

EECS 395/495: Engineering System Design 2

Final Project Report

CommuniTech

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Table of Contents

Table of Contents	2
Abstracts	3
Introduction	4
Design Description	5
1.System Overview	5
2. Block Diagram	6
3. Algorithms and Code	6
3.1 Touchscreen	6
3.2 Pan tilt base	7
3.3 Zentri AMW136	8
Final Product	10
Initial vs. Final	10
Performance and Limitation	11
Challenges Encountered	11
Planning and Organization	12
Gantt Charts	12
BOM	13
Market Research	13
Conclusion	14
Reference	15
Class feedback	16

Abstracts

In this project, the Communittech was designed to explore and develop a affordable, customizable, visualized and efficient system to improve the working efficiency of small business. The system components are cameras which mounted on pan tilt base, touchscreens with different digital command button located at different work stations, powerful server, database, Arduino 2560 MCU chip, and AMW136 wifi chip. The touchscreen and pan tilt base are controlled by AMW136 chip which is sending HTTP request to get the most recent updated control signal(value in database) from the website powered by Google Firebase server. The touchscreen is driven by Arduino 2560 using pixel-write library. The pan tilt base is powered and controlled by Arduino 2560 with different set of PWM signal for rotating between different station angles. The wifi chip is programmed with Arduino C++/C for communication with Arduino 2560 MCU for sending HTTP request, reconnection, reset function, etc. The website (TapTalk.net) hosted on Google Firebase is sending database the new requested data(value) for different operation. For this practical small scale project designed for business owners, the goal is to test the market demand for initial product module, contains separate features of

command button, camera stream, 360 degree camera angle control, web-based applications.

This project is going to be developed into a easy-customizable system for business owner could design and use for their specific work load/flow need. The price is set as \$30 per month including 45 days free trial. For the future goal, this system is going to be commercial business operation tool that non-technical users could design their own system through an interface, hardware is not included in the plan but would be sold for making the system more compatible and reliable.

Introduction

In the restaurant industry, the internal communication system is important during peak time.

For cases like foods or products being made in different rooms/location/situation in restaurants industry. Usually employees are calling between back and front of the house to be aware of their individual preparation stage and working situation.

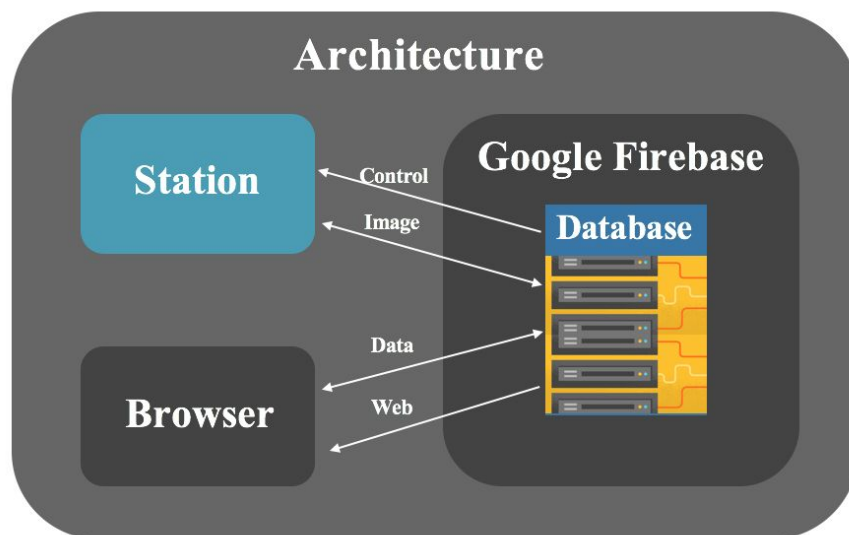
For example like a bubble tea shop, when the front needs certain ingredient for their beverage like bubble for their bubble tea, employee use the system to give command to the back. When the back is preparing the ingredient, employee at the back use the system to give the front a visualized pattern to show what stage or progress they have made.

