International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 11 Ver I || Nov 2018 || PP 60-68

The Application Of Modular Sensor In Environment Detection System And The Internet Of Things

Jen-Yu Shieh, Sheng-Chia Lin, Yong-Tang Zhang, Chun-Chia Wu
Department of Electro-Optics Engineering,National Formosa University,Taiwan.ROC
Corresponding author: Jen-Yu Shieh

Abstract : *The application of modular sensor in environment detection system and the Internet of Things developed in this thesis allowed user to select required modular sensor. For this research, a variety of sensors was developed, including DHT11 of a single bus transmission, BMP180 with IIC transmission interface, air quality sensor and UV index sensor with analog output, that various transmission modes were converted into UART transmission interface through MCU of each sensor. Once the exclusive interface of WIFI module was plugged in, the WIFI terminal would receive the data transmitted from the sensor end to be decoded and categorized by the MCU at the WIFI terminal, before these data from different sensors were released to MQTT and uploaded to the cloud storage, which could be observed via any network, as well as monitoring the current status with the remote mobile APP. User can real-time monitor and store data on the cloud with one single step to reduce experiment cost and program development.*

Keywords *-Modularization; IOT; Cloud; MQTT; Remote*

Date of Submission: 12-11-2018 Date of acceptance: 26-11-2018

I. INTRODUCTION

With the advance of science and technology, all industries are affected and transformed by it. In the machine age, farmers use machines in place of manpower, but agriculturally, farming still relies on their experiences. Thus, smart agriculture, based on IOT and Big Data, allows more data to accurately monitor the environment, where the records of predecessors can significantly improve the rapid development of agriculture. The future belongs to the era of Big Data. In the era of Big Data, it is time to connect various products and sensors to the Internet. For farmers who rely on the weather, which has a considerable impact on agricultural products, it is essential to employ different environmental sensors. However, many sensors adopt a variety of transmission methods, such as IIC, UART, SPI and analog data, that it is unlikely for farmers to totally understand these technical specifications to truly produce a network of IOT. The objective of this thesis was to integrate various transmission methods to upload data to the cloud through WIFI as a way to generate Big Data with convenience for users, allowing everyone to be part of IOT.

II. SYSTEM DESIGN

In this research, HT66F70A was used as the core MCU with two parts; one was the WIFI and the other was the sensor. The sensor used HT66F70A for different transmission interfaces and various sensors (DHT11, BMP180, GP2Y1010AU0F, GUVA-S12SD and etc.), where the measurement value from sensor was converted into format for UART transmission interface, which was then passed through a dedicated port to the WIFI terminal. The WIFI terminal used HT66F70A to control ESP8266-12S (WIFI module), and set the dedicated port to communicate with the sensor, in which the measured value from the sensor was released to MQTT for publication to the subscribers, as well as transmitting the information to Thingspeak for storage, such that 0 portrayed a block diagram of the hardware system.

