Individual Progress Report of

Low-cost Sensor for Seamless Road Quality Monitoring

ECE 445 Design Document — Spring 2022

Individual Report by Yuhang Chen
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1. Introduction

1.1 Team Project Overview

The monitoring and maintenance of road surface are essential to improve driving comfort, transport safety and maintain infrastructure integrity. Traditional road monitoring is carried out on a regular basis by specially designed instrument vehicles, which require a lot of time and money and can only cover a limited proportion of the road network. Therefore, our group determine to design a road anomalies detection system combined with hardware components and software design. An acceleration sensor, a GPS module, an independent power supply and a WIFI module are connected to a microcontroller unit (MCU) to serve as the hardware detection system. This system will fetch the data from testing on road and transfer the data to the cloud server through the WIFI module. The software design includes the data preprocessing on the data received from the cloud server and the filtering and segmentation algorithm implementation to do extracting on features of sensor data, which is also supposed to be displayed in real time on a smartphone.

1.2 Individual Responsibilities and Role

In this project, the major part I am responsible is to establish the cloud server and the build the connection between the cloud server and the hardware components. Specifically, the table below shows the main tasks for me to focus on.

IDX	Task	Aspect
1	Physical Circuit Connection Design between the WIFI module and MCU	Hardware
2	Programming on the hardware driver and uploading codes to the MCU	Hardware-software Interaction
3	Building the front end and back end of the cloud server	Software

Table 1. My Main Individual Responsibilities in this Project

2.Individual Design Work

2.1 Design Consideration

The design in Task 1 & 2 have changed a lot compared to the previous design since the Design Review. In the Design Review, our group considered to use a ESP8266 chip as the WIFI module and a stem32C103F chip as the MCU. We have gotten the ESP8266 and stem32C103F earlier. But we found that a TTL to USB converter was still needed to allow the stem32C103F to be connected with the computer, since the stem32C103F we bought only transmits TTL signal and we need to convert TTL signal to USB signal. So we decide to buy a CP2102 chip from TaoBao as the signal converter. However, due to the epidemic, we fail to get this chip. The university lab in our campus could not support any TTL to USB converter either while it could offer an integrated breadboard to solve this problem, which is called STEMTera BreadBoard. And we agree on using this breadboard after discussion. Basically, the STEMTera BreadBoard can be regarded as dual microcontrollers inserted in a breadboard while it provided with USB port and a port for external power supply. By using this board we solve the problem to connect the MCU with the computer. The details of the whole tolerance analysis according to this breadboard may be talked by my partners who are responsible for the sensor. But this breadboard could directly offer 3.3Vfor the WIFI module, so the problem of power supply for esp8266 has been basically solved.

As mentioned before, I am responsible for building the connection between the cloud server and hardware components while the use of STEMTera Breadboard make some change on the method that I drive the WIFI module. The tables below show the similarities and differences of the method that stem32 and STEMTera drive esp8266.

IDX	Similarities	Discription
1	Programming Software	Both can support varieties of programing IDE (MDK-ARM, Arduino, IAR, etc.) In this project, I choose Arduino IDE.
2	Used Command	Both can use AT commands to set WIFI module on STA mode and initialize TCP connection.

Table 2. The Similarities between Stem32C103F and STEMTera Breadboard

IDX	Differences	Stem32C103F		STEMTera BreadBoard	
1	Hardware Role	Stem32C103F only serve as the microcontroller for esp8266.		STEMTera not only serve as the microcontroller for esp8266 but also provide power supply for esp8266.	
2	Pin Connection in the Circuit	Stem32C103F	Esp8266-01	STEMTera	Esp8266-01
		Out of stem32	VCC	3.3V	VCC
		GND	GND	GND	GND
		PA3	TX	Pin 8	TX
		PA2	RX	Pin 9	RX
3	Programming Library	ESP8266WiFi.h by stem32 [1]		esp8266.h by esp8266 community	

