Wireless Sensor Network Positioning Technology for Traffic Collection & Analytics

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***Abstract* - Sensor, microelectromechanical, dispersed processing of data, and communication through wireless technologies are all combined in the wireless sensor network. This study develops and suggests a unique self-locating root node method to address this issue. In order to increase the internet-connected sensor network components' precision in locating, this study suggests an enhanced node placement algorithm that makes use of rectification of errors techniques to lessen built-up positioning and separation mistakes. The current research simulates, implements, and evaluates the designed networking method's performance utilising various system architectures. According to a study's findings, the forwarding methods developed in this study can significantly lower the power usage of the system and increase its lifespan when compared to the currently used routing algorithms. The algorithm's core task is to combine the system's known and accessible data to find unidentified anchor nodes. Because there are far fewer anchor nodes for which the system needs initial position data as an outcome, the price of the system has decreased, and its range of applications has expanded while having less of an impact on positioning accuracy. The problems with node placement, metabolic fluid supply localization, and tracking targets in cellular detector systems have been thoroughly examined in this paper. A framework for situating and monitoring application studies, which is needed to provide the foundation for future research on applications, has also been designed and developed. New locating and following techniques, including both theoretical and applied relevance, have been suggested over a variety of real-world examples of programmes, and their effectiveness has been confirmed as well as assessed by digital modelling in the study of the aforementioned issues.**

***keywords* - Wireless Sensor Network, Accuracy in WSN, Traffic Analysis in WSN, WSN Positioning**

I. INTRODUCTION

Unprecedented advancements in wireless and sensor technology have been made in recent years, and people are becoming more and more interested in associated technologies [1]. Moreover, a new kind of wireless sensor network technology has emerged. Because the sensor nodes are inexpensive, compact, and simple to install, the method is commonly employed in military-related industries, businesses, farms, animal care, home automation, smart cities, and numerous other industries [2]. The position data of one of the monitoring units was required by every single one of these uses, despite the fact that they each have their own unique features and span a variety of industries [3]. All of the system's information becomes meaningless in the absence of the sensor node's location data. As a result, the method for obtaining node location information is crucial. The collection of monitor location data has often been completed using satellite tracking systems [4]. The developers are aware that the following use of satellite gadgets is very expensive. This does not adhere to our standards for inexpensive sensor nodes. Hence, a popular topic at the moment is how to manage the cost of finding detector units [5].

The exchange of data among detector units will frequently be blocked by barriers if cellular detector systems are employed in inner or urban settings, which causes the system to not be able to interact within sight line. An immediate result of such an issue has increased the variance in the details we receive from the location element and lowered the system's positioning performance [6]. In order to address these issues, this research suggests using the non-line-of-sight recognition method. The approach applies a non-line-of-sight feature to significantly alter some of the information, finds the node in the system that lacks line-of-sight communication, and removes points throughout the fix, therefore removing the non-line-of-sight problem's negative effects upon a system's location ability.

In order to increase people's capacity for speedy emergency response, portable detection systems have been used in this paper to pinpoint the locations of biochemical gas sources. (1) This straight trilateral approach as well as the irregular most squares techniques have been contrasted, and a reliable maximum likelihood locating algorithm is given. (2) The structured detector system is used to place chemical sources, and a networked location technique built on better powder screening inside the structured detector system is suggested. This algorithm controls links via sections, eliminating the inherent flaws of a centralised positioning algorithm and conserving network energy. The position of the convergent biochemical gas source is determined by a condition change and cycle iteration estimate. A fresh idea for detector hub position data gathering innovation is being developed by numerous R&D organisations. The technique of using the radio detection system for tracking is currently extremely prevalent.

(3) This technology has the unique property that, in order to complete positioning, it simply requires the use of communication data between nodes and

the use of a unique algorithm. In order to examine the present issues with the technology and suggest changes, this article introduces the ideas associated with detection system location gadgets, a number of location structures, and the progress state.

A WSN is made up of a great deal of small, low-energy sensor nodes. Despite their limited cognitive power, they are able to communicate with one another on demand. The process of figuring out the actual locations of monitor units is known as localization. The location of an event is crucial for modern WSN applications, and depending on how precisely a place needs to be understood, various apps employ various localization strategies. These networks are used in a broad variety of everyday ideas today, including health surveillance [1, 2], intelligent cities [3, 4], clever garage [5,] target tracking [7], target tracking [8,] natural resource inquiry, forest fire discovery [8,] and follow-up inaccessible locations. With these uses, data is gathered and sent, together with the hub position data, to the washbasin for additional research. As the need for highly accurate placement grows, localization is becoming increasingly crucial. Overall, the WSN technology translation method relates the data inside formulae for the translation of as many sensors as possible [9] by using either global positioning system (GPS) devices or calculation methods for directional antennas with figures that include point of getting, time of arrival (ToA), delay of arrival (DoA), or received signal strength measure (RSSI).

II. Related Work

The examination of the scenario where every node in the sensor network is a static node is the main focus of the aforementioned positioning technique. The positioning strategy used by nodes that move in the monitoring system was initially studied in some of the literature. To determine the location of the node, the authors of Zhou et al. [7] were the initial group to combine a unique roving indicated point with RSSI detection gear. In addition to proposing a hub address approach based on distributed nonparametric kernel estimation and TOA range technology to determine the node position,Sugano et al. [8] brought a blurring technique from a picture area to the system address. Radio-frequency connection constraints are used by Liu et al.'s [9] proposed granular distance-independent placement method to lessen the unresolved ambiguity of unknown locations. The plane of the bisector is found between both of the flash spots. Vançin and Erdem [10] used rigidity theory to guess the position of unidentified mobile nodes, solved unidentified cells by a geometric method, and selected four received light places spread on rotating circles. The place of the mystery node is the intersection. The sequential Monte Carlo (SMC) technique was utilised by Jo et al. [11] to find each moving point of the mobile sensing network in the published material. For outdoor WSN, the author suggests an establishing method dubbed LandScape that estimates the node's position using the Unscented Kalman Filter (UKF).

