II. ADVANTAGES OF R.T.D OVER OTHER ALGORITHMS [5]

A. Method 1

The technique for defective sensor node distinguishing proof examined is relies on upon examination between neighbor nodes and dispersion of choice which is made at every sensor node. The calculation composed in this technique can't locate the malicious nodes present in the WSNs.

B. Method 2

Cluster head fault recovery technique to recognize failed sensor nodes has disadvantage of information misfortune because of exchange of cluster head.

C. Method 3

The strategy utilizing path redundancy technique for recognizable proof of faulty sensor nodes. On account of redundancy there is an augmentation in energy utilization and decrements in number of right results in network life range. Because of exorbitant redundant paths present in wireless sensor network speed of identification procedure gets moderate down.

D. Method 4

By utilizing Monitoring Cycles (MCs) and Monitoring paths (MPs) link failure can be detected. Disadvantages of this technique are three edge availability in wireless sensor network and each monitoring cycle and location uses separate wavelength.

E. Method 5

Utilizing Round Trip Delay (RTD) and Round Trip Paths (RTP) The procedure of location of faulty nodes utilizing RTD and RTP can be seen as two sections. The initial segment includes presumption that all the sensor nodes are working accurately and there is no faulty node present in the network and the threshold value is set by measuring RTD time of all the RTPs. In second part actual location of faulty nodes is finished by selecting discrete RTPs and comparing their RTD times with predefined threshold which is set in first part. Round Trip delay time of the RTP will change because of faulty sensor nodes. It will be either endlessness or more than the predefined threshold value. The sensor node which is defective can be identified by contrasting the RTD time of RTPs and predefined threshold value. The sensor node common to precise RTPs with infinity RTD time is detected as failed. On the off chance that this time is higher than predefined threshold value then this sensor node is identified as malfunctioning. The season of recognition of faulty sensor node relies on the numbers of RTPs and RTD time. Along these lines, RTD time estimation and estimation of RTPs is should minimize the detection time.

Method1 investigations the neighbor nodes with a specific end goal to recognize faulty nodes. Despite the fact that the method2 is straightforward yet t has data loss
problem because of cluster head transfer. Path redundancy technique has a disadvantage of energy consumption and slow speed. Use of separate wavelength for each monitoring cycle is the drawback of method4. According to work carried out, the technique of faulty node detection using RTD and RTP is found accurate and energy efficient.

III. ANALYSIS OF ROUND TRIP DELAY[3]
Round trip delay time of the RTP will change because of faulty sensor node. It will be either infinity or higher than the threshold value. Faulty sensor node is identified by contrasting the RTD time of RTPs with threshold value. The sensor nodes basic to particular RTPs with endlessness RTD time is recognized as failed. On the off chance that this time is higher than the threshold value then this sensor node is recognized as malfunctioning. Identification time of faulty sensor node relies on the numbers of RTPs and RTD time. In this manner, RTD time estimation and assessment of RTPs is must to minimize the detection time.

RTD time principally relies on the numbers of sensor nodes present in the round trip path and the distance between them. Proposed fault identification procedure precision can be expanded by lessening the RTD time of RTP. It can be lessening just by decreasing the sensor nodes in RTP in light of the fact that the distance between sensor nodes in WSNs is controlled by specific applications and can't be chosen. Selecting least numbers of sensor nodes in the RTP will reduce the RTD time. The round trip path (RTP) in WSNs is shaped by gathering least three sensor nodes. Thus the minimum round trip delay time (τRTD) of RTP with three sensor node is given by

\[ \tau_{RTD} = \tau_1 + \tau_2 + \tau_3 \]  

Where \( \tau_1, \tau_2 \) and \( \tau_3 \) are the delays for sensor node pairs (1,2), (2,3) and (3,1) respectively. Circular topology with six sensor nodes is shown in Fig. 1.

![Circular topology WSN with six sensor nodes](image)

Fig. 1: Circular topology WSN with six sensor nodes.

