# ENERGY AWARE MOBILE DISPATCHMENT AND SCHEDULING IN HYBRID WIRELESS SENSOR NETWORK

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*ABSTRACT*

*Wireless Sensor Networks (WSNs) are used in many places including strategic monitoring in Military and changes of nature in environmental monitoring. WSNs deploy sensors remotely in large numbers in unattainable environments and work autonomously. Though Wireless Sensor Networks (WSN) havebeen deployed in many places, their energy constraints is still an issue. Hence, this paper introduces Energy aware Mobile Dispatches and Scheduling Method (EMDSM) for an energy aware scheduling in WSNs.  In the proposed research work hybrid genetic PSO algorithm is utilized to choose the optimal energy aware route path.After route path selection, similar data grouping is done to reduce the computation overhead. The simulation results of EMDSM in comparison with LEACH showimprovement in its performance.*

*Keywords: Energy consumption, mobile dispatchment, reliability, computation overhead reduction, processing capacity, data redundancy*

## I. INTRODUCTION

Currently, WSN services are employed both in industrial and commercial applications. The network is built with nodes and applied used in various real-time applications like observing humidity, temperature, pressure and many other changes in surroundings. WSNs include several processes like smart detection, discovering neighbour nodes, processing data and routing to base stations. Grouping nodes is an important aspect in WSNs ad-hoc sensors [1]. Since, these sensors communicate data there is a possibility of load peaks and collisionswhich can drain the energy of sensors and WSNs quickly. Grouping of nodes is the first solution as in a grouped network as in clustering them clusters are formed and cluster heads (CHs) are created [2]. The CH collects data from its group and aggregates that data before forwarding it a centralized base station. The focus thus shifts to the energy levels CHs [3]. To overcome this hurdle, CHs energy can be averaged from remaining residual energyof nodes in their re-elections. Further, duplicates in data are filter by the CH. Thus, Clustering is projectedfor WSNs mainly for its long life, stability and communication overheads [4]. Though, Clustering has disadvantages in added energy overheads in CH selection and formations and sensor's energy, a proper design of WSNs is critical [5]. All hurdles of WSNs ultimately culminate in its efficient use of energy resources where Clustering plays an important role [6].In the proposed research work, energy aware mobile dispatchment is performed with the proposed EMDSM. This work organized as follows: In this section, introduction about the wireless sensor network, and need of energy conservation is discussed. In section 2, discussion about the existing related research techniques are given by using energy conserved mobile dispatchment can be done. In section 3, detailed discussion about the working flow of proposed research methodology is given.

## II. RELATED WORKS

WSNs and WSN clustering are attractive candidates in IoT applications, since these networks support distributed devices that can communicate and sensors can be a part of a real world IoT according to López et al. [7]. However, IoT clustering is dissimilarto WSNs clustering mainly because of its open architecture. It requires additional collaborations and dynamic interactions.

A novel protocol for WSNs HEED (Hybrid Energy-Efficient Distributed clustering) was presented by YounisM et al. [8]. Its periodical selection of CHs and node residual energy based on proximity to neighbors was an advantage. HEED proved its utility by achieving uniformity in its iterations and low message overheads. HEED also guaranteed asymptotical connectivity in clustered networks.

Re-clustering ignores data density in micro-clusters. This happens specifically when they might be closer but separated by low density. Desai et al. [9] used D-Stream algorithm's shared density graph to overcome this problem in their study. It captured the density of micro-clusters in clustering and thegraph was used separate them.

Sankalap and Satvir Singh proposed the Firefly Algorithm (FA) [10] a bio-inspired technique to solve non-linear optimizations based on Social Insects behaviour. They observed, left to themselves fireflies maintained their luminance while still being organized as a disciplined group. The ides was for ITO devices which could operate in a collective manner while maintaining competitiveness and selfishness.

Senthilnath et al. [11] in their study compared bio-inspired algorithmsand concluded FAs were more efficient than PSOs. Limited researches have proposed FAs for clustering in WSNs. The study in [4] also proposed FA for WSNs energy needs by considering the distances between cluster members and balance energy of possible CH candidates implementable at base stations.

