ISSN (Online) : 2455 - 3662
SJIF Impact Factor :3.395 (Morocco)

EPRA International Journal of Multidisciplinary Research

Volume: 2 Issue: 3 March 2016

Published By :
EPRA Journals

EPRA International Journal of Multidisciplinary Research (IJMR) ISSN (Online): 2455-3662
SJIF Impact Factor: 3.395 (Morocco) Volume: 2 Issue: 3 March 2016

COMPARISION OF RECEIVED SIGNAL STRENGTH INDICATION MEASUREMENTS SOFTWRE FOR WLAN FINGERPRINTING INDOOR POSITIONING ACCURACY IMROVEMENT

Nicholaus .R. Mrindoko[1]

[1]Department of Computer Engineering,
Mbeya University of Science and Technology,
Mbeya, Tanzania,

ABSTRACT

The accuracy of indoor positioning services by using wireless local area network (WLAN) location fingerprinting mostly depends on similarity of offline and online received signal strength indication (RSSI). This paper explores the distinctions of RSSI among different RSSI measurements software and the distributions of RSSI from these software. The measurable analysis of test results demonstrates the distinctions of RSSI among various RSSI measurements software in the same mobile device are not exactly identical. The distribution was found to be similar on the two software with small statistically difference between the two software. Hence, considering same software in offline and offline together with RSSI mean is adequate to guarantee an accuracy of an indoor positioning. The statistical data analysis could empower software indoor positioning designer to enhance positioning performance and to model location fingerprinting based indoor positioning systems.

KEYWORDS: *WLAN; RSSI; Indoor Positioning; Mean; Offline; Online; Software*

1. INTRODUCTION

Location-based services (LBS) depend on the accessibility of robust RSSI on mobile devices. Although the Global Positioning System (GPS) can provide sufficient positioning services in most cases, it suffers in indoor environments because of wall attenuation and excessive multipath (Mrindoko, 2015). As an alternative or complementary solution for indoor environments, Chan and Sohn (2012) proposed a positioning approach based on the RSSI in WLAN networks. These days, the WLAN positioning has turns out to be more alluring for indoor positioning as a result of the expanding accessibility of open and private system Access Point (APs) (Kaemarungsi, 2005).

Positioning systems that fit for the indoor positioning should be adaptable to a variety of Wi-Fi detection software with comparative positioning accuracy. The basic issue that influences the accuracy of the RSSI based positioning is the versatility of RSSI fingerprint database establishment for various RSSI measurements software. The positioning accuracy of mobile devices such as smart phone and iPod or laptop depends much on the comparison between the offline RSSI fingerprint database and the online RSSI data. If the online and offline RSSI data collected by different RSSI measurements software varies to some degree, the position accuracy contrasts too, this implies that the positioning system is not stable or reliable. At present, there are only a few types of Wi-Fi detection software that can be used to gather and set up the offline RSSI fingerprint database. Subsequently, there are huge of clients with enormous various types of Wi-Fi detection software and there will be more distinctive Wi-Fi detection software going to the business sector consistently. Thus, it is not realistic to set up the offline RSSI fingerprint database that covers every kind of Wi-Fi detection software. Therefore, the variations in the RSSI data of various RSSI measurements software should be taken full in consideration for a business indoor positioning framework that is intended for urban application.

The knowledge of the RSSI measurement software is important for location determination algorithms such as the deterministic and probabilistic approach (Dawes and Chin, 2011). The difference RSSI measurements software is currently used to collect the RSSI during offline. However, the substantial scale measurements in Madhan *et al* (2012) revealed that, the majority of RSSI histograms analyzed from the single RSSI measurements software used in offline is a well Gaussian distribution. On the other side, most existing data were collected and analyzed by considering offline phase scenario. Compared with online data, different software from the one used in offline phase can be used and the RSSI may vary from one RSSI measurement software to another, thus the positioning using different software would be cause error to the indoor positioning application. The measurement results are clearly supported in section 3. This has motivated the current study in impact of RSSI software for WLAN based indoor positioning accuracy and the popular Wi-Fi detection software such as wifi-analyzer-3.9.8.l-multi-android.apk and my own developed wifi-test were used in the experiments.

By comparing the histograms of RSSI collected in arbitrary direction scenarios, an evaluation of the RSSI collected by one offline RSSI measurements software was reported by Kaemarungsi and bi-model distribution was observed (Kaemarungsi and Krishnamurthy, 2004). Likewise, the bi-modal distribution was found in Kaemarungsi (2006) using one offline software but the impact of different Wi-Fi RSSI measurements software was not assessed.

