Locating Mobile Producer's Position in anchorless NDN environment using Signal Strength

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Abstract— This paper assesses the Muslim contribution in Computer Science Applications and Technology. This involves in-depth analysis of recent technologies in computer, based on perspective that Islam accommodates. All research conducted from the history of civilization is basically driven from script of the Quran and Sunnah. Therefore, technology and science are derivatives of Islamic civilization. Recent technology of the Internet is now centred on multimedia contents applications (such as audio, video and images). This is due to the rapid innovations and production of electronic devices across the globe. The idea of contents on the Internet is developed from the Content Concentric Network (CCN). And the most promising between CCN types is the Named Data Networking (NDN). Named Data Networking is a new content centric network architecture that can possibly overwhelm most issues of IP mobility and security. NDN approach is commonly identified under Information Concentric Network or Content Concentric Network and is centered on addressing contents by themselves using names, rather than assigning IP addresses to packets on hosts, where information is located on the global Internet. Due to the developing scope of remote access around the world and Wi-Fi accessibility, scenarios change as a result of additional networking devices. This paper also analyses existing methodologies of mobile device communication using Wi-Fi in NDN environment. This involves using a mobile producer and a rendezvous node connected via content routers in a network. Their location is detected and predicted immediately handoff occur and it transmit content as a consumer. The approach of transmitting content signals uses sign power pointer, Received Signal Strength Indicator (RSSI), Time of Arrival (TOA) and TSE in the network. Several challenges were noted and pointed out o enhance future work.

Keywords— NDN, handoff signal, RSSI, TOA, and TSE

I. INTRODUCTION

Several scholars from Europe who engaged in studies concerning Muslim contribution to science and technology make a negative remark against the Muslims [1]. However, Muslim scholars have immensely contributed highly to science and technology. Some of their contributions include founding the origin of arithmetical knowledge and teaching Arabic numerals etc [2].

A. Qur'anic Perspective of Knowledge

The word Al' ilm defined by Lisan al-Arab is an attribute of almighty Allah. Allah (SWT) has described Himself in the Holy Quran as ′ Aleem, ′ Alim and ′ Allam. Allah, is the Most Exalted has knowledge that embodies everything of the whole world wide. Al' ilm has several descriptions in al-Quran. The Quran describe al-'ilm as to have understanding and comprehension on anything using two approaches. These are, 1) to comprehend the importance of something in question and 2) to make conclusive remark on something in question. These two approaches must be proven beyond reasonable doubt [3]. The knowledge of Islamic civilization has basic characteristics of diversity and brilliance (wisdom). This means that technology plays a vital role in Islamic civilization.

B. Signalling

The strategy of discovering wireless devices and it's user are fundamental open issues in Named data networking. To store records of device, the use of discovery strategy can be a helpful asset to manage coordination and positioning very effectively. Cellular or mobile phone require additional application for GPS systems known as Global Positioning System. GPS is a tool that identify electronic devices in situation of loss from near and remote location. GPS signal sometimes could suffer penetrating buildings and other outdoor structures such as trees, mountains, and also some reflections and diffractions [4]. These open issues can be addressed using several approaches such as detecting time variation of arriving signals, and Radio Signal Strength Indicator [5].

GPS originates since from the Sputnik era at the time scientists can detect a satellite using shifts in radio signal.

This is referred to as the "Doppler Effect.". The US Navy carried out an experiment with satellite navigation during the mid 1960's to be able to detect US submarines that convey carrying nuclear missiles. Using six satellites revolving the extremes of poles, submarines vehicles could observe satellite transformation using Doppler and directly pinpoint or locate the submarine's whereabouts in short interval [4]

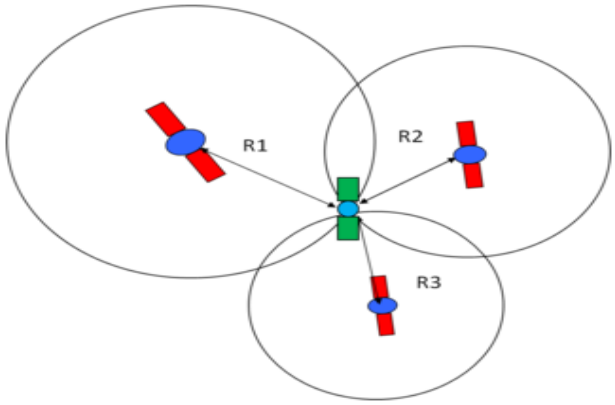

Fig. 1 GPS Radio Signals NASA [5]

II. Related Work

Content forwarding is the process of transmission from one transmitting NDN hop to another. For forwarding to take place in a mobile routing, it must use an algorithmic framework that is driven from a routing protocol and it will be conserved as a forwarding state known as the forwarding information Base (FIB) [6]. It depends on the network management system to set up the nature of the FIB as well as the directions where contents will be forwarded. Forwarding in IP architecture is done by sending the packet to a neighbor destination using path with the lowest cost [7] [17].

