***Node Localization in MIMO-WSN Using Adaptive mutation Artifial Bee colony***

**Overview of Proposed Technique:**

In the domain of radio systems, a stellar surge in the number of mobile users these days has brought in its train the added hassles of the excessive overlap of signal inputs with the attendant and awesome intricacies of the localization procedure. With an eager eye on eradicating the eventual signal overlapping dilemmas, the Multiple Input Multiple Output (MIMO) Cellular networks have been flagged off as a viable solution. The multiple-input and multiple-output, or its abbreviation MIMO with the phonetic representation of "my-moh" or "me-moh", has appeared on the arena as an august approach for the advancement in the ability of a radio link applying a host of transmit and receive antennas to take the added advantage of the multipath transmission. It has set its elegant foot as an indispensable segment of the wireless communication patterns such as the IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), HSPA+ (3G), WiMAX (4G), and the Long Term Evolution (4G). Striking a discordant chord from the smart antenna approaches it invests itself dedicated for the augmentation in the efficiency of a single data signal, like the beam-forming and diversity.

It has to be earnestly admitted that the MIMO networks offer a host of fruitful benefits. Nevertheless, it is unfortunate that they fail miserable to effectively address the localization hassles completely. Incidentally, there are four vital constraints habitually employed to appraise the localization approaches which include the Time of Arrival (ToA), Time Difference of Arrival (TDoA), and Angle of Arrival (AoA), the Received Signal Strength Indicator (RSSI). In the novel approach, the constraints are initialized in advance and a signal is generated for analysis. Further, an efficient optimization technique termed as the Adaptive mutation based Artificial Bee Colony (AMABC) optimization is kick-started to achieve the superior signal by reducing the BER (Bit Error Rate) values. Finally, beam-forming and equalization is also performed in the realms of the MIMO cellular technologies.

**1.1. Proposed node Localization Technique in MIMO Networks:**

The wireless sensor networks are fundamentally affected by the path loss impact and the path loss incidence is different for diverse directions. The power loss, in turn, is largely triggered by the hindrances by the parallel objects in the vicinity of the receiver and is habitually labelled as the Shadow fading or large-scale fading. The log-normal shadow model surfaces as the ideal candidate for the wireless sensor networks both in respect of the indoor and outdoor applications thanks to its global character and the innate skills of getting duly shaped in accordance with the ecosystem.

A spatially multiplexed MIMO system under the frequency-selective fading channel with L channel taps. N and M denote the numbers of transmit and receive antennas, respectively, and the block transmission environment. A sequence of data bits for a transmission block is modulated into a symbol sequence including KN symbols, where K is the number of transmit signal vectors in a transmission block. Let denote the kth transmit signal vector of a transmission block for where with the  identity matrix  . Then, the receive signal vector at time k with is written as



Where denotes the MN× channel matrix, which corresponds to the channel response of the lth tap at time k, and nk M×1 additive white Gaussian noise (AWGN) vector with zero-mean and the covariance matrix . The perfect channel estimation at the receiver is assumed, and therefore all and σ2 are perfectly known at the receiver. In addition, no inter-block interference is assumed. Furthermore, it is assumed that each sub-channel has unit energy regardless of k, which is written as



for any 1 ≤i≤ M and 1 ≤j≤ N, where is the element of  in the ith row and the jth column. let denote the M(K+L-1)×1 receive signal vector including all the received signals for the transmission block. Similarly, let denote the NK×1 transmit signal vector including all the transmitted signals for the transmission block. Then, the relationship between and can be written as



where denotes the AWGN vector including all the noise components for the transmission block, and is the channel matrix including the all the channel responses for the transmission block, which is written as



Whereis theall-zero matrix.

***1.1.1. Node Localization:***

The Location information of Mobile Terminal (MT) constitutes a demand in several wireless mechanisms. In this regard, the localization error is evaluated by means of Equation 4 shown hereunder.

 (4)

In the captioned equation for the node,  represents the real coordinate of the unidentified node and  signifies the approximate coordinate of unidentified node. corresponds to the communication radius of the sensor nodes. indicates the total number of the sensor nodes in the sensor field and  reveals the total number of anchor nodes. The lower localization error value exhibits superlative efficiency in accomplishment. The efficiency of the localization technique is significantly affected by the number of unidentified nodes, anchor nodes and the communication radius of the sensor nodes. In the document, the replication outcomes are assessed and appraised for the total number of nodes. In the authentic WSN networks, radio signals are adversely affected by the environ through which they are disseminated.

***1.1.2. Types of Node Localization Techniques:***

In accordance with the systems employed, various localization techniques may be broadly categorized into three types such as range-based Localization, angle-based Localization and the range-free or proximity-based Localization.

* **Range-based Localization:**

This mode of localization furnishes measurements dependent on the entire distance data among the nodes.

