Ain Shams University
Faculty of Engineering
Electronics & Electrical Communications Engineering

Design of Smart Embedded System for Wireless Sensor Network

This thesis is submitted as a partial fulfillment of the requirements for the degree of Master of Science in Electrical Engineering

(Electronics and Electrical Communications Engineering)

By

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Statement

This dissertation is submitted to Ain Shams University for 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 Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

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

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Abstract

Wireless Sensor Network (WSN) comprises a huge amount of sensor nodes arrayed densely in the environment. The arrayed sensor nodes gather information and send the gathered data towards the sink. This idea can be utilized for various critical issues where human manual contribution is difficult. There are many applications based on WSN such as fire detection in aircraft dry bays and engine compartments [1], traffic engineering [2], smart homes [3] and Event Detection in Wireless Sensor Networks [4].

One of the most attracting environmental applications is water parameters monitoring which is essential to protect fish farms. The deployment of such sensor nodes requires the use of both convenient and compatible control technique and sensors. Therefore, a compatible control system is required to characterize the water parameters that sensor nodes can understand. Most previous work in WSN uses precise, also called crisp, values to specify the water parameters. However, sensor readings are not always precise. In addition, some of the sensor readings may be affected and dependent on the others. Therefore, wrong decision will be taken. This makes the determination of precise values a very difficult task. Therefore, we believe that utilizing crisp values to characterize WSN events is rather an unsuitable technique. On the other hand, fuzzy logic might be better able to classify the issues that are facing the crisp logic.

This thesis discusses in details fuzzy logic control system used in water monitoring system for fish farms. Furthermore, this fuzzy control system is used in controlling three main water parameters which are temperature, the power of Hydrogen (pH) and turbidity to keep the

environment in good conditions for aquatic animal’s survival.

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Abbreviations

ADC	Analog to Digital Converter
AHF	Adaptive Frequency Hopping Feature
AI	Artificial Intelligence
CMOS	Complementary Metal Oxide Semiconductor
DC	Direct Current
DHT	Digital Humidity and Temperature Sensor
DSP	Digital Signal Processor
EDR	Enhanced Data Rate
EEPROM	Electrically Erasable Programmable Read Only Memory
FIS	Fuzzy Inference System
FL	Fuzzy Logic Controller
FLC	Fuzzy Logic Controller
FPGA	Field Programmable Gate Array
GPRS	General Packet Radio Service
GUI	Graphical User Interface
IDE	Integrated Development Environment
MAC	Media Access Control
Mac OS	Macintosh Operating System
MCU	Microcontroller Unit
MPU	Microprocessor Unit
NTC	Negative Temperature Coefficient
NTU	Nephelometric Turbidity Unit
OSI	Open System Interconnection
PC	Personal Computer
PCB	Printed Circuit Board
PDA	Personal Digital Assistant
PH	Power of Hydrogen
PIC	Peripheral Interface Controller
PID	Proportional Integral Derivative
PIO	Programmed Input/output

PLD	Programmable Logic Devices
RAM	Random Access Memory
RF	Radio Frequency
SRAM	Static Random Access Memory
TSK	Takagi-Sugeno-Kang fuzzy system
UART	Universal Asynchronous Receiver/Transmitter
WSN	Wireless Sensor Network

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Chapter 1
Introduction

1.1 Introduction

People and creatures have built up the capacity to utilize multiple senses at the same time as a way to survive. Such as evaluating the nature of eatable resources may not be conceivable utilizing just the feeling of vision, the mix of sight, touch, smell, and the taste is much more effective. Correspondingly, when vision is restricted by buildings and vegetation, the feeling of ears can give preemptive guidance of approaching perils. Therefore, multi-sensory data fusion is actually implemented by animals and people to survey more exactly the enclosed environment and to distinguish dangers; in this manner enhancing their odds of survival [1].That is the reason as of late, significant attention has concentrated on multi-sensory data fusion in a wide documented of sciences. Multi-sensory data fusion is a quickly advancing exploration range which needs interdisciplinary learning in control theory, probability, statistics, signal processing, artificial intelligence, and so on. Multi-sensory data fusion alludes to the synergistic mix of sensory data from different sensors and relative data to give more solid and precise data than could be accomplished by utilizing a single, separate sensor [5]. Really multi-sensory data fusion is a multilevel, multilayered operation which deals with the estimation, association, automatic detection, correlation, and collecting of information from one and different data provenances. The outcomes of a data fusion operation handle assist clients to settle on choices of confounded situations [6].

Present day research and business aquaculture have started to receive new innovations, including computer