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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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.

ACKNOWLEDGEMENT

- First of all I thank Allah for his generosity, kindness and for granting me the means and ability to finish this work.

- I would like to thank my parents and all my family members for their support.

- I would like to thank my professors Prof. Elsayed Hemayed and Prof. Magda Fayek, for their true efforts without which I would have never been able to finish this work.

- I would like to thank Prof. Khaled El Sayed and Prof. Ayman El Desouky, who allowed me to see more valuable ideas to be added and discussed in this thesis.

- I would like to thank Dr. Maged El Hakim, Dr. Sarah Motie, and Dr. Ahmed Gouda for their help and sincere support.

- Finally I would like to thank all my friends and colleagues who encouraged me to finish this work.

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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_2 = 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.