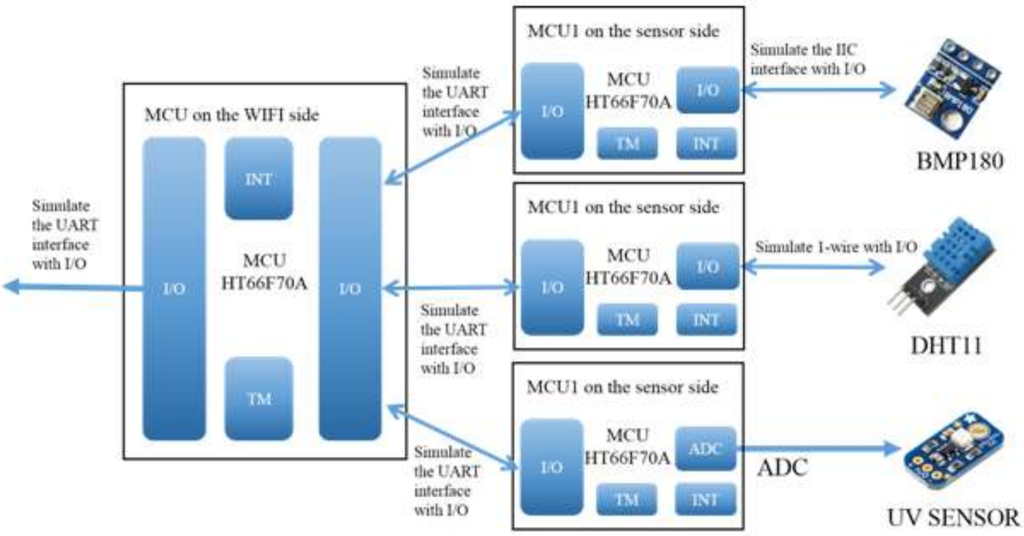


Figure1 Block diagram of the hardware system

III. METHOD

(1) WIFI terminal program architecture

Once ESP8266 was boot up for 6.5 seconds, the chip was reset and connected to the WIFI network [1][2] (ESP8266 was only allowed to connect to the mobile phone network, but in the future, WIFI network can be an option with input of password). The signal was sent to the first sensor and once received, it would start to read the current data, in which the data and the characters were transmitted back to the WIFI terminal. The WIFI terminal would temporarily suspend to acquire feedback data from the sensor. Upon completion, the presence of a second sensor would be checked and if present, the signal was transmitted to it. Once the value was received, TCP/UDP connection was established to ready the data transmission and configuration of characters. The data was released to MQTT to be relayed to subscribers. For every 15 seconds, the data from each sensor was transmitted to Thingspeak as a cloud storage. 0 showed the entire process.

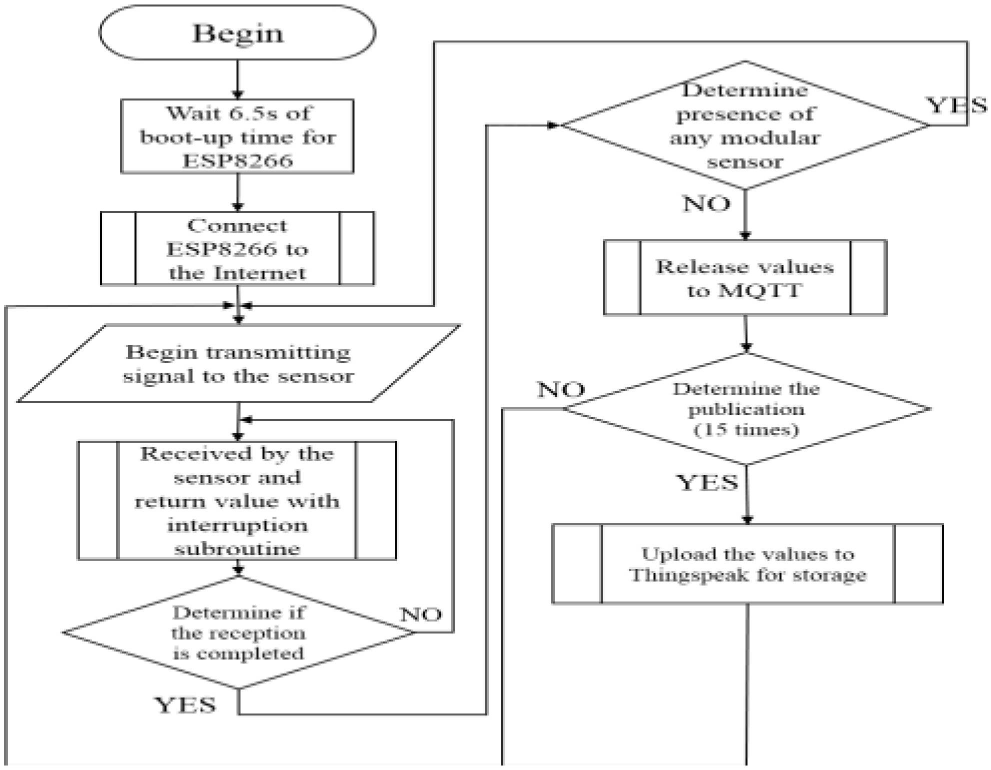


Figure 2 The flow chart at WIFI terminal

(2) BMP180 Pressure sensor[3][4]