Sandeep et al. [12] also applied FA in two phases to LEACH (Low-energy adaptive clustering hierarchy) for an enhanced energy efficiency. Their initial phase started with a broadcast on percentage of CH's requirements from the BS to the network. Each sensor node generates an intensity number randomly which should be lesser than the threshold value for it be a CH. In their next phase nodes exchanged their affiliations to CHs until clustersin the network were formed.

Xia et al [13] predicted trustworthiness of nodes for MANETs based on node's historical behaviour. They chose the shortest path in data transmissions withTSR (Trust-based Source Routing) protocol. Their results showed an improved PDR and reduced the average of end-end delays.

Airehrour et al [14] used Grade Trust for detecting black hole attacks in MANETs. Their protocol secured packets based on trust values. Their proposed protocol showed an improved PDR in comparison with AODV (Ad hoc On-demand Distance Vector ) and FSR (Fisheye State Routing ) protocols of MANETs.

Trust values were also used by Tan et al [15] in their study where their technique estimated node's trust values. Their proposal of finding the path with maximum path trust prevented malicious nodes in the network. The estimated trusted paths were integrated with OLSR (Optimized Link State Routing Protocol) for routing. Their simulations proved the worthiness of their FPNT-OLSR in terms of PDR ratio, network overheads and average latency values in comparison to OLSR.

Bar et al [16] also used trust values for computing a node's packet forwarding capability. The nodes were ranked based on their individual trust values and the path with maximum trust value instead of shorter paths was chosen using AODV. Their results showed that packet drops were a minimum.

## III. ENERGY AWARE MOBILE SENSOR SCHEDULING FRAMEWORK

In the proposed research work hybrid genetic PSO algorithm is utilized to choose the optimal energy aware route path. The objectives that are considered for optimal route path selection are remaining energy, available bandwidth, processing capacity of mobile sensor nodes and reliability. After route path selection, similar data grouping is done to reduce the computation overhead. In order to reduce the memory consumption, sensor gathered data will be compressed, thus the memory consumption and also energy consumption can be achieved. This proposed method is detailed in subsequent sub sections.

### 3.1. SIMILARITY BASED CLUSTERING NODES

The proposed protocol groups nodes with same readings logically by synchronizing locally their average aggregation readings using FA. This is done for verifying fragmentations or joining of clusters to get similarlevels. On establishment of clusters they are indexed for routingcommon node message to the CH. The use of helps in maintaining clusters. An Indexing Agent is used for assessing scoresat the nodes for choosing CH and remaining nodes curved towards their CH to route their data. An Adaptive Agent ensures adaption of intervals in beacon broadcasts for stability and increases intervals in unstable conditions. Interval decreases help clusters to respond quickly and dynamically on changes. Different clusters are formed by nodes which then merge on similarthresholds. Once stable, clusters are maintained dynamically by joins or fragmentations. Each sensor is periodic in transmitting to FA, present reading, node ADDR, average reading, aggregated reading and number of similar neighbours. A randomized delay in broadcastshelps avoid concurrent transmissions.

The synchronizing component introduced in the study is based on FA. It locally synchronizes value indicatedby the aggregated readings of current node's cluster to decide on merging or fragmentations, thus representing neighbourhoods that need to be clustered.

Algorithm 1.

```
procBEACON_TIMER_EXPIRE
       Send(AD, getRd(), getAvRd(), |SNbh|)
       Wait(intrv + rnd())
       BeaconRegulator()
end proc
proc RCVBEACON(src, a, b, c)
       NbhR[src] ← {a, b, c}
       lcAvg ← getAvR()
        if (|a-lcAvg| < CThr) & (|getR() – b| < CThr)
               SNbh← Sbh U {src}
       else
```

SNbh← SNbh – {src}

end if

end procedure

procedure GETAVRD

TotalReading ← getR()

nOfReads← 1

foreach v ϵ SNbh do

temp ← NbhR [v].b * NbhR[v]:c

TotalReading ←TotalReading + temp1

nOfReads ← nOfReads + NbhR[v].c

end foreach

return (TotalReading/nOfReads)

end procedure

## 3.2. MODIFIED LEACH BASED DATA AGGREGATION

Data aggregation is compiling nodes data from many sensor nodes and eliminating duplicates for power consumption reductions. WSNs have been applied in security, military and health zones. In healthcare, Doctors have monitoredremote patient'sphysiological data which helped them understand their patient's current health conditions. WSNs have been used for changes in chemical levels of water and air and for detecting location and level of pollution of the pollutant. In cluster-basednetworks, Nodes send their data to the CH where they are aggregated and forwarded to the BS. Cluster based data forwarding reduces collisions within the network and also consumes lesser power.