However, in NDN, when content reaches a mobile producer, the initial probability is that path may not be available to shear the content with another node. The mobile node will hence store the content in its buffer so that immediately it reaches another vehicle or new point of attachment, decision will be made to forward the content to another mobile producer or vehicle. To resolve this probability, the producer node has to have at least a duplicate content so that forwarding content to several mobile nodes enhances delivery probability of a content [8] For efficient forwarding in NDN, the use of Data reAchaBility Based Routing (DABBER) approach is necessary. The approach guides opportunistic wireless networks (multi-hop wireless network) locate end-to-end route path in-between every single node in critical location regardless of time. In addition, the protocol enhances better transmission of interest contents via an appropriate data content source. This enhancement is established according to the accessibility of multiple data content source, accessibility of neighbor NDN nodes and interval of forwarding content interest and receiving data content [9]. Normally, content exchange in NDN occurs when a consumer sends its query as an interest. The neighbor node then replies back with data provided the needed content is available it its cache [10] [15]. An NDN router makes announcement for the prefixes it can serve using routing protocol such as OSPFN (Open Shortest Path First for NDN – announces prefixes and compute best route to destination prefix) [11]. All routers use the announcement advertised to form their FIB from neighbours. Every router in NDN manages three crucial data structures [12] [16], These are: A. Pending Interest Table: The PIT manages the records of content interest that has been received as a query but is yet to be treated as data content by the NDN router.

B. Forwarding Information Base: The FIB records the information on where content interest that corresponds to some of the name prefixed should be transferred or forwarded to. Content Store: The CS records the already treated/satisfied data content that have been forwarded to the NDN router.

NDN performs its routing and forwarding decisions using names. This removes some of the issues affecting addresses in our traditional IP architecture such as limitation in address allocation and management, and NAT translations. However, in ICN architecture particularly NDN, the challenge of address limitation is fixed because namespace is limitless. Also, NAT translation is removed because NDN does not use neither private nor public IP address. Another positivity of NDN is its ability to use the conventional routing like the link state and distance vector algorithm. In route announcement, NDN node broadcasts its name prefix which consists of the knowledge of the next communicating node. Then the routing protocol fully broadcast the initial announcement to various FIBs all over the network. NDN uses almost similar mode of routing and forwarding as in IP. Basically, the NDN router manipulates its routing table more efficiently as compared to the IP router. The routing table of NDN is numbered with content names such that in the process of routing. In case of forwarding, the forwarding information base will give various destinations for one record as a result of its presence in the router buffer. Control plane in NDN's major task is to crowd the routing table such that topology information will be distributed. It also notices packet loss and try to fix it when network information changes as a result of mobility. Similarly, the Data plane has an indirect function because no computation is required by it. This is because the primary function of the data plane is to pass on the receiving enquiries to the appropriate path based on the records placed in the FIB. Routing protocol on a network is solely meant to distribute policy of how contents will exit and come into interfaces of the network [13][19].

A. Positioning and Distance Estimation

The distance between two content nodes is the most important points to compute in the network. Strategies to apply in this computation can be used with the following below.

i. Received Signal Strength Indicator (RSSI)
ii. Time of Arrival (TOA)
iii. Time Difference of Arrival (TDoA)
iv. Angle of Arrival (AOA)

B. Received Signal Strength Indicator (RSSI)

RSSI refers to the force approximation acquired in a radio signalling system. As the signal traverse sequentially, its strength becomes lessened. During RSSI-based localization, its values becomes highly affected using environmental noises. During wireless sensor network implementation, an actual localization environment in an indefinite or time-varying noise indicator eventually become larger due to localization errors. Hence, more significant research works is needed to address these issues [14] [18]. Some vital parameters to compute RSSI distance are as follows:

i. Power of the transmitted signal
ii. Power of the received signal
iii. Path loss model