BMP180 used the IIC interface for transmission. In this paper, the I/O of HT66F70A was used to simulate IIC interface transmission. First, the 176-bit calibration unit in the EEPROM of BMP180 was extracted to acquire the uncompensated temperature and pressure value. Then, with the use of calibration unit on the compensated temperature and pressure value, the actual temperature and pressure value could be calculated, as seen in Figure2.

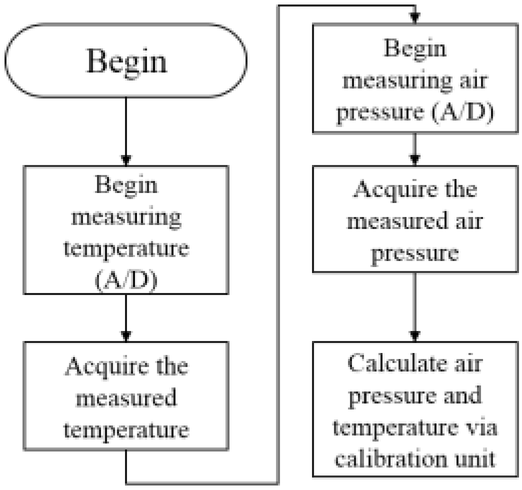


Figure 3 The flow chart of sampling value by BMP180

Height equation (1):

$$h = \frac{\left(\left(\frac{P_0}{P}\right)^{\frac{1}{5.257}}-1\right)\times(T+273.15)}{0.0065} \qquad \text{Eq. (1)}$$

(3) DHT11 temperature and humidity sensor[5][6]

The method to obtain value by DHT11 was special that it was a single-wire bidirectional transmission. After the MCU I/O transmitted the starting signal to DHT11, the sensor would be activated to high-speed from its low-power mode, and once the start signal ended, the sensor would begin transmitting measured value. Figure3 showed the connection diagram of MCU and DHT11.

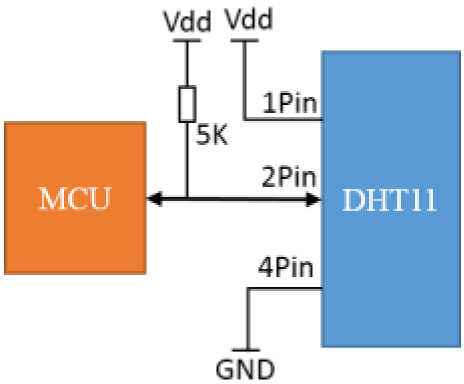


Figure 4 The connection diagram of MCU and DHT11

When idle, the MCU output was in high potential. The start signal would switch the MCU from high to low potential for a delay of at least 18ms to ensure that DHT11 detected the signal before turning to input mode for MCU at 20 to 40µs of the state of high potential. After switching to the input mode and reception of start signal from MCU by DHT11, the feedback was a low-potential response of 80µs before the electric potential was increased to high at 80µs to be ready to send data, as seen in Figure4.

