

Intelligent Data Gathering Mechanisms for IoT-enabled Wireless Sensor Networks



Thesis submitted in partial fulfillment
for the award of the degree of

Doctor of Philosophy

by

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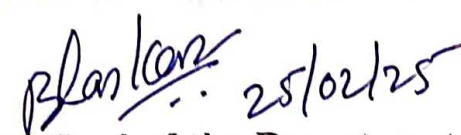
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Dedicated to both my families—the one that raised me, and the one that
embraced me with open arms

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List of Figures

1.1	Multi-hop data transmission in IoT-enabled WSNs.	2
1.2	MS-based data collection in IoT-enabled WSNs.	5
2.1	Taxonomy of literature review.	19
3.1	Rendezvous points based mobile sink traversal.	45
3.2	Proposed intelligent data routing scheme.	48
3.3	Stability period and network lifetime.	56
3.4	Energy consumption.	57
3.5	Residual energy.	57
3.6	Number of alive nodes.	58
4.1	Architecture of the proposed EERPS-DPDP approach.	65
4.2	MS based data collection with optimal number of cluster and RPs.	66
4.3	Special cases in RP selection and clustering.	69
4.4	Stability period.	76
4.5	Network lifetime.	76
4.6	Residual energy.	77
4.7	Data collection delay.	78
4.8	Data lost due to buffer overflow.	79
4.9	Runtime.	82
4.10	Sensor node deployment in the testbed.	83
4.11	Testbed results.	83
5.1	Obstacle-aware data collection using MS in an industry.	87
5.2	IIoT-based industrial safety monitoring in a smart chemical industry.	90
5.3	Flowchart of proposed MRFO algorithm.	97
5.4	Smoothing the path.	102
5.5	Obstacle aware path design for various environments.	107

5.6	Stability period.	108
5.7	Network lifetime.	108
5.8	Residual energy.	109
5.9	Data collection delay.	109
5.10	Testbed.	110
5.11	Testbed results.	111
6.1	Proposed RLBSO approach.	122
6.2	Example network.	127
6.3	Network lifetime.	132
6.4	Energy consumed.	133
6.5	Data collection latency.	133
6.6	Data collection ratio.	134
6.7	Network cut detection and recovery.	135
6.8	Sensor node deployed in the testbed.	136
6.9	Sensor node used in the testbed.	136
6.10	Testbed results.	137
7.1	Emergency evacuation system.	141
7.2	Emergency evacuation system in a typical public infrastructure.	144
7.3	Hardware module.	148
7.4	A sensor network with 156 nodes, two exits (the green box), 2 evacuees (the purple box) and hazardous area (coloured in red) at (a) $t=0$ sec (b) $t=4$ sec (c) $t=7$ sec (d) $t=14$ sec.	154
7.5	A sensor network with 225 nodes, one exit (the green box), one evacuee (the purple box) and hazardous area (coloured in red) at (a) $t=0$ sec (b) $t=4$ sec (c) $t=11$ sec (d) $t=22$ sec.	155
7.6	A sensor network with 100 nodes, two exits (the green box), two evacuees (the purple box) and hazardous area (coloured in red) at (a) $t=0$ sec (b) $t=2$ sec (c) $t=7$ sec (d) $t=12$ sec.	156
7.7	A sensor network with 650 nodes, five exits (the green box), eight evacuees (the purple box) and hazardous area (coloured in red) at (a) $t=0$ sec (b) $t=3$ sec (c) $t=7$ sec (d) $t=18$ sec.	157
7.8	A sensor network with 750 nodes, three exits (the green box), 11 evacuees (the purple box) and hazardous area (coloured in red) at (a) $t=0$ sec (b) $t=3$ sec (c) $t=10$ sec (d) $t=21$ sec.	158
7.9	Experimental site map 1 and fire locations.	159

7.10	Experimental site map 2 and fire locations.	159
7.11	Comparison of evacuation time.	160
7.12	Comparison of variance of evacuation time.	160
7.13	Survival rate.	160

List of Tables

2.1	Summary of MS-based data collection approaches in WSNs	22
2.2	Summary of MS-based data collection approaches in heterogeneous WSNs	25
2.3	Summary of existing obstacle-aware data routing approaches	29
2.4	Summary of network cut detection and recovery approaches	33
2.5	Summary of existing emergency evacuation systems	37
3.1	Terminologies and definitions	44
3.2	Simulation parameters	55
4.1	Terminologies and definitions	63
4.2	Algorithm 2 terminologies	67
4.3	Algorithm 3 Terminologies	71
4.4	Simulation parameters	75
4.5	Comparison of complexities	80
4.6	Testbed results: average residual energy	85
5.1	Terminologies and definition	89
5.2	Simulation parameters	106
5.3	MS safety assessment	110
5.4	Average residual energy	111
6.1	Terminologies and definitions	117
6.2	Simulation parameters	132
6.3	Average residual voltage (V)	136
7.1	Notations and descriptions	145
7.2	Experimental parameters	156

