

# **HSBS: A HUMAN'S HEAT SIGNATURE & BACKGROUND SUBTRACTION HYBRID APPROACH FOR CROWD COUNTING AND ANALYSIS**

**By**

*Nermin Kamal Abdel Wahab Mohamed Negied*

*A Thesis Submitted to  
The Faculty of Engineering at Cairo University  
In Partial Fulfillment of the Requirements for the Degree of  
**DOCTORATE OF PHILOSOPHY**  
in  
**COMPUTER ENGINEERING***

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
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FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT  
July, 2016

# *Dedication*

*I would like to dedicate my work to every person  
who thought me a lesson in my life,*

*Specially those unforgettable people who are  
close to my heart.*

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# TABLE OF CONTENTS

DEDICATION .....	i
ACKNOWLEDGEMENT.....	ii
TABLE OF CONTENTS .....	iii
LIST OF TABLES .....	v
LIST OF FIGURES .....	vi
LIST OF ABBREVIATIONS .....	ix
ABSTRACT .....	xi
<b>Chapter 1: INTRODUCTION.....</b>	<b>1</b>
1.1. Problem Statement.....	1
1.2. The Largest Human Gatherings that happened in History.....	2
1.3. Motivation of this work .....	3
1.4. Thesis Approach.....	3
1.5. Thesis Outline .....	4
<b>Chapter 2: BIOMETRICS IN THERMAL BANDS RELATED WORK.....</b>	<b>5</b>
2.1. Thermal Imaging: The Next Wide Step in the Field of Biometrics .....	5
2.1.1. Human Biometrics .....	5
2.1.2. Infrared Imaging .....	7
2.1.3. Infrared Bands and Thermal Spectrum .....	7
2.1.4. Thermal Imaging as a Biometric Approach .....	9
2.2. Thermal versus Visible bands .....	20
2.3. Summary of the Chapter .....	22
<b>Chapter 3: CROWD COUNTING LITERATURE REVIEW.....</b>	<b>23</b>
3.1. Crowd Counting in Visible Bands.....	23
3.1.1. Image information based methods.....	23
3.1.2. Tracked object properties based methods .....	31
3.2. Crowd Counting in Thermal Bands.....	34
3.3. Chapter Summary .....	37
<b>Chapter 4: THEORETICAL BACKGROUND.....</b>	<b>38</b>
4.1. Heat Signature Theory .....	38
4.1.1. Heat and Temperature .....	39
4.1.2. Heat Transfer .....	39
4.1.3. Discovery and first researches of the Infrared Radiation.....	43
4.1.4. The Electromagnetic Radiation Spectrum.....	44
4.1.5. Emissivity and Temperature Measurement.....	48
4.1.6. Application .....	50
4.2. Motion Analysis Theory .....	60
4.2.1. Background subtraction .....	62
4.2.2. Background modeling .....	62

4.2.3. Frame Differencing .....	63
4.3. Chapter Summary .....	64
<b>Chapter 5: THE PROPOSED APPROACH .....</b>	<b>66</b>
5.1. Crowd Density Measurement Using Human's Heat Signature .....	66
5.1.1. Frame extraction .....	69
5.1.2. Cropping the temperature rectangles from the frame .....	70
5.1.3. Image processing .....	71
5.1.4. Image enhancement .....	71
5.1.5. Numerical recognition.....	71
5.1.6. Human heat signature (Required temperature range) definition .....	72
5.1.7. People density calculation .....	73
5.1.8. Discussion .....	74
5.2. Crowd Density Measurement Using Motion Analysis .....	75
5.2.1. Frame extraction .....	76
5.2.2. Image preprocessing .....	77
5.2.3. Background deduction .....	77
5.2.4. Foreground (humans) extraction.....	78
5.2.5. Obtaining Motion Threshold .....	80
5.2.6. People density calculation.....	83
5.2.7. Discussion .....	83
5.3. Crowd density measurement using hybrid approach.....	83
5.4. Chapter Summary .....	85
<b>Chapter 6: EXPERIMENTAL WORK.....</b>	<b>86</b>
6.1. Experimental Results .....	86
6.1.1. Data set.....	86
6.1.2. Accuracy rate .....	87
6.1.3. Crowd classification.....	984
6.1.4. Comparison with previous work.....	98
6.2. Results Discussion.....	101
6.2.1. For Heat Signature approach .....	102
6.2.2. For Motion analysis approach .....	102
6.2.3. Combining both approaches .....	102
6.3. Chapter Summary .....	103
<b>Chapter 7: CONCLUSION AND FUTURE WORK .....</b>	<b>104</b>
7.1. Conclusion .....	104
7.2. Suggested Application .....	105
7.2.1. Framework proposal .....	106
7.3. Future Work .....	106
<b>Appendix A: THE LARGEST HUMAN GATHERINGS THAT HAPPENED IN HISTORY .....</b>	<b>108</b>
<b>Appendix B: JUSTIFICATION OF HEAT SIGNATURE THEORY .....</b>	<b>118</b>