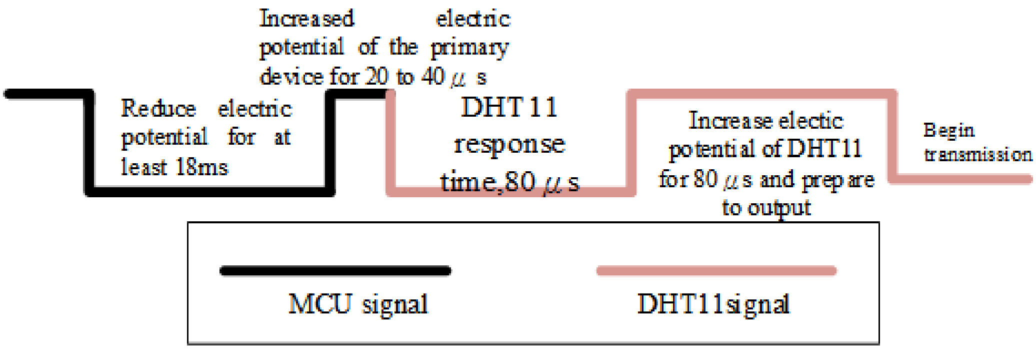


Figure 5 Start signal

Each 1 BIT of data started with a low potential gap of 50μS and the duration of high potential was used to determine the data as 0 or 1. For high potential time of 70μS, data was represented as 1, while high potential time of 26 to 28μS represented data as 0.

Data 1 signal was represented by the method seen in Figure5

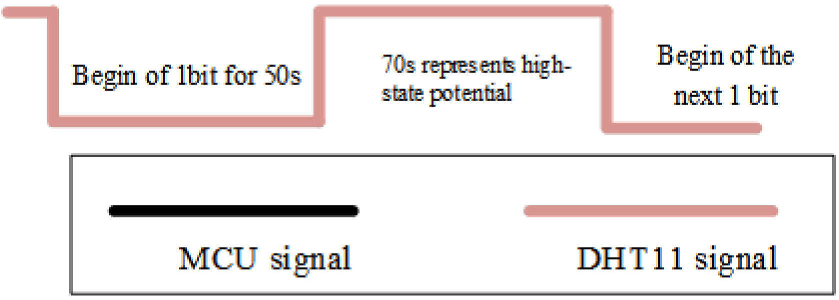


Figure 6 Highstate data

Data 0 signal was represented by the method seen in Figure6

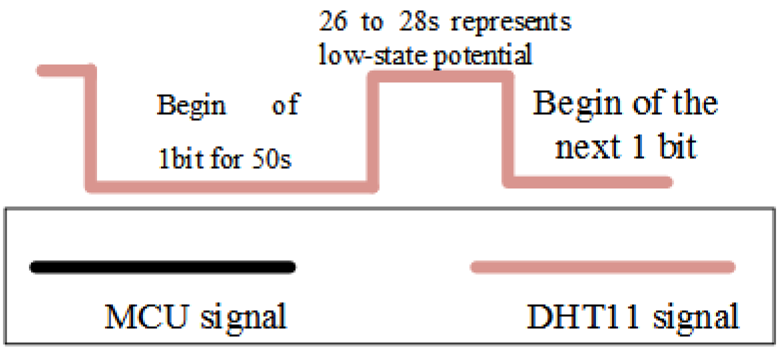


Figure 7 Lowstate data

The entire process would only stop when the 8 BIT integer data on temperature, the 8 BIT decimal data on humidity, the 8 BIT integer data on temperature and the 8 BIT decimal data on temperature were transmitted and calibrated, where the calibration data were the last 8 digits of the 8 BIT humidity integer data, the 8 BIT humidity decimal data, the 8 BIT temperature integer data and the 8 BIT temperature decimal data. After the stop, MCU was switched to high idle state for output and DHT11 was switched to the low speed mode. Since the DHT11 data was calibrated, no further calculation or correction was required.

(4) The sensor program architecture and description

The MCU at the sensor end was also HT66F70A. Different sensors were passed through the MCU control and sampled values of the sensors were converted into a UART transmission interface, where the data was transmitted to the WIFI terminal through a dedicated port.

After setting the external interrupt, the process began by waiting for the WIFI terminal to send the start signal. Upon reception of signal, it proceeded to the external interrupt subroutine as seen inFigure7, such that the data obtained from each sensor was converted into ASCII code and transmitted back to the WIFI terminal through the UART communication interface. Return data: The first code contained several records of data, the second code included discriminant byte along with data, and one data size was 7 Bytes.