For business owners, usually they would be purchasing camera for security purpose, most of it is designed with fixed angle camera with only one position. In this system, the camera is mounted on a pan tilt base which provides it a much more wider angle view that would enhance the user's experience of using the camera for monitoring their business whenever they

need. It would highly increase the time business owner using this feature since it provides much more visual information with more viewing angles.

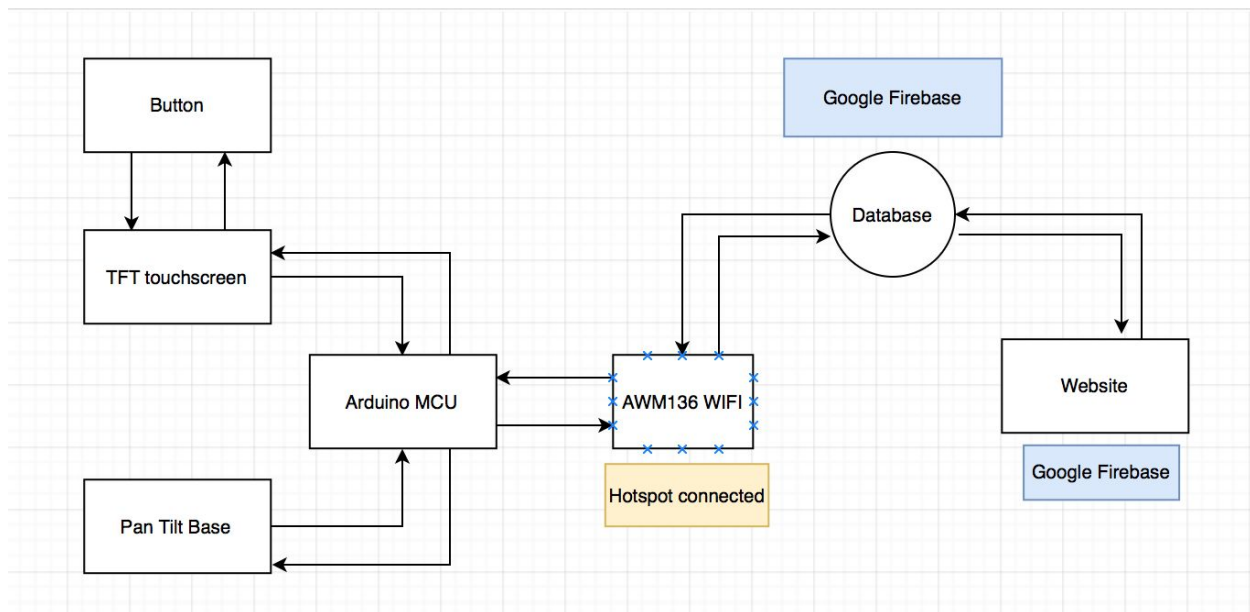
Design Description

1. System Overview



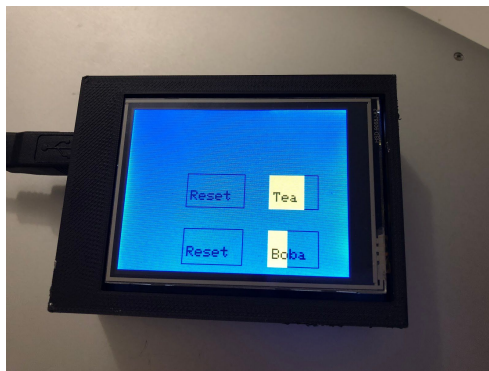
In this system, three main part is station, browser and database. For the local station, it has a camera mounted on pan tilt base, and a 2.8' touchscreen which is driven by Arduino MCU. The browser is hosted on Google Firebase as the domain is TapTalk.net. The browser and station are synced by using HTTP request and HTTP get functions from the database. The local browser is connected through internet via a wifi AMW136 chip with wifi hotspot.

