Ain Shams University
Faculty of Engineering
Electronics and Communications Engineering Department

Wireless Sensor Network for Smart Border

A Thesis
Submitted in partial fulfillment for the requirements
Of the degree of Master of Science in Electrical Engineering
(Electronics and Communications Engineering)

Submitted by

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Statement

This dissertation is submitted to Ain Shams University in partial fulfillment of the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis was carried out by the author at the department of Electronics and Communications Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or qualifications at any other university or institution.

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Abstract

The use of wireless sensor networks to protect sensitive facilities or international borders has recently attracted more and more attention. It has become a high-priority issue in many countries. In addition to the physical fences built for stopping illegal intruders from crossing the border, smart fencing has been proposed to extend intrusion detection capabilities. Event detection is a central component in numerous wireless sensor network (WSN) applications. In spite of this, the area of event description has not received enough attention. The majority of current event description approaches rely on using precise values to specify event thresholds. However this crisp values cannot adequately handle the imprecise sensor readings.

The Fuzzy Logic System (FLS), is known to be robust and has excellent immunity to external disturbances, can tolerate the unreliable and imprecise sensor readings, and much more intuitive and easier to use. In addition to Fuzzy Logic System, a hybrid event detection algorithm is also introduced and added to the proposed system to enhance the capability of noise reduction in the sensor output signals. Therefore, in this Thesis, Event-detection algorithm based on two layers, 12 bits resolution, fuzzy Logic system (FLS) is modeled using Matlab Simulink, and then designed with the same aspects using VHDL as a proposed design for each node in the wireless sensor Network, which significantly improves the accuracy of the event detection. Each sensor node has an acoustic signal sensor and 3-axis acceleration sensor to improve the precision of the detection system, as well as reducing false alarm rate specially in a noisy environment. Then, the simulation results from both models using Matlab and the VHDL design, have been compared and provided that the FPGA-based fuzzy controller is very close to the software-based controller using MATLAB. Finally, the proposed system has been tested and verified to show the detection ratio of the entire system, which is about 81.2%, the suggestions of improving this testing result is also illustrated in this thesis.

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List of Abbreviations

ANN	Artificial Neural Network
ASIC	Application Specific Integrated Circuits
C1WSN	Category 1 WSN
C2WSN	Category 2 WSN
COG	Center of Gravity
DOA	Degree Of Aggregation
DSP	Digital Signal Processing
FLC	Fuzzy Logic Controller
FLC	Fuzzy Logic Controller
FLIPS	Fuzzy Logic Inference Per Second
FLS	Fuzzy Logic System
FPGA	Field Programmable Gate Array
GUI	Graphical User Interface
IC	Integrated Circuit

LAN	Local Area Network
MEMS	Micro Electro Mechanical Systems
MF	Membership Function
NRE	Non-Recurring Engineering
OS	Operating System
PEG	Pursuer Evaders Game
PID	Proportional Integral Derivative
PIR	Passive Infrared
PLD	Programmable logic devices
R & D	Research and development
RF	Radio Frequency
RTL	Register Transfer logic
SOC	System on Chip
SPWSS	Self-Powered Wireless Sensor System
T-S type	Takagi-Sugeno type
VHDL	VHSIC Hardware Description Language