For example, if the measured data by BMP180 included three records and the air pressure was 1010.25hPa, the data was isolated into characters with addition of P for discriminant byte, as seen in Table1. If the temperature was 27.5 degrees, it was separated into characters and 0 was added to the data size to 7 BYTE before T was added as discriminant byte, as demonstrated in Table2. Also, with the height value of 26.5 meters for an example, its isolated characters were also added with 0 to a data size of 7 BYTE, along with the discriminant byte, A (Table3). As a result, for these three records, the data transmitted back to the WIF Iterminal was 3P1010.25T00027.5A00026.5. Because different sensors measured different data, the number of record was not constant; for example, in DHT11, there were two records and three records for BMP180, while GP2Y1010AU0F and GUVA-S12SD only had one record. Thus, different sensors could transmit correct values via the same interface.

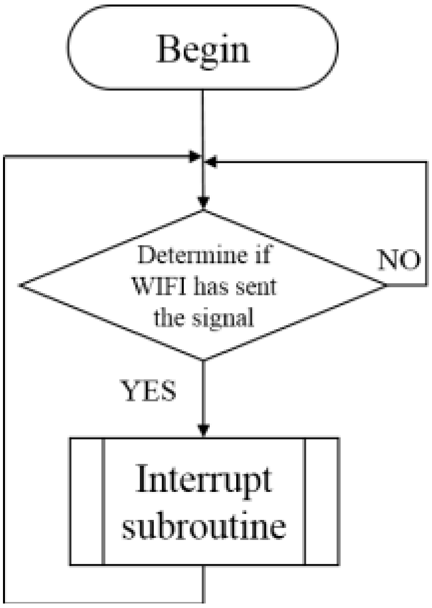


Figure 8 The flow chart at the sensor terminal

Figure1

Table1 Air pressure

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7	BYTE 8
P	1	0	1	0	.	2	5
Discriminant byte	Data						

Table2 Temperature

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7	BYTE 8
T	0	0	0	2	7	.	5
Discriminant byte	Supplement to data size of 7BYTE with 0.			Data			

Table3 Height

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7	BYTE 8
A	0	0	0	2	6	.	5
Discriminant byte	Supplement to data size of 7BYTE with 0.			Data			

IV. RESULT

(1) DHT11 measurement

After connecting the sensors, measurements in the morning, at the noon, and in the afternoon at the entrance of the Integration (Tsung Ho) Center 1 at National Formosa University were taken every five minutes over a three-day period. The followings were the average values, in comparison with values from The Weather Channel, as illustrated in Table4.

Table4 DHT11 measurement

		7/12			7/13			7/14		
		08:00	12:00	20:00	08:00	12:00	20:00	08:00	08:00	20:00
DHT11	Temperature	29	32	28	27	30	27	26	31	27
	Humidity	63	52	65	64	50	63	68	56	62
The Weather Channel	Temperature	29	33	29	29	33	29	28	32	29
	Humidity	70	59	70	72	61	71	82	60	69

There were differences between measurement and the referenced value, because the range of values from The Weather Channel was broader in spectrum, and DHT11 was actually measuring the data on site, hence the variation.

(2) BMP180 measurement

BMP180 is an atmospheric pressure sensor that can calculate altitude with sea level pressure. Since the Central Weather Bureau does not have sea level pressure in the Huwei area, the sea level pressure in the nearby Chiayi area was taken instead to calculate altitude with the atmospheric pressure by BMP180. Table5 showed altitudes and air pressure measurement data.