Three consecutive sensor nodes in each RTP are almost at equidistance because of circular topology. As a result sensor node pair delays \( \tau_1, \tau_2 \) and \( \tau_3 \) will be equal. Let \( \tau \) be the uniform time delay for all sensor node pairs in RTPs

i.e. \( \tau = \tau_1 = \tau_2 = \tau_3 \).

Round trip delay time for RTP with uniform sensor node pair delay is obtained by referring equation (1) as

\[ \tau_{RTD} = 3\tau \]  

This is the minimum RTD time of a RTP in WSNs. It is dictated by the sensor node pair delay (\( \tau \)), which is chosen by specific use of WSNs, as it relies on the distance between the sensor nodes. Consequently the effectiveness of proposed strategy can be enhanced just by reducing the RTPs in WSNs.

IV. ANALYSIS OF ROUND TRIP PATHS[3]
The numbers of RTPs formed with ‘m’ sensor nodes is given by

\[ P = N(N - m) \]  

Where \( P \) is the numbers of RTPs. Analysis time of fault detection method is the time required to measure the RTD times of all RTPs in the WSNs. It is the addition of all RTD times. The equation for analysis time with \( P \) numbers of RTPs is given by

\[ \tau_{ANL} (M) = \tau_{RTD} - 1 + \tau_{RTD} - 2 + \cdots + \tau_{RTD} - P \]  

(5)

RTD time of RTP will increment for extra number of sensor nodes. Referring (3), ideal estimation of RTD time of RTP is acquired by considering just three sensor nodes. All the RTPs in WSNs are formed by selecting just three sensor hubs (m = 3). At that point the round trip delay for all RTPs is around same.

i.e. \( \tau_{RTD} = \tau_{RTD} - 1 + \tau_{RTD} - 2 + \cdots + \tau_{RTD} - P \)

Equation (5) can be written with the equal RTD time as

\[ \tau_{ANL} = P \times 3\tau \]

(7)

Referring (2), analysis time can be written in terms of sensor node pair delay is as

\[ \tau_{ANL} = P \times 3\tau \]  

(8)

Minimum numbers of sensor nodes used to form RTP will create substantial numbers of RTPs. The maximum possible round trip paths \( P_M \) created by three sensor nodes per RTP are obtained by substituting \( m = 3 \) in (3) and is given by

\[ P_M = N(N - 3) \]  

(9)

Analysis time \( \tau_{ANL} (M) \), to detect the faulty sensor node using maximum RTPs is obtained by referring (8) and (9) as follows

\[ \tau_{ANL} = N(N - 3) \times 3\tau \]  

(10)

The fault identification analysis time the reality of the situation will become obvious eventually exponentially with increase in number of sensor nodes \( N \) in WSNs. Likewise the maximum numbers of RTPs produced are not required for correlation with distinguish the fault. Such determination of RTPs is not a sufficient answer for speed up fault detection. Consequently improvement of RTPs in WSNs is fundamental to accelerate the fault detection.

V. OPTIMIZATION OF RTPS
The large number of RTP will affect the performance. Optimization of RTPs in WSN is required to speed up the fault node detection. Therefore essential numbers

A. Linear Selection of RTPs
The number of RTP is equal to number of sensor node is called linear RTP. Because provide linear relationship between path and node. Single node is presented in three linear RTP. Fault detection process need to compare between three RTP to identify fault node. The linear RTPs in WSNs with \( N \) sensor nodes can be written as

\[ P_L = N \]  

(11)

Where, \( P_L \) is the number of linear RTPs

Linear RTPs is not significant for large value of sensor nodes. This will not optimize the fault detection time in case of large size WSNs. Therefore further reduction in
the numbers of RTPs is must to increase the efficiency of proposed method.

B. Discrete selection of RTPs [3]

The number of RTPs is high. For WSNs with large number of sensor node the fault detection time is significantly high. The number of RTP is reducing by selecting Discrete RTP from sequential linear RTP. To reduce the complexity and speed up the detection process by ignoring the two consecutive paths.

