Distributed Signal Strength Localization of FDMA Scheduling in WSN

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ABSTRACT
The study described the distributed signal strength localization of Frequency Division Multiple Access (FDMA) for splitting of the frequencies in various environments. Based on the signal strength, the Maximum Likelihood Estimator (MLE) have used to reduce the errors in the localized environment and also it described that the fixed time slots allocating for the distribution of the data with help of Frequency Division Multiple Access Algorithm (FDMASS) algorithm. The existing system of approach had used to access the Space Division Multiple Access (SDMA) in Total Least square Estimator (TLS) to minimize the errors. This approach was very difficult to identify the deviation of frequencies and also difficult to reduce the errors. During the data distribution, the experimental results consist of how FDMASS algorithm is functioning efficiently on allocation of the fixed time slots for minimizing the errors with respect to MLE than the TLS estimator.

Key words: Wireless sensor networks, localization, fdma, maximum likelihood estimator, total least square estimator

INTRODUCTION
Wireless sensor networks had recently come into prominence because they hold the potential to revolutionize many segments of our economy and signal processing embedded computing and connectivity. The distributed time frequency division multiple access protocol had used in Wireless sensor networks scheme defined the new protocol for measuring the data distribution delay until remaining system utilization was reached (Buranapanichkit and Andreopoulos, 2012). To improve the energy in various level of communication, most energy efficient medium access control protocols were used to compare their performances based on the new MAC protocol and on Orthogonal Frequency Division Multiplexing (OFDM). In Frequency Division Multiple Access (FDMA), different nodes have different carrier frequencies. In the case available bandwidth node decreases due to the frequency resources were divided (Sampoornam and Rameshwaran, 2011). To achieve the high throughput and eliminate small bounded end to end delay in for newer types of sensor network applications, such as real-time voices streaming produced in the hybrid Time Division Multiple Access/Frequency Division Multiple Access (TDMA/FDMA) medium access control protocol for wireless sensor networks. This scheme provides the high output for end to end delay across multiple hops and produces the collision free operation and predictable lifetime (Salajegeheh et al., 2007). To minimize the energy consumption, delay during data collection and reduce time
complexity. Scheduling of cluster was defined by the FDMA approach and allocate the frequency channel for each sub link from the existing protocol (Bansal and Singh, 2012; Ji et al., 2006). The square root process was measured in terms of interest rate time series (Xiu, 2010; Lettau et al., 2001). This scheme provides optimal solution for computational estimation of time series. The empirical modes in localizations were applied for WSNs in different indoor multipath environment; residential manufacturing floor. This scheme specifies that the localization accuracy of indoor application in comprehensive analysis such as network and ranging model parameters (Dardari et al., 2008; Henaut et al., 2010). Improve localization accuracy of range-free localization schemes and performed through performance evaluation based on ROCRSI (Ring Overlapping based on Comparison of Received Signal Strength Indicator) (Hu et al., 2010; Ergen and Varaiya, 2010). Hence, it improved the performance study of the system defined with the FDMA approach for splitting of the frequencies in every communication channel. The FDMASS algorithm was the proposed approach to define the time slots for allocating the frequencies in every communication channel. The performance measurement had to be taken into account of minimizing the error with help of MLE estimator. Finally the signal strength was measured in appropriate position for producing the efficient bandwidth in distributed environment.