In this paper, the RSSI information gathered by two Android smart mobile phones is examined. From the gathered information, software differences impacts on the RSSI value are discussed. Furthermore; the dispersion of RSSI data is analyzed and characterized by evaluating the skewness. An extensive assessment on the effects software affectability on the dissemination of WLAN RSSI is made and the reason for the distribution is additionally researched. The results of this paper could provide hypothetical support on indoor positioning innovation.

The paper comprises of five sections. Taking after this brief presentation, Section 2 presents the measurement setup and data gathering. Section 3 investigates the impact of different software on RSSI. The distribution of the RSSI data explained in Section 4. At last, Section 5 concluded the paper.

2. EXPERIMENTAL SETUP AND MEASUREMENT

The investigation was carried basing on precise measurements of the WLAN RSSI using Android smart phones and Wi-Fi detection software. Two Android smart phones namely; iNote beyond, HUAWEI Y330-U11 equipped with two RSSI collecting application software were utilized to gather samples of RSSI data from APs at the Postgraduate research room in the College of Information and Communication Technologies, University of Dar es Salaam. The dimension of the room is nearly 8 m × 5 m. Three wireless APs located at height of 2.0m above the floor were deployed as shown in Fig. 1. The three APs have the same merchant and models. As shown in Fig. 1, a small area is defined as a grid of 6 points (the solid red dots in Fig. 1). The minimum separation between two consecutive locations known as grid spacing was estimated at a distance of 0.5 to 1 meter. Firstly, the estimation was made to detect the differences of RSSI data gathered by different software at different points. Six estimation places as appeared in Fig. 1 meant as 1, 2, 3, 4, 5, and 6 were gathered the RSSI data. The 1, 2, 3 up to 6 represent point 1, point 2 up to point 6.

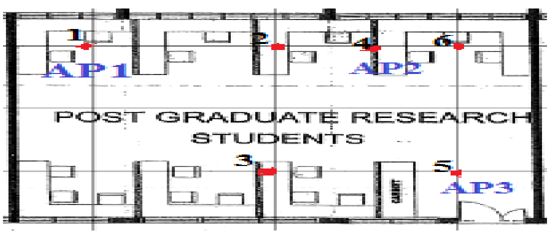


Figure 1. Location of APs and the measurement points on the Postgraduate research room

In the experiment, two smart phones were put together on a 1.2-meter high backing. The position of the smart phones is as appeared in Fig. 2. The purpose behind this plan was to quantify the distinction of RSSI quality gathered by these software at same location and the meantime. Table 1 demonstrates the fundamental setup of two Android mobile phones. All mobile devices were activated in the meantime and each gathered 200 RSSI tests in 5 minutes at a rate of 1Hz.

Figure 2. Placement and direction of two Mobile devices to measure RSSI data differences

Table 1. Basic configuration of mobile devices used to measure the RSSI

Configuration	Itel iNote beyond	Huawei Y330 U-11
CPU	Unknown	1.3GHz Dual core
Operating System	Android OS 2.3	Android OS 4.2
Wi-Fi Module	unknown	802.11b/g/n

3. DIFFERENCES OF DIVERSITY SOFTWRE

The investigations of Rainer (2012) proposed that the area fingerprints with various RSSI measurements software could be distinctive. Instinctively, the RSSI measured among different RSSI software ought to have distinctive results. To look at the impact of software on the RSSI data gathering, the attributes of measurable RSSI data gathered utilizing diverse software were examined. The genuine got signal vitality is a persistent amount and measured in dBm or decibel milliwatt, while in handy terms, the RSSI is accounted for in dBm as a whole number Mrindoko (2015). Different software has their own particular way to change over the genuine got signal vitality to RSSI esteem in dBm.

Table 2 lists the Wi-Fi detection applications software, minimum RSSI, maximum RSSI and the RSSI variation range for all the applications used for comparisons. The greatest estimation quality was gotten while putting the mobile devices close to the beacon, while the minimum estimation worth was acquired while setting the mobile devices beyond as possible from the same access point in the postgraduate research room. The variation scope of RSSI showed here won't be exact in light of the fact that, the device software will never receive some of the RSSI values in dBm.