2. Block Diagram



3. Algorithms and Code

3.1 Touchscreen



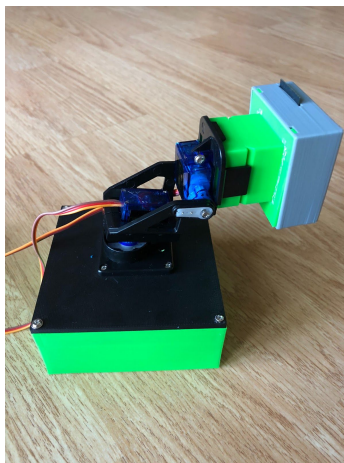
```
if((x > REDBUTTON_X-120) && (x < (REDBUTTON_X-120 + REDBUTTON_W))) {
  if ((y > REDBUTTON_Y) && (y <= (REDBUTTON_Y + REDBUTTON_H))) {
    Serial.println("reset btn hit");
    tft.fillRect(REDBUTTON_X-120, REDBUTTON_Y, REDBUTTON_W+20, REDBUTTON_H, ILI9341_GREEN);
    delay(50);
    tft.fillRect(REDBUTTON_X-120, REDBUTTON_Y, REDBUTTON_W+20, REDBUTTON_H, ILI9341_BLUE);
    drawFrame();
    tft.setCursor(REDBUTTON_X -120 + 6 , REDBUTTON_Y + (REDBUTTON_H/2));
    tft.setTextColor(ILI9341_BLACK);
    tft.setTextSize(2);
    tft.println("Reset");
    tft.fillRect(REDBUTTON_X, REDBUTTON_Y, REDBUTTON_W+17, REDBUTTON_H, ILI9341_BLUE);
    drawFrame();
    //resetBtn1();
    tft.setCursor(REDBUTTON_X + 6 , REDBUTTON_Y + (REDBUTTON_H/2));
    tft.setTextColor(ILI9341_BLACK);
    tft.setTextSize(2);
```

For the LCD display, I was able to drive the screen with Mega 2560 MCU for making two digital buttons as for now, which could be lighted up with yellow color when pressed and been reset by pressing the “reset” button next to them[1]. The design of those reset buttons are considered for those accidental operation in place that are noisy and public open that leads to mistake.

[2]This code is programmed as if there is an pressure pressed on screen with axis X and Y marked within certain area, the tft object will be reprogrammed as using fillRect library function to refill the button with yellow color. SetCursor and SetTextSize functions is controlling the text size style in the button area. [3]

3.2 Pan tilt base

The pan tilt is assembled under by 10 minutes and the rest effort I spend on this thing is to test it with the PWM from the MCU and write the angle value for its rotation which is not bad. I also tested the pan tilt base which the database for using the wifi module making http request and by using gpio pin to the MCU which did work fine.



```
else if(strBuffer.indexOf("up") != -1){  
  Serial.println("found up");  
  stillmove="up";  
  strBuffer = "";  
  Serial1.print(dark_led);  
  count=count+1.1;  
  angle_still2=-175;//servo_test2.write(175);  
  delay(500);  
  Serial1.print(get_request);  
}
```

Whenever, there is incoming signal from website for making the pan tilt move, the Arduino MCU is sending PWM signal to the servo with certain angle. The code is programmed as the angles associated with different command like “up” “down”, the servo will operate with the angle value using Arduino C++ function servo.write(angle).