Table 3. The Differences between Stem32C103F and STEMTera Breadboard

2.2 Physical Diagram

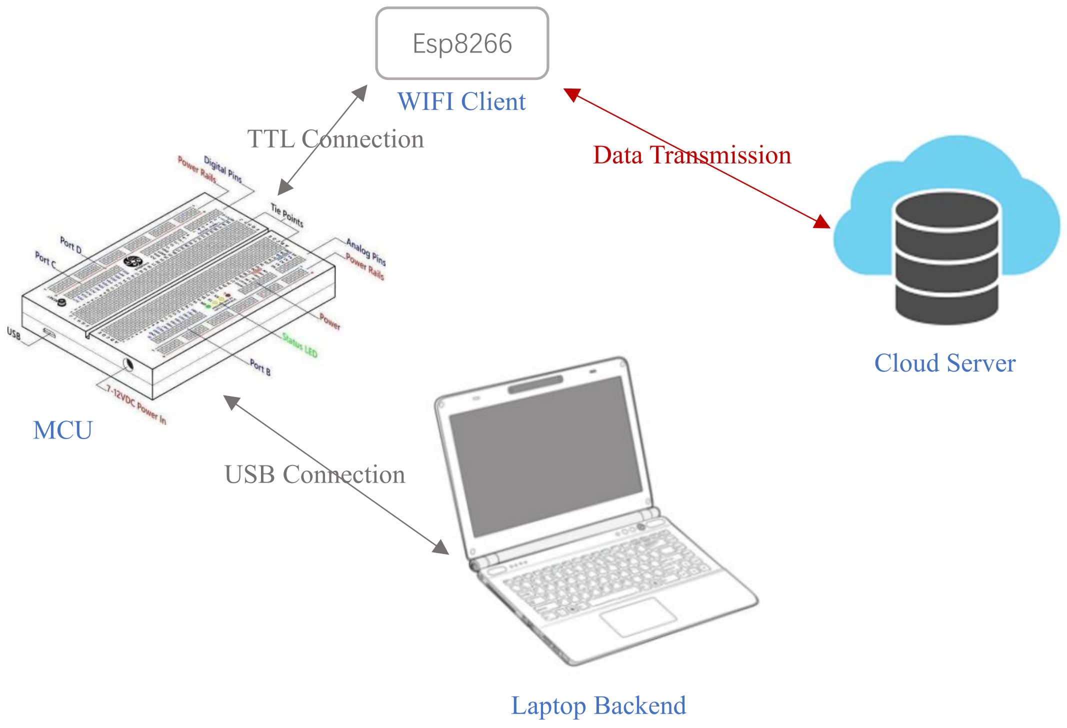


Figure 1. Physical Diagram on the Building the Connection between the WIFI Module and the Cloud Server