As shown in Table 2, the variation scope of RSSI data gathered by Wifi -analyzer-3.9.8.l-multi-android.apk when installed in HUAWEI Y330-U11 seems more prominent than others. This implies it can quantify the signal with higher determination and see more variation of signal contrasted with alternate device utilized as a part of this analysis. Then again, the Wifi -analyzer-3.9.8.l-multi-android.apk has the shortest range when Itel iNote beyond was used. This implies the application to have the more prominent it will depend also of a device used to measure a signal. Thusly, various real measured signal levels might be mapped into mean RSSI esteem for position fingerprinting purposes.

Table 2. MIN, MAX AND VARIATION RANGE OF RSSI COLLECTED BY DIFFERENT RSSI APPLICATION SOFTWARE

Manufacturer	Device Model	Wifi software	MIN (dBm)	MAX (dBm)	Range (dBm)
HUAWEI	Y330-U11	Wifi -analyzer-3.9.8.l-multi-	-73	-22	-51
		Wifi-test -2.3 multi-android.apk	-77	-24	-53
Itel	iNote beyond	Wifi -analyzer-3.9.8.l-multi-	-69	-39	-30
		Wifi-test -2.3 multi-android.apk	-79	-40	-39

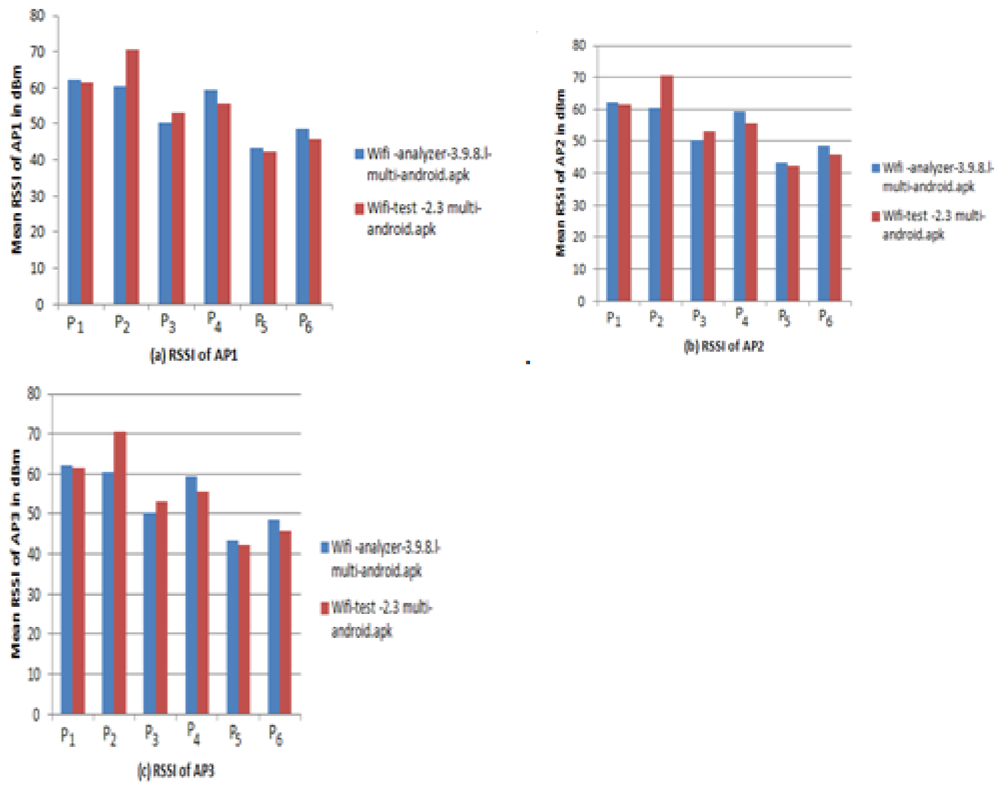


Figure 3. Mean RSSI of three APs collected by two RSSI applications software at 6 places using HUAWEI Y330 U11