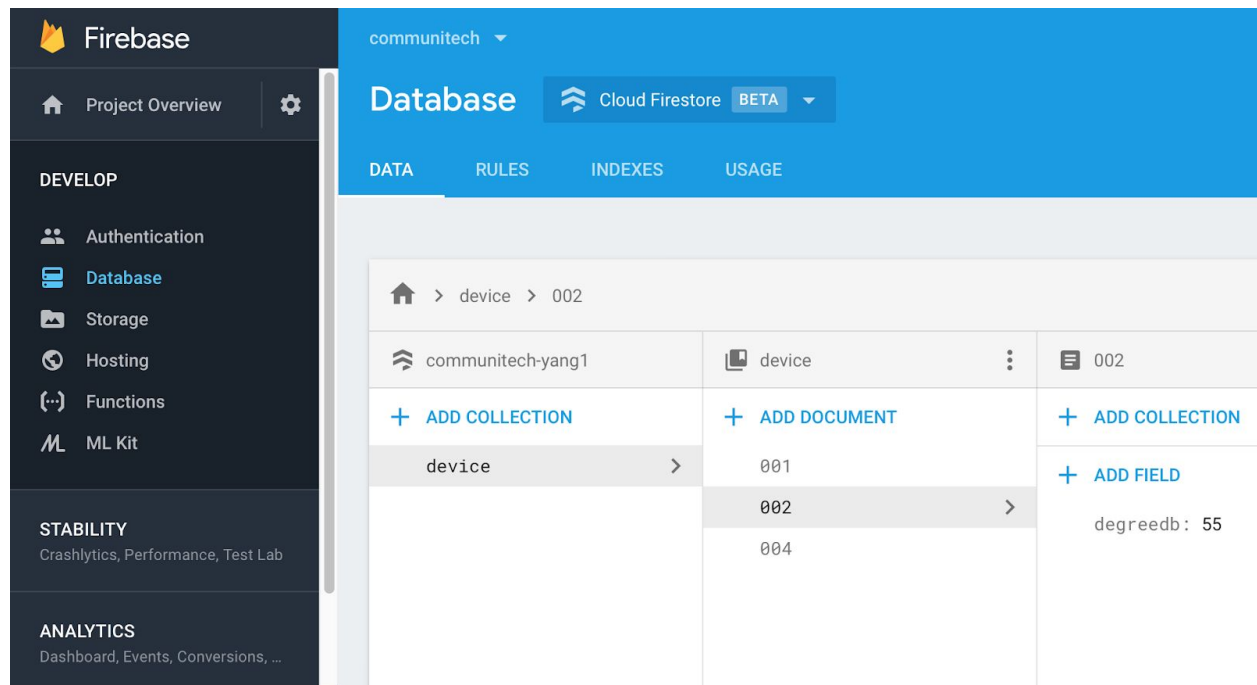
3.3 Zentri AMW136

For this part, I make Zentri as client to get connected with Internet making http request and post for all the control in my project which is quite important for making this work. The challenge in this part is that reading the Zentri terminal output and input and making this linked to my designed control signal. When Zentri get connected to hotspot, I display “connected” on my Arduino monitor other than just display the Zentri terminal connection message. When letting Zentri make the http request and get feedback with certain value, the MCU get the value and send out control signal if that match the control signal value.

```
void loop() {  
  // put your main code here, to run repeatedly:  
  if(Serial1.available()){  
    int inPut = Serial1.read();  
    strBuffer = strBuffer + char(inPut);  
    if(strBuffer.indexOf("[Associated]") != -1){  
      Serial.println("Connected");  
      isConnected = true;  
      strBuffer = "";  
      Serial1.print(get_request);  
      delay(500);  
    } else if(strBuffer.indexOf("55") != -1){  
      Serial.println("found 55");  
      strBuffer = "";  
      Serial1.print(bright_led);  
      delay(500);  
      Serial1.print(get_request);  
    } else if(strBuffer.indexOf("66") != -1){  
      Serial.println("found 66");  
      strBuffer = "";  
      Serial1.print(dark_led);  
      delay(500);  
      Serial1.print(get_request);  
    }  
  }  
}
```

The two serial port is communicated each other. Once the incoming message from wifi serial has the command message piece, Arduino MCU will recognize and operate certain command. In the figure above, since AMW 136 will output message of Associated successfully ... when there is a connection of hotspot, the MCU will recognize it “Associated” and output “connected” on the monitor. Additionally, the MCU does send command to AMW136 using these two serial. The “get_request” string command is actually programmed as the HTTP request command from Zentri AMW136.

