A Compilation of Methods and Datasets for Group and Crowd Action Recognition

Luis Felipe Borja, Universidad Central del Ecuador, Quito, Ecuador
Jorge Azorin-Lopez, Department of Computer Technology, University of Alicante, Alicante, Spain
Marcelo Saval-Calvo, Department of Computer Technology, University of Alicante, Alicante, Spain

ABSTRACT

The human behaviour analysis has been a subject of study in various fields of science (e.g. sociology, psychology, computer science). Specifically, the automated understanding of the behaviour of both individuals and groups remains a very challenging problem from the sensor systems to artificial intelligence techniques. Being aware of the extent of the topic, the objective of this paper is to review the state of the art focusing on machine learning techniques and computer vision as sensor system to the artificial intelligence techniques. Moreover, a lack of review comparing the level of abstraction in terms of activities duration is found in the literature. In this paper, a review of the methods and techniques based on machine learning to classify group behaviour in sequence of images is presented. The review takes into account the different levels of understanding and the number of people in the group.

KEYWORDS

Computer Vision, Crowd Automated Analysis, Human Behavior Analysis, Machine Learning, Motion Analysis, Trajectory Analysis

1. INTRODUCTION

Nowadays, video surveillance of people is a widely used tool because there are many cameras that facilitate the capture and storage of video. Most of these products are dependent on an operator to analyze the content of stored information. Knowing this limitation, it is necessary to provide systems of video surveillance that make possible the automatic identification of behavior. These types of system can be carried out using computer vision techniques, since they allow the identification of patterns of people behavior in an unsupervised manner as gestures, movements and activities among others. In general terms, machine learning, it is possible to model the behavior of people in open or closed spaces such as universities, shopping malls, parks or streets, and then analyze them using automatic learning methods.

There are currently many researches on Human Behavior Analysis such as, (Azorin-Lopez et al., 2015) that have resulted in the identification of various types of people’s behavior in video sequences. These behaviors have been classified from the simplest to the most complex taking into account their duration, from seconds to hours. For these behaviors, a classification has been proposed in (Chaaraoui et al., 2012).

The objective of this paper is to provide a classification of human behavior analysis proposals taking into account the size of the group or crowd, identifying the number of people that comprises
it, the type of behavior detected, the level of abstraction (from simple actions to complex behaviors) and the techniques used for its treatment and analysis. The most important public datasets are also reviewed which are used to test algorithms there exist several studies on the identification of human behaviors such as (Chaaraoui et al., 2012), (Cardinaux et al., 2011), (Turaga et al., 2008), (Ryoo & Aggarwal, 2008). In (Mihaylova et al., 2014) a taxonomy of groups with fewer and more members is established, in addition the methods to analyze them are specified. There are works such as (Climent-Pérez et al., 2014), where it is proposed to analyze the behavior of crowds by classifying them into two levels, macro and micro. Despite research efforts to analyze behavior in groups and crowds, we still have many fronts on this subject for researchers.

The organization of the paper is as follow: Section 2. Aspects of human behavior, levels of semantics and datasets; Section 3. Classification of the state of the art proposals; finally, conclusions and possible future works.

2. ASPECTS OF HUMAN BEHAVIOR ANALYSIS

In this section, the main aspects of the human behavior analysis are explained. First, we will present the different levels of understanding and later the main datasets available for experimentation.

2.1. Description of Human Behavior Types and Semantics (Gesture, Motions, Activities, Behavior)

In order to identify human behavior according to the level of abstraction and understanding the data has to be classified depending on the meaning, duration and complexity of tasks performed by humans. Classifications of activities have taking as its main reference the level of complexity of them, from the easiest to the most complex. The complexity factor is directly related to the time duration of the activity, generally, an activity is considered complex if it has a longer duration. In (Vishwakarma & Agrawal, 2013) four levels related to their semantics:

- **Level 1 (Gestures):** Basic movements of parts of the body that last a time. Examples of gestures can be movements of the hand, arm, foot or head among others.
- **Level 2 (Actions):** Also called atomic, consists of actions performed by a single person, their duration is larger than a gesture. An example of actions could be walking, running, jumping.
- **Level 3 (Interaction):** In this category human-human or human-object interaction activities are performed. Examples of these interactions can be two people dancing, kissing, running one behind another, children playing, people cycling.
- **Level 4 (Group Activity):** At this level of description it conforms to two or more groups of people, one or more objects can intervene in the scene. An athletic race, basketball team forwarding, pedestrians crossing a street, a football game, a fight in a stadium can be examples of group activities.

Another taxonomy of human behavior that classifies it according to the complexity and duration time is proposed in (Chaaraoui et al., 2012). In this approach, the analysis is classified on the degree of semantics in four levels:

- **Level 1 (Motion):** Detection in seconds or frames.
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