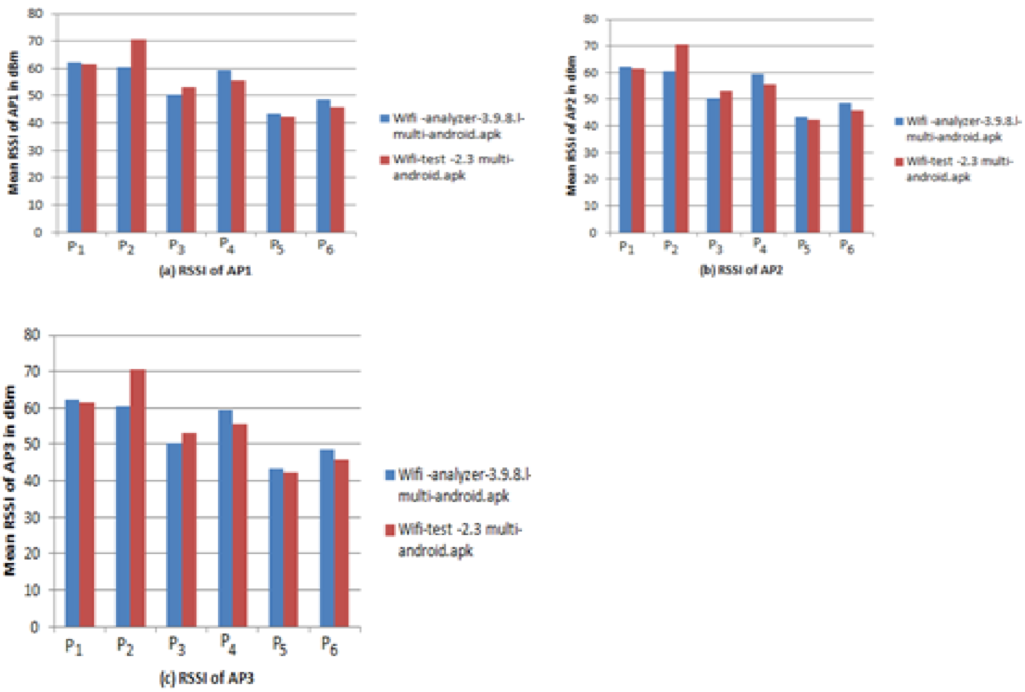


Figure 4. Mean RSSI of three APs collected by two RSSI applications software at 6 places using Itel iNote beyond

The Mean RSSI data gathered among different software is appeared in Fig. 3 and Fig. 4. The RSSI contrast fluctuates for the most part, and once in a while the distinction can reach up to 10 dBm, even at the same area, the same mobile and same access point. The average RSSI between two RSSI measurements software from the same reference point and same mobile are recorded in Table 3 and Table 4. It demonstrates the average of RSSI between two applications is relative to their variation range of RSSI data and their standard deviation. The bigger the variation scopes of RSSI are, the bigger the average of RSSI qualities could be. Along these lines, the location accuracy would diminish essentially if the variation scopes of RSSI data belong to the application used on offline stage and online stage varies much extensive. The RSSI of the difference applications in this investigation demonstrates less contrasts, e.g., the average, the average differences of RSSI between Wifi analyzer-3.9.8.l-multi-android.apk and Wifi-test 2.3 multi-android.apk when both used in HUAWEI Y330-U11 is 7 dBm. The data were recorded at point 4 from the Fig. 1.

Table 3. THE AVERAGE (IN dBm) OF RSSI VALUE BETWEEN TWO RSSI APPLICATION SOFTWARE IN SAME REFERENCE POINT AND ACCESS POINT AS COLLECTED USING HUAWEI Y330 U11

	N	Minimum	Maximum	Mean	Std. Deviation
Wifi -analyzer-3.9.8.l-multi-android.apk	10	25	30	27.80	1.989
Wifi-test -2.3 multi-android.apk	10	24	29	26.70	1.494
Valid N (listwise)	10				

Table 4. THE AVERAGE (IN dBm) OF RSSI VALUE BETWEEN TWO RSSI APPLICATION SOFTWARE IN SAME REFERENCE POINT AND ACCESS POINT AS COLLECTED USING Itel iNote beyond

Itel iNote beyond					
	N	Minimum	Maximum	Mean	Std. Deviation
Wifi -analyzer-3.9.8.l-multi-android.apk	10	38	46	41.30	2.497
Wifi-test -2.3 multi-android.apk	10	45	51	48.50	1.958
Valid N (listwise)	10				

Also Table 3 and Table 4 demonstrate the standard deviation comparisons of the RSSI data collected by two different RSSI measurements software. The standard deviation of the RSSI data collected by the Wifi-test -2.3 multi-android.apk appears smaller than the Wifi -analyzer-3.9.8.l-multi-android.apk. This is due to the fact that the variation range of value collected by Wifi -analyzer-3.9.8.l-multi-android.apk Wi-Fi detection is larger than Wifi-test -2.3 multi-android.apk.

As shown by the measurement results, the RSSI data gathered by different applications differ, but not substantially. The offline RSSI fingerprint database consists of the mean of RSSI data or the mean combined standard deviation of RSSI data in generally, while the online RSSI data usually consists of the mean of RSSI data depend on the algorithm selected. The minor difference between RSSI collected by offline application and online application would result in tremendous positioning error in case the error accumulation algorithm would be used. Therefore, it is essential to use the same application between offline and online phase.