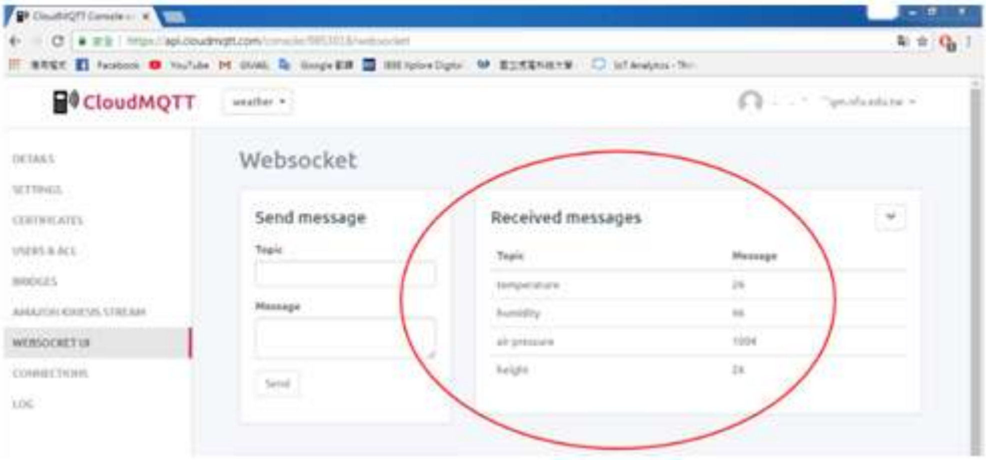
Table5 BMP180 measurement

Floor	Measured air pressure (hPa)	Altitude (m)
1st floor	1003.35	29
2nd floor	1004	32
3rd floor	1003.63	36
4th floor	1003.2	40
5th floor	1002.9	42
6th floor	1002.6	45
7th floor	1002.26	48
8th floor	1001.86	51
9th floor	1001.5	55

On the Internet, the altitude of the experimental location is 32 meters. The difference was probably due to the use of sea level air pressure from Chiayi. However, under the condition of same time, same location but different height, the measured pressure can still lead to an accurate calculation of altitude.

(3) Thingspeak and MQTT

The sensor was connected to the network to release the data to MQTT. Figure8 was the CLOUDMQTT website. It enabled subscribers to receive its data via MQTT. It was also uploaded to ThingSpeak as a record every 15 seconds. Figure9 was the THINGSPEAK website.



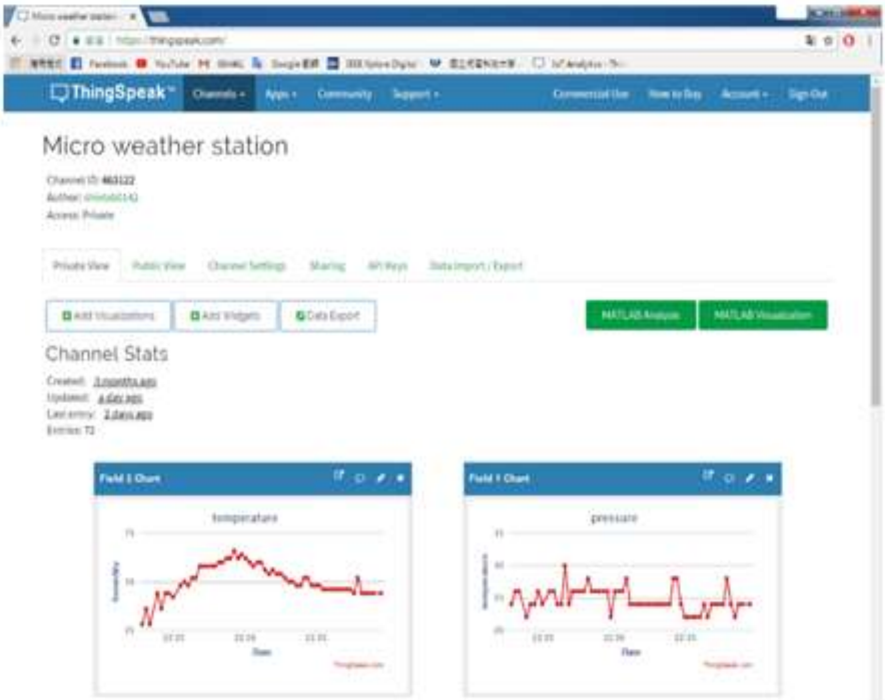


Figure 8 CLOUDMQTT website
Figure 10 THINGSPEAK website

(4) APP

By subscribing to MQTT in the APP, it will be possible to receive updated data, as illustrated in Figure10. Moreover, more details of the location can be displayed when clicking on specific spot on the curve graph of ThingSpeak, as seen in Figure11.