MATERIALS AND METHODS

Proposed approach: The study of the proposed approach was used to minimize the error, reduced energy consumption and found the average life time of the network. In localization environment, the signal was distributed in every location. The measurement of the signal strength could be defined in every data transmission. Every channel was included during data transmission dynamically adapted from the source. FDMA approach allocates a frequency to every channel on each sub link from the existing pool. If frequency channel was not available then the channel allocates half frequency to a sub-link from a low data transferring cluster. The signal strength scheme would broadcast the topology packet containing information of the network. This location scheme could be implemented in FDMA/TDMA approach and found the efficient way of utilizing the signal strength in every location. FDMA Signal strength approach was used according to which node broadcasts a schedule data in one location and inform other location about their time slots as well as their channel frequencies for exchanging data. Using this algorithm multi hop nodes were developed and arranged in hierarchy. By maintain this hierarchy network, lifetime would be maximized and delay in time complexity would be minimized. The maximum likelihood estimator technique was applied in this algorithm to found the errors in every location. The errors cannot be fully reduced but it could be minimized. So, the existing errors would be identified in every location. Based on this mechanism, the signal strength was measured to identify the location having minimum error and finally adapts the signal position in the particular location.

FDMASS scheduling algorithm: As per the previous section defined, the signal was passed from one location to every other location. All the locations were aggregating to compare the signal position. Construction of minimum delay schedules could be reduced with help of FDMASS scheduling algorithm. Figure 1 shows that how the data was scheduled in every location.

The FDMASS algorithm performs, based on Breath First Search (BFS) but it was used efficiently in every location, so that the new algorithm was formed here to perform the localization operation. As each location N, was traversed by FDMASS, it was assigned a default time slot and a frequency. Then the possibility of having an interference with any of its same-height
Fig. 1: FDMA Scheduling Model with Timestamp

previously-visited location and found for Ni, the algorithm checks whether N_i and N_j are same location. If so, N_i would be assigned a different time slot. If they were not siblings then N_i would be assigned a different frequency. When FDMAS was about to start a new level (height) of nodes the default time slot number would be increased by one. Once all the data are processed according the above method, the time slot assignments would be inverted such that the slot number assigned to every node was smaller than that of its parent. This inversion was done as following:

\[ B_{new} = n_{max} \times (n_{current} + 1)/\text{timeslots} \]

(1)

Algorithm 1: FDMAS Algorithm

1: ENQUEUE (Q, S)
2: while Q is not empty do
3: v = Deque
4: timeslot = currenttimeslot
5: channelv = 1
6: calculate signal strength based on the frequency level with the following
7: if frequency[v] > 50 and frequency[v] < 100
8: slottedTime1 = (timeinhours * 60) + timeinminutes
9: executionTime = n*(n+1)/slottedTime
10: end
11: if frequency[v] > 100 and frequency[v] < 500
12: slottedTime2 = (timeinhours * 60) + timeinminutes
13: executionTime = n*(n+1)/slottedTime
14: end
15: if frequency[v] > 500
16: slottedTime3 = (timeinhours * 60) + timeinminutes
17: executionTime = n*(n+1)/slottedTime
18: end
Algorithm 1: Continue

17: end
18: if(timeslot1<timeslot2)
   Display the approximate signal strength $S_i$ is getting weak for the particular time period.
   end
19: if(timeslot2<timeslot3)
   Display the 50% signal strength $S_i$ is getting weak for the particular time period.
   end
11: else
   The accurate signal strength is measured with fast transmission.
   end
20: else
21: timeslot = timeslotn
22: channeln = channeln
23: end
24: for e=0:100
25: parentw = v
26: height = height + 1
27: Calculate directly the approximate value of signal strength (if the channel is unknown) of
   the following
   executionTime = $n^*(n+1)/$timeslot3
28: end for
29: end while

where, $E_{new}$ is the new inverted assigned slot, $n_{max}$ is the current slot number assigned to the node
and $n_{current}$ is the total number of assigned slots. The overall performances are measured in the
Algorithm 1.

Localization scheme: The Localization scheme proposed with Signal strength real scheme with
weighted centroid localization for estimating the communication channel to find out the position
of the receiver in the location. The Fig. 2 is the block diagram of localization scheme.

Weighted centroid localization: The range free localization scheme was the weighted centroid
localization. This scheme was used to find out the position of the receiver in the communication

![Diagram](image-url)

Fig. 2: Signal Strength scheme using FDMA
channel from one node to another anchor node and finally calculated the weighted average of Sensor nodes. In this method, the anchor nodes transmit a beacon containing their respective location information. This scheme helps us to find the position of every sensor node by minimizing errors.

