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ESP8266 WI-FI MODULE FOR MONITORING SYSTEM APPLICATION

Tae-Gue Oh[1] , Chung-Hyuk Yim[2] and Gyu-Sik Kim[*1]

[*1,1]Department of Electrical Engineering, The Univ. of Seoul, Seoul, Korea
[2]Dept. of Mechanical System Design Eng., Seoul National Univ. of Science & Technology, Seoul, Korea
[*]Corresponding Author- Gyu-Sik Kim

ABSTRACT

The ESP8266 Wi-Fi module is a self-contained system-on-chip (SOC) with integrated TCP/IP protocol stacks that can give any microcontroller access to a Wi-Fi network. In this paper, the interface between the ESP8266 Wi-Fi module and arduino MCU is studied for monitoring system application. Through some experimental studies, we believe that the ESP8266 Wi-Fi module is very useful for monitoring system application.

Keywords: *ESP8266, Wi-Fi Module, arduino MCU, monitoring system, networking*

I. INTRODUCTION

The ESP8266 Wi-Fi module is a self-contained system-on-chip (SOC) with integrated TCP/IP protocol stacks that can give any microcontroller access to a Wi-Fi network [1, 2, 3]. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions to another application processor. Each ESP8266 module comes pre-programmed with AT Command Set firmware, meaning the module can be hooked up to an Arduino device with about the same Wi-Fi ability as a Wi-Fi shield. The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community of users. This module has powerful enough on-board processing and storage capability to allow it to be integrated with the sensors and other application-specific devices through its general-purpose input/outputs (GPIOs), with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry. The front-end module is designed to occupy minimal PCB space.

The logic connections between the Arduino and the ESP8266 are very simple: the ESP Rx connects to the Arduino Tx, and the ESP Tx connects to the Arduino Rx; however, the ESP8266 runs off 3.3V, while Arduino pins run off 5V. Before connecting them, it is necessary to provide a way to reconcile these voltages, or the ESP might be damaged. Either Access Point (AP) mode or Station mode (for the ESP8266) was chosen by the command of Arduino MCU. Station mode is the default-operating mode for the ESP8266 adapter. In this mode, the ESP8266 adapter operates as a client that connects to a Wi-Fi access point. This mode is used to connect a Wi-Fi adapter to a wireless network. In AP mode, the adapter acts as an access point enabling other Wi-Fi adapters to connect to it; therefore, the adapter can be used to create one's own wireless network. In Station mode, the ESP8266 Wi-Fi module receives the data from the local controller's MCU using serial communication. It then sends the data to the monitoring server system over the Internet.

In this paper, the ESP8266 Wi-Fi module is studied for monitoring system application. Through experimental studies, we believe that the ESP8266 Wi-Fi module is very useful for monitoring system application.

II. ESP8266 WI-FI MODULE

2.1 Wi-Fi networking

Wi-Fi is a technology for wireless local area networking with devices based on the IEEE 802.11 standards [4]. Wi-Fi is a trademark of the Wi-Fi Alliance, which restricts the use of the term Wi-Fi Certified to products that successfully complete interoperability certification testing. Devices that can use Wi-Fi technology include personal computers, video-game consoles, smartphones, digital cameras, tablet computers, digital audio players and modern printers. Wi-Fi compatible devices can connect to the Internet via a WLAN network and a wireless access point. Such an access point (or hotspot) has a range of about 20 meters indoors and a greater range outdoors. Hotspot

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coverage can be as small as a single room with walls that block radio waves, or as large as many square kilometers achieved by using multiple overlapping access points. Wi-Fi most commonly uses the 2.4 gigahertz UHF and 5 gigahertz SHF ISM radio bands. Having no physical connections, it is more vulnerable to attack than wired connections, such as Ethernet. Web pages that use Transport Layer Security (TLS) are secure, but unencrypted Internet access can easily be detected by intruders. For protection, Wi-Fi has adopted various encryption technologies. The early encryption Wired Equivalent Privacy (WEP) proved easy to break. Higher quality protocols, such as Wi-Fi Protected Access (WPA, WPA2) were added later. An optional feature added in 2007, called Wi-Fi Protected Setup (WPS), had a serious flaw that allowed an attacker to recover the router's password. The Wi-Fi Alliance has since updated its test plan and certification program to ensure all newly certified devices resist attacks.

2.2 ESP Wi-Fi module:

ESP-07 Wi-Fi module is developed by Ai-thinker Team [5]. The Core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra low power 32-bit MCU micro, with the 16-bit short mode, clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.