To be able to find the exact location of the object that is moving at any given moment and determine its trajectory, tracking the target in WSN uses joint work among hubs with current positions in the system. While wireless sensor networks are utilised for target location and tracking, they confront several obstacles compared to conventional tracking techniques, yet they also clearly have advantages. The three primary stages of a goal-following method built upon detector networks—detection, position, and notification—were each thoroughly examined in the study by Nabeel et al. [12]. This monitor hub cooperatively identifies and monitors the target, alerts nodes close to the target's estimated trajectory to join the tracking effort, and simultaneously limits communication to nodes close to the target and its projected path of travel. A goal monitoring system built upon ternary monitor modules was proposed by Oppermann et al. [13]. Each node may identify the circle space in which the target is located and how long it has been there, but not the target's distance from it. The target location is an overlapped coverage region that is created by several nodes working together. This method uses a large number of straightforward and inexpensive sensor nodes to determine the target's trajectory, but it requires that each node's position be known and that the nodes' timing be synchronised. IDSQ, a message-driven sensor query system, has been proposed by certain academics (information-driven sensor querying). The fundamental concept is based on the Bayesian algorithm, which iteratively estimates the target position using the data collected by the sensor nodes. The basic idea of the Bayesian classification method is straightforward: when it pertains to text grouping, it views the feature vector of an item as independent of the relationship among any two terms in the container of phrases. Each dimension operates separately from the others. Using a variety of data acquisition cues such as Mahalanobis distance, interactive data, and data entrapment, the method picks a single tracking head node to perform data fusion at the next step. This approach significantly reduces the number of nodes involved in tracking and positioning as well as the energy used by the entire network. However, it also significantly affects the network's failure tolerance and robustness [14–16]. In order to follow a continuously changing surface target, such as the growth of wildfires, the routes of typhoons, or the spread of biochemical compounds, several researchers have also proposed a dual space method. For cooperative sensing and target positioning, they suggested the "location centre" method. The current node predicts the target's direction and alerts the user to any fixed-division units that are being targeted. The alert unit's nodes work together to identify the shape of the target, and the monitoring plan is started when the classifier decides that it is the anticipated object type [17].

Additionally, as can be seen from the references [18, 19], some researchers had also indicated a few self-organising spread detector system target tracking prediction methods, in which the forecast gadgets use scent, Bayesian, and extended Kalman filters on the internet, as well as linked statistical algorithms. The target tracking research conducted from the viewpoint of system connection served as the foundation for the suggested DCTC (dynamic convoy tree-based collaboration) transport branch monitoring technique. A moving tree made up of links located close to the moving target is the transmission tree. Moreover, as the target moves, some nodes will be dynamically added or removed [20]. Via the transmission tree topology, the nodes close to the moving target perform cooperative tracking, lowering the extra transmission costs between nodes and ensuring effective tracking of the target. The approach emphasises the network layer domain by relying on the delivery tree's own tree structure. Using Sequential Monte Carlo (SMC) methodology and the auxiliary particle filter approach, some researchers choose, determined by the information utility function of the ideal moisture content, the next head node for fusion. Similar to IDSQ, the utility function's calculation on the basis of head node selection is rather intricate. A distributed particle filter algorithm is used by the distributed fusion centre to anticipate and track the target. It is based on a single activation node. The Gaussian mixture parameters are trained by the algorithm using the EM technique to get their proximity to the expression particle. The moving of the particles themselves is replaced by the transfer of the parameters in the Gaussian mixture model (GMM), which significantly reduces data communication and energy use between the head nodes. A lot more particles need to be given, and placement precision needs to be increased in particular [21–23].

III. BUILDING A MODEL FOR COLLECTING TRAFFIC DATA USING WIRELESS SENSOR NETWORK POSITIONING TECHNOLOGY

3.1. The WSN's structured organization. A novel form of network technology known as wireless sensor networks (WSN) combines sensor, MEMS, dispersed information and transmission via wireless processing technologies [24–27]. The structured arrangement of wireless sensor networks is depicted in Figure 1.

With the assistance of collaborating nodes, it may perceive, collect, and process data about the surroundings or monitored objects in the monitored region in real-time, and it may send the processed data to relevant system end users.

$$(x, y) = \left\{\frac{1}{n} * \sum x(i), \frac{1}{n} * \sum y(i)\right\}, \quad (1)$$

$$\begin{cases} d1 = \sqrt{(x - x1)^2 + (y - y1)^2} \\ d2 = \sqrt{(x - x2)^2 + (y - y2)^2} \end{cases}. \quad (2)$$

Many ubiquitously distributed small sensor nodes with transmission and processing capabilities make up the distributed self-organizing network system known as WSN. Collaborative thinking, information gathering, processing, and dissemination amongst very small nodes of sensors with restricted capabilities can be used to complete the designated tasks according to the needs of the environment.

$$\begin{bmatrix} x \\ y \end{bmatrix} = [x - x1\ y - y1]^{-1} * \begin{bmatrix} x^2 - x1^2 \\ y^2 - y1^2 \end{bmatrix}. \quad (3)$$

Sensor nodes, observers, and sensing objects are the system's three fundamental components. A wireless network is used to establish communication paths between nodes and observers as well as between sensors and other nodes and observers.

$$G(i, j) = \begin{bmatrix} (x - x1) * \sec^2(i) & 0 \\ 0 & (x - x2) * \sec^2(j) \end{bmatrix}. \quad (4)$$

Different nodes in the network or nodes in various locations create various networks, and the routers that connect between them (or base stations). The entrance uses a satellite, wireless network, or the Internet to provide the pertinent WSN signals to the control center server.

$$u(x, y) = \tan(\theta) = \frac{y(i) - y0}{x(i) - x0}, i = 1, 2, \cdots, n. \quad (5)$$

Desktop clients query and search for relevant data through the server and transmit related downlink instructions to the gateway through the server in order to perform remote monitoring and control of the observed region. The gateway then sends these downlink commands the WSN's nodes, one to each, where they are carried out by the networks.

$$p(x(k)|k - 1) = \int p(x(k)|k - 1, y) * p(x(k - 1)|y) * d(x(k - 1)). \quad (6)$$

The node's processing, storage, and communication capabilities are typically inferior to those of the gateway, and its available energy is constrained (usually powered by batteries). A single node is capable of performing a range of activities, including collecting and analyzing local data, transmitting secondary data, and more. In order to complete certain duties, it can also work in conjunction with other nodes.

$$\begin{cases} S(k) = \left.\dfrac{df(x)}{dx}\right|_{x=m(k-1),k-1}, \\ T(k) = \left.\dfrac{dh(x)}{dx}\right|_{x=m(k-1),k-1}. \end{cases} \quad (7)$$

