Wi-Fi Signal Strength Indicator

Diksha Singla
ECE Department
Chandigarh Engineering College, Landran, Mohali, Punjab, India

Harmanjit Singh
ECE Department
Chandigarh Engineering College, Landran, Mohali, Punjab, India

Jitesh K. Chawla
ECE Department
Chandigarh Engineering College, Landran, Mohali, Punjab, India

Smriti Ranjan
ECE Department
Chandigarh Engineering College, Landran, Mohali, Punjab, India

Shaina Parvanda
ECE Department
Chandigarh Engineering College, Landran, Mohali, Punjab, India

ABSTRACT
Twenty first century showed a phenomenal growth in wireless technology. From north to south, east to west, the world today uses varied technologies ranging from Radio Frequency (RF), Infrared (IR), Bluetooth, ZigBee and Wi-Fi. Embodied with various advantages like feasibility, easy accessibility and scalability, emerging wireless technologies have gained an extra edge over the wired installation enhancing its acceptance and usage among the masses. In today's scenario, where internet connectivity is the most sought after thing after basic amenities, and because of this very reason the design of Wi-Fi Signal Strength Indicator was undertaken. Wi-Fi Signal Strength Indicator is a compact, economical and a portable device designed to display signal strength of available Wi-Fi network present on LED display. This indicator basically has an ESP8266 module, a microcontroller unit and a LED display quantized in the form of bars. This device can display signal strength of a particular SSID that has been specified in the programming and it can be easily configured at any location as per the availability of SSID. The basic principle on which the device works is "Internet of Things", that is the network of physical objects or "things" embedded with the electronics, software, sensors and network connectivity, which enables these objects to collect and exchange data. This device can be employed anywhere at the public places where Wi-Fi is made available like universities, malls, cafes and airports. The latest Railway budget delineating and emphasising on concept of "Digital India" also had the application of such devices. There was a proposal in it to install such Wi-Fi signal indicators at railway stations and trains to make the users aware of the available Wi-Fi facility.

Keywords
Wi-Fi, SSID, RSSI, AP, Arduino®, Adafruit, ESP8266, AT Commands, LED, LCD and IoT

1. INTRODUCTION
The advent of twenty first century saw a great boom in the usage of internet. While the internet became the indispensable part of modern life, Wi-Fi added an on-the-go availability of internet feature to devices like laptops, palmtops and mobile phones, thus making them smart devices. The need of the hour is the real time depiction of Wi-Fi Signal Strength, allowing users to identify where Wi-Fi is available and with what signal strength, without having them open their devices.

The motivation behind the development of this device was to make a portable and affordable Wi-Fi signal strength display device which could connect to a specific SSID (Service Set Identifier) and display the RSSI (Received Signal Strength Indication) in the form of quantized bars made from LEDs. The Wi-Fi module used for this purpose is the ESP8266. It generates the absolute strength of the signal from a specific Access Point and renders it on the LED display. The signal strength is represented on the LED display as bars using rows of LEDs with each row having a different color.

This device is designed to be connected to both secured and unsecured Wi-Fi Access Points. The connection to secured Wi-Fi routers is established by assigning the router's unique SSID (Service Set Identifier) and password while the unsecured Wi-Fi routers require only the SSID in the commands. An uninterrupted power supply is crucial for this.

The working of this device has three stages:

1. Setting up communication between the controller or development board and Wi-Fi module.
2. Sending commands to ESP8266 via serial communication.
3. Listing of SSIDs and fetching RSSI value for the required SSID.

ESP8266 can work in three modes, namely-STA (Hotspot mode), AP (Access Point mode) and STA+AP (Both Hotspot and Access Point mode). After the execution of certain commands, the device scans and lists various SSIDs, present in range, along with their corresponding absolute RSSI values. It compares the SSID of both the searched Access Point and the specified one to calculate the value of the signal in decibels (dB). It converts the same into percentage which is displayed on the LED pattern. LEDs glow in a manner such that hundred percent signal strength is denoted by all the LED bars glowing, seventy-five percent with one bar less and so on. Twenty-five percent signal is denoted by only red bars glowing and no LEDs glowing depict that signal strength is less than twenty five percent.

While this portable device can be used to measure signal strengths so as to deploy Access Points or routers in appropriate locations for network troubleshooting and diagnostics. The device is easy on the pocket and costs merely □ 1000. It is aesthetically designed and is compact. Moreover, it can be used with various SSIDs and networks just by changing the SSID in the program.

The device can be used wherever Wi-Fi Access Points are deployed. For the assistance of the user, this device shows the signal strength of the access point and notifies the user of the location where the signal strength is strong and weak. This is the utmost requirement at public places as mentioned by Prime Minister Mr. Narendra Modi under the Digital India scheme to signify the Wi-Fi availability and corresponding signal strength at various locations.