Using these mentioned parameters, the distance between the transmitter and receiver hub can be computed (as in equation 1).

$$P_R(t) = PT - 10\eta\log(d) + X(t) \quad (2.1)$$

Where PR(t) = power of the received signal from transmitter content node, PT = power of the transmitted signal (content), η = attenuation constant which is the value decided by the surrounding of the receiver content node, d = distance between transmitter and receiver content node, and X(t) = unknown noise which is the value decided by multipath shadowing and fading. Also, by discovering the value of 'd' from the driven formula, the distance between content nodes can easily be realized.

III. Methodology

In this analysis, Time Difference of Arrival (TDoA) is considered a main application that can detect and locate the wireless mobile producer. Other literatures proved that TDoA can have potential of in some cases, during wireless devices detection. With the combination of using Ultra-Wideband (UWB), RSSI, TOA and TDoA technique, it will be optimal to improve the localization for detecting wireless devices in this framework.

The process can be divided into three processes,

i. The initialization: In the initialization, the data for position is collected. The first state, the device will collect the distance value for RSSI, and TOA. The coordinates of the beacon node use also been collected. These data are then using to calculate and find the initial value for the NDN content node by using TDoA method.

ii. The initial estimation: In the initial estimation, Maximum Likelihood Estimate (MLE) is used to calculate the initial value of target NDN content node. This initial value will be used for the Taylor Series Expansion. The initial value needs to be close as possible to the real value to ensure the convergence of the algorithm.

iii. Location estimation: The location will be estimate and detect the target NDN content node by using the TSE.

A. Coordinate the Base Station (BS)

For the coordination of signal at the BS, content nodes are deployed to operate separately between BS, within 50 meters radium to create a square shape. The size of stimulation environment is 2.5km2 where the design could accept expansion of another base station (BS). Four base station were selected and are positioned in the simulation in form of representation below as follow.

BS2 = (0, 50), BS3 = (50, 50)
BS1 = (0, 0), BS2 = (0, 50)

Meanwhile the mobile producers and rendezvous nodes with content names can be identified and located based on their RSSI. Note that, A User Device (UD) is represented as a mobile producer which request or transmit a content as a consumer.

The mobile producer or (UD) will be mobile within the simulation domain to enhance the precision and accuracy of location.

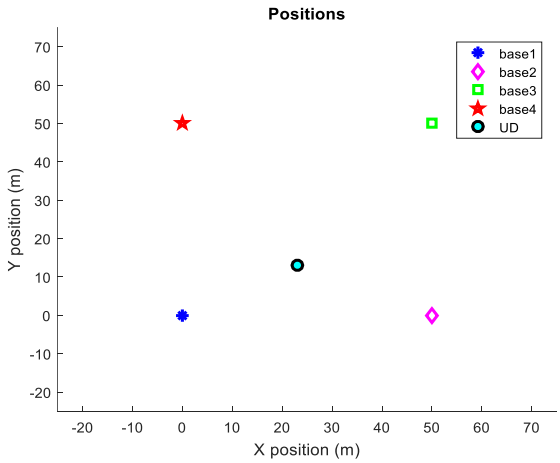

Fig. 2 Sample Coordinate for BS and UD

B. Implementation

Content names routing in the NDN network moves between transmitting and receiving devices (consumer and producer) and can be computed easily using the equations below. The Time of Arrival (TOA) strategy can be employed because a transmitting content can be sent to a producer device in a unidirectional link and can be located despite their parallel distances of separation. Equation 2.1 above can

be continued to compute the distance of separation as below. Strategies of Received Signal Strength Indicator (RSSI) and Time Difference of Arrival (TDoA) is used to automatically rearrange the content nodes in mathematical form as follows.

$$f(x) = \frac{f(x_0)}{0!} + \frac{f(x_0)}{1!} \quad (1)$$

(X_o, Y_o) are regarded the starting value of the target content node. However, the second order is eliminated, and the equation can be transformed below as follows.

$$d_{i1} = \sqrt{(x_i - x_0)^2 + (y_1 - y_0)} - \sqrt{(x_1 - x_0)^2 - (y_1 - y_0)^2} + a_{i1}\delta x + a_{i2}\delta y \quad (2)$$

