



# **ENERGY EFFICIENT SMART WIRELESS SENSOR NETWORK FOR BORDER MONITORING**

By

**Islam Wagih Mahdy**

A Thesis Submitted to the

Faculty of Engineering at Cairo University

In Partial Fulfillment of the

Requirements for the Degree of

**MASTER OF SCIENCE**

In

**Electronics and Communications Engineering**

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**Title of Thesis:**

**Energy Efficient Smart Wireless Sensor Network for Border Monitoring**

**Key Words:** Wireless sensor network, intrusion detection, fuzzy logic, Neuro-fuzzy, border monitoring.

**Summary:**

In this thesis, we firstly consider the power problem in wireless sensor network and solution for this problem through software and hardware architectures, secondly we survey the fuzzy logic controller and how it works and different types of the fuzzy logic, thirdly we define energy efficient smart protocol for border monitoring and classify the intruder by two different techniques, the first one is to reduce the monitoring cycle period without effecting the efficiency of the system and the second is the power gating technique to reduce the losing power due to switching and leakage current and voltage in inactive blocks in the circuit, finally we implement the system on arduino mega 2560 then the total saved power are measured and compared with the power without using these technique

# Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately all sources used and have cited them in references section.

Name:

Date:

Signature:

# Dedication

*To the soul of my father, who is my source of inspiration.*

*To my beloved family, for its endless support.*

# Acknowledgements

In the name of Allah the most merciful the most gracious; all thanks to *Allah* the Lord of the Heavens and Earth and peace is upon Mohamed and his companions.

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# Nomenclature

|                 |                                                                                |
|-----------------|--------------------------------------------------------------------------------|
| ACO             | Acoustic                                                                       |
| ANFIS           | Adaptive neuro fuzzy interference system                                       |
| B-MAC           | Barkeley media access control                                                  |
| $C_L$           | Load capacitance                                                               |
| $d$             | Distance between transmitter and receiver                                      |
| D-MAC           | Data gathering                                                                 |
| $E_{elec}$      | Energy required to run radio electronics for one bit                           |
| $E_{tx}$        | Energy required to transmit                                                    |
| $\epsilon_{FS}$ | Energy required for bit/m <sup>2</sup>                                         |
| E-MAC           | Energy efficient MAC                                                           |
| E/Trans         | Energy per transmission                                                        |
| $f_{clock}$     | Clock frequency                                                                |
| FLC             | Fuzzy logic control                                                            |
| $I_{peak}$      | Short circuit current plus current required to charge the internal capacitance |
| LEACH           | Low energy adaptive clustering hierarchy                                       |
| MAG             | Magnetic                                                                       |
| $P$             | Desired percentage of cluster heads                                            |
| $P_{dyn}$       | Dynamic power loss                                                             |
| PEGASIS         | Power-efficient gathering in sensor information systems                        |
| PIR             | Passive infra-red                                                              |
| $P_{SC}$        | Static power                                                                   |
| $P_{SW}$        | Switching power                                                                |
| S-MAC           | Sensor MAC protocol                                                            |
| SMACS           | Self-organized medium access control for sensor network                        |
| SPIN            | Sensor protocol for information via negotiation                                |
| $T(n)$          | Threshold value                                                                |
| $t_{sc}$        | Duration of short circuit                                                      |
| T-MAC           | Time out MAC                                                                   |

|          |                                                              |
|----------|--------------------------------------------------------------|
| TEEN     | Threshold sensitive energy efficient sensor network protocol |
| $V_{dd}$ | Supply voltage                                               |
| $V_{th}$ | Threshold voltage                                            |
| WSN      | Wireless sensor network                                      |
| $\alpha$ | Probability of transition                                    |