2. LITERATURE SURVEY

While looking for Wi-Fi modules that suited the purpose of the project, the major concerns were versatility of use with controllers, cost and availability of the module. There were two Arduino® based shields that were widely used, namely:

Adafruit CC3000, an Arduino® shield which works on SPI protocol, basically was not suitable because of non-availability of header files for controllers or development boards other than Arduino®. It costs approximately □ 5600 [1] and which made it completely unviable to use.

Arduino® Wi-Fi Shield, as the name suggests, it has ease to use with Arduino® only. With almost comparable cost of □ 5480[2], genuine Arduino® Wi-Fi Shield was hard to find as it was not available in local market and even on e-commerce websites.

Using Adafruit CC3000 and Arduino® Wi-Fi Shield the total cost of project came to approximately □ 6000 and Arduino® also provides a development board with integrated Wi-Fi named Arduino® Yun that requires no header files to be included while programming and is easy to use. The Arduino® Yun was not readily available and is very expensive, now worth □ 5999[3] on Amazon India Marketplace.

Finally a low cost Wi-Fi Module which was basically meant to implement IoT based projects and was readily available in the market at very low rates, starting □ 450[4] is used for the reason that it uses AT command set, like GSM and it can be implemented on any controller or development board as it uses UART protocol for communication and has General Purpose Inputs/Outputs (GPIOs) to attach various sensors.

Table 1: Comparison of Wi-Fi Modules based on their working with controllers and cost

Module Name	Programmable on	Cost of module
Adafruit CC3000	Arduino®	□5600
Arduino® Wi-Fi Shield	Arduino®	□5480
Arduino® Yun	Arduino®	□5999
ESP8266	8051, PIC, ARM, AVR, Arduino® (any), Raspberry Pi, BeagleBone, etcetera.	□450

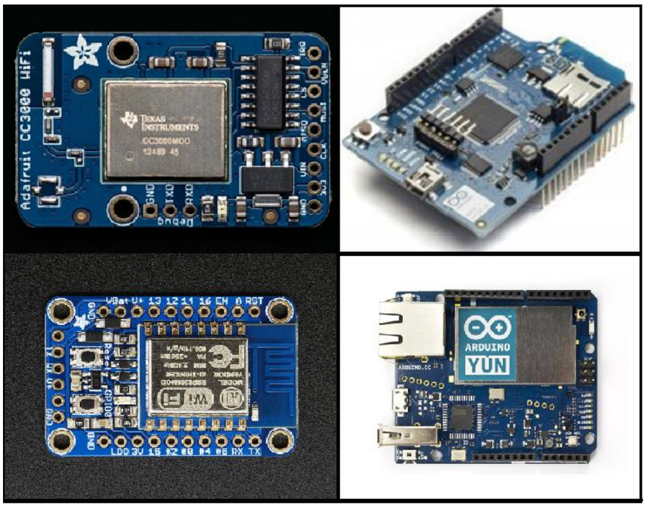

Figure 1: (Clockwise from top left) Adafruit CC3000, Arduino® Wi-Fi Shield, Arduino® Yun and ESP8266

With a motive to make a product which can be used easily on-the-go and requires less power, a controller or development board was required to implement AT commands sent to ESP8266 which works on 3.3V.

Primarily, ESP8266 module was tested on ARM7TDMI LCP2148, which used MAX3232 IC to convert 5V to 3.3V. PIC was considered for usage, but because of its own immensely large register set for UART protocol, the programming was tedious. Later the project was implemented on Arduino® Uno which was easy to use to accomplish UART based serial communication without using any extra header file.

3. HARDWARE SPECIFICATIONS

For providing a cost effective solution to cater to the need, the hardware includes an Arduino® Uno serially interfaced with an ESP8266, the Wi-Fi module. For smooth operation, a level shifter circuitry is required between Arduino® Uno and ESP8266 since the two units have different working voltages, 5V and 3.3V respectively. It also includes interfacing of LED display and LCD display with the Arduino® Uno development board for the output in user readable form.

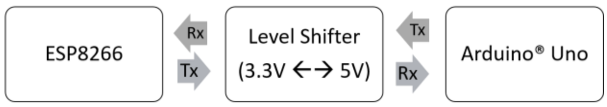

Figure 2: Block diagram depicting the use of level shifter

The pins of the module only allow 3.3V for serial communication and also require 3.3V power supply for its operation. A few more connections like connecting CH_PD to VCC (3.3V) and its GPIO15 to ground are also required to make ESP8266 bootable. Various level shifter circuitries were tried and tested. Initially, the module was tested with ARM microcontroller as it also works on 3.3 volts and uses MAX3232. Connecting TX (transmitter) of Wi-Fi module to RX (receiver) pin of microcontroller and RX (receiver) of Wi-Fi module to TX (transmitter) pin of microcontroller was done and the command set of the module was tested on serial monitors like Realterm and Terminal software. After the observation of the output of the commands that were needed to perform the task, the final hardware was designed.