Set,

$$a_{i1} = \frac{\partial d_{i1}}{\partial x}\Big| x_0, y_0 = \frac{x_0 - x_i}{d_i} - \frac{x_0 - x_1}{d_1} \quad (3)$$

$$a_{i2} = \frac{\partial d_{i1}}{\partial y}\Big| x_0, y_0 = \frac{y_0 - y_i}{d_i} - \frac{y_0 - y_1}{d_1} \quad (4)$$

"d_{i1}" signifies the distance between the starting position (X_o, Y_o) and the location of i ideal content node. By computing the equation becomes.

$$\delta = Y - AX \quad (5)$$

Set,

$$y = \begin{bmatrix} d_{21} - d_2 + d_1 \\ d_{31} - d_3 + d_1 \\ \cdots \\ d_{n1} - d_n + d_1 \end{bmatrix} \quad A = \begin{bmatrix} a_{21} & a_{22} \\ a_{31} & a_{32} \\ & \cdots \\ a_{n1} & a_{n2} \end{bmatrix} \quad X = \begin{bmatrix} \delta x \\ \delta y \end{bmatrix} \quad (6)$$

In addition to the preceding analysis,

$$x_0 = x_0 + \delta x y_0 = y_0 + \delta y \quad (7)$$

Until the $\delta <$ threshold.

It is imperative to note the bottleneck in determining the expected outcome. Therefore, Time of Arrival (TOA) and Received Signal Strength Indicator (RSSI) is both used to rearrange using its algorithm below.

Starting estimation

Time of Arrival (TOA) and Received Signal Strength Indicator (RSSI) can be determined using Maximum Livelihood Estimators and probabilities are assigned individually for RSSI and TOA.

$$\begin{cases} f_{RSSI}(X) = \prod_{k=1}^{p} \frac{1}{\sqrt{2\pi} d_k S_k} e^{-\frac{(\ln d_k - M_k)^2}{2S_k^2}} \\ f_{TOA}(X) = \prod_{k=p+1}^{p} \frac{1}{\sqrt{2\pi}\sigma_k} e^{-\frac{(c\tau_k - d_k)^2}{2\sigma_k^2}} \end{cases} \quad (8)$$

Where S_k and M_k are defined for each k respectively by:

$$S_k = -\frac{\sigma_{shk} \ln 10}{10 n_p} \quad (9)$$

$$M_k = \frac{(P_0 - P_k) \ln 10}{10 n_p} + \ln d_0 \quad (10)$$

After analysing these mathematical equations on the network varying value of ML estimator is achieved for both and Received Signal Strength Indicator (RSSI) and Time Difference of Arrival (TDoA).

$$\begin{cases} \nabla f_{RSSI} = \prod_{k=1}^{p} \frac{(M_k - S_k^2) - \ln d_k}{{d_k}^2} \left(\hat{X} - X_k\right) = 0 \\ \nabla f_{TOA} = \prod_{k=p+1}^{p} \frac{1}{\sigma_k^2} \frac{(c\tau_k - d_k)}{d_k} \left(\hat{X} - X_k\right) = 0 \end{cases} \quad (11)$$

The hybrid likelihood function can be defined as follows:

$$\nabla f_{Hybrid} = \nabla f_{RSSI} + \nabla f_{TOA} \quad (12)$$

Location Detection

Locating a mobile producer is based on TOA and RSSI computation where the analysis is based upon approximation of Taylor algorithm. This is discussed with the aid of the above equations.

IV. PRESENTATION OF RESULT

Results of simulation is recorded using ndnSIM2.1 and MATLAB 2015. For the ndnSIM2.1, a successful compilation of initial simulation is presented (as in figure 4.1) below.

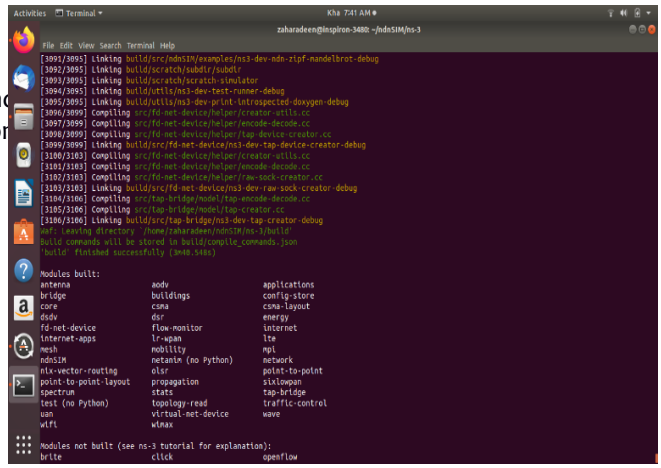

Fig. 3 Successful output Compilation

The mobile producer successful simulation using the default NDN simple file is presented (as in figure 4) below.