4. DISTRIBUTION OF RSSI

Existing works of Li (2012) used the kurtosis coefficient and normalized histogram distribution to study the randomness of RSSI although the impact of different RSSI measurements software in data collection was not investigated. Li (2012) use the Gaussian distribution to model RSSI value with parameters (μ, δ) where μ is the mean of RSSI samples, δ is the standard deviation of RSSI samples. However, Li (2012) claimed an ambiguous conclusion: 'Most of the intensity histograms were near to Gaussian, the details of the assessment criteria were not reported. On the contrary, the test results in Xu *et al.* (2013) demonstrated that the dissemination or histogram of the RSSI have a long tail to one side, which is called left-skewed dispersion, if the average RSSI is high (−80 dBm or above). On the off chance, the typical RSSI is low (underneath −80 dBm), the scattering will be practically symmetric or appear to be log-normal distribution without the long tail. Clearly, the distribution of RSSI using different application software was not analyzed.

A. Skewness of RSSI:-

In the current work, three APs'(as appeared in Fig.1) RSSI data collected by the Wifi -analyzer-3.9.8.l-multi-android.apk and Wifi-test 2.3 multi-android.apk installed in HUAWEI Y330-U11and Itel iNote beyond at 6 grid points as designed in Section 2 were analyzed as well as the distribution of the RSSI data. Although 50 samples were gathered from each grid point, the numbers of RSSI values were limited and in most cases the numbers of RSSI values were below 10 and above 4. In this subsection, skewness used to roughly assess whether the RSSI collected using both application software obeys the Gaussian distribution. The skewness is reported by using a scatter plot of the standardized value from the data set, if the data are well normally distributed with the same mean and standard deviation as in the data set. Fig. 5 and Fig. 6 shows the comparisons of the skewness between two application software as collected from 3 AP's RSSI data in 6 locations. Intuitively, it shows that from both applications a lot of the skewness is left or right.

Figure 5. The skewness of three AP's RSSI from 6 locations collected by two application software using HUAWEI Y330 U11

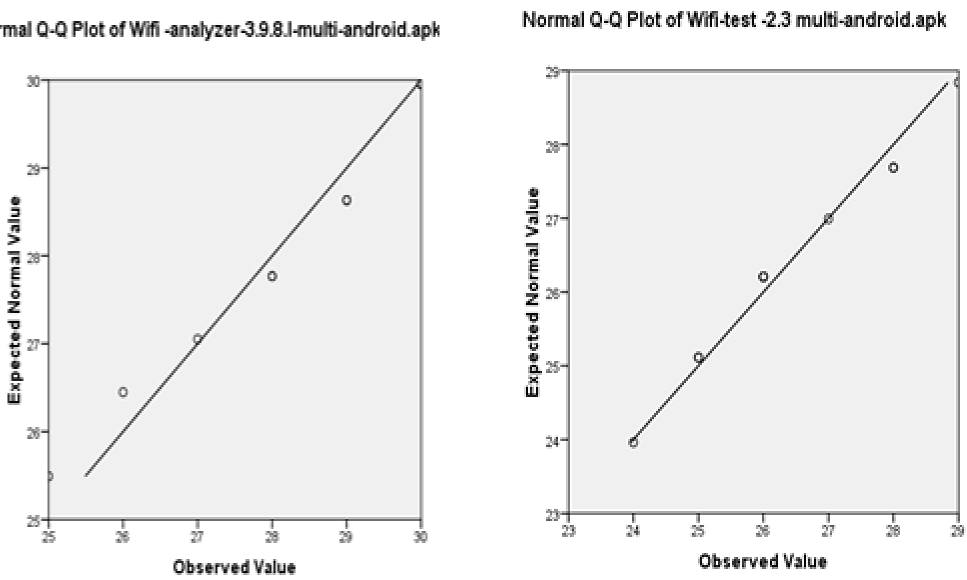
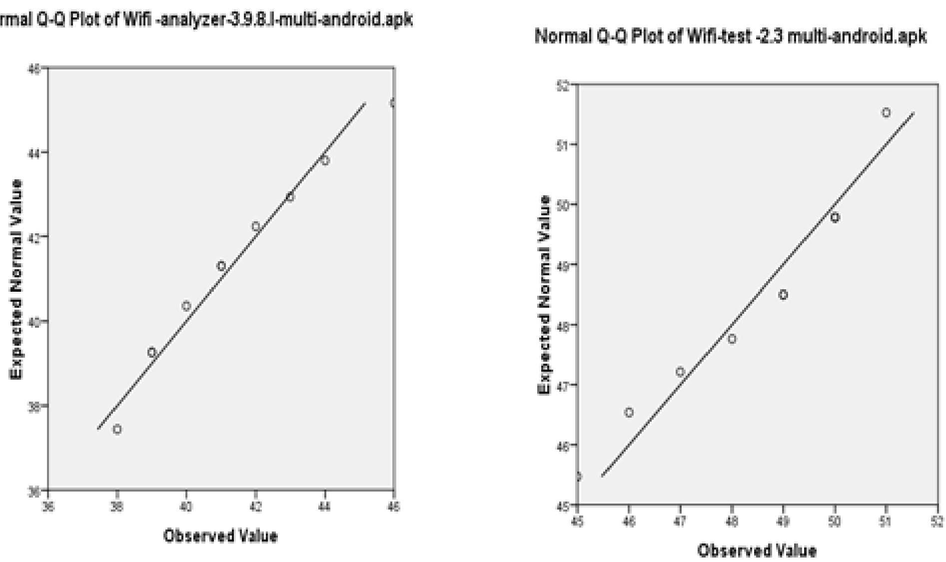