The machine serves as the central node network and is in charge of managing its operations as well as the collection, processing, and transmission of information by other nodes. Information about control, wireless connections among nodes, and data are handled by the Journal of Sensors 3 communication module.

$$\sum_{i-0}^{2n} w(i) * (x(i) - z)^T * (x(i) - z) = 0, \quad (8)$$

$$z(k) \sim q(x(k)|x(k-1)) \approx N\left(\overline{m(k)}, \overline{p(k)}\right). \quad (9)$$

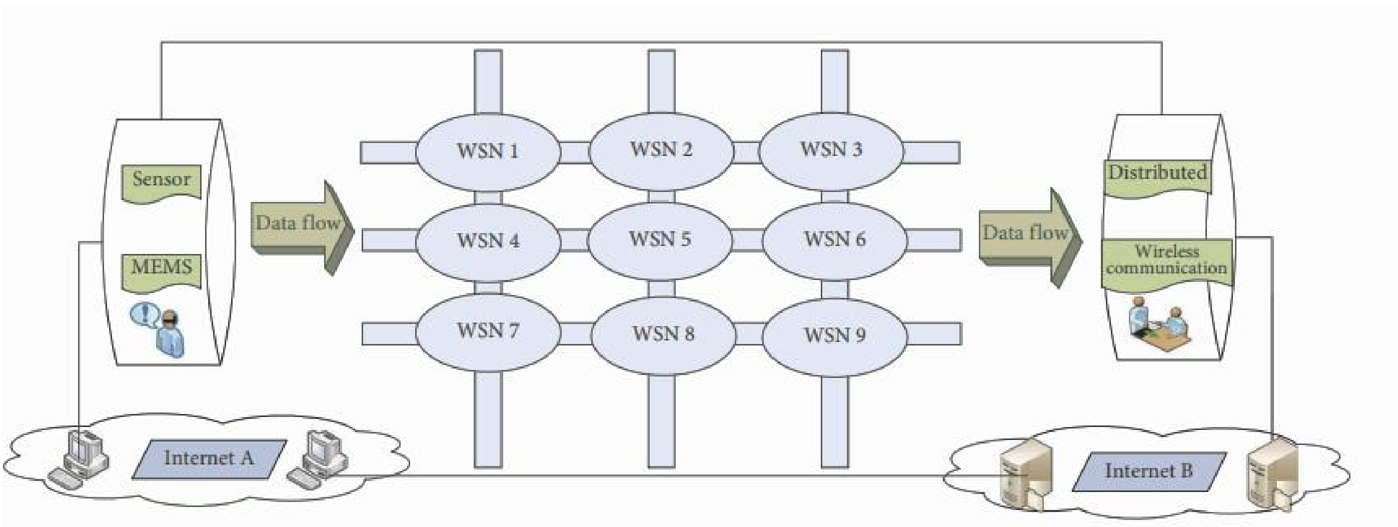

Figure 1 Hierarchical Distribution of Wireless Sensor Networks

The energy supply module is in charge of providing the necessary energy for the whole node's operation (the gateway may run on a continuous power source, regular nodes frequently run on batteries, and for some crucial nodes, energy recovery technology like photonic converter devices can be utilized). Additional components are present at a few nodes.

3.2. Algorithm for Gathering Traffic Information Two examples of placement and tracking methods used in WSN are node self-positioning and placing and tracking moving targets. [28–30]. Node self-positioning is a topic of research for network middleware technology and is a component of network system research [31, 32]. The information is to be provided for services at the upper application scale and within the network forwarding layer, including node location. Monitoring and locating moving objectives are aspects of WSN application layer research that make utilization of network-wide cooperative signal processing necessary to fulfil these tasks. [33–35]. The current positioning algorithms are classified into a range-based algorithm and a range-free algorithm depending on whether distance information is measured during the positioning process. The trajectory of the moving target and the data gathered while tracking the target can both be referred to as moving target tracking data. For example, based on the location and tracking information of the sound emitted by the moving target, the position of the target at each instant can be determined based on the trajectory of the target, and the noise the target emits after coming in at the node is then determined according to the position of the node. To make the data more realistic, some minor random variables are included and scattered throughout the data. Positioning with help from mobile nodes is covered in some of the studies. The linked categories of common positioning algorithms are listed below. The distance-dependent positioning algorithm uses the measured data to determine the location of unidentified nodes by measuring the distance or angle information between nearby nodes. The algorithm for gathering traffic data is depicted in Figure 2. Angle of Arrival (AOA), Signal Strength (Received Signal Strength Indicator, RSSI), and Distance Measurement Correlation is one of the three basic categories into which the measuring technology in the sensor network can be categorized. Using the known signal strength of the transmitting point and the signal strength received by the receiving node, the RSSI ranging mechanism calculates the signal's propagation loss and then applies a theoretical or empirical model to turn the propagation loss into a distance meter to measure the distance. Yet using RSSI as a range is frequently inaccurate and imprecise. This is due to the fact that complicated settings, such as barriers and shields, have a greater negative impact on RF transmissions. We typically use sound or radio-frequency signals because of their superior accuracy. AOA ranging mechanism based on signal arrival angle: the receiving node senses the direction of the transmitting node signal's arrival through an antenna array or multiple ultrasonic receivers, calculates the relative position or angle between the receiving node and the transmitting node, and then calculates it by triangulating the node's location. TDO ranging mechanism based on signal arrival time difference: the transmitting node sends out two wireless signals with various propagation rates at the same time, and the receiving node determines the distance between the two nodes based on the interval between the arrival of the two signals and their known rates. Radiofrequency signals and sound signals are frequently employed. In open spaces, sound propagation is straightforward and predictable, allowing for excellent precision and minimal cost using this technique. For instance, all that is needed is a microphone and speakers.