The proposed algorithm works in subsequent stages which are: construction of cluster (choice of cluster head), intra-cluster data aggregation (combination of sensors for sending of data packets to cluster heads for aggregation), inter-cluster data aggregation(combination of cluster heads for sending of aggregated packets to a relay node) and compression of information.

**Procedure for modified LEACH Phases**

1) **Initialization**

Randomly distributed nodes form clusters.

2) **Setup**

CH selection is executed using the following equations:

$$P_s(t) = \begin{cases} \dfrac{k}{N - k * (r \bmod \frac{N}{k})} & : \ H_s(t) = 1 \\ 0 & : \ H_s(t) = 0 \end{cases}$$

Where N – No of nodes, k –cluster numbers, r – No of rounds, If $H_s(t) = 1$, then nodes is not with the CH in recentr mod(N/k) rounds and when 0, it is with CH. CHs broadcast messages to nodes which join their corresponding CHs based on the received signal strength. CH then allocates the TDMA schedule to nodes.

3) **Phase 1 of Transmissions**

Data is transmitted as per TDMA schedule from CMs to CH.

4) **Intracluster Data Aggregation**

CH sends and receives packets from nodes periodically The data aggregation is done using functions listed below:

(a) Addition = $\sum_{j=1}^{y}(A_j)$ for $\forall$ $(A_j)$ = Distinct Data

Where j=1…J,  Y=nodes with varying data packets

(b) Division $= \frac{1}{rn} \sum_{x=1}^{rn}(B_i)$ for $\forall (B_i) =$ Nodes have same Data

Where i=1...X, X=nodes with same data packets.

5) Selection of **Relay Nodes**

The Distancebetween BS and CHs are calculated using

$$Distance = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

When CH distance from the BS is lesser it becomes a relay node.

6) **Phase 2 of Transmissions**

CH gathers aggregates to the BS and Datagets transmitted to relay nodes from CHs .

7) **Additive Data Aggregation functions at Relay Nodes for Internal clusters**

Assuming maximum_data frame holds aggregated data when it is empty Maximum_data = n.data     where n is a node of a CH, n.data is its data.

when maximum_data and n.data <= channel_lmt, where channel_lmt is the max transfer capacity of data in a  network then  Maximum_data = maximum_data + n.data

When sum of maximum_data and n.data >= channel_lmt, then maximum_data = additive_packet (k), clear the frame, initialize a new additive packet k using equation:

$$k = k+1$$

8) **LZW Compression**

LZW Highest compression ratio =9.42

$$Packeting\ packet\ size\ (PPS) = \frac{RPS}{9.42}$$

where RPS = Real packet size.

The equation  of modified energy dissipation of compressed data is listed below:

$$S(i).En = S(i).En - \left((Tx_{en} + CDA) * PPS + MFCC * PPS * d^4 : if\ d > d_a\right)$$
$$S(i).En = S(i).En - \left((Tx_{en} + CDA) * PPS + FSCC * PPS + d^2 : if\ d < d_a\right)$$

Where S(i).En - the power of $^{ith}$ node,

CDA = CapableData Aggregation,

$Tx_{en}$ = energy  in the Transmitter

MFCC= Multipath Fading Channel Cost,

FSCC= Free Space Channel Cost,

d = distance between CH and BS,

$d_0$ = least allowed distance.

9) **Phase 3 of Transmission**

The packed data is transmitted from relay nodes to the BS which is extracted using LZWdecompression.

10) **Apply Divisible Data Aggregation**

Divisible aggregation is applied to the received data at BS and extracted from the packets havinga complete label count_additive_packet and the count is decremented until the packet count is zero with the equation:

$$count\_additive\_packet = count\_additive\_packet - 1$$

Collection of the sensors in intra-cluster and gathering of CH at inter-cluster lessen the packet count at the BS. It minimizes the definite power vital, which results in prolonging the network lifetime.

**B. Modified LEACH Algorithm**

BEGIN

Random node deployment.