Abbreviations

Abbreviation	Description
ABC	Artificial Bee Colony
ACO	Ant Colony Optimization
APN	Articulation Point Node
BS	Base Station
CH	Cluster Head
CM	Cluster Member
DASO	Donkey And Smuggler Optimization
DBP	Delay Bound Path
DBRKM	Delay Bound Reduced K-Means
DCD	Data Collection Delay
DERP	Dynamic Escape Route Planning
DESSN	Dynamic emergency Evacuation system for Shortest-Safe path Navigation
DFN	Data Forwarder Node
DFS	Depth First Search
DP	Dynamic Programming
DPDP	Deep Policy Dynamic Programming
DRL	Deep Reinforcement Learning
EAPC	Energy-Aware Path Construction
EC	Energy Consumption

Abbreviation	Description
ECSSN	Emergency evacuation system for Clogging free and Shortest-Safe path Navigation
EDEDA	Energy and Delay Efficient Data Acquisition
EERPS	Energy Efficient Rendezvous Points Selection
FEBIM	Fire Evacuation Building Information Modeling
FN	Far-away Nodes
GA	Genetic Algorithm
GA-SMT	Genetic Algorithm based Sink Mobility Technique
GBA	GTSP-Based Algorithm
GN	Gateway Node
GNN	Graph Neural Network
GTA	Group Teaching Algorithm
GTSP	Generalised Travelling Salesperson Problem
GWO	Gray Wolf Optimization
IIoT	Industrial Internet of Things
IoT	Internet of Things
IRDA	Improved Reed-Deer Algorithm
KNN	K-Nearest Neighbour
MARL	Multi-Agent Reinforcement Learning
MDC	Mobile Data Collector
MILP	Mixed Integer Linear Programming
MOGWO	Multi-Objective Gray Wolf Optimization
MRFO	Manta-Ray Foraging Optimization
MS	Mobile Sink
OCRS-MD	Obstacle Aware Connectivity Restoration using Mobile Data carrier
OVTP	Objective Variable Tour Planning
PSO	Particle Swarm Optimization

Abbreviation	Description
QoS	Quality of Service
RDP	Reduce Delay Path
REP	Reduced Energy Path
RESM	Region Energy Conscious Sink Movement
RKM	Reduced K-means
RLBSO	Reinforcement learning Brain Storm Optimization
RP	Rendezvous Point
RSARSA	Radar-assisted State–Action–Reward–State–Action
SNs	Sensor Nodes
TDMA	Time Division Multiple Access
TEO-MCRP	Thermal Exchange Optimization Clustering Routing Protocol
TSP	Travelling Salesman Problem
UAV	Unmanned Aerial Vehicle
VGDR	Virtual Grid Based Route Adjustment
VS	Virtual Structure
WRP	Weighted Rendezvous Planning
WSN	Wireless Sensor Network

List of Symbols

Symbol	Description
\mathcal{N}	Number of deployed sensor nodes.
\mathcal{S}	Set of sensor nodes. $\mathcal{S} = sn_1, sn_2, sn_3, sn_4, \dots, sn_n$.
r	Communication range of sensor nodes.
m	Number of rendezvous points.
\mathcal{R}	Set of rendezvous points. $\mathcal{R} = \mathcal{RP}_1, \mathcal{RP}_2, \mathcal{RP}_3, \dots, \mathcal{RP}_m$.
rp_{id}	Id assigned to each RP. $rp_{id} = 1, 2, 3, 4, \dots, m$. For eg. rp_{id} of \mathcal{RP}_7 is 7.
$\mathcal{TDist}(sn_i)$	Euclidean distance between the sensor node and the next-hop node.
$Dist(sn_i, sn_j)$	Euclidean distance between node sn_i and sn_j .
$\mathcal{HCounts}(sn_i)$	Number of hops required by sn_i to send data to RP.
$SumD(\mathcal{RP}_j)$	Sum of distances among nodes allocated to \mathcal{RP}_j
$allot(sn_i)$	A variable that holds the rp_{id} of the RP to which the sensor node is allocated.
\mathcal{AR}	Archive which contains non-dominated solutions.
\mathcal{E}_{ij}	Edge between node i and j .
\mathcal{EC}	Energy Consumption.
\mathcal{DCD}	Data Collection Delay.
\mathcal{DLBO}	Data Lost Due to Buffer Overflow.
$InDeg_i$	In-degree of a node i .
\mathbb{L}	Length of the MS data collection path.
C_s	Current grid cell in forward search direction.

Symbol	Description
C_d	Current grid cell in backward search direction.
S_g	Source grid cell.
D_g	Destination grid cell.
$NG_i(C_s)$	Neighbour grid cells of cell C_s .
ξ_i	Remaining energy of node i .
\mathcal{W}	Weight function.
AJ	Adjacency list of nodes in the network.
AP	List of APNs.
F	List of faulty nodes.
D	List of dead nodes.
RL	List of recovery nodes.
P	MDC path.
d	Distance between source and destination node
G	Graph of network
V	Set of vertices
E	Set of edges
a	Vertex in set V
$ngb(a)$	Set of neighboring vertices of vertex a
e_{ab}	Edge connecting vertices a and b
S	Source or Evacuee
D	Door or Exit
F	Fire region
W	Wall
K	Set of fire spread rate/speed
T	Time when a fire will reach all the exit nodes