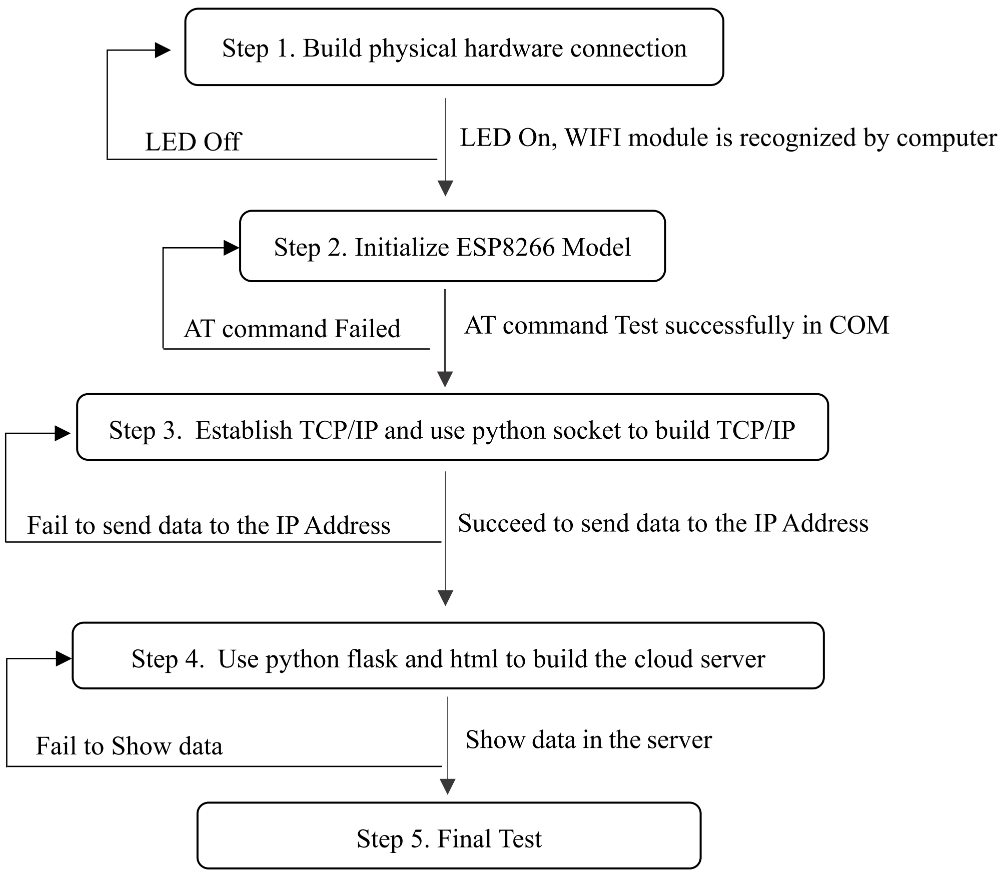

Step 1. Build physical hardware connection
LED Off
LED On, WIFI module is recognized by computer
Step 2. Initialize ESP8266 Model
AT command Failed
AT command Test successfully in COM
Step 3. Establish TCP/IP and use python socket to build TCP/IP
Fail to send data to the IP Address
Succeed to send data to the IP Address
Step 4. Use python flask and html to build the cloud server
Fail to Show data
Show data in the server
Step 5. Final Test

Figure 2. Flow Chart on the work on the WIFI Module and the Cloud Server

2.3 Test & Verification

2.3.1 Test Plans and Procedures

Date	Procedures
3/14-3/20	Collect all of the hardware components in the project from Taobao and the university lab
3/21-3/27	Build the physical connection and weld the used pin ports in the WIFI module esp8266; Test on the connection between WIFI module and the computer backend
3/28-4/3	Test on the Initialization on the WIFI module, set WIFI module to STA Mode and Initialize TCP link by AT command inserted in esp8266
4/4-4/10	Test on establishing TCP/UDP to set IP and use python socket to build TCP/UDP