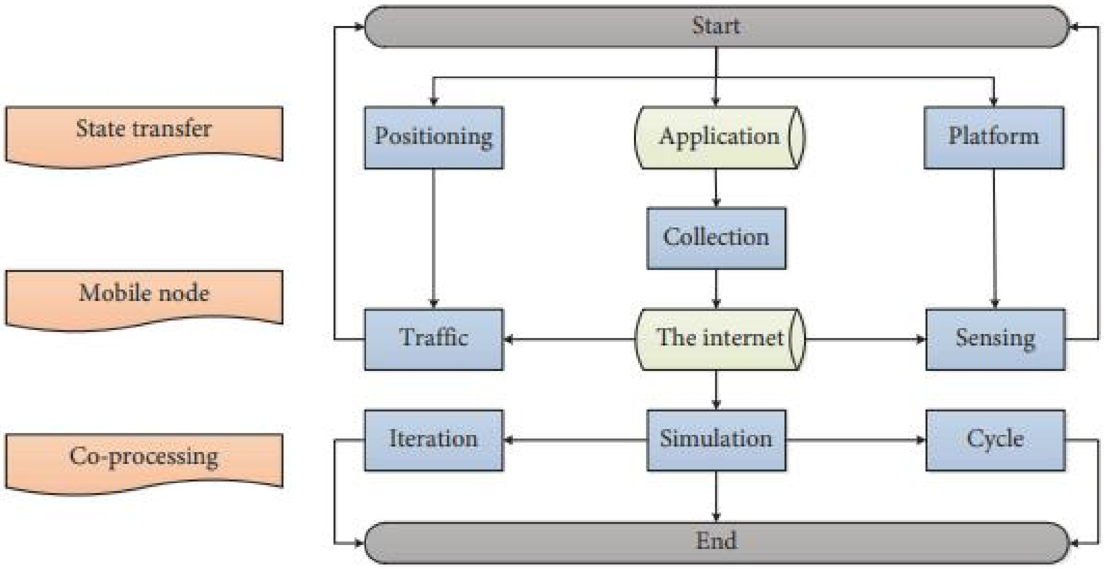

Figure 2 Flow of the algorithm for collecting traffic data.

3.3. Optimizing the parameters of the model node Depending on whether a beacon node is utilized in the positioning process, the positioning algorithm is divided into a beacon-based positioning algorithm and a beacon-free positioning algorithm. The former is now being positioned. The placement procedure uses the beacon node as a reference point and creates the global absolute coordinate system once each node has been placed. The latter does not need a beacon node and only considers the nodes' relative positions. The network nodes are included in the coordinate system that they have created for themselves. Next, the coordinate systems that are next to each other are transformed and combined, and thereafter, the global relative coordinate system is developed. The number of hops from the anchor node is first obtained by all nodes in the network using a standard distance-vector exchange protocol. The anchor node determines the average network hop distance and broadcasts it to the network as a correction value in the second stage after learning the positions and hop separations of other anchor nodes. Controlled flooding is adopted as the corrective value. The technique spreads throughout the network, so each node only accepts the first rectification value acquired and discards all subsequent values. The majority of nodes will be able to get the correction value from the closest anchor node thanks to this method. Setting a data packet's domain can help reduce communication volume in large networks. The node determines the distance to the anchor node based on the number of hops after receiving the corrective value. The relationship between the network connection radius and the sample node is depicted in Figure 3. The third stage of trilateration positioning is carried out once the unknown node has received distance estimates from three or more anchor nodes. Typically, before the positioning equations produced according to nonlinear characteristics can be used, linear equations must first be solved. The Taylor sequence expansion approach, which has the advantages of high accuracy and good robustness, is a powerful technique for solving nonlinear equations. Each equation looks like a hyperbola when viewed geometrically. The geographic setting of the region where the sensor node will be installed or the unique requirements of a particular location for node density are described using the object and environment models, which are one of them. The deployed associated parameters, along with other features, define a single node's sensing model, sensing range, communication range, and other coverage models. The framework of the wireless sensor network placement model for gathering traffic information is depicted in Figure 4. Nevertheless, in the propagation environment for wireless sensor networks, multipath effects and nonline-of-sight are typically present, and the error term in the measurement will undoubtedly be caused by the nodes' processing latency.

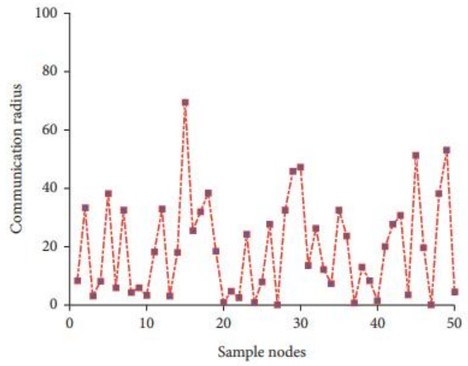

FIGURE 3: Dependency of network communication radius with sample nodes.

Figure 3 Dependencies between sample nodes and the network's communication radius.

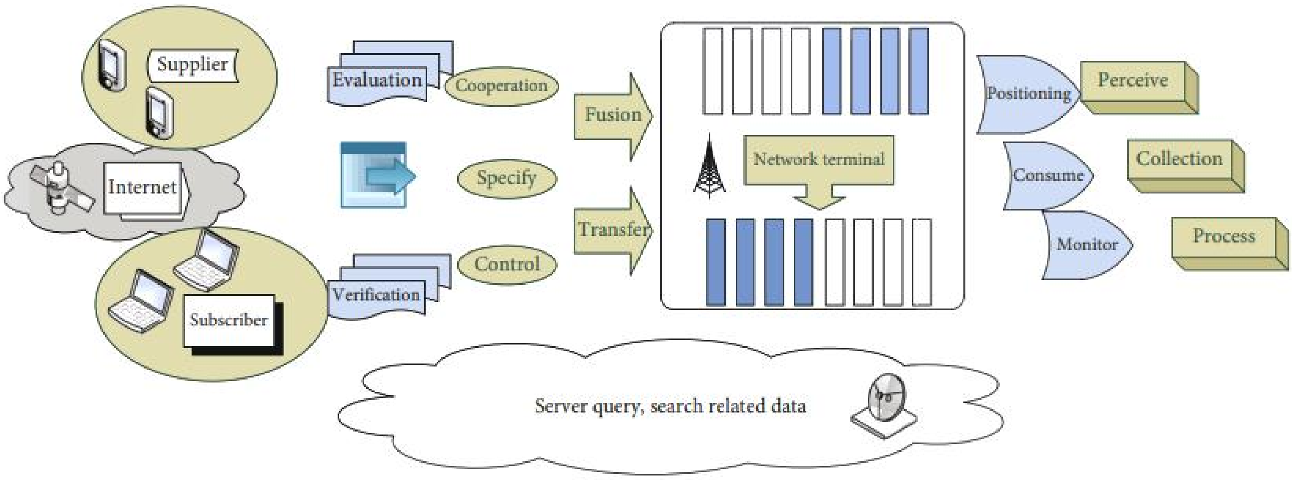

Figure 4 The architecture for gathering traffic data utilizing location technologies from wireless sensor networks.