ESP8266 Wi-Fi module and its circuit diagram are shown in Fig. 1. ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controller based design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated Wi-Fi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area. ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

Figure:

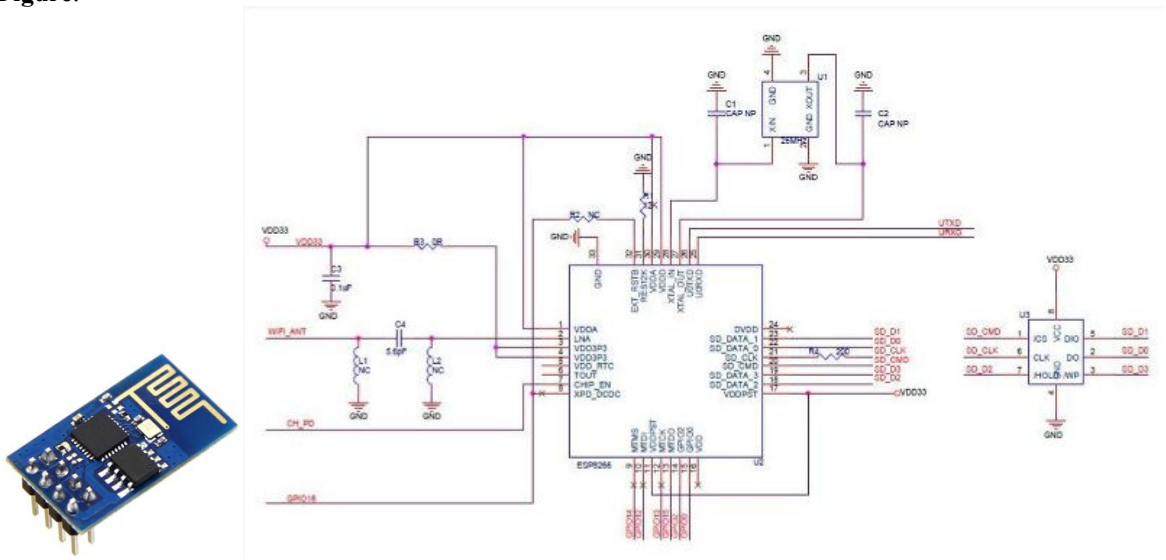

Figure 1. ESP8266 module and circuit diagram

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The features of ESP Wi-Fi module are as follows

- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- Supports antenna diversity
- Wi-Fi 2.4 GHz, support WPA/WPA2
- Support STA/AP/STA+AP operation modes
- Support Smart Link Function for both Android and iOS devices
- SDIO 2.0, (H) SPI, UART, I2C, I2S, IRDA, PWM, GPIO
- STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation and 0.4s guard interval
- Deep sleep power <10uA, Power down leakage current < 5uA
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)
- +20dBm output power in 802.11b mode
- Operating temperature range -40C ~ 125C

Figure:

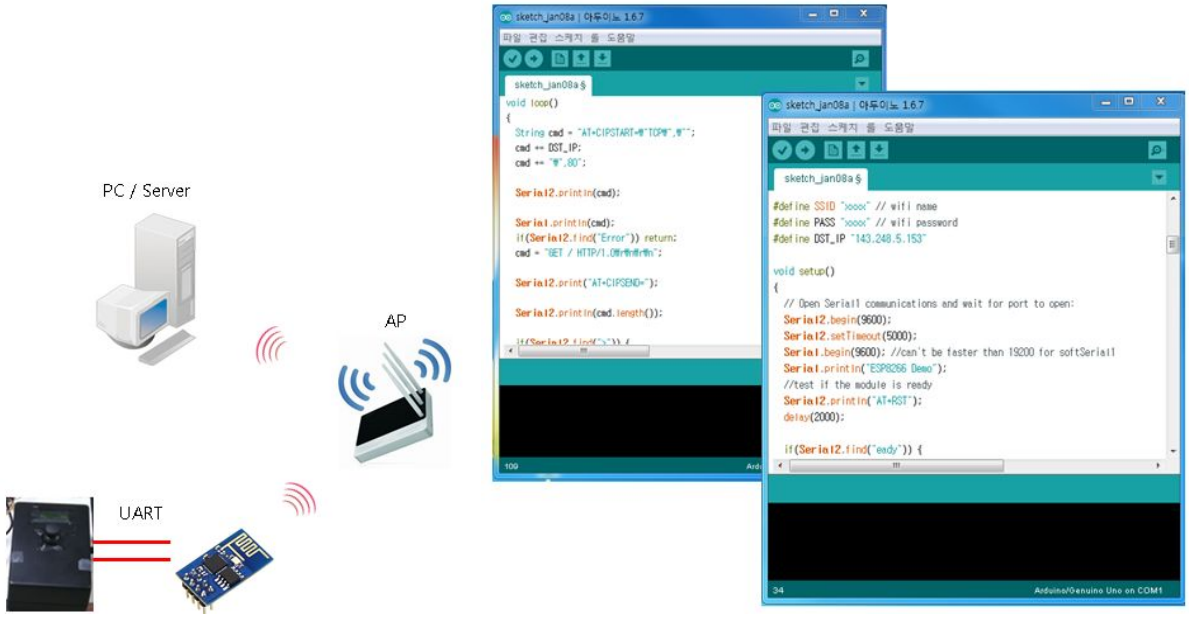

Figure 2. Example code for wireless Wi-Fi communication test

An example code for wireless Wi-Fi communication test is shown in Fig. 2. The logic connections between the Arduino and the ESP8266 are very simple: the ESP Rx connects to the Arduino Tx, and the ESP Tx connects to the Arduino Rx; however, the ESP8266 runs off 3.3V, while Arduino pins run off 5V. Before connecting them, it is necessary to provide a way to reconcile these voltages, or the ESP might be damaged. Fig. 3 shows the Arduino Tx to ESP8266 Rx pin voltage pulse waveforms. Some test for interface between Arduino MCU and ESP8266 was done as shown in Fig. 4.

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Figure:

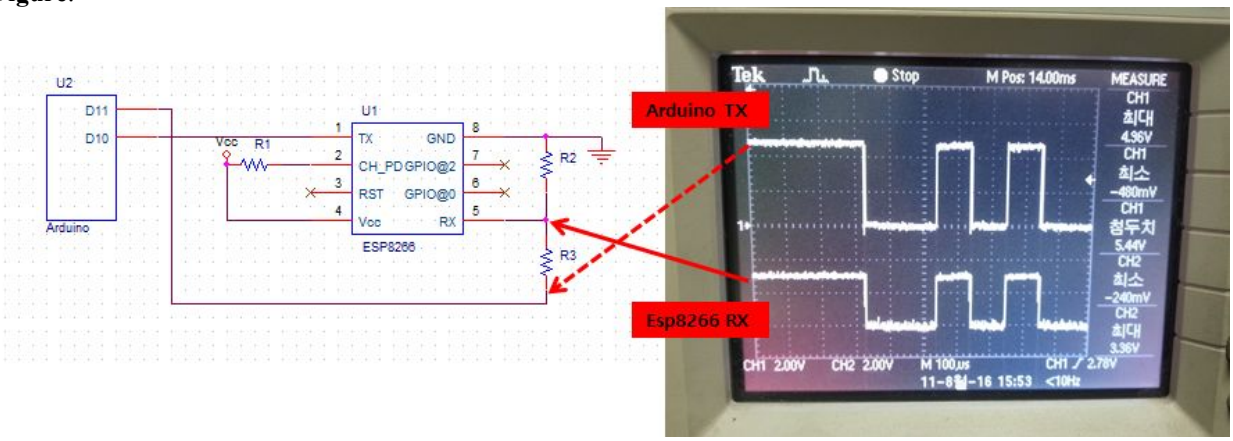

Figure 3. Arduino Tx to ESP8266 Rx pin voltage pulse waveforms

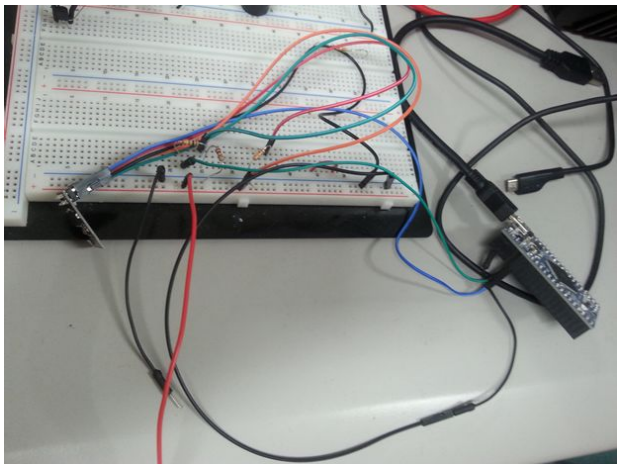

Figure 4. Test for interface between Arduino MCU and ESP8266

2.3 Performance evaluation for Wi-Fi module

The data communication between Wi-Fi module and Arduino MCU is done using Software Serial. In order to confirm whether the data communication is successful or not, the PC Serial Monitor was used as shown in Fig. 5. Hardware Serial was used for it. The confirmation of Wi-Fi data transmission success using Serial Monitor was done as shown in Fig. 6 and Fig. 7.

