Design of a Vision Enabled Wireless Sensor Node

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Declaration

I declare that this is my own work, and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Abstract

This thesis describes a novel system architecture and implementation of a wireless visual sensor node. The proposed design of the node can be used to extract traffic information based on the visual description of road. In this research, the real-time performances and the capability to perform at low power consumption meanwhile obtaining accurate results were considered as the essential factors since a large amount of data need to be processed in an embedded level vision system.

At first, a suitable vision algorithm is proposed to harvest the traffic condition on road. The functionality for each section of the algorithm has been performed by using carefully selected available vision techniques and image processing algorithms. The vehicle extraction from the current frame of view and the tracking process of the vehicle are identified as the most important functions in the algorithm. The vehicle extraction from the current frame is carried out by the ViBe algorithm with some modifications in order to acquire promising real time performances and the tracking process is carried out by a light weight but an accurate enough particle filtering technique.

Moreover, the complete system is implemented in the FPSoC hardware system as a hardware and software co-design by considering advantages that can be obtained from different aspects. The performances of the system have been evaluated from many aspects for different standard data available from other research works. The conclusions and suggestions for further development have been presented at the end of this thesis.

Index terms— FPSoC, HW/SW Co-Design, ITS, ViBe, FPGA, WSN, VSN

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Contents

Declaration i

Abstract ii

Acknowledgements iii

List of Figures vi

List of Tables viii

1 INTRODUCTION 1

1.1 Background to the Research Topic 1

1.2 Aim, Objectives and Scope of the Thesis 6

1.3 Structure of the Thesis 7

2 LITERATURE REVIEW 9

2.1 Summary 22

3 SYSTEM ARCHITECTURE 23

3.1 Selection of Traffic Parameters 23

3.2 Proposed Vision Model for Traffic Estimation 26

3.3 Vehicle Extraction 28

3.4 The ViBe Algorithm 31

3.4.1 Description of the Model and Pixel Classification Method . 31

3.4.2 Initialization of the ViBe Model 32

3.4.3 The Updating Process of the Background Model 33

3.4.4 Identified Drawbacks in the ViBe Algorithm and Modification Proposed to the Original 34

3.5 Vehicle Tracking 39

4 IMPLEMENTATION **49**
4.1 Hardware-Software Partitioning and Optimization of the Algorithm 54

5 RESULTS AND DISCUSSION **62**
5.1 Accuracy of the Vision Algorithm 62
5.2 Power Consumption of the Hardware Platform 68

6 CONCLUSION AND FUTURE WORK **70**
6.1 Major Contributions 70
6.2 Future Works 71
6.2.1 Increase the Frame Rate of the System 71
6.2.2 Improve the accuracy of Vehicle Tracking 71
6.2.3 Improve the Accuracy of Detecting the Stopped Vehicles in the Scene 72
6.2.4 Enhance the Capability to Count the Number of Vehicles in the Scene 72
6.2.5 Evaluate the Usability of this VSN in the Real world . . . 73

References **74**

Appendices **81**

A The ViBe Algorithm **82**
A.0.1 The Update and Classification of Modified ViBe 82

List of Figures

1.1 The concept of using WVSN in ITS applications. 2
1.2 The basic hardware architecture of a VSN in ITS application. . . 5

2.1 The hardware architecture of VSN in [1] 11
2.2 Example TSI image in left side and block diagram of the algorithm in right side. 13
2.3 Hardware architecture for proposed vision algorithm in [11] 14
2.4 The Proposed algorithm to measure traffic condition. 15
2.5 The steps of the vehicle classification. 16
2.6 Block diagram of the night vision algorithm. 17
2.7 Comparison of performance of the night vision algorithm for different SBCs. 18
2.8 Implementation of the parallel functions presented in [19]. 20
2.9 HW/SW data flow and interrupt route. 21

3.1 Flow Diagram of the Vision Algorithm. 27
3.2 Illustration of the foreground extraction process. 28
3.3 Gaussian distribution. 30
3.4 Distribution of Mixture of Gaussian. 30
3.5 Representation of the sphere. 32
3.6 The neighborhood pixels at location, “x”. 33
3.7 The updating location of the model. 34
3.8 The cuboid concept. 36
3.9 PCC values for different tolerance values. 37
3.10 Resultant frame for each tolerance value. 37
3.11 The cuboid in actual model and the update process. 38
3.12 Comparison of modified ViBe with MoG and original ViBe. 39
3.13 Accuracy of the MoG, Modified ViBe and the original ViBe in term of PCC. 39
3.14 Basic steps in a tracking algorithm. 40

3.15 Meanshift vector 40
3.16 Illustration of the displacement. 42
3.17 The process of LBP 43

4.1 Overview of a vision system 49
4.2 The architecture of a modern FPSoC. 52
4.3 Ultra 96 Development board 54
4.4 Resources of the Ultra 96 board 54
4.5 Time consumption profile for the execution of one frame. 55
4.6 Types of AXI4 interfaces. 56
4.7 Block diagram of ViBe. 57
4.8 Block diagram of the weight calculation using Bhattacharya coefficient 57
4.9 Integration custom IP with Zynq 58
4.10 Complete flow chart of the algorithm with balanced processing load between PL and PS side. 59

5.1 (a) Early tracking initialization (b) Correct tracking initialization. 63
5.2 Background noise of the patch 63
5.3 Location deviation due to background pixels in the tracking template. 64
5.4 Deviation of the tracking box even though the vehicle is stopped. 65
5.5 Partially occluded situation. 65
5.6 Power consumption of the hardware platform. 66
5.7 The effect of merged blobs. 67
5.8 Static power consumption. 68
5.9 Dynamic power consumption. 69

List of Tables

2.1 Specifications of the SBCs that have been used to compare the performance of the algorithm. 18

3.1 PCC and tolerance values 36

4.1 Comparison of hardware platforms 50
4.2 Specifications of the SBCs that have been used to compare the performance of the algorithm. 60
4.3 Performances and resource utilization for different frame sizes . . 60
4.4 Comparison with other implementation 61

5.1 Accuracy of the average velocity. 63
5.2 The accuracy of the waiting time. 64
5.3 Accuracy of the LO 66
5.4 Accuracy of Traffic Density 67

List of Abbreviations

Abbreviation	Description
WSN	Wireless Sensor Node
RoI	Region of Interest
WVSN	Wireless Visual Sensor Node
ITS	Intelligent Transportation Systems
VSN	Visual Sensor Node
FPU	Floating Point Unit
SIMD	Single Instructions Multiple Data
FPSoC	Field Programmable System on Chip
FoV	Field of View
FPGA	Field Programmable Gate Array
ASIC	Application Specific Integrated Circuit
SoC	System on Chip
TSI	Time-Spatial Images
VDL	Virtual Detection Line
LBP	Linear Binary Pattern
APSoC	All Programmable System on Chip
PS	Processing System
HW	Hardware
SW	Software
CPU	Central Processing Unit
SBC	Single Board Computer
MoG	Mixture of Gaussian
SRP	Sparse Random Projection
NCC	Normalized Cross Correlation
GIC	Global Interrupt Controller
PL	Programmable Logic
CNN	Convolutional Neural Network

LO	Lane Occupancy
ViBe	Visual Background extractor
FN	False Negative
FP	False Positive
PCC	Percentage of Correct Classifications
TP	True Positive
TN	True Negative
SAD	Sum of the Average Difference
GPU	Graphic Processing Unit
WT	Waiting Time
AV	Average Velocity
CLB	Combinational Logic Block