


## CERTIFICATE

I certify that the thesis entitled “**Energy Efficient Congestion Control Techniques in Wireless Sensor Networks**” submitted for the degree of Doctor of Philosophy (Ph.D.) in Computer Science and Engineering is the record of research work carried out by **Mrs. G. Vanitha (19PHEOF004)** during the period of her study from **July 2019 to June 2024** in the Department of Computer Science and Engineering, School of Engineering at Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, under my guidance and supervision, and the thesis has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowship or other similar titles of any Candidate of this Institute or any other University/Institution of Higher Learning.

  
24/6/2024  
Signature of the

**Head of the Department**

  
24/6/2024  
Signature of the Supervisor

  
24/6/24  
Signature of the Dean

## DECLARATION

I, **Mrs. G.Vanitha** hereby declare that the thesis entitled “**Energy Efficient Congestion Control Techniques in Wireless Sensor Networks**” submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore in the partial fulfillment of the requirements for the award of **Doctor of Philosophy (Ph.D.)** in Computer Science and Engineering is the record of original and independent research work carried out by me during the period from **July 2019 to June 2024** under the guidance of **Dr. P.Amudha** M.Tech., Ph.D., Professor, Department of Computer Science and Engineering, School of Engineering, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore and has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowship or any other similar titles in this Institute or any other University or other similar Institution of Higher Learning.



Signature of the Research Scholar



Signature of the Supervisor

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## LIST OF ABBREVIATIONS

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AQM	Active Queue Management
AMR	Automatic Message Receipt
BER	Bit Error Rate
CSMA	Carrier Sense Multiple Access
CA	Collision Avoidance
CTS	Clear to Send
CCP	Congestion Control Protocol
CCRT	Congestion Control Based on Reliable Transmission
CTP	Collection Tree Protocol
CDA	Congestion Detection and Avoidance
CHs	Cluster Heads
CCPC	Congestion And Computer Program Control
CADC	Congestion-Adaptive Data Collecting
DTP-PA	Data Transmission Protocol Based on Priority Approach
DVMRP	Distance Vector Multicast Routing Protocol
DDRC	Difference of Differential Rate Control
DDR	Directed Data Replication
ECN	Explicit Congestion Notification
E2E	End-to-End delay
EPRCDA-FBA	Enhanced PRCDA-FBA
FSMC	Fuzzy Sliding Mode Congestion Controller
GPS	Global Positioning System
HCSO	Hybrid Chicken Swarm Optimization
HNRT	High Priority NRT
ICN	Implicit Congestion Notification
LMIs	Linear Matrix Inequalities

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LSTM	Long Short-Term Memory
LNRT	Low Priority NRT
LUF	Logarithmic Utility Function
LPL	Low-Power Listen
MAC	Media Access Control
MST	Minimum Spanning Tree
MNRT	Medium Priority NRT
NRT	Non-Real-Time
PDR	Packet Delivery Ratio
PASCCC	Priority-Based Application Specific Congestion Control Clustering
PRC	Proficiency Rate Control
PRC-FBA	PRC with Fair Bandwidth Allocation
PRCDA-FBA	PRC With Data Aggregation And FBA
PPI	Packet Priority Intimation
PBFRC	Priority Based Fairness Rate Control
PETS	Periodic Event-Triggered Sampling
PRT	Position-Based Routing Tree
QoS	Quality of Service
Q-DAEER	Q-Learning-Based Data Aggregation-Aware Energy-Efficient Routing
RTT	Round Trip Time
RTS	Request to Send
RDC	Radio Duty Cycle
RT	Real-Time
RACC	Rate Aware Congestion Control
REFIACC	Reliable, Efficient, Fair, and Interference-Aware Congestion Control
RP-MAC	Ring Partitioned Based MAC
RLNC	Random Linear Network Coding
RT	Real-Time

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SNR	Signal-To-Noise Ratio
SMC	Sliding Mode Control
SVM	Support Vector Machine
SINR	Signal-to-Noise and Interference Ratio
TC	Topology Control
TTS	Time Triggered Sampling
TFDA	Two-Fold Data Aggregation
TTDFP	Two-Tier Distributed Fuzzy Logic Based Protocol
TFDA	Two-Fold Data Aggregation
TTDFP	Two-Tier Distributed Fuzzy Logic Based Protocol
UDP	User Datagram Protocol
VCH	Virtual Cluster Head
WSN	Wireless Sensor Networks
WCCP	Wireless Multimedia Congestion Control Protocol
WVD	Weighted Voronoi Diagram
WFCC	Weighted Fairness Congestion Control Protocol
WPDR	Weighted Priority Differential Rate Control
WMSN	Wireless Multimedia Sensor Networks
WP-DDRC	Weighted Priority-DDRC
WPDDRC	Weighted Priority Differential Rate Control

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## LIST OF SYMBOLS

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$OR^k n$	Aggregate Output Rates of the Child Nodes
$\mathcal{C}$	Child Node
$RSS_{kc}$	RSS from node $k$ to child node $c$
$RSS_{ij}$	RSS from node $i$ to child node $j$
$P_t$	Transfer Energy
$PL$	Path Loss
$PL(d_0) - 10\eta \log(d/d_0)$	Log-Distance Radio Propagation Framework
$p_{ij}$	Amount of time it takes for data to travel from node A to node $a_i$
$\omega_j$	Weight Given to Node $u_j$
$(Tr)$	Transmitter
$(Rr)$	Reception
$O_t$	Power Level of Transmission
$(f)$	Resumption at the Receiver
$O_l(f)$	Path Loss at the Receiver

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