3.4 Google Firebase



Here is the center console of Google Firebase, it shows that I use three different field data 001, 002, 003 for CommuniTech. The 002 value will be changed once control button of pan tilt base on the web been hit. The 001 value is used for control the TFT touchscreen.

```
exports.webupload = functions.https.onRequest((req, res) => {
  var devicenumber = req.body.sn;
  var degree = req.body.deg;

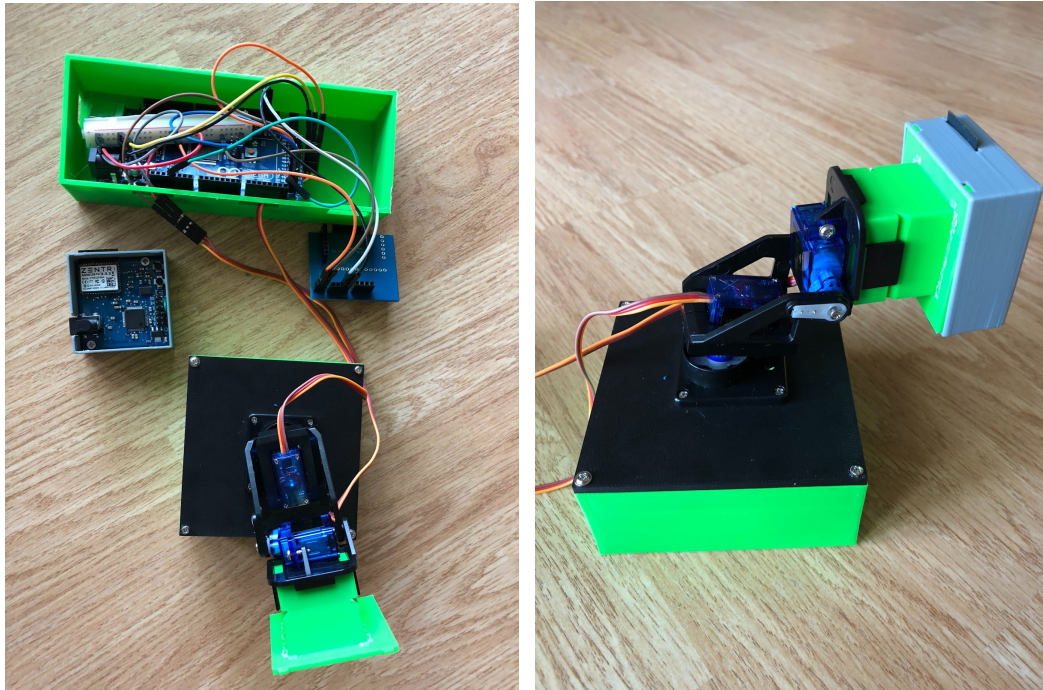
  var deviceRef = db.collection('device').doc(devicenumber);

  return updateDegree = deviceRef.set({
    degreedb: degree
  }, {merge: false}).then(() => {
    return res.status(200).send("successful");
  }).catch(err => {
    console.warn(err);
    return res.status(200).send("fail");
  });
});
```

This is my webupload function, which enable the data to be uploaded to the database once the website button been hit. I was able to control led light and pan tile rotation by changing my database where the light and pan tilt base is connected with zentri.

Final Product

1. Initial vs. Final



The initial product is designed with touchscreen, pan tilt base and server database hosting the website. 95% of these parts are finished only the method of driving image taken from webcam onto the website is not completed. In the initial stage of this project, some of the feature and its development stage and planning is not well organized. The final product has the camera feature that could rotate its viewing angle, it has touchscreen control system that allows user to control the screen and LED associated with it. The website is well-built with necessary component, hosted on Google Firebase,

the database is framed to let the local station communicating and synced with website activity.

Performance and Limitation

The performance of the server and its server function is beyond expectation. Google Firebase is free to upgrade to have more powerful server function and performance.

The pan tilt rotated with 4 different view angle with no lag. The touchscreen performed with two demo button shows the color and text nicely. Any press on the TFT screen results an activity associated to its pre-programmed code. The only limitation on the TFT touchscreen is that the quick press will results a lag on performance. The website code is programmed for larger screen, when viewing on small screen like phone screen will result some overlap of content.