* **Angle-based Localization:**

In this type of localization, measurements are offered by attaining the angle data among the nodes.

* **Range-free or proximity-based Localization:**

In this case, only the connectivity data are presented.

**1.1.3. Distance Estimation in Localization:**

The ranging between two nodes is unearthed by bringing in two nodes in a network and subsequently locating the distance between them. In this regard, there are four general techniques for measuring in the localization approaches which are shown below.

* The Angle of Arrival (AoA)
* The Time of Arrival (ToA)
* The Time Different of Arrival (TDoA)
* The Received Signal Strength Indicator (RSSI)
* **Time of Arrival:**

The Time of arrival (TOA or ToA), at times termed as the Time of Flight (ToF), represents the travel time of a radio signal from a single transmitter to a far-off single receiver.

The travel time taken by a radio signal to travel from the single transmitter to the far-flung single receiver is represented by means of Equation 5 shown below.

 (5)

* **Angle of arrival (AoA):**

The Angle of Arrival (AOA) invariably entails a minimum of two towers, identifying the caller at the point of intersection of the lines along the angles from each tower. This type of measurement represents a technique for ascertaining the direction of transmission of a radio-frequency wave incident on an antenna array. The AoA decides the direction by evaluating the Time Difference of Arrival (TDOA) at individual elements of the array and from the corresponding delays the AoA is effectively evaluated.

* **Time Difference of Arrival (TDOA):**

The Time Difference of Arrival (TDOA) functions by means of the multilateration, with the exception that the networks play a vital role in calculating the time difference and hence the distance from each tower (as with seismometers).

Let the receiver be positioned at a distance  from the transmitter. The transmitter is placed at the distance . The Time Difference of Arrival is estimated by means of the following Equations 6 and 7.

 (6)

 (7) Where, the distance  represents the wave speed  times the transmit time .

* **Received Signal Strength Indicator (RSSI):**

In the domain of the telecommunications, the received signal strength indicator (RSSI) constitutes a measure of the power existing in a received radio signal.

The RSSI is habitually invisible to a user of a receiving device. Nevertheless, as the signal strength is capable of fluctuating significantly and having a significant impact on the functionality in the wireless networking, IEEE 802.11 tools generally make the measure accessible to users.

The RSSI is usually performed in the intermediate frequency (IF) stage before the IF amplifier. In the zero-IF mechanisms, it is carried out in the baseband signal chain, before the baseband amplifier. The RSSI output is frequently a DC analog level. It may also be sampled by an internal ADC and the resultant codes accessible directly or through the peripheral or internal processor bus.

**Received signal strength (RSS):**

The received signal strength represents the easiest and the cost-effective metric to estimate the distance between the sensor nodes for the localization objectives . In the RSS based localization techniques, the signal strength received at the sensor node is mapped into distances by means of certain channel model. The most well-acknowledged channel model is the log normal shadowing model. The received power at the sensor nodes employing the log normal shadowing model is represented by means of the following Equation 5.

 (5)

The sensor nodes are arbitrarily employed in a square region. All the anchor nodes and unidentified nodes comprise an identical communication radius of 15m.

In our proposed model, a signal is generated with some of the localization parameters. At transmitter side the signal is OFDM modulated. While transmission through the channel, thermal noise is added. In between this, the propagation loss (path loss) and the interferences are measured.

The proposed architecture is shown through the below figure1.

Reconstructed signal



Input Signal

OFDM Modulation

Determine Interference & Propagation Loss

Noise addition (Thermal noise)

AMABC Optimization

OFDM Demodulation

Transmitter

Channel

Receiver

Beam forming

Equalization

**Figure 1:** Architecture Diagram

**Path Loss**

The mathematical equation for the Path Loss Function evaluated and expressed in decibel is represented by the following Equation 1.

 (1)

Where,

 relates to the distance between the sending and receiving nodes

 denotes the near earth reference distance

 corresponds to the Path loss index

 signifies the zero-mean Gaussian random noise

The Path Loss function represented in terms of the Transmitter and Receiver is furnished by Equation 2 given below.

 (2)

Where,

 symbolizes the Transmitted Signal Power

 represents the Received Signal Power. The value of path loss index is invariably dependent on the environment or the transmission scenario. The distance  is considered as one meter for the sake of easy evaluation. The basic edition of Equation 1 may be expressed with respect to the received power as shown by Equation 3 given hereunder.

 (3)

The overall procedure diagram is colourfully pictured in Fig1, where the MIMO cellular network going through the data-sharing procedure is elegantly exhibited.

At the transmitter side, the signal will be OFDM demodulated. Then in order to reduce the noisy content, AMABC algorithm is employed.

**3.1.4. Adaptive Mutation based Artificial Bee Colony Optimization Algorithm (AMABC):**

The Adaptive Mutation based Artificial Bee Colony Optimization Algorithm is introduced in our proposed method to reduce the BER by optimizing the input signal. The ABC algorithm and its drawbacks are explained below.