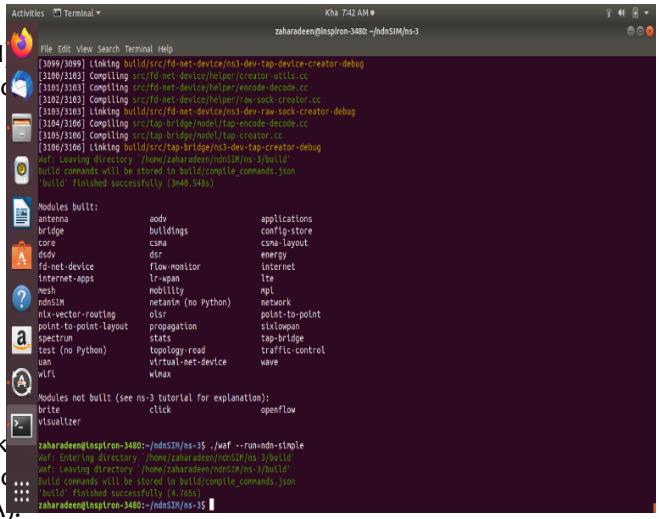

Fig. 4 Successful Run

The network topology simulation is run in a grid topology as in the standard NDN topology in grid file is presented (as in figure 5) below.

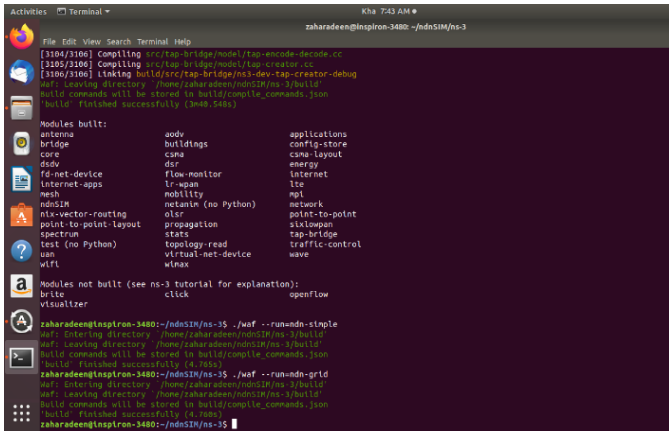

Fig. 5 Grid Topology

The mobile producer successful integration with scenario-aware protocol is simulated in the sixth NDN standard file is presented (as in figure 6) below.

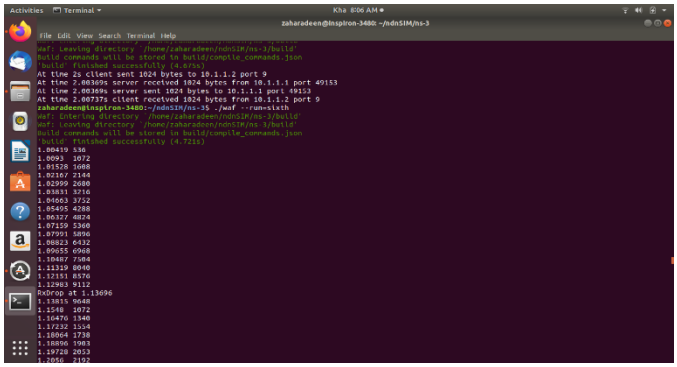

Fig. 6 Producer Mobility Result

However, using MATLAB simulator, the mobile producer or User Device (UD) is regarded as the target hub or content node randomly selected during input selection. The grid topology is an array of four Base Station (BS) whereas the size remains 2500m2. Figure 7.4 and figure 7 below presents the output.

