Department of Electronic & Telecommunications Engineering

University of Moratuwa

EN3251 Internet of Things

Lab Assignment 2 : WiFi as a Sensing and Communication Tool

2020 Batch **Semester 5**

Overview:

In this assignment, you will observe and experiment with WiFi signals and measurements and use simple IoT and data analytic techniques to work with them. You will experience a simple instance of localization using WiFi fingerprinting.

Objective:

To become familiar with WiFi as a tool for sensing and communication in IoT systems.

Learning outcomes covered:

LO4: Select appropriate hardware platforms for devices and network technologies for connectivity for IoT applications.

LO5: appropriate techniques and platforms for management of data in IoT systems.

LO6: Use appropriate devices, software and tools to implement an end-to-end IoT system.

What you require:

- Python installed and running on your computer with relevant libraries
- Node-RED installed on your computer
- A NodeMCU device
- The Arduino IDE and relevant libraries
- Multiple operational WiFi access points

Assignment Part A: WiFi Scanning

When a device tries to connect to a WiFi network, the Access Point (AP) has to negotiate which technical specifications it supports, and this gives away its identity. So, a device can scan all Access Points in the vicinity and obtain basic information such as the Service Set ID (SSID), the MAC address (MAC), also called the Basic Service Set Identifier (BSSID) and the received signal strength indicator (RSSI). Of the (SSID, BSSID, RSSI) trio, the pair (BSSID, SSID) found by any device at a particular location is called the "fingerprint" of that location.

Task 1:

Use *Wirelessmon* or a similar desktop/mobile app to and carry out a basic WiFi sensing activity. Prepare a list of (SSID, BSSID) pairs that you observe at the following 5 locations. You will observe that the RSSI measurement varies. Ignore RSSI for the time being.

- Entrance to Telecommunications Laboratory, ENTC 3rd floor
- Entrance to Digital Electronics Laboratory, ENTC 2nd floor
- Study area, ENTC 2nd floor balcony
- Entrance to Computer Laboratory, ENTC 1st Floor
- Lobby area at the entrance to ENTC

Task 2:

Repeat the above task by creating a WiFi scanner on your NodeMCU. You may use the example code *WiFiScan.ino* for this. Prepare a list of (SSID, BSSID) pairs that you observe at the above 5 locations.

Task 3:

(a) Using your nodeMCU scanner, obtain samples of (BSSID, RSSI) pairs in the Telecommunications laboratory and publish to an MQTT topic. You may use an appropriate JSON message format to publish the scan results.
(b) Visualize the RSSI of each available AP on a NodeRed dashboard and observe the dynamic nature of the measurements.
(c) Display the mean and standard deviation of the RSSI from each AP for the immediate past 25 observations.

Task 4:

NodeRed's SQLite node can be used to save data within Node-Red itself. A sample flow to read and write to a local SQLite database is shown in Figure 1.

(a) Save 100 WiFi Scan captures as in Task 3 in a built-in nodeRed SQLite database.
(b) Retrieve a user-selected range of records from a selected AP and visualize on the NodeRed dashboard.

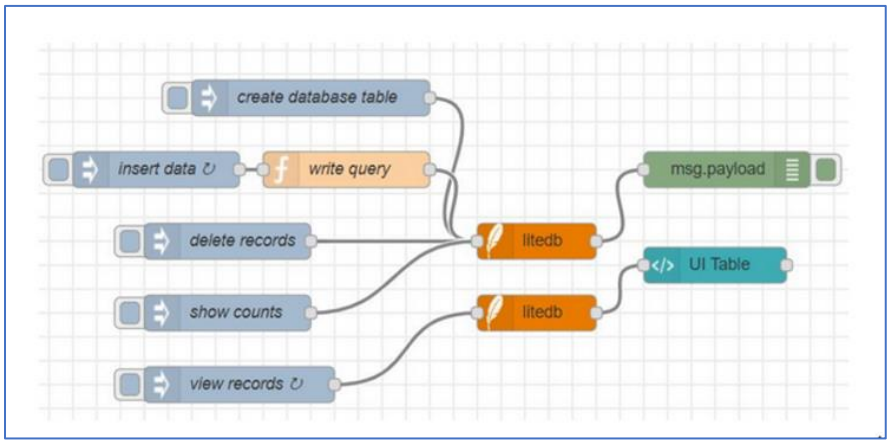

Figure 1

Task 5:

Transfer the contents of your database to a spreadsheet. Your spreadsheet should appear similar to Figure 2. Each column header has the name of an access point seen (BSSID). The rightmost column header "id" identifies the location at which the data was collected.

	A	B	C	D	E	F	G	H	I	J
1	UoM_Wireless1	UoM_Wireless6	UoM_Wireless11	eduroam1	eduroam6	eduroam11	Jungle Book10	PROLINK_H500	UNIC-wifi11	id
2	-100	-72	-71	-100	-71	-75	-100	-100	-100	5
3	-100	-54	-90	-100	-53	-100	-84	-63	-100	1
4	-100	-83	-90	-100	-84	-88	-90	-100	-100	2
5	-100	-100	-100	-100	-100	-100	-100	-100	-100	3
6	-100	-75	-83	-100	-67	-100	-100	-100	-100	7
7	-80	-100	-100	-80	-100	-100	-70	-68	-100	4
8	-72	-87	-100	-100	-89	-100	-62	-86	-100	6
9	-100	-73	-70	-100	-73	-73	-88	-100	-100	5
10	-100	-55	-100	-87	-53	-100	-83	-67	-100	1
11	-100	-92	-87	-100	-100	-88	-74	-100	-100	2
12	-100	-100	-100	-100	-100	-100	-100	-100	-100	3
13	-100	-78	-82	-100	-70	-100	-100	-100	-100	7
14	-73	-90	-100	-100	-90	-100	-50	-92	-100	6
15	-100	-89	-100	-100	-100	-100	-68	-71	-100	4
16	-100	-72	-75	-100	-69	-74	-86	-100	-100	5
17	-100	-56	-100	-89	-54	-100	-86	-65	-100	1
18	-100	-85	-84	-100	-100	-86	-87	-93	-100	2
19	-100	-100	-100	-100	-100	-100	-100	-100	-100	3
20	-100	-80	-84	-100	-68	-100	-100	-100	-100	7

Figure 2

Assignment Part B: Localization with WiFi fingprinting

RSSI values from a set of visible APs is called a "fingerprint" because this is unique to a given physical location, and hence a useful feature for localization. However, the random variations in RSSI make localization complex. This task is to train a classification model using the collected data to localize a test data set.

You are given a set of WiFi scan measurements in file *wifi_data_train.csv* and a set of test data in *wifi_data_test1.csv.* This data has been previously collected following a methodology as in Part A of this assignment.

Train a classification model using *wifi_data_train.csv.* Use it to infer the locations of each of the test data points given in *wifi_data_test1.csv* and compare with the corresponding locations given in the file.

You will be given another test dataset to validate your model in class.

Some learning resources on classification you may use is available at: https://uniofmora-my.sharepoint.com/:f:/g/personal/dileeka_uom_lk/En9A2zZEPzdNpg5t8bmr6cUBHOOKUEZ-1j9AcmBPC4GwXA?e=JglP5h

Report:

Submit your report (one per group). The report should contain a brief description of your work in each task. Submit all your code and Node-Red flows with descriptive names along with the report.

Evaluation: Based on Report and Demonstration