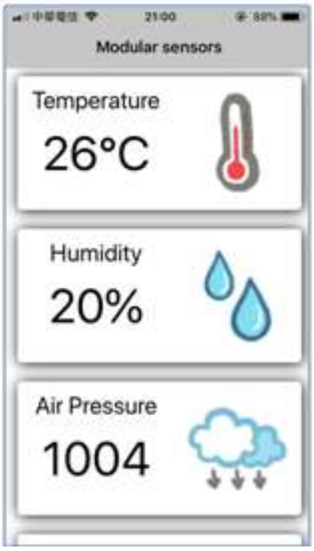


Figure 11 Reviewing real-time update information from MQTT in the APP

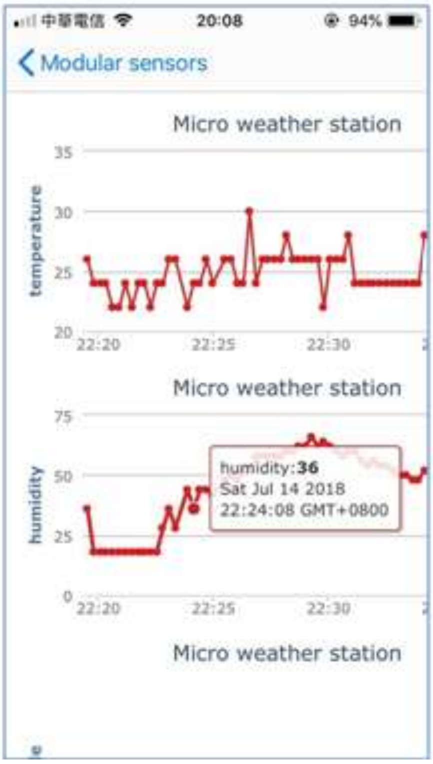


Figure 12 Reviewing ThingSpeak curve graph on the APP

V. CONCLUSION

There are many types of sensor with different transmission interface and usage on the market, that not everyone has mastered all applications. It is even more difficult for people who are expert in programming, hence the need of developing modular sensor with the use of MCU for control and change the transmission mode. In this paper, IIC, single bus and digital signal transmission modes were all changed to UART transmission interface, which constituted the modular sensor. The WIFI terminal adopted an MCU and a WIFI module for future expansion according to user requirement. One WIFI terminal could have up to three different sensor expansions. Lastly, the sensor values were released to MQTT and uploaded to the cloud storage, achieving the functions of IOT and real-time surveillance, that APP development facilitated users to monitor real-time values and review historical records.

Acknowledgements

The authors gratefully acknowledge the funding of the research by the collaboration of National Formosa University and Kai Fung International Co., Ltd. Underproject 106AF116.

REFERENCES

[1]. Ankur Singh Rana, Mohit Bajaj , Prakhar Srivastava , 2018 , " IoT based controlling of hybrid energy system using ESP8266 " , 2018 IEEMA Engineer Infinite Conference (eTechNxT) , 1-5 , 14 June
[2]. " ESP-12S_User_Manual " , pp. 1-17
[3]. Data sheet BMP180 Digital pressure sensor" , pp. 1-28
[4]. Ravi Kishore Kodali , Snehashish Mandal , 2016 , "IoT based weather station" , 2016 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT) , pp. 680 – 683 , July
[5]. "DHT11.pdf " pp. 1-6
[6]. Maulana Yusuf Fathany , Syifaul Fuada , Trio Adiono , 2018 , "A portable node of humidity and temperature sensor for indoor environment monitoring" , 2018 3rd International Conference on Intelligent Green Building and Smart Grid (IGBSG) , pp. 1-5 , 25 June

D.S.Dabhade "Optimization Of Process Parameters During Dry Turning Of Inconel 625 By Using Sialon Ceramic Insert "International Journal of Engineering Science Invention (IJESI), vol. 07, no. 11, 2018, pp 60-68