Table 4. Test Plans and Procedures of My Individual Work Process

2.3.2 Modular Testing

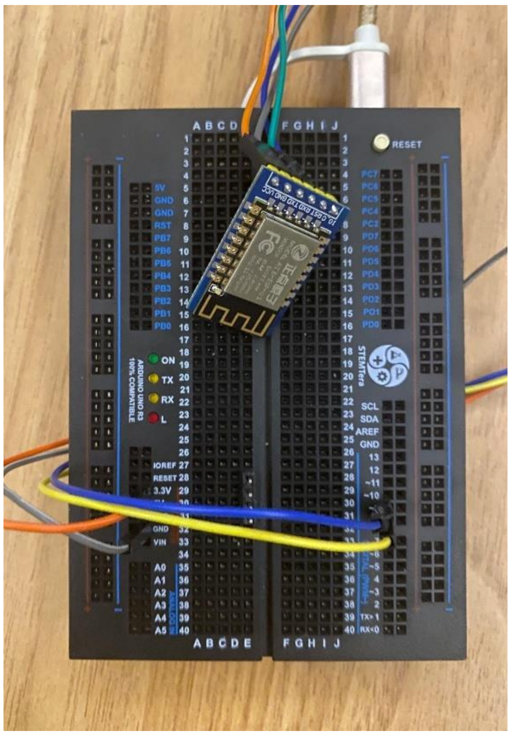


Figure 3. Circuit Connection of esp8266 and STEMTera BreadBoard

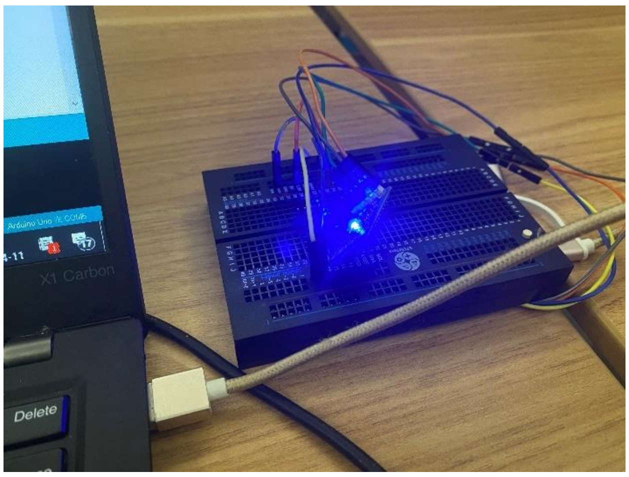
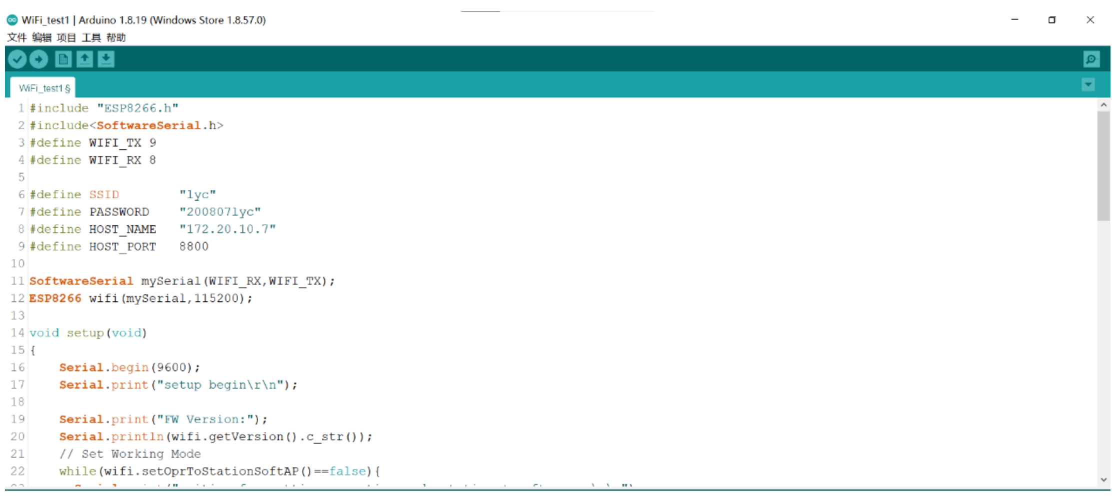


Figure 4. Connection between the hardware components and the laptop



```
#include "ESP8266.h"
#include<SoftwareSerial.h>
#define WIFI_TX 9
#define WIFI_RX 8

#define SSID         "lyc"
#define PASSWORD     "200807lyc"
#define HOST_NAME    "172.20.10.7"
#define HOST_PORT    8800

SoftwareSerial mySerial(WIFI_RX,WIFI_TX);
ESP8266 wifi(mySerial,115200);

void setup(void)
{
    Serial.begin(9600);
    Serial.print("setup begin\r\n");

    Serial.print("FW Version:");
    Serial.println(wifi.getVersion().c_str());
    // Set Working Mode
    while(wifi.setOprToStationSoftAP()==false){
```