Challenges Encountered

Setting up the database and program for the framework of database is time-consuming especially for me to code for first time using Node.js. I followed the Google tutorial as ask my tutor for some guide on Node.js since there is so limited amount of resource for Google Firebase compared to AWS. Spent several day to set up the program environment, learn the node.js and deploy it to the server.

Secondly, for website javascript function that connected with database is pretty new to me as well, even I coded basic web with html and css before, still take small steps when get exposed to learn Javascript independently.

For AMW136 connection issue, since this project is not using AMW136 for a server, instead, my project uses it as a client. It happens disconnection all the time when I first time make it works, I tried writing different reset and wake command to AMW136 using Arduino serial to place the command, but AMW136 still not permanently connected to my hotspot. I finally come up with an approach to reset the connection AMW136 every 2 minutes followed by immediately making a HTTP request and it works finally.

Planning and Organization

Gantt Charts

	Start Date	End Date	Timeline	Status
ESD2_Yang	Apr 5, 2018	Jun 15, 2018		
Define project goals	Apr 5, 2018	Apr 10, 2018		Complete ▾
Research components	Apr 5, 2018	Apr 10, 2018		Complete ▾
Prepare order	Apr 5, 2018	Apr 10, 2018		Complete ▾
Create PCB layout	Apr 6, 2018	Apr 12, 2018		Complete ▾
Modify Code	Apr 10, 2018	Apr 19, 2018		Complete ▾
Put together breakout prototype	Apr 19, 2018	Apr 26, 2018		Complete ▾
make revisions	Apr 26, 2018	May 3, 2018		Complete ▾
using breakouts to control servo properly	May 3, 2018	May 8, 2018		Complete ▾
3D printing webcam base	May 8, 2018	May 10, 2018		Complete ▾
keep LCD control code perfect	May 8, 2018	May 12, 2018		Complete ▾
set wifi model for control signal	May 12, 2018	May 16, 2018		Complete ▾
keep the code perfect w/breakouts	May 15, 2018	Jun 1, 2018		Complete ▾
website/database	Jun 1, 2018	Jun 9, 2018		Complete ▾
Put together final prototype	Jun 8, 2018	Jun 15, 2018		Complete ▾
Prepare final report	Jun 5, 2018	Jun 15, 2018		Upcoming ▾

BOM

Item Desc.	Mfg. Part #	Unit Price	1000 Unit Price	Quantity	URL	In Final Design?	Total Unit Price	Total Bulk Price
SG90 pan tilt	UA741CP	\$2.060	\$2.060	1	https://www.aliexpress.com/item/32861052812.html	Yes	\$48.26	\$37.63
2.8" Adafruit TFT	1651	\$14.450	\$12.030	1	https://www.adafruit.com/product/1651	Yes		
Camera		\$9.990	\$6.630	1	http://www.uctronics.com/	Yes		
0.1uF		\$0.020	\$0.014	12	https://www.digikids.com.au/products/0-1uf-5v-tantalum-capacitor-12-pack	Yes		
1uF		\$0.120	\$0.120	2	https://www.digikids.com.au/products/1uf-5v-tantalum-capacitor-2-pack	Yes		
1k resistor		\$0.094	\$0.010	5	https://www.aliexpress.com/item/32861052812.html	Yes		
PCB		\$0.908	\$0.908	1	www.pcbway.com	Yes		
3D printing		\$1.800	\$0.900	1				
AMW136 Zentri	Amw136	\$19.900	\$15.550	1		Yes		

Market Research

Non-Expert: Camera feature could be added to the product that people could control the camera to see more angles of the corners or working station where food/product being made.

The whole project idea could be implemented based on website excluding the camera feature (more control unit involved). WIFI module could be implemented instead of using wires here in the current project plan for making a completely wireless system.