The efficiency of fault node detection method is improved. Analysis time to detect the fault is proportional to number of RTPs used. Fault detection process will be done faster with discrete RTP. Source node in the RTP is a failure node then fault is identified with the discrete RTP plus one additional path is required.

The discrete RTPs obtained are very much optimized as compared to linear RTP cases. RTD time of very few RTPs is measured in case of discrete path selection, which will save the utilization of sensor node in fault detection. The RTD analysis time required for linear and discrete RTPs with different numbers of sensor nodes.

The Discrete RTPs in WSNs with N sensor node can be written as

$$P_{D} = Q + C$$  

(12)

Q and C in above equation are expressed as below

$$Q = \left\lfloor \frac{N}{m} \right\rfloor$$

$$C = 0 \text{ if } R = 0$$

$$C = 1 \text{ otherwise.}$$

Where Q is the quotient, m is the numbers of sensor nodes in RTP, R is remainder, N is numbers of sensor nodes in wireless sensor networks and C is correction factor to be added. Correction factor will be 0 if remainder is 0 otherwise it is 1.

VI. RESULT ANALYSIS.

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>RTPs</th>
<th>N = 6</th>
<th>N = 10</th>
<th>N = 20</th>
<th>N = 40</th>
<th>N = 60</th>
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<td>70</td>
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<td>1480</td>
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<td>2.</td>
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<td>10</td>
<td>20</td>
<td>40</td>
<td>60</td>
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<td>4</td>
<td>7</td>
<td>14</td>
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</table>

Table 1: RTPs Comparisons for Maximum, Linear and Discrete Methods for Various WSNs

From the above table we can compare the maximum path, linear selection of RTPs and discrete selection of RTPs and came to know that discrete selection of RTPs is much lesser then the other two. Fig-2 shows the behavior of how RTPs change with change in number of sensor nodes in WSNs.

![Fig. 2: Maximum, linear and discrete RTPs formed for different values of sensor nodes N in WSNs](image)

![Fig. 3: RTD time of 6 number of node in WSNs](image)

Fig-3 is the result of RTD time of 6 number of node in wireless sensor network in which node 4 is faulty node as is value is negative and here negative values are considered as a infinite.

![Fig. 4: Xgraph of RTD time of 6 number of node in WSNs](image)

Fig-4 is the xgraph of RTD time of 6 number of node in wireless sensor network using NS2.

![Fig. 5: circular topology of sensor node in NS2](image)

![Fig. 6: Analysis Time Comparisons For Linear And Discrete Methods For Various Nodes (N) Wsns](image)

Table 2: Analysis Time Comparisons For Linear And Discrete Methods For Various Nodes (N) Wsns
Node Failure Detection in Wireless Sensor Networks

Fig. 6: Comparison of LINEAR τANL & DISCRETE τANL

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>N</th>
<th>m</th>
<th>Q = [N/m]</th>
<th>R</th>
<th>C</th>
<th>L = (m-1)</th>
<th>P_t = Q+C+L</th>
<th>Analysis time P_t * RTD</th>
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<td>1</td>
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<td>2</td>
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<td>8</td>
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<td>5</td>
<td>9</td>
<td>16.23978</td>
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</table>

Table 3: Analysis time of discrete RTPs with variable number of sensor nodes from 3 to 6 for WSNs with 20 sensor node

Fig. 7: Comparison Analysis time of discrete RTPs with variable number of sensor nodes

VII. CONCLUSION

Here I have created wireless sensor networks and discuss the fault detection technique, issues and problem of W.S.Ns and found out the RTD. Here I have create a wireless sensor network and calculate the RTD of RTP and finally find faulty node participating in WSNs using RTD. Here I have create a wireless sensor network using different combination of sensor nodes and calculate the RTD time of their RTPS and finally concluded that the nodes in RTPs increase the analysis time also increase. The best of them is RTPs with 3 sensor node in it. I had also compared the maximum, linear & discrete selection of path and conclude that discrete selection of path is best.

REFERENCE