Select Ch using Equation 2

Elected CH broadcasts to sensor nodes

Cluster Members are allocated TDMA schedule by the CHs

for CHs and for Cluster Members

Cluster Members send data to CH based on TDMA schedule.
Internal cluster Data aggregation using data aggregation functions.
end of loop Cluster Members
 For relay nodes
while stat = 0 // unprocessed node
use Euclidean distance for measuring distance between cluster member and BS
If dist < min_dist then
dist= min_dist
Cluster Member= relay node
End if
End while
Set stat = 1 // Processed node
 CHs send data to relay node
 End of loop CH
 Internal cluster data aggregation using Additive data aggregation functions and continue till all CHs are inactive
 End, End
Use LZW compression for evaluation of energy dissipation
Relay node sends compressed data to BS
 End of loop for relay node
BS extracts data using LZW
BS applies divisible data aggregation
 END

### 3.3. OPTIMAL ENERGY AWARE ROUTE PATH SELECTION USING HGAPSO

WSNs can be affected by topological changes making routing paths inoperative and is detrimental WSNs ability to support QoS. WSNs offer connectivity richness in their multiple paths between sources and destinations. BS's routing paths change every time packets are sent making it imperative to assess long-living paths within the network. Following initial deployment, BS generates a routing path table corresponding to each cluster area using received neighbour node lists. Each routing table contains optimal paths, as well as candidate paths. The optimal path is chosen by a HGAPSO that decides the qualification as the path that is both reliable and energy conserving, based on the fitness of the node Bandwidth, Processing capacity, and Reliability. The base station preferentially selects the optimal path to request the sensing data. The base station may choose the second best path to request the sensing data when the malicious node is on the optimal path and disturbs the data transmission. The request message sent by the base station contains the list of forwarding nodes on the path based on respective identification of the forwarding nodes. Once an optimal routing path is confirmed by the base station the flooding routing message starts. HPSOGA starts by setting its parameters. It then starts an iteration where the initial population is randomly generated and each solution is evaluated. The proposed algorithm generates new solutions by applying PSO in the network. An intermediate population is chosen by applying GA selection operator and it is divided into sub-partitions for searching the number of solutions within each sub-partition. It then applies **a** arithmetical crossover operator on each sub-partition. Premature in the application is stopped by using genetic mutation operator. A fitness function evaluates solutions. It iterates until termination criteria is satisfied and the best solution is presented. The main structure of the proposed HPSOGA algorithm is detailed below.
HGAPSO Algorithm

Set starting values of Ps-Population Size, $k_1$ and $k_2$ - acceleration constants, $P_b$crossover probability, $P_m$ - mutation probability, $prt_{no}$ - partition No, $V_r$- No of variables in each partition, η- No of solutions in a partition and $Max_{rc}$- Max No of iterations

Set ctr := 0. {Initialize Counter}.

for (j = 1 : j≤ Ps) do

Create initial population $\vec{X}_j$ (ctr) randomly.

Agent Evaluation of fitness for every search agent (solution) $f(\vec{X}_j)$.

end of for loop

do again

Apply PSOalgorithm for the population $\vec{X}$(ctr).

Apply GA selection operator for the population $\vec{X}$(ctr).

Divide the population $\vec{X}$(ctr) into $prt_{no}$ sub-partitions, where each sub-partition $\vec{X'}$(ctr)with size $V_r$ x η

for (j = 1 : j≤ $prt_{no}$) do

Apply Mathematical crossover on each sub-partition $\vec{X'}$(ctr).

end of for loopp

Apply GA mutation operator on population $\vec{X}$(ctr).

Update population $\vec{X}$(ctr) for solutions.

Set ctr = ctr + 1. {Next Iteration}.

until (ctr> $Max_{rc}$). {Termination}.

Output best solution

## IV. RESULTS AND DISCUSSION

The performance evaluation of the proposed method EMDSMwas compared with LEACH protocol. The comparison was done based on parameters are called Routing overheads, PDR, throughputs, Energy Consumption, and delay. In this model of WSN, each and every node is represented by a software agent.This multi-agent system when  simulated on NS2 simulator displayed optimal outcomes when compared to other methods.

**Routing overheads:**These are the count of  packets routed either for route discovery or network maintenance. **Packet delivery ratio:**PDR is a measure of the packets received and packets sent using the equation

$$PDR = \frac{\sum_0^n Packets\ Received}{\sum_0^n Packet\ Sent}$$

**Throughput:** This is the effective transmission of data packets to the sink node or BS and measured in bits per second (bps).