Figure 6. The skewness of three AP's RSSI from 6 locations collected by two application software using

Itel iNote beyond



5.CONCLUSION

This paper examines the impact of RSSI application software on RSSI and characterizes the distribution of RSSI. The RSSI data gathered by two RSSI applications software were analyzed. By comparing the RSSI data of two applications, the differences between different application software in terms of the mean, standard deviation, and range of RSSI are assessed. The test result demonstrates that the mean estimation of the RSSI data gathered by different RSSI application software not varies significantly, some of the time as less as 1dBm. Also, the examination of the RSSI dispersion demonstrates the similarity distribution. The effect of the small dispersion observed will depend much on the nature of the algorithm to be used. Besides, the small dispersion observed, using the mean to model the RSSI is sufficient to ensure accurate approximation.

REFERENCE

1. *CHAN, S. & SOHN, G. 2012. Indoor localization using Wi-Fi based fingerprinting and trilateration techiques for LBS applications. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 38, 4.*
2. *CURRAN, K., FUREY, E., LUNNEY, T., SANTOS, J., WOODS, D. & MCCAUGHEY, A. 2011. An evaluation of indoor location determination technologies. Journal of Location Based Services, 5, 61-78.*
3. *DAWES, B. & CHIN, K.-W. 2011. A comparison of deterministic and probabilistic methods for indoor localization. Journal of Systems and Software, 84, 442-451.*
4. *KAEMARUNGSI, K. 2005. Efficient design of indoor positioning systems based on location fingerprinting. Wireless Networks, Communications and Mobile Computing, 2005 International Conference on. IEEE.*
5. *KAEMARUNGSI, K. Distribution of WLAN received signal strength indication for indoor location determination. Wireless Pervasive Computing, 2006 1st International Symposium on, 2006. IEEE, 6 pp.*
6. *KAEMARUNGSI, K. & KRISHNAMURTHY, P. Properties of indoor received signal strength for WLAN location fingerprinting. Mobile and Ubiquitous Systems: Networking and Services, 2004. MOBIQUITOUS 2004. The First Annual International Conference on, 2004. IEEE, 14-23.*
7. *LI, J. 2012. Characterization of WLAN Location Fingerprinting Systems. Master of Science, University of Edinburgh.*
8. *MADHAN, M. G., SUSARITHA, U., RAGUPATHI, R. & THOMAS, A. P. 2014. Rssi Based Location Estimation in A Wi-Fi Environment: an Experimental Study. ICTACT Journal on Communication Technology, 5.*
9. *MRINDOKO, N. R. September 2015. IMPROVING PERFORMANCE OF INDOOR POSITIONING SYSTEM USING RECEIVED SIGNAL STRENGTH (RSS) – BASED WLAN FINGERPRINTING. M.Sc Electronics Engineering and Information Technology Dissertation, University of Dar es Salaam.*
10. *RAINER, M. 2012. Indoor Positioning Technologies. Habilitation Thesis. ETH Zurich University.*
11. *XU, Z., SANDRASEGARAN, K., HU, B. & LIN, C. 2013. A Study of WLAN RSSI Based Distance Measurement Using EEMD. International Journal of Advanced Research in Computer Science and Software Engineering.*