## **LIST OF TABLES**

Table1.1. The Largest Human Gatherings Happened in History .....	2
Table.2.1. Wavelength Range for Different Spectrums. ....	9
Table.4.1. Different units of temperature degrees. ....	39
Table 4.2. Some examples for materials' emissivity. ....	42
Table.4.3. Average surface temperature of different ground composing materials .....	52
Table.4.4. Records of Skin Temperature under the Clothing .....	58
Table.4.5. Background and Foreground apparent temperature ranges in different possible ambient air temperatures. ....	67



## LIST OF FIGURES

Fig.2.1. Different types and technologies of biometrics .....	6
Fig.2.2. Sample result of face segmentation from thermal images .....	11
Fig.2.3. Acquired hand images and extracted hand-vein .....	12
Fig.2.4. Sample thermal (MWIR) profile images of multiple subjects where the ears are left and right 'detection results' .....	13
Fig.2.5. Human eye in visible and thermal images .....	14
Fig.2.6. Finger thermal images and their filtered results .....	14
Fig.2.7. Sample results of Betrozzi's framework pedestrians' detection .....	15
Fig.2.8. Examples of detection results achieved by Keck and Davis's approach .....	16
Fig.2.9. Sample results of successful detection of Arens and Jungling .....	17
Fig.2.10. Sample result of successful detection for Wang's framework .....	17
Fig.2.11. Tracking results of Li and Gang's framework (three different frames) .....	18
Fig.2.12. Results of John, et al frame work (detected human body in a small bounding box) .....	18
Fig.2.13. Zhang, el al examples of detection results .....	19
Fig.2.14. Zin, et al examples of detected pedestrians .....	20
Fig.2.15. Sample visible (top) and thermal (down) images. ....	21
Fig.3.1. Sample results for crowd counting achieved by Huiyuan, et.al framework .....	24
Fig.3.2. Sample results of motion detection obtained by Chonthisa and Nikon .....	25
Fig.3.3. the output window of Lim and Zarita's framework indicating the correct number of persons .....	26
Fig. 3.4. Results of pedestrian detection when multiple persons appeared (by Hsieh, et.al) .....	27
Fig.3.5. Multi-resolution density cells obtained by Xianyu, Guoyuan, Keung, and Yangsheng's framework .....	28
Fig.3.6. Images from dataset used to examine the system, (Railway station (UK)) for various densities, low, moderate, and very high crowded scenes .....	28
Fig.3.7. Sample results obtained by Sidla, et.al system .....	29
Fig. 3.8. Detection example achieved by Subbraman, et.al from Turin database .....	30
Fig. 3.9. Sample results of detected humans by Merad, et.al system .....	31
Figure 3.10. Ground-truth annotations of moving persons indicating the direction of motion .....	32
Fig.3.11. Segmented humans obtained by Arif, et.al framework .....	32
Fig.3.12. Segmented persons obtained by Rajeev and Sridhar's framework .....	33
Fig.3.13. Hashem, et.al people counting framework sample results .....	34
Fig. 3.14. Sample result of Abuarafah, Khozium, and AbdRabou's system .....	35
Fig. 3.16. Density calculation using a thermal image utilizing background subtraction by Abu Arafah .....	36
Fig.3.15. Abuarafah's Output window indicating the moving pixels in the frame and the amount of them .....	36
Fig.4.1. Electromagnetic Radiation. ....	38
Fig.4.2. William Herschel (1738 - 1822) discovering IR energy .....	43
Fig.4.3. Example of the calculation of object's apparent temperature based on its emissivity and true temperature. ....	50
Fig.4.4. Relationship between Color and Heat Absorption. ....	53
Fig.4.5. Estimated hourly temperature, on the basis of air temperatures, at different depths for the period of two days in August, 2008. ....	54
Fig.4.6. Correlation between air temperature and different ground composing materials temperature .....	55
Fig.4.7. Correlation between outdoor apparent air temperature and human skin temperature. ....	57