However, as there are often more anchor nodes involved in positioning than there are unknowns in the equations, the least squares technique, which can fully utilize redundant information, is an effective algorithm for solving such equations. An unconstrained nonlinear optimization problem is the same as addressing a set of nonlinear problems. It needs to be linearized first. Because of their great precision and robustness, cellular locating systems commonly use the Taylor series expansion technique. The Taylor sequence expansion method, however, can result in accurate calculation results. A starting estimated location that is near the actual position of the node to be measured is required to ensure algorithm convergence. It is impossible to predict the non-convergence condition in advance. It is impossible to predict whether the method will converge without a close approximation of the real position to the first predicted position. As a result, this study compares the positioning performance of the algorithm and the Taylor sequence expansion method before proposing an improved Taylor sequence expansion method that can be used with outdoor WSN positioning systems. The performance of the algorithm is then optimized using the extended Kalman filter method.

IV. Analysis of the WSN Positioning Technology-Based Traffic Information Collection Model

4.1. Data collection for traffic statistics Three scenarios were simulated using Matlab when the throwing radius was 50 m and the grid inner ring radius was R = 12:5 m. The three possibilities are scenario 1, where 250 nodes are spread at random; scenario 2, where 500 nodes are dispersed at random; and scenario 3, where 500 nodes are distributed, with at least six nodes in each grid. The routing tree may require gateway nodes, which are dispersed throughout a node-light grid. Gateway nodes in the routing tree are essentially unnecessary as node density rises due to the more uniform distribution of nodes and cluster heads. The total number of nodes in the wireless sensor network region must be known in order to ascertain whether the ideal node communication radius and the lowest node placement error change. The wireless sensor data packet's three-dimensional fitting curve is shown in Figure 5. It exhibits differences in node placement error depending on whether the total number of nodes is 100, 300, or 500, and the node communication radius is modified from 5 to 50. The anchor node uses the distance vector exchange protocol to broadcast its own position beacon to the network, which includes the hop and accumulated hop distances (both initialized to 0). The node receiving the signal only logs the data of the anchor node with the fewest hops. The hop count is then raised by 1 in order to advance the beacon after collecting the appropriate hop distance. All nodes in the network can eventually obtain the anchor node with the shortest cumulative hop distance. As nodes start to fail one by one while the network is in use, the number of effective nodes—those that can send data to the base station—decreases.

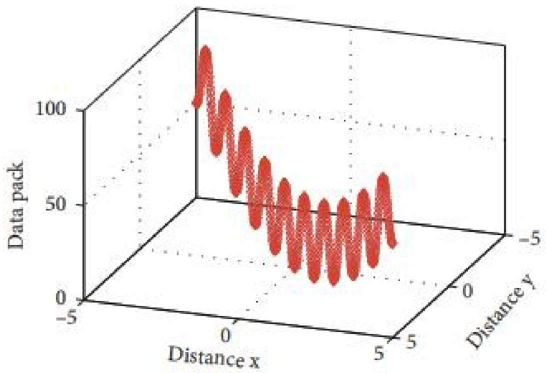

Figure 5 Wireless sensor data packet fitting curve in three dimensions.

In a uniform topology, the probability of each node being selected when selecting the next hop has little variation, resulting in a more evenly distributed load across each node. In random topology, the coordinates of nodes are generated at random, which causes some nodes to be selected frequently and die quickly. It shows how the networking and routing protocols proposed in this study can balance node energy consumption and considerably increase the network lifetime. As the number of nodes grows, so does the optimal node communication radius, but the overall placement error of the nodes is also decreasing. Internet Fusion Cooperation: Specify, Control, Perceive, Collect, Process, Evaluate, Position, Consume, Monitor Server Queries, Search for Related Data Terminals for the Supplier Subscriber Transfer Network Verification Search for similar data using an Internet Fusion Cooperation Define Control Evaluation Server query. Verification of the Supplier Subscriber Transfer Network terminal, Figure 4: The wireless sensor network positioning model's structure for gathering traffic information 50 Distance x, -5 Distance y, and -5 Distance Pack of data: 5 5 100 Figure 5: A fitting curve in three dimensions for a wireless sensor data packet The Journal of Changing Sensors It displays the associated lowest node positioning error value and optimal node communication radius. Under various total node counts, there is an optimal node communication radius that will reduce the positioning error to its lowest value. The placement accuracy is highest for the hop algorithm. It claims that the optimal node communication radius can be selected for different total node counts.

4.2. Positioning using a wireless sensor network simulation The period of time between the antenna picking up a signal and the receiver accurately decoding it is referred to as the processing delay of the receiver. The receiver's circuit determines this delay. Since it is typically taken to be a constant or fluctuates only slightly, the inaccuracy it causes can be disregarded. The simulation conditions (0, 0) consist of three anchor nodes participating in TDOA measurement and establishing their location coordinates as follows: Only how the TDQA measurement inaccuracy affects the positioning result is taken into consideration. The size of the various information packets used in the simulation during base station scanning and location is 128 bits. The source data packet has 128 bits, the forwarding data packet has 512 bits, and the additional control information packets each have 64 bits. The measurement error has a mean value of 0 and standard deviations of 1 m, 2 m, 3 m, 4 m, and 5 m, all of which are perfectly Gaussian in distribution. The simulation's findings are shown in the following figure. To improve the efficacy and realism of the simulation results, the values are the average values acquired from 100 simulation results. When there are 8 anchor nodes, which equals 12, we can reach the region of 1 m l m if there are 100 total nodes. where R = 22 meters is the node's communication radius. The node's placement inaccuracy is minimal. The statistical distribution of three-dimensional traffic errors is shown in Figure 6. There are 12 anchor nodes in the 1 m x 1 m wireless sensor network. Secondly, we assess how well the enhanced DV-distance placement algorithm performs in the presence of erratic and sparse network topologies. A node defined in an organization and added to the pipeline is known as an anchor node. Node discovery is this node's main purpose. Every organization that joins the pipeline has at least one anchor node, and the organization's node may find all the other organizations' nodes in the pipeline by searching for the anchor node. When the anchor node ratio is between 10% and 20%, the average positioning error of the revised algorithm will be around 10% to 30% less than that of the original method, demonstrating that the improved algorithm has higher adaptability and consistent positioning accuracy for low-density networks. Then, it compares the average placement error between the algorithm's original and modified versions. The range of inaccuracy (relative to the communication radius) ranges from 5% to 40%. The positioning error of the improved method has been significantly decreased, by a factor of more than 50%. Figure 7 depicts the accuracy-fitting curve of the method for a range of node numbers. As can be seen, the improved DV-distance algorithm offers a more accurate location and is more resilient. The node sleep waiting time is shorter than other algorithms' average energy usage. This demonstrates how the energy usage of WSNs rises with time at a pace that is noticeably lower than that of other networks. Because the energy consumption gap between nodes increases quickly as the number of nodes increases, the traffic information cluster collection algorithm offers superior scalability. Under various node communication radii, the projected distance between the two nodes varies significantly, which affects the node's placement accuracy. Therefore, the positioning accuracy will vary depending on the communication radii of the nodes.