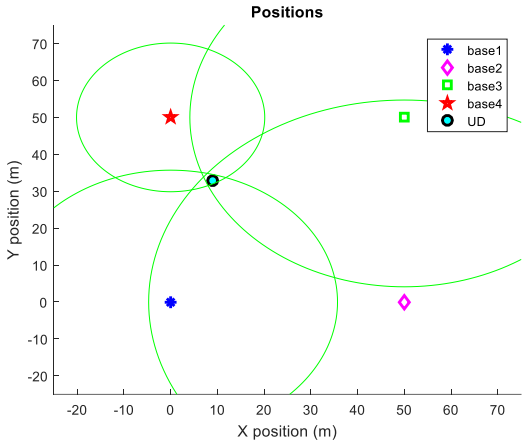

Fig. 7 Sample of RSSI radius.

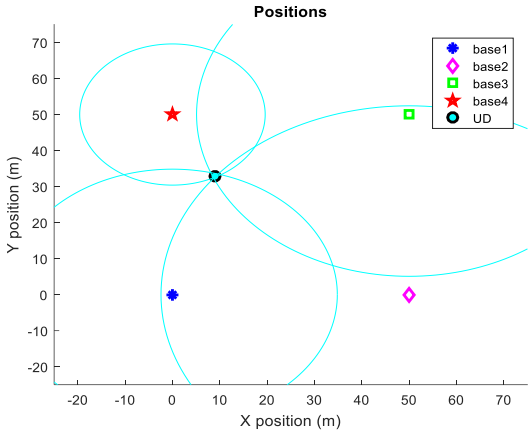

Fig. 8 Sample of TOA radius.

V. CONCLUSIONS

This paper analysed some contributions of Muslim in technology and specifically Computer Science Applications. Knowledge of Islamic civilization worldwide becomes crucial to our Ummah to improve interaction between Muslim and non-Muslim. This can encourage humans because there is no question of faith when it comes to the use of Technology application. All humans use technology directly and indirectly. In this study, an analysis of position mobile producer is conducted in an NDN network using RSSI approach. Related work on detecting signals is conducted using approaches of RSSI, TOA, and TDoA. The framework design of this work is conducted by Coordinate the Base Station (BS) using initialization, initial estimation, Location estimation. In the implementation, we begin by Starting estimation of TOA and RSSI and later conclude using Location Detection of a Mobile producer in an NDN network. for the result, we present Successful output for the simulation Compilation in ndnSIM2.1 (ns3-based), Successful Run, Grid Topology, Producer Mobility, while Sample of RSSI radius, Sample of TOA radius is conducted using MATLAB2015. Finally, the methodology adopted in the analysis presents better identification of transmitted content signals by the mobile producer to a noticeable destination. Hence can locate the rendezvous node in a less delay and signalling cost.

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TABLE 1 Summary of Related Work

Author			
	Contribution	**Result**	**Limitation**
Yang, B., Qiu, Q., Han, Q. L., & Yang, F. (2020).	• Both Transmit power and path-loss proponent is computed using new least-squares curve fitting (LSCF) approach using RSSI localization. • A convex optimization approach is developed to achieve state ellipsoid computation with multidimensional noises. • Use recursive algorithm to estimate global ellipsoid that ensure identifying specific target.	• Use experimental to validation the accuracy and effectiveness its set-membership filtering approach of indoor localization.	• Could not cover improvement of accuracy by focussing on a less noise system such as stochastic noise.
Cunha, A. O., Loureiro, J. V., & Guimarães, R. L. (2020, November).	• A prototype for small and low-cost wearable electronic machines device that presents output of Wi-Fi signal strength. Uses notification in form of audible and visual alarm anytime distance between two point is less as compared to the reference value.	• results suggest that the framework may be a viable choice to implement social distancing due to the pandemic caused by COVID-19.	• Could not measure accuracy of the readings presented by the Wi-Fi machine.
Yuan, G., Ze, Z., Changcheng, H., Chuanqi, H., & Li, C. (2020).	• presents a high-precision vehicular based localization approach using functional analysis and use of multi-channel RSSI of Bluetooth Low Energy.	• Present its approach can differentiate location of driver/passenger with accuracy between 86.80% to 92.02%.	• The approach is limited to vehicular systems only.
Zhang, C., Qin, N., Xue, Y., & Yang, L. (2020).	• propose hierarchical classification-based approach as another alternative of indoor localization bottleneck. • Uses enhanced algorithm of K-Means clustering to locate the interesting area	• Results present the algorithm offers enhancement of 1.4% to 3.2% in terms of position classification accuracy	Not stated in the research