Fig.4.9. Cold vs. hot human body temperatures.....	59
Fig.4.10. Covered vs. uncovered human skin temperatures .....	59
Fig.4.13. A general framework for human motion analysis. ....	60
Fig5.1. Background and Foreground apparent temperature ranges in different possible ambient air temperatures. ....	67
Fig.5.2. Samples of the data set video frames, humans are cooler than their background. ....	68
Fig.5.3. Abstraction of Heat Signature framework phases. ....	69
Fig.5.4. A sample extracted frame from the thermal video sequence.....	70
Frame # 87 in a 560 frames video sequence. ....	70
Fig.5.5. Image enhancement steps, the original cropped rectangles, converted to gray level images,.....	71
and their binary equivalents. ....	71
Fig.5.6. the 10 pre-stored possibilities. ....	72
Fig.5.7. the temperature ruler, (a) the original cropped ruler, (b) converted to gray level, .....	73
and (c) the required portion.....	73
Fig.5.8. the frame converted from colored to gray levels .....	73
Fig.5.9. Binary frame, white pixels representing pixels that matched the required temperature range.....	74
and black pixels representing the background .....	74
Fig.5.10. Abstraction of motion analysis framework phases. ....	76
Fig.5.10. the original colored frame, frame #3, in the video #5.....	77
Fig.5.11. The mean frame, background, or rigid pixels.....	78
Fig.5.12. the chosen frame converted to gray .....	82
Fig.5.13. the chosen frame subtracted from the mean frame .....	82
Fig.5.14. the difference converted to binary image.....	82
Fig.5.15. HSBS Frame work phases and outputs. ....	84
Fig.6.13. Sample results from video sequence #8. (Light Mixed Crowd). ....	95
Fig.6.14. Sample results from video sequence #2. (Moderate Fully Dynamic Crowd).....	96
Fig.6.15. Sample results from video sequence #3. (Heavy Fully Dynamic Crowd). ....	97
Fig. 6.16. FLIR camera calibration held by Abuarafah, Khozium, and Abdrabou . ....	98
Fig. 6.17. Some video frames with no passing pilgrims in the center point. ....	98
Fig.6.18. CMINS sample results .....	99
Fig.6.19. CMINS heat signature vs. background subtraction results for mixed crowd. ....	100
Fig.6.20. CMINS heat signature vs. background subtraction results for fully dynamic crowd. ....	101
Fig.7.1. Proposal framework for suggested application .....	106
Fig.A.1. the biggest tranquil social affair on the planet, Allahabad, India, 2013.....	108
Fig.A.2. Arbreen religious festival in Kerbala, 2014. ....	109
Fig.A.3. Funeral of C.N. Annadurai the Chief Minister of the South Indian state of Tamil Nadu. ....	110
(The largest funeral in history).....	110
Fig.A.4. Funeral of the Egyptian President Gamal Abdel Nasser, Cairo, Egypt, 1970. ....	111
Fig.A.5. World Youth Day, Catholic youth festival in Manila, Philippines, 1995. ....	112
Fig.A.6. Funeral for Pope John Paul II, Rome, 2005. ....	113
Fig.A.7. Funeral of Star of the East (Umm Kulthum), Cairo, Egypt, 1975. ....	114
Fig.A.8. Rod Stewart concert, Brazil, 1994. (The largest concert in history).....	115
Fig.A.9. Funeral of Ruhollah Khomeini, the Grand Ayatollah, Iran, Tehran, 1989.....	116
Fig.A.10. Pilgrims doing Hajj in Mecca (Haram Meccy).....	117
Fig.B.1. Sample result of randomly taken frame from video sequence #1. (27% < manual estimation < 30%).	118