Arduino® Uno development board has 14 digital input/output (IO) pins and each pin operates on 5V. It can simply be connected to a computer with a USB cable for programming due to inbuilt FTDI chip present onboard. It can easily be powered up by an AC to DC adapter, to fix the device, or battery, to make it portable, as per the requirement. Any of the digital pins of Arduino® can be used as TX and RX combination for UART serial communication using the Software Serial library. So, TX of Arduino® (digital pin 3) was connected to RX of the Wi-Fi module and RX of Arduino® (digital pin 2) was connected to TX of the Wi-Fi module and a level shifter circuitry was employed between Arduino® Uno and ESP8266, which was designed using the Sparkfun level shifter, as shown in figure 3. It converts level of signal from 3.3V to 5V while sending response to Arduino® Uno and 5 to 3.3V while sending commands to ESP8266 so that ESP8266 does not get damaged

Figure 3: PCB with Arduino® Uno connected to ESP8266 via Sparkfun Level Shifter

The data consisting of the RSSI values which was primarily being displayed on Arduino® serial monitor is received and assigned tokens [5]. The commands which were being sent one-by-one through the serial monitor are now sent directly via Arduino® code without the aid of any serial monitor. The data received using CWLAP command contains the RSSI value for a particular SSID in terms of decibels (dB) which is further converted into the bars of percentages. The LCD and LED display interfaced with Arduino® display the required data, as shown in Figure 4.The LED display is visible at a distance. It was designed in the standardized forms as the Wi-Fi signals are displayed. Since the current requirement is higher than what a single pin can drive for the large number of LEDs used, a current driver IC ULN2003 is used to drive a large number of LEDs from a single output pin of Arduino®. Hence, the RSSI value is displayed in the form of bars made of LEDs [6].

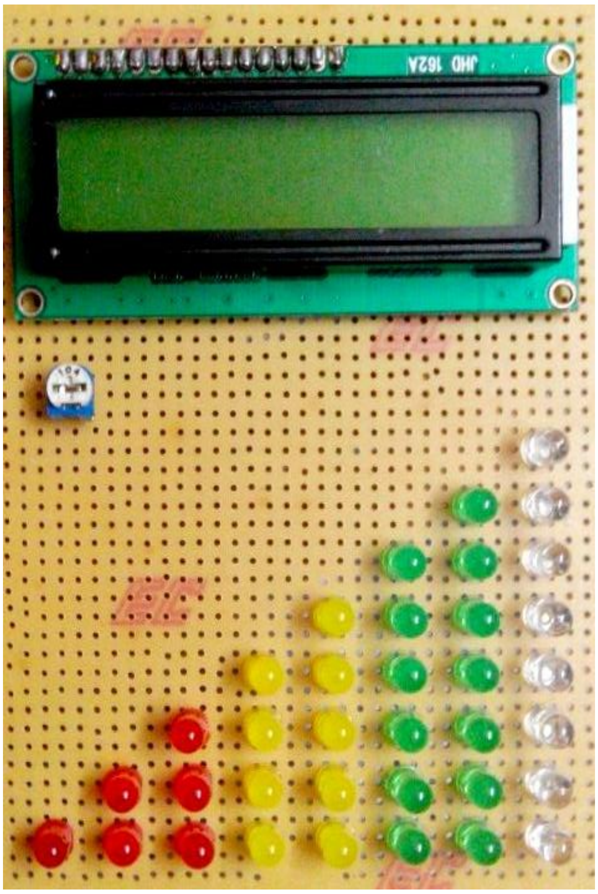

Figure 4: The LCD and LED matrix to display data

4. SOFTWARE SPECIFICATIONS

The code for the device is written in Arduino® IDE. Software Serial library is included in the code and serial communication is done using digital pins 2 (RX) and 3 (TX) of Arduino® Uno. Making an object for the library defines the RX and TX. Serial.available(), Serial.read(), Serial.write() are used for displaying the values on Arduino® serial monitor. AT command [7] are used to communicate with ESP8266. AT+RST command is used to boot the module and reset it. AT+CWLAP command is used to list the available SSIDs and their respective RSSI values in decibels (dB). For LCD interfacing, Liquid Crystal library and its respective functions like lcd.write(), lcd.setCursor() are used by defining . To interface the LEDs, basic Arduino® function like digitalWrite() is used with arguments pin number and operation - HIGH or LOW.

