ENERGY EFFICIENT CHAIN BASED ROUTING PROTOCOL FOR DETERMINISTIC NODE DEPLOYMENT IN WIRELESS SENSOR NETWORKS

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Abstrak

Rangkaian sensor tanpa wayar (WSN) terdiri daripada sensor peranti kecil yang dihubungi secara tanpa wayar untuk tujuan penderiaan dan pengiriman data kepada stesen pengkalan (BS). Protokol penghalaan dalam WSN telah menjadi bidang aktif bagi penyelidik dan industri disebabkan oleh potensi pengiriman data, dan keupayaannya meningkatkan jangka hayat rangkaian, mengurangkan kelewatan, dan penjimatan tenaga nod.Berdasarkan pendekatan hiraki, asas rantaian protokol rutin adalah jenis berpotensi yang berupaya memanjangkan jangka hayat rangkaian dan mengurangkan penggunaan tenaga. Namun, ia masih mempunyai kelemahan seperti kelewatan, kelewahan data, jarak panjang antara jiran, kepala rantaian (CH) pengunaan turus tenaga, dan cerutan. Kajian ini mencadangkan Seragam Asas Rantaian Rutin Protokol (DCBRP) untuk penyeragaman penempatan nod, yang terdiri daripada Mekanisme Pembinaan Tulang Belakang (BCM), mekanisme Pemilihan Ketua Rantaian (CHS) dan mekanisme Sambungan Seterusnya Hop (NHC). Mekanisma BCM bertangungjawab untuk pembinaan rantaian menggunakan pendekatan konsep pelbagai rantaian, dimana ia membahagikan rangkaian ini ke bilangan kluster yang khusus bergantung kepad bilangan jalurnya. Manakala mekanisma CHS bertanggungjawab kepada kepala rantaian, dan pemilihan nod kepala rantaian ditentukan oleh keupayaannya untuk penyerahan data. Pada masa sama, mekanisma NHC bertanggungjawab kepada sambungan hop seterusnya dalam setiap kepala baris berdasarkan kepada tenaga dan jarak antara nod untuk menyingkir nod yang lemah daripada berada dalam rantaian utama. Network Simulator 3 (ns-3) digunakan untuk mensimulasikan DCBRP dan ia dinilai dengan protokol penghalaan terdekat dalam penempatan berketentuan dalam WSN, yang merangkumi protokol Rangkaian Kluster Campuran (CCM) dan Protokol Berasaskan Rantaian Dua Peringkat (TSCP). Hasil menunjukkan bahawa pencapaian DCBRP mengatasi CCM dan TSCP dari segi kelewatan hujung dengan hujung, penggunaan tenaga CH, penggunaan tenaga keseluruhan, jangka hayat rangkaian dan metric tenaga*kelewatan. DCBRP atau salah satu daripada mekanismenya membantu aplikasi WSN dengan melanjutkan hayat nod sensor dan menjimatkan tenaga untuk tujuan pengesanan seberapa lama yang boleh.

Kata kunci: Rangkaian sensor tanpa wayar, Rangkaian berpusat pendekatan, Seragam nod penempatan, Hierarki penghalaan protokol

Abstract

Wireless Sensor Network (WSN) consists of small sensor devices, which are connected wirelessly for sensing and delivering specific data to Base Station (BS). Routing protocols in WSN becomes an active area for both researchers and industrial, due to its responsibility for delivering data, extending network lifetime, reducing the delay and saving the node's energy. According to hierarchical approach, chain base routing protocol is a promising type that can prolong the network lifetime and decrease the energy consumption. However, it is still suffering from long/single chain impacts such as delay, data redundancy, distance between the neighbors, chain head (CH) energy consumption and bottleneck. This research proposes a Deterministic Chain-Based Routing Protocol (DCBRP) for uniform nodes deployment, which consists of Backbone Construction Mechanism (BCM), Chain Heads Selection mechanism (CHS) and Next Hop Connection mechanism (NHC). BCM is responsible for chain construction by using multi chain concept, so it will divide the network to specific number of clusters depending on the number of columns. While, CHS is answerable on the number of chain heads and CH nodes selection based on their ability for data delivery. On the other hand, NHC is responsible for next hop connection in each row based on the energy and distance between the nodes to eliminate the weak nodes to be in the main chain. Network Simulator 3 (ns-3) is used to simulate DCBRP and it is evaluated with the closest routing protocols in the deterministic deployment in WSN, which are Chain-Cluster Mixed protocol (CCM) and Two Stage Chain based Protocol (TSCP). The results show that DCBRP outperforms CCM and TSCP in terms of end to end delay, CH energy consumption, overall energy consumption, network lifetime and energy*delay metrics. DCBRP or one of its mechanisms helps WSN applications by extending the sensor nodes lifetime and saving the energy for sensing purposes as long as possible.