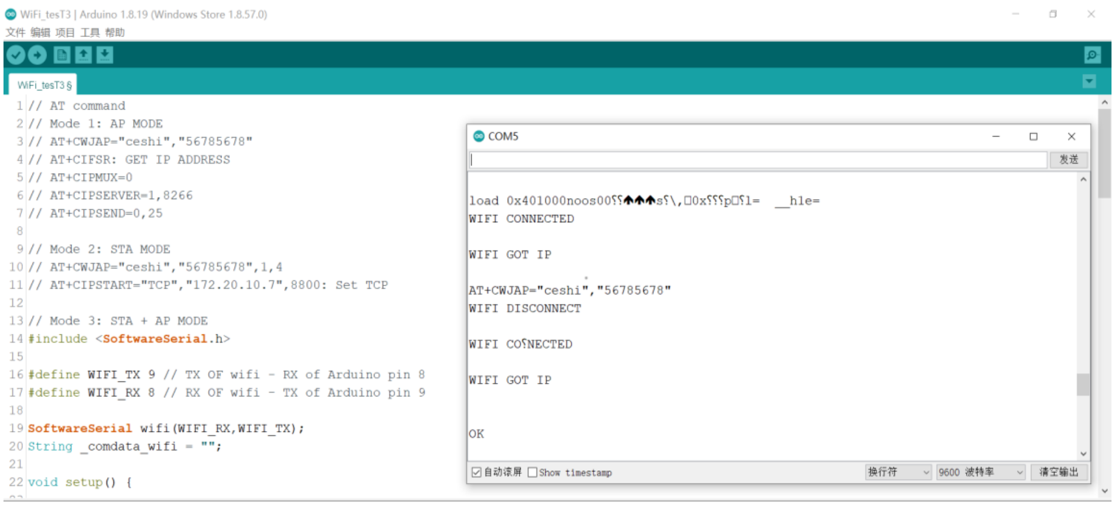
Figure 5. Code Snips of WIFI modular Test

2.3.3 Test Results

IDX	Test Content	Result Status	Failure Analysis
1	Connect Pin 0 and Pin 1 on STEMTera Breadboard with RX and TX port on esp8266 and test on whether the connection between WIFI module and the MCU is successful by using serial port print in Arduino IDE	Fail	By learning that the pin 0 (RX) is the receiver part of this communication system for the serial port monitor in Arduino IDE, I got that we can not connect pin 0 with the slave(WIFI module or other chips) and require the serial port monitor to work. Thus we may choose other pins in STEMTera Breadboard for connection. [2]
2	Connect Pin 8 and Pin 9 on STEMTera Breadboard with RX and TX port on esp8266 and test on whether the connection between WIFI module and the MCU is successful by using serial port print in Arduino IDE	Success	NULL
3	Use AT command to initialize WIFI module as AP mode to send data to the cloud server	Fail	Learning that we cannot set the WIFI module as AP mode to make it serve as the server, instead, we should set it to STA mode to make it as the client and use the client to send data to the server. [3]

4	Use AT command to initialize WIFI module as STA mode to send data to the cloud server	Success	NULL
5	Use socket in python to establish TCP link to show the received data in the server (in Wins 10 system)	Fail	There exist some Network Protection Protocol in Wins 10 System to block the links. [4]
6	Use socket in python to establish TCP link to show the received data in the server (in linux system build in urbuntu)	Success	NULL

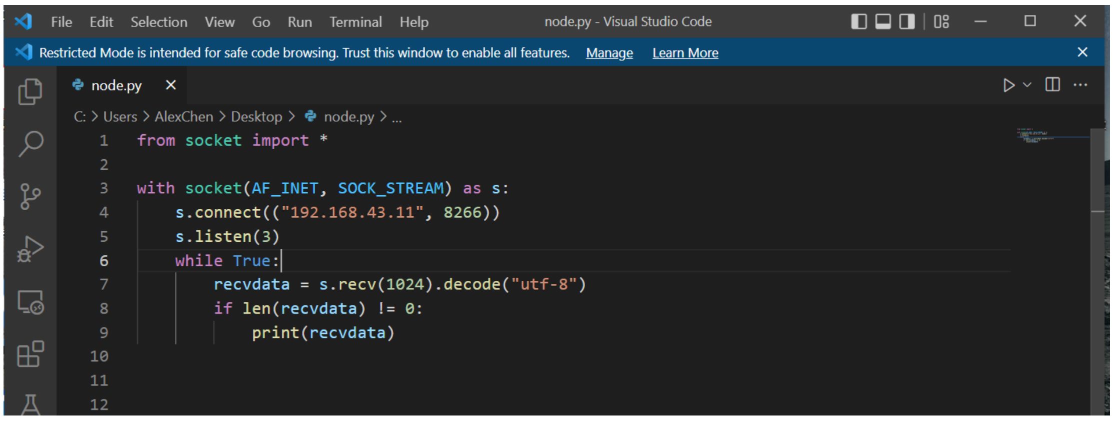
Table 5. Test Trials and Results during the process of Connection between WIFI module and the Cloud Server



```
// AT command
// Mode 1: AP MODE
// AT+CWJAP="ceshi","56785678"
// AT+CIFSR: GET IP ADDRESS
// AT+CIPMUX=0
// AT+CIPSERVER=1,8266
// AT+CIPSEND=0,25

// Mode 2: STA MODE
// AT+CWJAP="ceshi","56785678",1,4
// AT+CIPSTART="TCP","172.20.10.7",8800: Set TCP

// Mode 3: STA + AP MODE
#include <SoftwareSerial.h>

#define WIFI_TX 9 // TX OF wifi - RX of Arduino pin 8
#define WIFI_RX 8 // RX OF wifi - TX of Arduino pin 9

SoftwareSerial wifi(WIFI_RX,WIFI_TX);
String _comdata_wifi = "";

void setup() {
```

```
load 0x401000noos00ʕʕ🡅🡅🡅sʕ\,□0xʕʕʕp□ʕl=  __hle=
WIFI CONNECTED

WIFI GOT IP

AT+CWJAP="ceshi","56785678"
WIFI DISCONNECT

WIFI COʕNECTED

WIFI GOT IP


OK
```

