DYNAMIC POSITIONING BASE STATION FOR WIRELESS SENSOR NETWORK USING PARTICLE SWARM OPTIMIZATION (PSO)

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Dynamic Positioning Base Station for Wireless Sensor Network using Particle Swarm Optimization (PSO)

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Thesis Outline

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List of Acronyms

ADV	Advertise
B-MAC	Berkeley Medium Access Control
CA	Collision Avoidance
CCA	Clear Channel Assessment
CC-MAC	Spatial Correlation-based Collaborative MAC
CDMA	Code Division Multiple Access
CPU	Central Processing Unit
CSMA	Carrier Sense Multiple Access
CTS	Clear to Send
DD	Directed Diffusion
DS-SS	Direct Sequence - Spread Spectrum
EECS	Energy Efficient Clustering Algorithms
EEHC	Energy Efficient Heterogeneous Clustered
E-MAC	Event Medium Access Control
FDMA	Frequency Division Multiple Access
GA	Genetic Algorithm
gbest	global best
GMRE	Greedy Maximum Residual Energy
GPS	Global Positioning System
HEED	Hybrid Energy-Efficient Distributed
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers

ILP	Integer Linear Programming
IP	Internet Protocol
J	Joules
LAN	Local Area Network
lbest	local best
LEACH	Low-Energy Adaptive Clustering Hierarchy
LEACH-C	Low-Energy Adaptive Clustering Hierarchy Centralised
LP	Linear Programming
LPL	Low Power Listening
MAC	Medium Access Control
MAL	Mobile-assisted Localization
MILP	Mixed Integer Linear Programming
MPSO	Multi-objective Particle Swarm Optimisation
MTE	Minimum Transmission Energy
N-MAC	Network Medium Access Control
NP	Non-deterministic Polynomial
ns2	network simulator 2
OPT	Optimal MILP
pbest	particle best
PDA	Personal Digital Assistant
PEGASIS	Power-Efficient gathering in Sensor Information System
PSO	Particle Swarm Optimisation
PSO-BSP	PSO Base Station Positioning
PSO-C	PSO Clustering

PSO-MBS	PSO Mobile Base Station
QoS	Quality of Service
RAM	Random Access Memory
Rand-MBS	Random Mobile Base Station
REQ	Request
RIPS	Radio Interferometric Positioning System
RTS	Request to Send
SA	Simulated Annealing
SNR	Signal-to-Noise-Ratio
SPIN	Sensor Protocols for Information via Negotiation
TDMA	Time Division Multiple Access
TEEN	Threshold-Sensitive Energy Efficient sensor Network protocol
TSP	Travelling Salesman Problem
WPAN	Wireless Personal Area Network
WSN	Wireless Sensor Network
Z-MAC	Hybrid Medium Access Control

Abstrak

Penempatan Stesen Pangkalan Dinamik untuk Rangkaian Penderia Wayarles menggunakan Pengoptimuman Kawanan Zarah (PSO)

Penempatan stesen pangkalan merupakan salah satu cara untuk meningkatkan prestasi keseluruhan rangkaian penderia wayarles (WSN). Stesen pangkalan biasanya terletak jauh dari kawasan penderiaan. Oleh itu, semua nod-nod penderia menggunakan tenaga tambahan untuk menghantar data pada stesen yang berkedudukan jauh ini dan seterusnya akan mengakibatkan penggunaan tenaga yang lebih tinggi. Pada setengah-setengah situasi, stesen pangkalan ini boleh ditempatkan di tengah kawasan penderiaan. Namun dalam kes ini, sebuah nod penderia yang terletak di kedudukan tepi kawasan penderiaan akan mengambil lebih banyak tenaga untuk menghantar data ke stesen pangkalan berbanding dengan nod penderia yang terletak berhampiran dengan stesen pangkalan. Hal ini akan mengakibatkan penggunaan tenaga yang tidak seimbang antara semua nod-nod penderia dan seterusnya mengurangkan tahap kecekapan tenaga rangkaian. Disebabkan pemilihan lokasi yang optimum untuk stesen pangkalan di dalam sesuatu rangkaian diletakkan pada masalah polinomial tidak ketentuan yang kuat (NP), maka aplikasi algoritma hampiran seperti Pengoptimuman Kawanan Zarah (PSO) dipilih untuk mengatasi masalah ini.