Expert: In my case, the expert is considered as business owner. As their experience, the visualization is the major need in this system, since during their business peak time, the voice message can not be delivered successfully sometimes. Voice message also is easy to be forgotten since it is not been kept on and been displayed out. The

business owner also want the system could be customizable due to the reason that all small business is different and they require special need for hardware and software.

Pricing:

The proposed retail price is \$30 per month for subscription. The subscription payment is set up because this product can not be purchased with a design that fit every user need. So the payment system needs to be subscription as user give out feedback when they use, and the product will get more design improvement.[4] The free 45 days of trial is calculated for a roughy \$45 cost for the BOM so that the free trial is actually paying towards the hardware itself during the free trial.

Labor: Technical support and warranty will be mostly considered for the labor in the long term. The estimate labor time over on one single system is about 0.3 hour per month.

So equal to about 9.5 dollar cost on labor over one system maintenance.

Conclusion

I learnt the framework of database with basic understanding of how the implementation of a command using database for sync. For the website, coding function using Javascript is another major part I learnt in this project. For the AMW136 wifi chip, I learnt further control over on this chip like different commands, the HTTP command is the one I used for this project. Control the TFT screen and pan tilt base with its corresponding library will not be too much time-consuming but still independent study.

If I started over on this project, I would definitely spend more time on streaming the image to the website and get touch base on learning OpenCv and trying implement some examples with simple application aspect.

For the future step, I am definitely going to be developing an interface most likely a web front end to let user inputting their need of software/hardware and purpose of use in business in a detail format. Ideally, the interface will virtually shows how is the final prototype and software interface UI looks like.[5] Basically, it is designed for non-technical programmer who would like to create and design a system that has simple electronics components to meet their unique small business need.

Reference

[1] <https://www.arduino.cc/en/Reference/TFTLibrary>

[2]<https://www.youtube.com/watch?v=YqmLRlqwOPA>

[3]<https://learn.adafruit.com/adafruit-2-4-tft-touch-screen-featherwing?view=all>

[4]https://books.google.com/books?id=u273KKS3xYgC&pg=PT253&lpg=PT253&dq=how+to+set+subscript+payment+price&source=bl&ots=9rQQQPc-_a&sig=CfIS6VaNI7Gq357r-D-sVUTBkPc&hl=en&sa=X&ved=0ahUKEwIU9d-IyNXbAhUQoVMKHYi5DA4Q6AEI_djAH#v=onepage&q=how%20to%20set%20subscript%20payment%20price&f=false

[5]<https://arstechnica.com/information-technology/2013/12/how-does-a-non-technical-manager-add-value-to-a-team-of-self-motivated-software-developers/>

Class feedback

I am still in a learning attitude for more of software side. This project I am aiming to create a system best fit the business owner' need. For academic prospective, I learnt almost what I am expecting from the beginning. I still trying to use the prototype I made now for testing the image stream to my website during the summer. The rest of the design, the system could be adding a voice stream feature for competing with regular radio communication system. For the business side, I learnt quite a lot since I am in the business, the initial design is my personal approach to solve the current issue with my restaurant, but after couple interviews, I found out the same point and different aspects for different business. Business owner is focusing more on price and the reliability of the system, so the delivery of the message that between employees and different locations in the business is quite important. So I learnt some business thinking skill from this project.

The improvement suggestion could be adding more mandatory group talk and group seminar just for talk and brain storm, the rest of the time could be used for group development time.

I think the discussion talk with Shawn and Prof. Ilya is really good for speeding and make move on the progress. I personally think, it could be having a record collection for those who fix their design issue or coding issue, they write it briefly with necessary but limited proof to help others who doing the same or similar topic project.

For the overall experience, I like everything here, the small group of student is a plus, the major benefit for this class is that it is so open to post question, to practice presentation skill, to independently solving issue. This class provide so much resource for student to build things from scratch and get it improved with necessary guideline. For prototyping a product, Shawn always provide necessary resource and suggestion for all-cross aspects. Overall, this class is a best fit for teaching students who would like to be exposed to independent study environment in Electrical Engineering and Computer Science field.