5. RESULTS AND DISCUSSIONS

The outputs were primarily analyzed on the serial monitor of Arduino® as shown in Figure 5. The RSSI value also varied in accordance with the distance between the device and the access point [8]. The next step was to tokenize the output of command AT+CWLAP and then the RSSI value was printed on LCD alone as shown in Figure 6 and Figure 7.

```
AT

OK
AT+RST

OK
bBÕ†AùSbNgÏ□£Å|☉e[b1□R□^¥C$â□0□€öü®HH•…'å5
AT+CWLAP
+CWLAP:(1,"SATWANT",-85,"48:ee:0c:e1:15:54",1)
+CWLAP:(2,"Realm",-72,"b8:c1:a2:19:a4:4c",7)
+CWLAP:(3,"Realm",-46,"f8:01:13:12:40:98",6)
+CWLAP:(4,"AIRTEL_E5172_8BD3",-67,"d4:6e:5c:74:8b:d3",10)

OK
AT+CWLAP
+CWLAP:(1,"SATWANT",-87,"48:ee:0c:e1:15:54",1)
+CWLAP:(2,"Realm",-69,"b8:c1:a2:19:a4:4c",7)
+CWLAP:(3,"SinghHarmanjit",-50,"f8:01:13:12:40:98",6)
+CWLAP:(4,"AIRTEL_E5172_8BD3",-65,"d4:6e:5c:74:8b:d3",10)
+CWLAP:(0,"HimRaxX",-91,"00:15:61:90:84:5c",11)

OK
```

Figure 5: Arduino® serial monitor with SSIDs and RSSI values

Figure 6: RSSI value alone on LCD

Figure 7: SSID and corresponding RSSI value on LCD

The LED matrix was made and connected to the Arduino® Uno and then the RSSI value was converted into quantized bars of LEDs, as shown in Figure 8 and Figure 9.

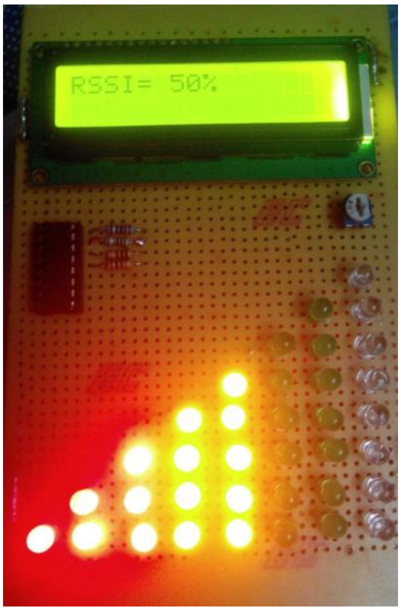

Figure 8: LEDs depicting 50% RSSI value

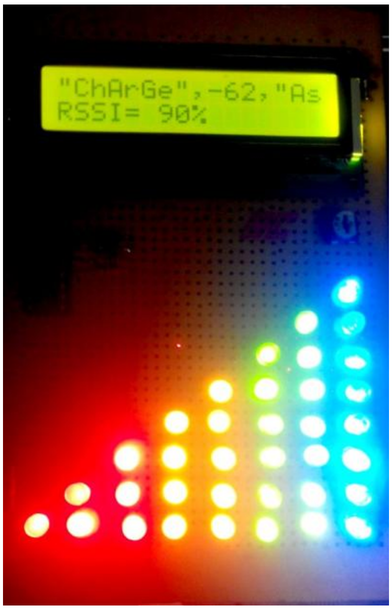

Figure 9: LEDs depicting RSSI value greater than 90%

6. APPLICATIONS AND FUTURE SCOPE

This project was made with the objective of designing an economical and viable device which can measure Wi-Fi signal strength. Wi-Fi Signal Strength Indicator is a compact, economical and portable device developed to display the signal strengths of the Wi-Fi networks available in the vicinity of the device. With the enhancing importance of internet and its all-time availability, the information about the availability of the networks in the surroundings of a person has gained a pivotal position. Whether it be cafes, airports, shopping malls, railway stations, people need internet connectivity at each and every point, to be connected with the world round the clock and people cannot afford to miss out on even a single event. So, considering this present scenario this device finds its application at every place.

Wi-Fi Signal Strength Indicator can be employed at almost all the public places to make people aware of the fact that internet connectivity is available in their immediate surroundings. With the advent of technology at such a fast pace, this device embodied with a fascinating LED display to indicate the signal strength proves to be of great importance and usage.

In addition to such applications, the module utilised in developing this device that is ESP8266 which is part of a bigger domain of technology that is "Internet of Things (IoT)" which is a network of physical objects or "things" embedded with electronics, sensors and network connectivity, which enables these objects to collect and exchange data has a great future ahead. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include thermostat systems and washers/dryers that use Wi-Fi for remote monitoring.

Besides the plethora of new application areas for internet connected automation to expand into, IoT is also expected to generate large amounts of data from diverse locations that is aggregated very quickly, thereby increasing the need to better index, store and process such data. In future the applications of the existing system can be enhanced by consolidating various technologies in it.

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