Figure 6. Code Snips and Serial Port Monitor Show of WIFI STA Mode Test


File
Edit
Selection
View
Go
Run
Terminal
Help
node.py - Visual Studio Code
Restricted Mode is intended for safe code browsing. Trust this window to enable all features.
Manage
Learn More
node.py
C: > Users > AlexChen > Desktop > node.py > ...

```python
from socket import *

with socket(AF_INET, SOCK_STREAM) as s:
    s.connect(("192.168.43.11", 8266))
    s.listen(3)
    while True:
        recvdata = s.recv(1024).decode("utf-8")
        if len(recvdata) != 0:
            print(recvdata)
```

Figure 7. Code Snips of Using Socket to Show the Received Data in Cloud Server

3.Conclusion

3.1 Self-assessment

My Individual workload is enough for me to contribute myself on this project. Since our group project has both hardware design and software design, meanwhile with hard-soft interaction implementation work, our total workload is very large. There is a clear division of work in our group. So far I am satisfied with the division and the progress of our project. We discussed every week in discussion room and work together if some team members have some problem in some part of the project work like the sensor testing, etc.
I think I am working on schedule, at least not behind the schedule because I have succeeded to make the hardware and software work together and I can focus more on the software programming about how to build the cloud server efficiently. Although there is still a lot of work to do, I believe my part of work could be done according to the schedule plan and I may even have remaining time to help my partners on the filtering and segmentation algorithm.

3.2 Plan for Remaining Work

Date	Procedures
4/11-4/24	Succeed to establish the whole TCP link and transmit sensor data from the MCU to the cloud server
4/25-5/8	Write html page and use flask in python to establish the front end and back end of the cloud server
5/9-5/22	Final Test and make adjustment on the cloud server and help on data processing

Table 6. Plan for Remaining Work from Apri.11

4.Reference

[1] Connecting ESP8266 with STM32F103C8: Creating a Webserver. Pramoth Thangavel. Oct 25, 2018 https://circuitdigest.com/microcontroller-projects/interfacing-esp8266-with-stm32f103c8-stm32-to-create-a-webserver

[2] Troubles in Connecting esp8266-01 with Arduino in forum Arduino.cc https://forum.arduino.cc/t/troubles-connecting-esp8266-01-with-arduino-mega-2560/646624

[3] Esp8266, Use Python to Establish Client Connections and Realize Data Mutual Transmission (Transparent Transmission). Tian, Xiaohua. Feb 16, 2020. https://blog.csdn.net/qq_44179528/article/details/104346620

[4] Fail to Connect esp8266 ip address by CSDN blog. Douran. May 28, 2019. https://blog.csdn.net/weixin_44986800/article/details/90637668?spm=1001.2101.3001.6650.1&utm_medium=distribute.pc_relevant.none-task-blog-2%7Edefault%7ECTRLIST%7ERate-1.pc_relevant_default&depth_1-utm_source=distribute.pc_relevant.none-task-blog-2%7Edefault%7ECTRLIST%7ERate-1.pc_relevant_default&utm_relevant_index=2