**Energy Consumption:**The energy spent in sensing, transmission or computing.

**Delay:** This is the time interval between data packet generation and the time the last bit is received at destination.

The numerical values obtained are shown in the following table 1 and 2.

Table 1. Numerical values

| Time | Routing overhead | | Packet delivery ratio | | Throughput | |
|------|-------|-------|-------|-------|-------|-------|
| | LEACH | EMDSM | LEACH | EMDSM | LEACH | EMDSM |
| 10 | 40 | 35 | 450 | 450 | 78 | 80 |
| 20 | 80.3 | 71.3 | 881.3 | 901.3 | 154.3 | 163.3 |
| 30 | 83.4 | 75.4 | 883.4 | 918.4 | 154.4 | 166.4 |
| 40 | 85.5 | 76.5 | 896.5 | 929.5 | 159.5 | 167.5 |

| 50 | 86 | 79 | 903 | 946 | 161 | 168 |

Table 2. Numerical analysis values

| Time | Energy consumption | | Delay | |
|---|---|---|---|---|
| | LEACH | EMDSM | LEACH | EMDSM |
| 10 | 4.1 | 3.8 | 35 | 34 |
| 20 | 8.173 | 7.293 | 71.3 | 66.3 |
| 30 | 10.894 | 8.964 | 76.4 | 67.4 |
| 40 | 11.985 | 9.585 | 77.5 | 67.5 |
| 50 | 12.44 | 10.11 | 85 | 69 |

In the following figure 1, comparison analysis of the proposed and existing method in terms of routing overhead is shown.
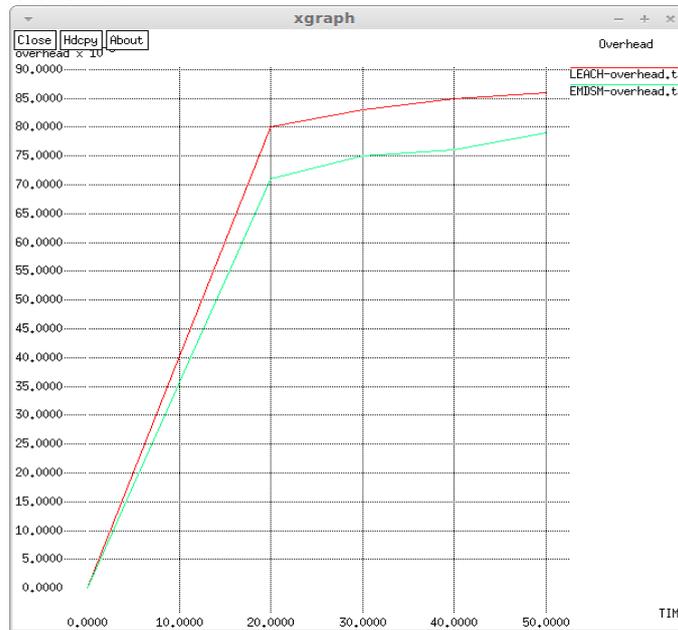


Figure 1. Routing overhead comparison

In the above figure 1, comparison analysis of the proposed and existing method's routing overheads is shown. This is comparison is made against varying simulation time. As the simulation time increases, routing overhead also increases linearly. From the numerical analysis it is confirmed that the proposed EMDSM shows 10.12% lesser routing overhead than the existing LEACH method.
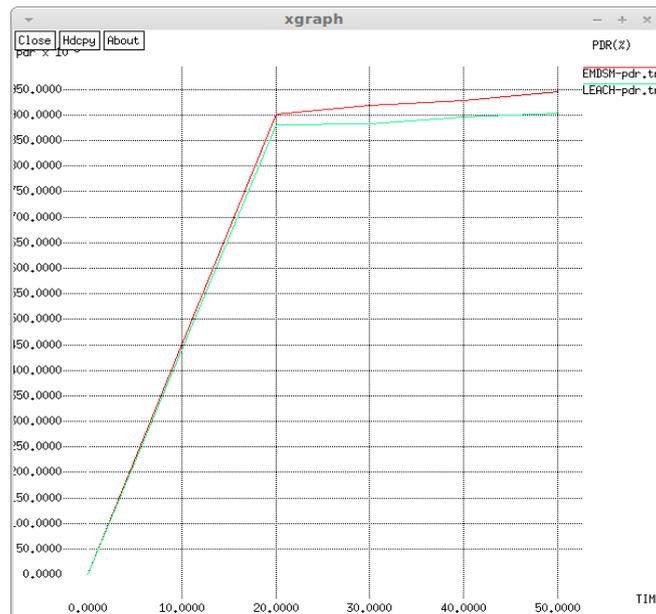
Figure 2. Packet delivery ratio comparison