**Localization:** The localization scheme collects the information from reflector database. The reflector position could be set as the position in the location of source. The variances of $t$ can be found the unbiased estimator with minimizing the error in anchor node by calculating the weighted average in all sensor nodes of the following:

\[
\begin{pmatrix}
X_n, Y_n
\end{pmatrix} = \left\{ \frac{w_1 X_1 + \ldots + w_n X_n}{\sum w_i}, \frac{w_1 Y_1 + \ldots + w_n Y_n}{\sum w_i} \right\}
\]  

(2)

where, the $(x_1, y_1), \ldots, (x_n, y_n)$ denote the anchor nodes’ coordinates $(X_n, Y_n)$ is node’s estimated coordinate. $N$ is the number of anchor node in the network, $w_i$ represents weighted edge factor.

The performance of this approach highly depends up on the optimization of edge weights. In this case multiple sensor nodes could communicate easily with efficient energy consumption and lower errors.

**Maximum likelihood estimator:** Let $f(x, \theta)$ be given by a Gaussian distribution. Let $a = m$ be the mean of the Gaussian. The best estimate of $\theta$ from the set of $n$ measurements $x = \{x_1, x_2, \ldots, x_n\}$. Let’s assume that $\sigma$ is the same for each measurement.

\[
f(x_i, \theta) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x_i - \theta)^2}{2\sigma^2}}
\]  

(3)

The likelihood function for this problem is:

\[
\mathcal{L} = \prod f(x_i, \theta) = \prod \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x_i - \theta)^2}{2\sigma^2}} = \left[ \frac{1}{\sigma \sqrt{2\pi}} \right]^n e^{-\frac{1}{2\sigma^2} \sum (x_i - \theta)^2}
\]

(4)

Find $\theta$ that maximizes the log likelihood function:

\[
-\frac{\partial}{\partial \theta} \sum (x_i - \theta)^2 - \sum 2(x_i - \alpha)(-1) = 0
\]

\[
\sum x_i = m_n
\]

\[
a = -\frac{1}{n} \sum x_i
\]  

(5)
If $o$ is different for each data point $a$ is just the weighted average:

$$
\frac{\sum_{i=1}^{n} a_i}{\sum_{i=1}^{n} w_i}
$$

(6)

From Equations 3-6 the Maximum Likelihood Estimate (MLE) of $a$ that maximizes $f(x, a)$ where, $x_i = \{x_1, x_2, \ldots, x_n\}$ is random variable, each component of variance $\sigma^2$, must satisfy the constraint $\sigma^2 \geq 0$ and $a$ is biased estimator.

RESULTS AND DISCUSSION

The simulation results were calculated in matlab. The Fig. 3 shows that scheduling the frequency in every node. In this study, the MLE was applied to found the constant level of the frequency in all the nodes. Each node was connected to its neighboring node. It shows that totally 20 nodes were distributed in the signal strength of the frequency 600. The signal frequency was measured for transmitting the data in every node with approximately from 0-600 MHZ. Based on the algorithm 1 (FDMASS) the transmission time was calculated with respect to the range of the frequency in between 50-100, 100-500 and etc. The error rates are measured in every signal distributed with respect to nodes.

The previous discussion of study had defined with TLS(Total Least Square), Least Square(LS) and Minimum Variance Unbiased Estimator (MVE). The frequency levels were increasing based on the number of nodes increased in every level. If the number of sensors nodes increased then it could further improve the average correlation magnitude of data transfer was 0.8. In this case the least square estimator applied in FDMA with value of frequency was 0.8. The Weighted average time slot calculation of the frequency was varying in every sensor nodes. In the same scenario of TLS, the frequency level of the value is 0.65 when data can be transferred from one sensor node to all other sensor node. The weighted average time delay of every node had measured with 0.5 in TLS. The Minimum Variance Unbiased Estimator was used in another factor to calculate the frequency level calculated as 0.5 and the weighted average time slot was measured as 0.5. So the MLE is the best estimator than all other technique to define the average weighted time slot is fixed in all sensor nodes. The average time was calculated in the range of 0.21 with all the frequency level was 0.4 in terms of MHZ. So, this study was compared with one of the estimator technique

