Chapter 3
Image Processing for Surveillance and Security

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ABSTRACT

Security is a fundamental issue in today's world. In this chapter we discuss various aspects of security in daily life that can be solved using image processing techniques by grouping in three main categories: visual tracking, biometrics and digital media security. Visual tracking refers to computer vision techniques that analyses the scene to extract features representing objects (e.g., pedestrian) and track them to provide input to analyse any anomalous behaviour. Biometrics is the technology of detecting, extracting and analysing human's physical or behavioural features for identification purposes. Digital media security typically includes multimedia signal processing techniques that can protect copyright by embedding information within the media content using watermarking approaches. Individual topics are discussed referring recent literature.

INTRODUCTION

Surveillance and security are the integral part of today's life particularly when million's of CCTVs are in action covering many public places including, airports, railway stations, high streets, market places, shopping complexes, theaters and many more to name. At the same time, in today's digital world we capture, store and share millions of images, videos and other creative contents. Development in network infrastructure and media compression technology influenced a paradigm shift in entertainment content consumption such as video streaming, and on-demand video services. However all these scenarios pose several challenges in image processing community in addressing digital security in everyday life.

The security and surveillance are often treated separately in the image and signal processing research domain. While computer vision techniques deal with challenges in visual tracking, anomaly detection or biometric identifications, multimedia signal processing community is more concern with digital

media security and digital right management using data hiding techniques (e.g., watermarking). In this book chapter we attempted to discuss image processing approaches proposed in the literature addressing various digital security related issues, from surveillance to media security. To the best knowledge of the authors' there is no such attempt made in the literature that brings together such range of topics under one common theme.

The chapter is broadly categorised in three sections: a) visual tracking, b) biometric and c) multimedia security. We restricted our discussion of the individual topics with respect to image processing techniques.

IMAGE PROCESSING FOR VISUAL TRACKING

Automatic detection, tracking and anomaly identification occupy a considerable space in computer vision research and have many applications including intelligent surveillance, human-computer interaction (HCI), human-robot interaction (HRI), augmented reality (AR), medical applications and visual vehicle navigation etc. More importantly, recently there is a great deal of interest in robust visual tracking algorithms due to the increased need of automated video analysis relating safety in public places such as railway station, airport, shopping areas, religious festivals or governmental offices. This poses fundamental challenges in computer vision which involves input from image processing research along with input from machine learning community. In this section we discussed fundamental steps for visual tracking by dissecting the algorithms available in recent literature.

Image analysis for tracking consists of three key steps: 1) detection of interesting moving objects; 2) tracking moving objects in time lapsed frames and 3) analysis of tracked objects for behavioural study such as recognition, prediction and anomaly detection. One can broadly dissect the visual tracking algorithms in four different categories (Yilmaz et al., 2006; Haering et al., 2008; Yang et al., 2011): a) Object representation, b) Feature selection, c) Object detection and d) Object tracking. These categories can also be grouped and fitted into a classical image processing pyramid of low level, medium level, intermediate level and high level algorithms, based on the complexity and the type of data they process (Figure 1).

Object Representation

Shape Representation

Objects in a scene can be represented by their shape of appearance. Example of shape representations are: i) Points where objects can be represented by a point, e.g., centroid (Veenman et al., 2001) or by a set of points (Serby et al., 2004) to track objects that engage a smaller region of the image space; ii) Primitive geometric shapes where objects can be represented by various geometric shapes such as rectangle, ellipse (Comaniciu et al., 2003) or parametric ellipsoid (Limprasert et al., 2013) for tracking purposes; iii) Object silhouette and contour where the contour of object boundary and the contour region is called as silhouette and used in tracking (Yilmaz et al., 2004). iv) Articulated shape models where targets are composed of combination of connected body parts, e.g., human subject can be articulated with the torso, head, arm, leg etc... (Husz et al., 2011). Individual body parts are represented using cylinders or ellipses; and v) Skeletal models where skeletons are extracted from object silhouettes by applying medial axis transform and used in object recognition (Ali and Aggarwal, 2001) or tracking (Schwarz et al., 2012).

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