In the above figure 2, comparison analysis of the proposed and existing method in terms of packet delivery ratio is shown. This is comparison is made against varying simulation time. As the simulation time increases, packet delivery ratio also increases linearly. From the numerical analysis it is confirmed that the proposed EMDSM shows 3.26% increased packet delivery ratio than the existing LEACH method.



Figure 3. Throughput comparison

In the above figure 3, comparison analysis of the proposed and existing method in terms of throughput is shown. This is comparison is made against varying simulation time. As the simulation time increases, throughput also increases linearly. From the numerical analysis it

is confirmed that the proposed EMDSM shows 5.37% increased throughput than the existing LEACH method.
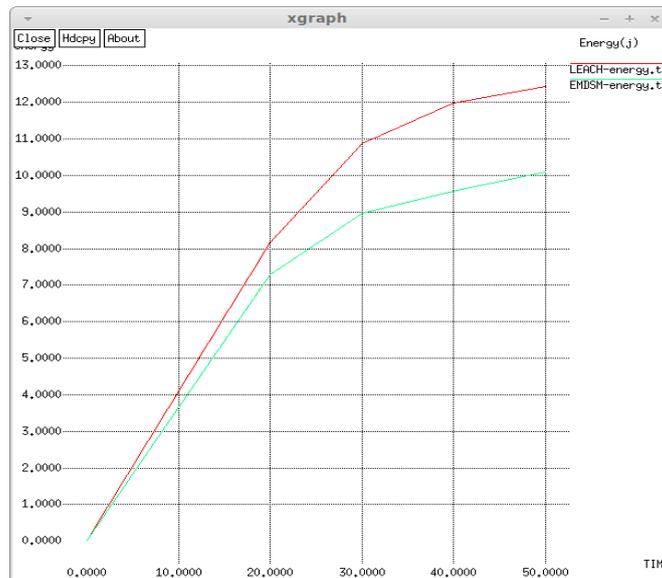


Figure 4. Energy comparison

In the above figure 4, comparison analysis of the proposed and existing method in terms of energy consumption is shown. This is comparison is made against varying simulation time. As the simulation time increases, energy consumption also increases linearly. From the numerical analysis it is confirmed that the proposed EMDSM shows 16.47% lesser energy consumption than the existing LEACH method.



Figure 5. Delay comparison

In the above figure 5, comparison analysis of the proposed and existing method in terms of delay is shown. This is comparison is made against varying simulation time. As the simulation time increases, delay also increases linearly. From the numerical analysis it is

confirmed that the proposed EMDSM shows 11.87% lesser delay than the existing LEACH method.

## V. CONCLUSION

Energy aware mobile sensor dispatchment in the distributed network is the most difficult task where there won't be any centralized network. In the existing work it is achieved as CDH method attempts to schedule the mobile sensors-based travelling path of sensor data. However, in the existing work, distance is the only important parameter considered for selecting CHs and the reliable transmission of data packets. Data redundancy is not considered effectively in the existing work which would consume more amount of energy. This is focused and resolved in the proposed research work the objectives that are considered for optimal route path selection are remaining energy, available bandwidth, processing capacity of mobile sensor nodes and reliability.In order to reduce the memory consumption, sensor gathered data will be compressed, thus the memory consumption and also energy consumption can be achieved.        In the proposed research work hybrid genetic PSO algorithm is utilized to choose the optimal energy aware route path. The objectives that are considered for optimal route path selection are remaining energy, available bandwidth, processing capacity of mobile sensor nodes and reliability. After route path selection, similar data grouping is done to reduce the computation overhead. In order to reduce the memory consumption, sensor gathered data will be compressed, thus the memory consumption and also energy consumption can be achieved. It can be concluded that the proposed EMDSM shows improvements than other methods and is implementable.

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