Figure

Figure 5. Experimental test for Wi-Fi wireless communication

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Figure:

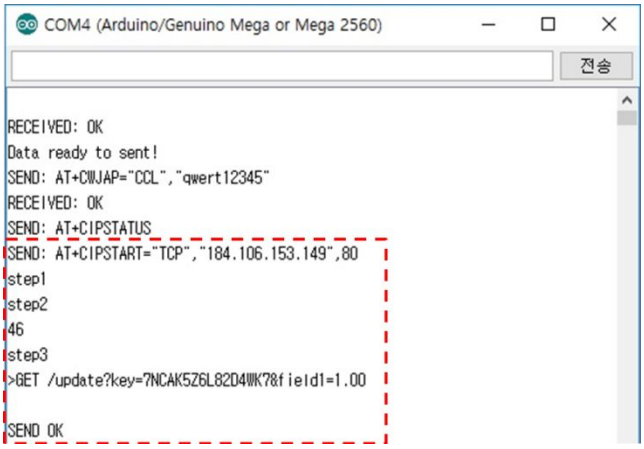

Figure 6. Confirmation of data transmission success using Serial Monitor

Figure

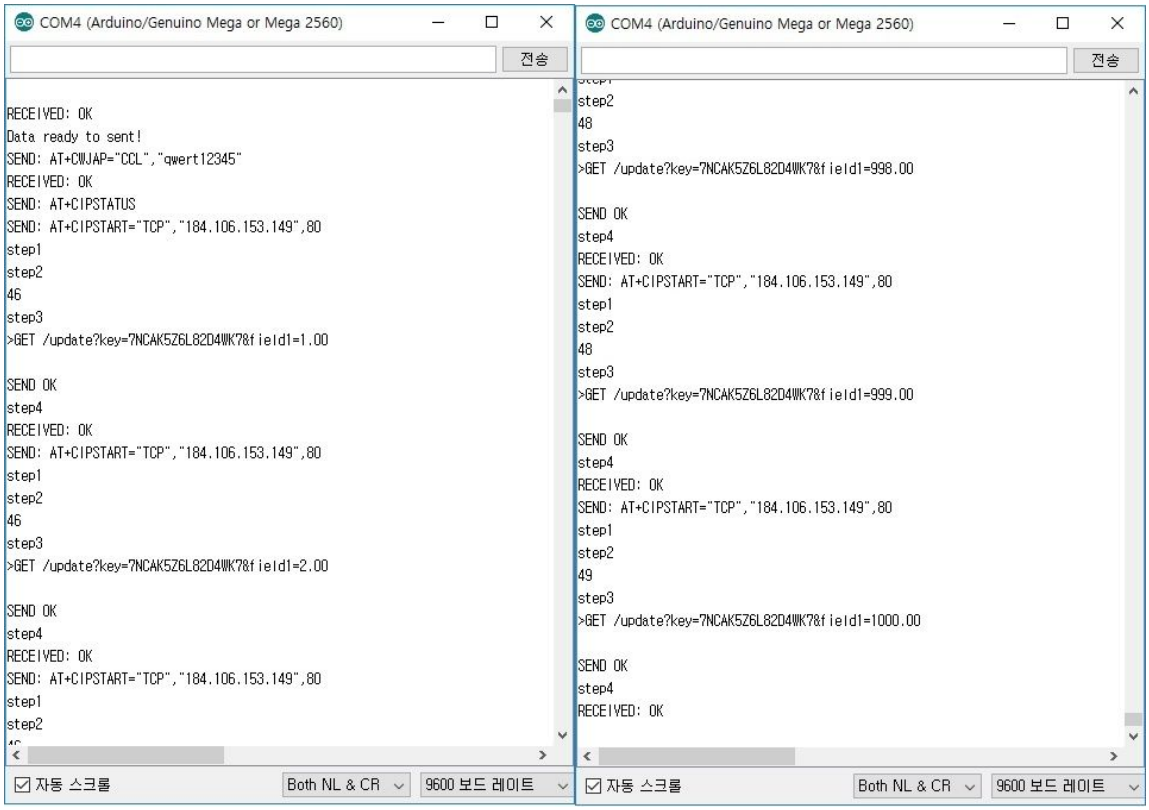

Figure 7. Confirmation of Wi-Fi data transmission success using Serial Monitor

III. CONCLUSION

The ESP8266 Wi-Fi module is a self-contained system-on-chip (SOC) with integrated TCP/IP protocol stacks that can give any microcontroller access to a Wi-Fi network. In this paper, the interface between the ESP8266 Wi-Fi module and arduino MCU is studied for monitoring system application. The confirmation of Wi-Fi data transmission success using Serial Monitor was done. Through experimental studies, we believe that the ESP8266 Wi-Fi module is very useful for monitoring system application.

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IV. ACKNOWLEDGEMENTS

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