

#### Wireless Sensor Networks for Environmental Monitoring

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A thesis submitted in conformity with the requirement for Degree of Doctor of Philosophy in Science (Physics - Electronics)

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## يِسُمِ اللهِ الرَّحْهِنِ الرَّحِيمِ

تُن لَوْ لَانَ الْبَهْرُ بِرَاوَّ الْقَلِيَاتِ رَبِّي لَنَفْرَ الْبَهْرُ تَبْلَ أَنْ لَوْ لَانَهُ الْبَهْرُ بَبْلَ أَنْ تَنْفَرَ لَلْبَهْرُ بَيْنَا بِمِثْلِهِ مَرَوًّ الْهِ ١٠٩﴾ أَنْ تَنْفَرَ لَلْمَا اللَّهُ مُن مِثْلُهُ يُومَى إِلَيَّ الْنَمَا إِلَاهُهُمْ ثُلُهُ يُومَى إِلَيَّ النَّمَا إِلَاهُمُهُمْ لَكُونُ وَلَيْ اللَّهُ مُرَا اللَّهُ مُرَا اللَّهُ مَلَا مَا اللَّهُ وَالْمُ مَا لَا اللَّهُ مَلَا مَا اللَّهُ وَاللَّهُ مَا اللَّهُ مَا اللَّهُ مَا اللَّهُ مَا اللَّهُ مَا اللَّهُ الْمَرَّ اللَّهُ مَا اللَّهُ مَا اللَّهُ اللَّهُ مَا اللَّهُ مَا اللَّهُ الْمَرَّ اللَّهُ اللَّهُ مَا اللَّهُ مَا اللَّهُ اللَّهُ مَا اللَّهُ اللَّهُ مَا اللَّهُ مَا اللَّهُ اللَّهُ مَا اللَّهُ اللَّهُ اللَّهُ مَا اللَّهُ مَا اللَّهُ مَا اللَّهُ اللَّهُ مَا اللَّهُ مَا اللَّهُ اللْهُ اللَّهُ مَا اللَّهُ الْمُؤْمِلُولُ اللَّهُ اللَّهُ اللَّهُ اللَّهُ اللَّهُ اللَّهُ اللَّهُ اللَّهُ اللَّهُ الْمُؤْمِلُولُ اللَّهُ الْمُؤْمِلُولُ اللْمُ اللَّهُ الْمُؤْمِلُولُ اللَّهُ الْمُؤْمُ الْمُؤْمِلُولُ اللَّهُ الْمُؤْمِلُولُ اللَّهُ الْمُؤْمُ اللَّهُ الْمُؤْمُ اللَّهُ الْمُؤْمُ اللَّهُ الْمُؤْمُ الْمُؤْمُ اللَّهُ الْمُؤْمُ اللَّهُ الْمُؤْمُ اللَّهُ اللَّهُ الْمُؤْمُ اللَّهُ اللَّهُ الْمُؤْمُ اللَّهُ اللَّهُ الْمُؤْمُ اللَّهُ الْمُؤْمُ اللْمُؤْمُ اللْمُؤْمُ اللَّهُ اللَّهُ الْمُؤْمُ اللْمُؤْمُ اللَّهُ اللَّهُ الْمُؤْمُ الْمُؤْمُ اللَّهُ اللَّهُ الْمُؤْمُ اللَّهُ اللَّهُ اللَّهُ اللْمُو

[ننبورة الكمف.]

## Dedicated

To

My Professor

Dr. Aísha Mostafa Swídan

(معلاها)



To

My parents (Father and Mother),
My brothers & sister
My professors,
And
My friends

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# List of Symbols and Abbreviations

## List of Symbols and Abbreviations

A.U Arbitrary Unit

ACA Ant Colony Algorithm

AWACS Airborne Warning and Control System

CONSLUT Consultation Algorithm

 $C_s$  Communication range

DARPA Defense Research Advanced Projects Agency

DSN Distributed Sensor Networks

Eas Evolutionary Algorithms

 $E_f$  Sensor efficiency

Ei Dissipated energy

 $E_s$  Residual energy

 $F_{avg}$  Average fitness of current generation

FL Fuzzy Logic

FLCs Fuzzy Logic Controllers

 $F_{max}$  Maximum fitness by current generation

 $F_{min}$  Minimum fitness by current generation

F<sub>ratio</sub> Current fitness level of chromosomes

GA Genetic Algorithm

Homo-HHomogeneous Hierarchical Virtual Force Directed

VFCPSO Coevolutionary Particle Swarm Optimization

I Radioactive intensity

IPRL Intelligent Personal Radiation Locator

K Link budget constant

LEDR Leader Election Algorithm

M. Intensity Robot Intensity

MEMS Micro-Electro-Mechanical Systems

MODA Multi-Objective Deployment Algorithm

Mp Robot decision

N<sub>CG</sub> Current generation number

NEMS Nanoscale Electro-Mechanical systems

N<sub>G</sub> Total number of generations

N<sub>ratio</sub> Optimization stage of GA

 $N_s$  Sensing range

P<sub>C</sub> Crossover percentage

 $P_a^t$  Probability of locating the sensor in cell a at time t

PFDA Potential Field Deployment Algorithm

P<sub>M</sub> Mutation percentage

RF Radio Frequency

 $R_s$  Reliability

SOSUS SOund SUrveillance System

WSN Wireless Sensor Network.

Y. Intensity Consulted robot intensity

Yp Consulted robot decision

ω<sub>a</sub> Weight function