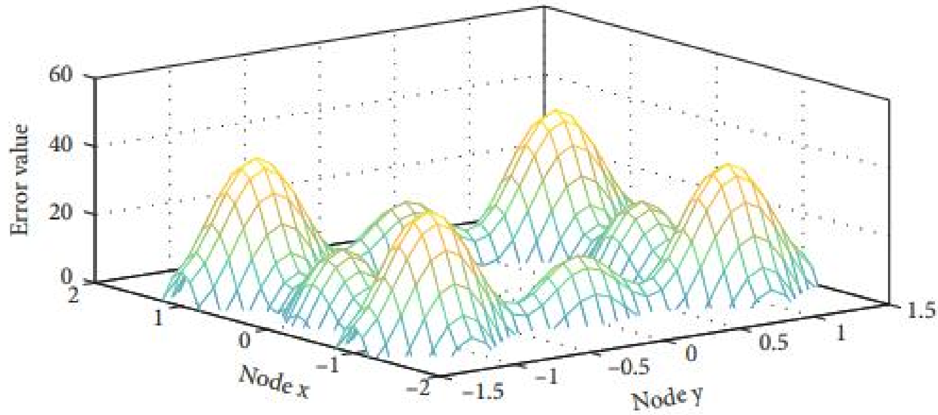

Figure 6 Statistical distribution of three-dimensional traffic error.

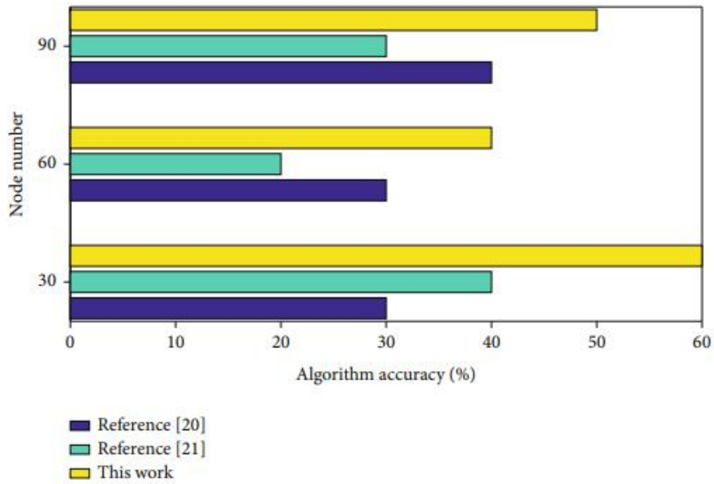

Figure 7 Accuracy of the algorithm in fitting a curve with various node counts.

4.3 Case for application and analysis. This section examines the simulation results of the node positioning error in a wireless sensor network measuring 100 m by 100 m when the number of anchor nodes, the node's communication radius, and the overall node count are altered. The number of anchor nodes varies among wireless sensor networks. The number of reference nodes (m = 4), the node communication radius (R) of 5 meters, the number of iterations (k), the quantity of unknown nodes (n = 30), and the empirical threshold (s = 0:0001) based on accuracy requirements are some examples of parameters. The unknown nodes are arranged in a 9 m by 9 m rectangle at random. For easier viewing, the reference nodes are positioned at each of the quadrilateral area's four vertices. In this instance, the positioning error rate is used to determine how effectively the positioning algorithm is performing. The positioning algorithm is thought to be more accurate if there is a lesser placement error. To facilitate comparisons, we initially set k = 60 to compare the placement situation before and after the improvement. DV is also influenced by the total number of different sensor nodes in a certain portion of the sensing area. As seen in the illustration, different nodes fall under the same node communication radius. A two-dimensional scatter plot of the number of iterations and the positioning of wireless sensors can be seen in Figure 8. A typical hop will contain many different nodes. If the number of nodes is too low, there might not be any nodes within the anchor node's communication range. The main idea behind serial interference cancellation is to apply an interference elimination approach that evaluates each user in turn in the received signal step by step. The multiple access interference brought on by the user signal is then deducted from the received signal and the residual after the amplitude has been restored. The procedure is repeated until the following user's decision is free of any multiple access interference. Because other nodes are unable to access the anchor node's data, the node cannot be found. Prior to and after the improvement, we calculate the positioning error rate for each iteration. Then, we increase k and s to find the correlation between positioning error and the number of iterations. T The improved iterative strategy only needs fewer than 10 iterations to attain the same precision as the enhanced iterative technique, which, as shown in the figure, requires more than 220 iterations to produce a placement error of 0.10 m. Using this method, the computing workload is reduced by a factor of more than 20.

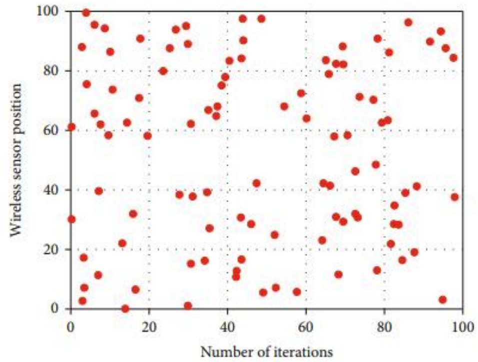

Figure 8 Wireless sensor location in a two-dimensional scatter plot with iterations.