![Graph](image)

Fig. 3: Scheduling the frequency level in no of sensor nodes

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Fig. 4: Signal strength is measured in every frequency level

named as TLS and produces the best result. The frequency level was increased when no of nodes were distributed, the signal strength is measured based on the error rate. The Fig. 3 shows that the frequency was increased in every bandwidth and the error rate was minimized in the position of signal. The frequency level was constantly maintained in every node, when the data are transferred perfectly. The comparison values with the frequency value of MLE is 0.4. The total estimation time calculated from the distribution of dynamic data with localization errors are given in Fig. 3. It has seen from the Fig. 3 localization error % was less in the case of 0.4% with 50 nodes and also remains the same in the case of 200 nodes. It shown that 50-500 nodes were distributed by calculating the arrival time of action with TLS and MLE estimator of computation time was measured as between the range 0<<T<<1 and average time was measured 0.4 with Linear and Non-Linear data model.

From the Fig. 4, every signal position was measured in data transmission and it could maintain the time slot in every transaction. It also defined that every data was reached within the time slot. Every data was transferred with different signal strength (i.e.) 200-350 but it reaches within one minute. Due to various frequency levels, the time slots are fixed and scheduled for transmission.

The Fig. 5 shows the maximum likelihood estimator for minimizing the errors. Once the time slots were measured, the errors were calculated based on the maximum likelihood estimator. The MLE estimator was compared with Total least square estimator. The MLE was the best estimator technique to find the errors in every frequency. The frequencies were measured in terms of MLE estimator, totally 25 nodes were sending the data with its location. The position of the location was specified as 2-14.

The curves in Fig. 5 further illustrate the behavior of localization error by the two methods that are adopted in the present approach. MLE shows two minima whereas, TLS shows two maxima from this it was clear that MLE has minimum localization error.
Fig. 5: Variation of localization error in maximum likelihood estimator and total least square estimator

Table 1: Weighted average compute time with dynamically distribution of data

<table>
<thead>
<tr>
<th>No of Nodes</th>
<th>Frequency (MHz)</th>
<th>Random data</th>
<th>Weighted average compute time</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>50</td>
<td>4</td>
<td>0.15</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
<td>5</td>
<td>0.17</td>
</tr>
<tr>
<td>200</td>
<td>250</td>
<td>6</td>
<td>0.21</td>
</tr>
<tr>
<td>250</td>
<td>300</td>
<td>7</td>
<td>0.21</td>
</tr>
<tr>
<td>300</td>
<td>350</td>
<td>8</td>
<td>0.21</td>
</tr>
<tr>
<td>400</td>
<td>500</td>
<td>9</td>
<td>0.2</td>
</tr>
<tr>
<td>500</td>
<td>600</td>
<td>10</td>
<td>0.2</td>
</tr>
</tbody>
</table>

cmpared to TLS. The comparison value with the frequency of index value of MLE is 0.4 and the index value of TLS is 0.76. Table 1 shows that the Weighted average in every distribution of data.

**CONCLUSION**

The main purpose of localization in WSN was evaluated in this study. This study proposed the distributed signal strength localization of FDMA scheduling in WSN. The result of analysis performed MLE was compared with TLS estimator. During the transmission, the fixed time slots are measured in terms of various frequency levels. The Signal strength was measured in the carrier frequency channel of FDMA scheduling algorithm for distributing the data. During the data transmission the average weighted computation time was calculated for taking the communication with every anchor node which is given in Table 1 So, the system of simulation proposed the MLE estimator were producing the better results than TLS for minimizing the errors.

**REFERENCES**


