

Chapter 14

Visual Attention for Behavioral Biometric Systems

Concetto Spampinato
University of Catania, Italy

ABSTRACT

The chapter is so articulated: the first section will tackle the state of art of the attention theory, with the third paragraph related to the computational models that implement the attention theories, with a particular focus on the model that is the basis for the proposed biometric systems. Such an algorithm will be used for describing the first biometric system. The following section will tackle the people recognition algorithms carried out by evaluating the FOAs distribution. In detail, two different systems are proposed: 1) a face recognition system that takes into account both the behavioral and morphological aspects, and 2) a pure behavioral biometric system that recognizes people according to their actions evaluated by a careful analysis of the extracted FOAs.

INTRODUCTION

With the establishment of the information society, personal identification systems have gained an increased interest, either for security or personalization purposes. Traditionally, computer systems have based identification procedures on something that one has (keys, magnetic cards or chip cards) or something that one knows (personal identification numbers and passwords) (Gamba, & Fred, 2004). These systems can easily fail to serve their objec-

tive in situations of loss or lent of a key or card, or in cases of forgotten passwords or disclosure of codes. Biometric authentication or identification systems use something one is, creating more reliable systems, with higher immunity to authorization theft, loss or lent.

Biometric techniques can be divided into *physiological* and *behavioral*. A physiological trait tends to be a more stable physical characteristic, such as finger print, hand silhouette, blood vessel pattern in the hand, face or back of the eye. A behavioral characteristic is a reflection of an individual's

DOI: 10.4018/978-1-60566-725-6.ch014

psychology. Because of the variability over time of most behavioral characteristics, a biometric system needs to be designed to be more dynamic and accept some degree of variability. On the other hand, behavioral biometrics are associated with less intrusive systems, conducing to a better acceptability by the users.

In this book chapter we propose novel behavioral biometric applications based on the *human visual attention* system. More in detail, we will discuss about two biometrics systems based on how humans recognize faces, bodies, postures, etc... according to the distribution of the *focuses of attention* (FOAs, that represent the most interesting parts in a visual scene) that are *fixations* reproducing the ability of humans in the interpretation of visual scenes. Indeed the pattern of these fixations and the choice of where to send the eye next are not random but appear to be guided (Rayner, K., & Pollatsek, A. (1989)).

In detail we will propose two approaches for behavioral biometrics: the first one uses a combination of *morphological features* with *behavioral features* by analyzing the FOAs distribution (*scanpath*) for recognizing faces and the second one uses just these *scanpaths*, suitably organized in *Information Path* (Boccignone et al., 2002), for recognizing people according to their actions.

As concern the face recognition system the analysis of the FOAs, allows us to integrate the face features (e.g., eyes, nose, mouth shape), the holistic features (the relations between the various parts of the face) and the facial expressions in the recognition task thus allowing us integration between physiological and behavioral features.

The same approach has been applied for recognizing people according to their actions and it is based just on spatial distribution of the FOAs and the saliency order of such a points.

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with a particular focus on the model that is the basis for the proposed biometric systems. Such an algorithm will be used for describing the first biometric system. The following section will tackle the people recognition algorithms carried out by evaluating the FOAs distribution. In detail two different systems are proposed: 1) A face recognition system that takes into account both the behavioral and morphological aspects and 2) A pure behavioral biometric system that recognizes people according to their actions evaluated by analyzing the extracted FOAs.

BACKGROUND OF ATTENTIONAL RESEARCH

Human vision system seems to apply serial computational strategy when inspecting complex visual scenes. Particular locations in scenes are selected based on their relevance from both the objective and subjective point of view, with reference to the observer, i.e. In notable study of 1967, Yarbus (Yarbus, A. L. (1967)) demonstrated that perception of complex scene involves complicated pattern of fixations, where the eye stands still, and saccades, where the eye moves to include in the fovea a part of the scene. Basically, fixations occur for zones that are salient to determine specific features of the scene under consideration. Therefore when humans look a face, they usually concentrate the attention (evidenced by the *saccadic movements*) to the main facial features like eyes, nose, mouth, etc. See Figure 1 for instance. The distributions of those movements are strongly connected to the personal psychology.

As is know the detection and the recognition of objects in a complex scene are difficult tasks for the artificial machines. Differently humans easily analyze and select interesting information in a generic scene according to a specific task.

In fact, humans have a remarkable ability to interpret scenes in real time, in spite of the limited speed of the neuronal hardware available for such

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