Fig.B.2. Sample result of randomly taken frame from video sequence #2. (17% < manual estimation < 22%).	119
Fig.B.3. Sample result of randomly taken frame from video sequence #3. (77% < manual estimation < 82%).	119
Fig.B.4. Sample result of randomly taken frame from video sequence #4. (51% < manual estimation < 56%).	120
Fig.B.5. Sample result of randomly taken frame from video sequence #5. (71% < manual estimation < 76%).	120
Fig.B.6. Sample result of randomly taken frame from video sequence #6. (40% < manual estimation < 45%).	121
Fig.B.7. Sample result of randomly taken frame from video sequence #7. (37% < manual estimation < 42%).	121
Fig.B.8. Sample result of randomly taken frame from video sequence #8. (25% < manual estimation < 30%).	122
Fig.B.9. Sample result of randomly taken frame from video sequence #9. (64% < manual estimation < 69%).	122
Fig.B.10. Sample result of randomly taken frame from video sequence #10. (71% < manual estimation < 76%).	123
Fig.B.11. Sample result of randomly taken frame from video sequence #11. (30% < manual estimation < 35%).	123
Fig.B.12. The difference happened in HSBS Heat Crowd size estimation results compared to average human eye estimation after considering the temperature gap.	124

## **LIST OF ABBREVIATIONS**

ADAS = Advanced Driver Assistant System  
CA = Curve Analysis  
CIE = The International Commission on Illumination  
CSM = Contour Saliency Map  
DSP = Digital Signal Processor  
EM = Expectation Maximization  
FFT = Fast Fourier Transform  
FLIR = Forward-looking infrared  
FPGA = Field-Programmable Gate Array  
GMM = Gaussian Mixture Model  
HOG = Histograms of Oriented Gradients  
IIR = Intermediate Infrared  
IR = InfraRed  
IRT = Infrared thermography  
ISM = Implicit Shape Model  
K-SVD = K means Singular Value Decomposition  
LBP = Local Binary Pattern  
LDP = Local Derivative Pattern  
LWIR = Long-wavelength infrared  
MWIR = Mid-wavelength infrared  
NIR = Near-infrared  
RGB-D = RGB plus depth  
ROI = Region of Interest  
SCD = Shape Context Descriptor  
SiO<sub>2</sub> = Silica glass

**SURF = SpeedUp Robust Features**

**SWIR = Short-wavelength infrared**

**SVM = Supported Vector Machine**

**UAV = Unmanned Aerial Vehicle**

**VLWIR = Very Long-wave infrared**

## **ABSTRACT**

This work presents a new approach for crowd counting and classification based upon human thermal and motion features. The technique is efficient for automatic crowd density estimation and type of motion determination. Crowd density is measured without any need for camera calibration or assumption of prior knowledge about the input videos. It does not need any human intervention so it can be used successfully in a fully automated crowd control systems. Two new features are introduced for crowd counting purpose: The first represents thermal characteristics of humans and is expressed by the ratio between their temperature and their ambient environment temperature. The second describes humans' motion characteristics and is measured by the ratio between humans' motion velocity and the ambient environment rigidity. These features have been investigated and proved to give accurate crowd counting performance in real time. Moreover, the two features are combined and used together for crowd classification into one of three main types, which are: fully mobile, fully static, or mix of both types. Last but not least the proposed system offers several advantages over previous crowd counting approaches such as being a: privacy preserving crowd counting system, reliable for homogeneous and non-homogeneous crowds, it does not depend on a certain direction in motion detection, has no limitations on crowd size. The experimental results demonstrate the effectiveness of the approach.

### **Keywords:**

Crowd counting, Crowd classification, Heat signature theory, Motion analysis theory, Background subtraction, Human temperature, Ground temperature, Emissivity, Apparent temperature, IR imaging.

# Chapter 1

## INTRODUCTION

### 1.1. Problem Statement

This thesis addresses the problem of programmed crowd size estimation and characterization in Infrared bands. A generally understood definition for crowd is large number of persons gathered closely together and having something in common. Crowds can be classified into two primary classes, *static* crowds and *dynamic* crowds. The framework presented by this thesis automatically tells to which class a particular crowd belongs. Crowd size estimation is a method used to measure the quantity of individuals in a crowd. At ticketed events, bought tickets and entryways are frequently used to accurately count the quantity of persons entering a venue. Then again un-ticketed events, like the events that occur in an open venue like roads or squares, crowd counting is an exceptionally difficult issue and the aftereffects of group thickness estimation are constantly less precise. For some occasions, particularly political energizes, disagrees and religious occasions, overcrowding and dilemma in crowd control have brought various fatal or possibly savage mischance.

Crowd counting or size estimation and control methods are important to give complete security to individuals composing the group. Along the history of human beings there were numerous events that gathered individuals in extremely huge crowds. Many reasons gathered individuals a long history of human beings. The fundamental reason was constantly either religious or political in some way, despite the fact of the distinction in places, inspirations, and cultures.