Penyelidikan ini melibatkan penggunaan PSO dalam bidang penempatan stesen pangkalan pada rangkaian penderia wayarles (WSN). Protokol yang cekap dan jimat tenaga untuk aplikasi pergerakan stesen pangkalan telah dicadangkan dalam tesis ini.Masalah pergerakan stesen pangkalan ini di transformasikan menjadi masalah pengoptimuman dan algoritma PSO digunakan untuk mencari jalan dan lokasi kedudukan pengumpulan data yang optimum. Seterusnya, Masalah Jurujual Kembara (TSP) diselesaikan menggunakan algoritman jiran terdekat untuk menentukan turutan tempat persinggahan bagi stesen pangkalan di dalam rangkaian penderia wayarles ini. Hal ini membolehkan meningkatkan lagi tahap kecekapan tenaga rangkaian.

Protokol yang dicadangkan telah dibuat penilaian prestasinya dari segi jangka hayat rangkaian tersebut, kebolehan penghantaran data dan kecekapan tenaganya. Perbandingan telah dibuat antara protokol-protokol yang dirujuk dalam literasi seperti LEACH, LEACH-C dan juga beberapa variasi yang telah dibuat pada protokol tersebut. Keputusan simulasi menunjukkan bahawa protokol yang telah dicadangkan iaitu protokol menggunakan algoritma PSO memperoleh peningkatan 238% berbanding dengan LEACH dan peningkatan 100% berbanding dengan LEACH-C dari segi penghantaran data dan kecekapan tenaga.

Tesis ini juga telah memperkenalkan mekanisma berasaskan PSO untuk mengubah kedudukan stesen pangkalan dalam rangkaian penderia wayarles berkluster. Dalam mekanisma ini, algoritma PSO diaplikasikan pada stesen pangkalan untuk mencari kedudukan ketua-ketua kluster yang optimum dan juga kedudukan stesen pangkalan yang optimum berdasarkan lokasi ketua-ketua kluster tersebut. Hasil simulasi dan juga penilaian prestasi telah menunjukkan kekuatan penggunaan algoritma ini dalam meningkatkan tahap kecekapan penggunaan tenaga dalam rangkaian.

Abstract

The positioning of base station is one of the methods to improve the overall performance of wireless sensor network. The base station is normally located far from the sensing area. Therefore, all sensor nodes use extra power to transmit its data to this far base station and result in higher energy consumption. In some situations, the base station can be placed in the middle of a sensing area. However in this case, a sensor node that is located at the edge of the sensing area consumes more energy to transmit data to the base station compared to sensor nodes that are located near the base station. This creates unbalanced energy consumption among all sensor nodes and furthermore reduces the network energy efficiency. Since the optimal selection of base station location in a network belongs to non-deterministic polynomial (NP) hard problem, the use of approximation algorithms such as Particle Swarm Optimization (PSO) are generally more suitable due to its simplicity and outstanding search strength.

This work investigates the application of PSO algorithm in the area of base station positioning in wireless sensor network. An energy efficient protocol for mobile base station problem is proposed in this thesis. This mobile base station problem is transformed into an optimization problem, and the PSO algorithm is employed to search for optimal path and locations of data gathering points. The travelling salesman problem is solved using nearest neighbour algorithm to determine the order of sites visit to further increase the network energy efficiency.

Performance evaluation of the proposed protocol has been made in terms of network lifetime, data delivery, and energy efficiency. The comparisons were made with existing protocols in the literature such as LEACH and LEACH-C, as well as several variations of the protocol. Simulation results demonstrate that the proposed protocol using PSO algorithm obtains 238% improvement compared to LEACH and 100% improvement compared to LEACH-C in terms of data delivery and energy efficiency.

This thesis also introduces a PSO-based mechanism to reposition the base station in a clustered wireless sensor network. This mechanism applies PSO algorithm at the base station for optimal position of cluster heads and also the optimal position of the base station based on the cluster heads' locations. Performance evaluation through simulation exhibits the superior strength of this algorithm in enhancing the network energy efficiency.