Keywords: Wireless sensor network, Chain-based approach, Deterministic node deployment, Hierarchical routing protocol

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACO	-	Ant Colony Optimization
BCBRP	-	Balancing Chain-Based Routing Protocol
BCM	-	Backbone Construction Mechanism
BS	-	Base Station
CCBRP	-	Chain-Chain Based Routing Protocol
CCM	-	Chain-Cluster Mixed
CCPAR	-	Cluster Chain Based Power Aware Routing
CDT	-	C/C++ Developing Tools
CH	-	Chain Head or Cluster Head
CHS	-	Chain Head Selection mechanism
CRBCC	-	Chain Routing Based on Coordinates-oriented Cluster
CSMA	-	Carrier Sense Multiple Access
DCBRP	-	Deterministic Chain-Based Routing Protocol
DD	-	Direct Diffusion
DRINA	-	Data Routing For in-Network Aggregation
DRM	-	Design Research Methodology
DS-I	-	Descriptive Study 1
DS-II	-	Descriptive Study 2
DSP	-	Deterministic Sensor Placement
DT	-	Deterministic Topology
EAR	-	Energy Aware Routing
ECCP	-	Energy Efficient Cluster-Chain Based Protocol
EECB	-	Energy Efficient Chain Based Routing Protocol

FND	-	First Node Die
GPS	-	Global Position System
HHR	-	Hop-by-Hop Reliability
IEEE	-	Institute of Electrical and Electronic Engineering
IEEPB	-	Improvement Energy Efficient PEGASIS Based
IGR	-	Intra-Grid Random
IoT	-	Internet of Thing
ISO	-	International Organization of Standardization
LEACH	-	Low Energy Adaptive Clustering Hierarchy
LL	-	Long Link
LND	-	Last Node Die
LR-WPAN	-	Low Rate Wireless Personal Area Network
MAC	-	Media Access Control
MN	-	Member Node
NHC	-	Next Hop Connection mechanism
NS-3	-	Network Simulator 3
ON	-	Ordinary Node
OSI	-	Open System Interconnection
PEGASIS	-	Power Efficient Gathering in Sensor information System
PS	-	Perspective Study
QoS	-	Quality of Service
RC	-	Research Clarification
REC+	-	Reliable and Energy Efficient Chain-Cluster Protocol
RNs	-	Relay Nodes
RPB	-	Rotation PEGASIS Based Routing Protocol

SAT	-	Secure Aggregation Tree
SN	-	Sensor Node
SPIN	-	Sensor Protocol Information Negotiation
TCP	-	Transport Control Protocol
TDMA	-	Time Diffusion Media Access
TSCP	-	Two Stage Chain Protocol
UDP	-	User Datagram Protocol
WSN	-	Wireless Sensor Network

CHAPTER ONE
INTRODUCTION

1.1 Background

Wireless Sensor Network (WSN) as the name implies, refers to a number of small sensor devices, which are connected to each other wirelessly. WSN applications are widely used in several areas. These include industrial domain, military institutions, habitat monitoring, environmental establishments and disaster management [1]. The main components of a WSN are the sensor nodes which have many limitations in its characteristics. These include, the power resources, computational capabilities, bandwidth and memory [2]. These nodes have the capability of communicating with each other. The communications are also established between one or more super nodes known as the Base Station (BS). This BS is thus connected to the Internet. Each distinct node has a built in sensor devices for a specific task (one or more task). The sensors consists of a radio module used in sending data through the wireless medium, a micro controller for processing, and the power supply component for providing the necessary energy for all mechanism in the devices [3]. Typically, batteries are the main source of power in the sensor nodes and consequently, due to its deployment, recharging seems a difficult task. WSN nodes also have particular level of algorithms intelligence used in collecting and transmitting data to the BS [4].

Routing is one of the most pertinent perplexing issues that directly affect the performance of WSN. Proportionally; the main goal of the routing protocols in WSN is to deliver all sensing data to the base station with minimum power consumption to extend the lifetime of the network's nodes. Different factors have been identified to

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