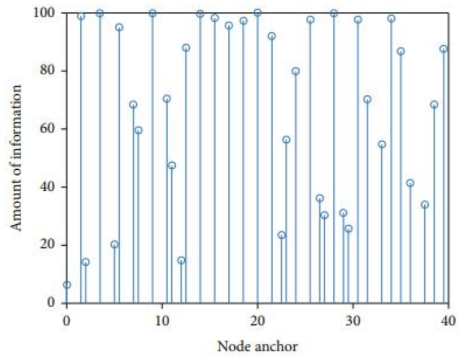

Figure 9 Matchstick-shaped traffic data graph that changes with anchor nodes.

Figure 9 shows the matchstick graph of the amount of traffic data that changes with anchor nodes. The amount 0 10 20 30 40 Node d'anchor 0 20 40 60 80 100 the volume of the data Figure 9 shows a graph of traffic data that fluctuates with anchor nodes. 0 20 40 60 80 100 Several iterations Wireless sensor location: 0 20 40 60 80 100 Figure 8 displays a two-dimensional scatter plot of the number of wireless sensor placement iterations. 60 percent of algorithm accuracy is 0 10 20 30 40 50 30 60 90 Citation count citations [20] and [21] The algorithm accuracy fitting curve for different node counts is displayed in this task in Figure 7. 8 Sensors Review Given the quantity of anchor nodes, the node placement error is exhibited when the node communication radius R is increased from 10 to 50. It is evident that the placement inaccuracy of the node lowers as the number of anchor nodes gradually increases (from 6 to 12). As the number of anchor nodes varies, from 10 to 20, so does the node's communication radius. The node placement error diminishes to its lowest level very quickly. When the anchor nodes are different and there are 100 nodes total, the ideal ruler value exists. This is demonstrated by the fact that as the nodes' communication radius grows, so too does their placement error. One may observe the node's precise positioning: When the node's communication radius and total number of nodes are different, there are approximately 12 anchor nodes. The positioning inaccuracy of the node can be decreased to a lower value when the number of anchor nodes is increased from 3 to 10. As the number of anchor nodes increases, the node's placement error rapidly decreases. The amplitude, however, tends to be flat at this time. The influence of the anchor nodes on the node positioning error reduces when they rise above a particular threshold, as seen from the analysis above. The communication node distribution curves for several sample groups are compared in Figure 10. It indicates that the node placement error is practically the lowest when there are 12 anchor nodes and the node communication radius is different from the overall node count. This study assumes that the entire number of nodes is known and discusses the change in node placement error as the number of anchor nodes changes. The node's communication radius R changes from 10 to 50, and its location accuracy changes as well.

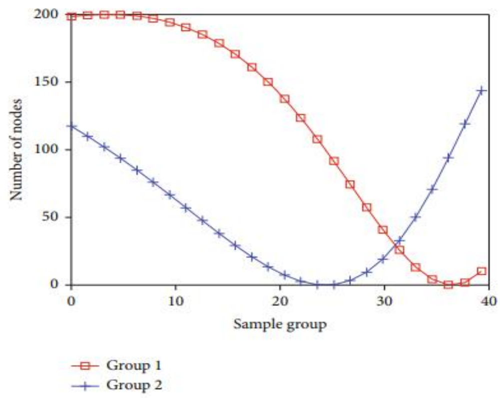

Figure 10 Comparison of communication node distribution curves across several sample groups.

V. Conclusion

The overdetermined nonlinearity of the positioning equation poses a challenge to the standard positioning method used in this work, necessitating an iterative solution. On the basis of these discoveries, the study suggests a hybrid positioning algorithm that successfully lowers algorithm complexity, facilitates the solution of iterative positioning equations, and consumes less energy in the system. In order to address the issue of excessive system power consumption, this article also suggests creating a positioning system using the Zigbee protocol rather than the conventional Wi-Fi protocol. The system's lifespan is enhanced, its application space is expanded, and its power consumption is minimized as a result. The energy efficiency ratio requirements for 6G are fairly high in order to create a balance between the transmitted energy and the necessary processing energy. Encoding, modulation, transmitting, and receiving processing must all be energy efficient as a result. Backscatter is an ultralow-power communication method that makes use of radio frequency power for connectivity and processing. The lifespan of Internet of Things nodes can be increased using backscatter communication, which can obtain energy from the environment and radio frequency waveforms. A node location method based on virtual beacon points is presented, which is different from the current location technique based on fixed beacon sites, to address the node location problem in wireless sensor networks as well as the dual problem of target tracking. To achieve node self-positioning, the minimal cost function based on energy comparison is computed using the nonlinear least squares optimization approach. Without adding communication volume or processing complexity over the conventional method, this strategy increases location accuracy. The simulation results demonstrate that the positioning accuracy of the strategy suggested in this study is increased by 5 to 10% under the same circumstances.

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References

[1] M. A. Matin and M. M. Islam, "Overview of wireless sensor network," Wireless Sensor Networks-Technology and Protocols, vol. 2, pp. 1–3, 2019.

[2] N. Jing, "Application of wireless sensor network in urban intel- ligent traffic information acquisition," Automatic Control and Computer Sciences, vol. 52, no. 5, pp. 431–438, 2018.

[3] M. Mbodila, E. Obeten, and I. Bassey, "Implementation of novel vehicles' traffic monitoring using wireless sensor network in South Africa," Communication Software and Net- works, vol. 5, pp. 282–286, 2019.

[4] J. Jiang, H. Wang, X. Mu, and S. Guan, "Logistics industry monitoring system based on wireless sensor network plat- form," Computer Communications, vol. 155, pp. 58–65, 2020.

[5] A. U. Rahman, A. Alharby, H. Hasbullah, and K. Almuzaini, "Corona based deployment strategies in wireless sensor net- work: a survey," Journal of Network and Computer Applica- tions, vol. 64, pp. 176–193, 2016.

[6] J. Yick, B. Mukherjee, and D. Ghosal, "Wireless sensor net- work survey," Computer Networks, vol. 52, no. 12, pp. 2292–2330, 2018.

[7] J. Zhou, C. L. P. Chen, L. Chen, and W. Zhao, "A user- customizable urban traffic information collection method based on wireless sensor networks," IEEE Transactions on Intelligent Transportation Systems, vol. 14, no. 3, pp. 1119– 1128, 2013.

[8] M. Sugano, T. Kawazoe, Y. Ohta, and M. Murata, "Indoor localization system using RSSI measurement of wireless sensor network based on ZigBee standard," Wireless and Optical Communications, vol. 538, pp. 1–6, 2018.

