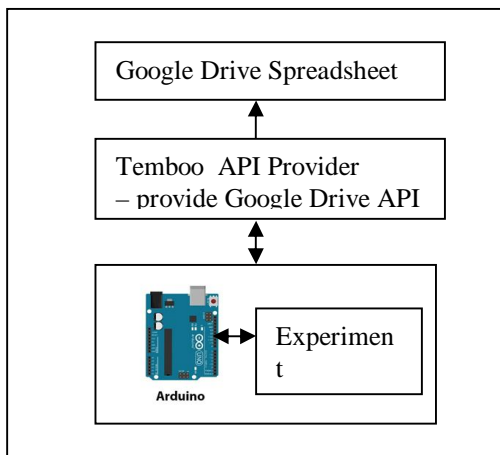

Figure 2: Design of Take-away Lab Experiment for detecting student conducting an experiment

The development processes of Take-away Lab are implemented by two Phases, at hardware part and software part.

Phase 1: Hardware Setup

A laptop is needed for a student to write Arduino sketch and upload the coding to the Arduino board.

Arduino Yun has been chosen because its capability having a linux machine and connecting to internet feature.

An experiment connected to the Arduino Yun

And special purposed connection from experiment to Arduino Yun for the lecturer to detects whether the student have conducting the experiment or not.

Arduino Yun needed to be setup to connect to the wifi/Internet.

Phase 2:. Software and Web Setup

After hardware has been setup, some software and web setup are needed.

Google Drive API Setup

Login to Google's Developer Console, and create a new **Project.** Under **APIs & auth > APIs**, API Access for the Google Drive API was enabled. And under **APIs & auth > Credentials**, create a new **Client ID** and specify **Web application** for the Application Type. When configuring the **Consent Screen**, make sure we fill out the **Email Address** and **Product Name** fields. Save the Consent Screen details and specify this callback URL as the **Authorized Redirect URI**.

Temboo Setup

The experiment use Temboo (www.temboo.com), a third party API provider to be use by a programmer. The Temboo API is called CHOREO and also providing Google API, whereby after registering and setup our google drive API, we can use it through Temboo.

The next step was to run the **Google > OAuth > InitializeOAuth** Choreo, specifying the Client ID from the app you registered at Google and the following Scope: https://spreadsheets.google.com/feeds/

The InitializeOAuth choreo will return an authorization URL and a callback ID (required for the FinalizeOAuth step). Open a new web browser, navigate to the authorization URL returned by the InitializeOAuth Choreo, and click "Accept" to grant the app access to your Google account.

Run the **Google > OAuth > FinalizeOAuth** Choreo, specifying the callback ID returned earlier by the InitializeOAuth Choreo. This process will return a Refresh Token which can be used along with the Client ID and Client Secret to authenticate with Google.

Next step is creating a Google Spreadsheet. And make sure that arduino Yún is connected to the Internet.

Temboo will generate the header file as shown in Figure 3 below.

```
#define TEMBOO_ACCOUNT "hasnim"  //
your Temboo account name
#define TEMBOO_APP_KEY_NAME "takeawayApp"
 // your Temboo app key name
#define TEMBOO_APP_KEY  "1bdda9391a7a4d11a
d097f3bb7db611b" // your Temboo app key
```

Figure 3: Temboo.h

Generated Temboo arduino sketch code to be used to call Google Drive API are shown in Figure 4 and Figure 5 below.

```
#include <Bridge.h>
#include <Temboo.h>
#include "TembooAccount.h" //
contains Temboo account information

const String GOOGLE_CLIENT_ID = "your-goo
gle-client-id";
const String GOOGLE_CLIENT_SECRET = "yo
ur-google-client-secret";
const String GOOGLE_REFRESH_TOKEN = "y
our-google-refresh-token";

const String SPREADSHEET_TITLE = "your-spr
eadsheet-title";
```

Figure 4: Segment of arduino generated sketch code

The GOOGLE_CLIENT_ID, GOOGLE_CLIENT_SECRET and GOOGLE_REFRESH_TOKEN are the ID when register the project at the google developer console and the value must be change to replace the Temboo generated code as above.

```
Serial.println("Appending value to
spreadsheet...");

   // we need a Process object to send
a Choreo request to Temboo
   TembooChoreo AppendRowChoreo;

   // invoke the Temboo client
   // NOTE that the client must be reinvoked and
repopulated with
   // appropriate arguments each time its run()
method is called.
   AppendRowChoreo.begin();

   // set Temboo account credentials
   AppendRowChoreo.setAccountName(TEMB
OO_ACCOUNT);
   AppendRowChoreo.setAppKeyName(TEMBO
O_APP_KEY_NAME);
   AppendRowChoreo.setAppKey(TEMBOO_AP
P_KEY);

   // identify the Temboo Library choreo to run
(Google > Spreadsheets > AppendRow)
   AppendRowChoreo.setChoreo("/Library/Goog
le/Spreadsheets/AppendRow");
```

Figure 5: Temboo Choreo – Google Drive API , AppendRowChoreo is declare and been used

Experiment Setup

It's a simple experiment by connecting sensor to pin analog 0 arduino Yun. The student will write sketch coding to get sensor data and then log it to Google Drive spreadsheet. Showing in Figure 6 below is the segment of Arduino sketch code to get the sensor data.

```
unsigned long getSensorValue() {
return analogRead(A0);
```

Figure 6: Segment of sketch code to get sensor data

4. DISCUSSION

Although the experiment is quite simple, the purpose of it is to demonstrate the possibility and concept of Take-away Lab can be implemented by using a suitable and selected hardware and software i.e. Arduino Yun, Google Drive Spreadsheet and Temboo API provider. The most important element in Take-away lab is a mechanism to alert and logging experiment data when the student do the experiment.

To complete the study on Take-away lab, all lab experiment in the academic program should be study and be identified as Take-away lab able or not able.

5. CONCLUSION

The design of take-away experiment has been successfully develop. The new approach of taking lab experiment can open many possibilities in managing lab usage and student time table. The setup of this take away lab using Arduino Yun as microcontroller and Temboo as an API provider and Google Drive for place to log data for lecturer reference. The selection of hardware and software used, shows the design as a perfect combination because of easy and fast development phase to develop many more take-away lab experiment.

REFERENCES

1. Parkhomenko et. al., **Development and Application of Remote Laboratory for Embedded Systems Design**, International Journal On Online Engineering (www.i-joe.com), Volume 11, Issue 3, 2015.
2. Platunov, A.E., Postnikov, N.P., **High-level design of embedded systems**, p.121, SPb.: NIU ITMO, 2011. http://dx.doi.org/10.1109/jproc.2011.2182009
3. Teich, J., **Hardware/Software Codesign: The Past, the Present, and Predicting the Future**, Proceedings of the IEEE, Vol.100, pp. 1411-1429, Germany, May 13, 2012.
4. Abdurohman, et. al., A., **The New Embedded System Design Methodology For Improving Design Process Performance**, International Journal of Computer Science and Information Security, Vol. 8, No. 1, pp. 35-43, 2010.
5. Wolf H., Wayne, **Hardware-Software Co-Design of Embedded Systems**, Proceedings of the IEEE, Vol.82, NO. 7, pp. 967-989, Germany, July 1994.
6. Parkhomenko, A., Gladkova, O., **Interactive remote laboratory for research of hardware-software platforms**, Proceedings of the International Scientific Practical Conference «Internet-EducationScience-2014», pp. 111-113, Vinnytsia: VNTU, October 14 - 17, 2014.