* **Artificial Bee Colony Optimization Algorithm:**

The vital objective of the optimization method is to find a set of fittest values for the input parameters. The Artificial bee colony (ABC) optimization represents a swarm intelligence based algorithm which replicates the foraging character of the honey bees. An enormously huge number of bespoke and superior versions like the G best guided ABC, binary version of the ABC known as the DisABC, differential ABC, interactive ABC, and the cooperative ABC have been flagged off and are in vogue at present.

In the ABC model, foraging honey bees are classified into three vital categories such as the Employed bee, Onlooker Bee and the Scout bee.

In accordance with the two essential leading modes of the forages such as the employment to a food source and refusal of a source, the procedure of bees on the hunt for sources with an elevated amount of nectar is the one deployed to ascertain the optimal solution for the specified optimization issue.

* **Steps involved in AMABC:**

The steps involving in AMABC algorithm is detailed in the below section.

**Step (1): Initialization:**

* An initial population of  individuals is created.
* For each and every individual,  represents a food source (i.e. solution) consisting of  attributes (i.e., dimensionality).

**Step (2): Fitness Evaluation of**  **Individuals**

* In this phase, the fitness of each individual solution is estimated.

**Step (3): Obtain Neighborhood position**

* Here, the neighbourhood of the current position of each employed bee is attained to locate a superior food source.

**Step (4): New Solution Generation**

* Hence, in respect of each and every employed bee, a new solution is produced around its current position, with the help of Equation 6 given below.

 (6) Where,

 and - arbitrarily selected list

- number of employed bees

- even arbitrary number within range [-1, 1].

**Step (5): Selection of Best probability based on Fitness Function**

* In this step, the fitness of both  and are determined and the selection method is initiated to shortlist the superior among them.
* **Step (5a) : Selection Probability** 
  + Now, the selection probability values,  are estimated and standardized for each and every employed bee, with the assistance of the roulette-wheel selection approach.

The selection probability  of the parameter is given as,

 (7)

The adaptive mutation function in the food source position (solution) generation procedure enhances the efficiency in performance of the ABC technique. The novel adaptive mutation function in the AMABC is illustrated as follows.

 (8)  (9)

Where, - mutation probability; , - mutation coefficient factors; , and  are the maximum, minimum and average fitness of food sources. When the evaluation of  of the entire  is finished, average of Equation (7) is estimated and which exceed the valued of the average probability is shortlisted.



*then*  is modernized by means of onlooker bee phase

**Step (6): Assigning Onlooker Bee**

* Here, each and every onlooker bee is allocated to an employed bee,  arbitrarily with probability in direct proportion to 
* **Step (6a) :**
* In this stage, new food positions,  for each and every onlooker bee,  are generated deploying its employed bee as  in (6).
* **Step (6b) :**
* Thereafter, the fitness of each onlooker bee  is estimated together with the new solution. Now the greedy selection method is followed to retain the superior bee, after rejecting others.
* When the evaluation of the bestis finished, the best outcomes from the onlooker bee phase and employed bee phase are analysed, assessed and contrasted one by one.

**Step (7): Replacing with Scout Bee**

* In case a specific  has not been enhanced even after a number of iterations, it has to be abandoned.
* The solution is replaced by introducing a scout bee at a food source at the search space by means of Equation 7 illustrated as follows.

 for (10)

**Step (8): Placing Final Best Solution**

* In this step, the best food source position (solution) discovered till now, has to be tracked.

**Step (9): Termination**

* At this juncture, the termination has to be verified. If the best solution discovered is satisfactory or a maximum number of iterations have been reached, the process has to be stopped. When the stoppage standard is satisfied, the best are shortlisted and replaced in Equation (6) to achieve the ultimate clustered outcome. Or else, return to step 2 and continue the process.

In the long run, the AMABC Optimization technique is carried out for the purpose of reducing noisy contents so as to achieve the lucid communication of the radio signal through the transmitter/receiver units. Subsequently, the MIMO networks are facilitate to carryout the beam-forming so as to evaluate the signal strength at any direction.

**3.1.5. Beam forming & Equalization:**

The beam forming or spatial filtering represents a signal processing approach extensively employed in the sensor arrays for the directional signal conduction or reception. It is attained by integrating the elements in a phased array in order that the signals at specific angles are subjected to constructive interference while others undergo destructive interference. It is effectively utilized at the communicating and receiving ends so as to attain the spatial selectivity. It is beneficially employed for radio or sound waves. It is widely accepted in a number of applications in the domains of the radar, sonar, seismology, wireless communications, radio astronomy, acoustics, and the biomedicine. Finally, the process of equalization is performed within the MIMO cellular system in order to balance the frequency components of the received signal.