[9] Y. Liu, X. Mao, Y. He, K. Liu, W. Gong, and J. Wang, "CitySee: not only a wireless sensor network," IEEE Network, vol. 27, no. 5, pp. 42–47, 2013.

[10] S. Vançin and E. Erdem, "Design and simulation of wireless sensor network topologies using the ZigBee standard," International Journal of Computer Networks and Applications, vol. 2, no. 3, pp. 135–143, 2019.

[11] Y. Jo, J. Choi, and I. Jung, "Traffic information acquisition sys- tem with ultrasonic sensors in wireless sensor networks," International Journal of Distributed Sensor Networks, vol. 10, no. 5, Article ID 961073, 2014.

[12] M. M. Nabeel, M. F. el Deen, and S. El-Kader, "Intelligent vehi- cle recognition based on wireless sensor network," International Journal of Computer Science, vol. 10, no. 4, pp. 164– 174, 2019.

[13] I. Oppermann, L. Stoica, A. Rabbachin, Z. Shelby, and J. Haapola, "UWB wireless sensor networks: UWEN - a prac- tical example," IEEE Communications Magazine, vol. 42, no. 12, pp. S27–S32, 2004.

[14] C. F. Zhen, W. Liu, Y. Liu, and A. Yan, "Energy-efficient sleep/wake scheduling for acoustic localization wireless sensor network node," International Journal of Distributed Sensor Networks, vol. 10, no. 2, Article ID 970524, 2014.

[15] S. S. Jan, L. T. Hsu, and W. M. Tsai, "Development of an indoor location based service test bed and geographic informa- tion system with a wireless sensor network," Sensors, vol. 10, no. 4, pp. 2957–2974, 2010.

[16] M. Cardei and D. Z. Du, “Improving wireless sensor network lifetime through power aware organization,” Wireless Networks, vol. 11, no. 3, pp. 333–340, 2005.
[17] A. M. Badescu and L. Cotofana, “A wireless sensor network to monitor and protect tigers in the wild,” Ecological Indicators, vol. 57, pp. 447–451, 2015.
[18] M. C. Chen, S. Q. Lu, and Q. L. Liu, “Uniqueness of weak solu- tions to a Keller–Segel–Navier–Stokes system,” Applied Math- ematics Letters, vol. 121, article 107417, 2021.
[19] M. C. Chen, S. Q. Lu, and Q. L. Liu, “Uniqueness of weak solu- tions to a Keller-Segel-Navier-Stokes model with a logistic source,” Applications of Mathematics, pp. 1–9, 2021.

[20] P. Wang and G. Tu, “Localization algorithm of wireless sensor network based on matrix reconstruction,” Computer Communications, vol. 154, pp. 216–222, 2020.
[21] W. Chen, L. Gao, Z. Chai, Z. Chen, and S. Tu, “An intelligent guiding and controlling system for transportation network based on wireless sensor network technology,” Computer and Information Technology, vol. 5, pp. 810–814, 2019.
[22] Z. Wu, H. Chu, Y. Pan, and X. Yang, “Bus priority control sys- tem based on wireless sensor network (WSN) and zigbee,” in 2006 IEEE International Conference on Vehicular Electronics and Safety, Shanghai, China, December 2006.
[23] Z. Zheng, J. Lv, C. Li et al., “The improved indoor localisation algorithm based on wireless sensor network,” International Journal of Computational Science and Engineering, vol. 15, no. 3-4, pp. 322–329, 2017.
[24] C. Gong, Y. Hu, J. Gao, Y. Wang, and L. Yan, “An improved delay-suppressed sliding-mode observer for sensorless vector-controlled PMSM,” IEEE Transactions on Industrial Electronics, vol. 67, no. 7, pp. 5913–5923, 2020.
[25] Y. Liu, B. Zhang, Y. Feng et al., “Development of 340-GHz transceiver front end based on GaAs monolithic integration technology for THz active imaging array,” Applied Sciences, vol. 10, no. 21, p. 7924, 2020.
[26] J. Yang, S. Xiao, B. Jiang, H. Song, S. Khan, and S. . Islam, “Cache-enabled unmanned aerial vehicles for cooperative cognitive radio networks,” IEEE Wireless Communications, vol. 27, no. 2, pp. 155–161, 2020.
[27] Z. Cai, Z. He, X. Guan, and Y. Li, “Collective data-sanitization for preventing sensitive information inference attacks in social networks,” IEEE Transactions on Dependable and Secure Com- puting, p. 1, 2016.
[28] J. Chen, C. Du, Y. Zhang et al., “A clustering-based coverage path planning method for autonomous heterogeneous UAVs,” IEEE Transactions on Intelligent Transportation Systems, 2021.
[29] W. Wang, N. Kumar, J. Chen et al., “Realizing the potential of the internet of things for smart tourism with 5G and AI,” IEEE Network, vol. 34, no. 6, pp. 295–301, 2020.
[30] C. Peng and Z. Yu, “Modeling analysis for positioning error of mobile Lidar based on multi-body system kinematics,” Intelligent automation and soft computing, vol. 25, no. 4, pp. 827–834, 2019.
[31] T. Zhou, B. Lian, S. Yang, Y. Zhang, and Y. Liu, “Improved GNSS cooperation positioning algorithm for indoor localization,” Computers, Materials and Continua, vol. 56, no. 2, pp. 225–245, 2018.
[32] J. Wang, X. Qiu, and Y. Tu, “An improved MDS-MAP locali- zation algorithm based on weighted clustering and heuristic merging for anisotropic wireless networks with energy holes,” Computers, Materials and Continua, vol. 58, no. 2, pp. 227–244, 2019.
[33] M. Kanthimathi, R. Amutha, and K. S. Kumar, “Energy effi- ciency analysis of differential cooperative algorithm in wireless sensor network,” Cluster Computing, vol. 22, no. S4, pp. 9837– 9845, 2019.
[34] J. Wen, J. Yang, B. Jiang, H. Song, and H. Wang, “Big data driven marine environment information forecasting: a time series prediction network,” IEEE Transactions on Fuzzy Sys- tems, vol. 29, no. 1, pp. 4–18, 2021.
[35] S. C. Chu, Z. G. Du, and J. S. Pan, “Symbiotic organism search algorithm with multi-group quantum-behavior communication scheme applied in wireless sensor networks,” Applied Sci- ences, vol. 10, no. 3, p. 930, 2020.