The Analysis of Facial Beauty: An Emerging Area of Research in Pattern Analysis

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Abstract. Much research presented recently supports the idea that the human perception of attractiveness is data-driven and largely irrespective of the perceiver. This suggests using pattern analysis techniques for beauty analysis. Several scientific papers on this subject are appearing in image processing, computer vision and pattern analysis contexts, or use techniques of these areas. In this paper, we will survey the recent studies on automatic analysis of facial beauty, and discuss research lines and practical applications.

Keywords: Face image analysis, facial landmarks, attractiveness.

1 Introduction

Analyzing 2D or 3D images of humans is a main area of research in pattern analysis and computer vision. The human face is by far the part of the body which conveys more information to human beings, and thus potentially to computer systems [2]. Such information span identity, intentions, emotional and health states, attractiveness, age, gender, ethnicity, attention, etc. At present, the most studied application of face image analysis is identity recognition [1], which is essentially an engineering deformable object recognition problem. Other face image analysis applications are multidisciplinary and related to human sciences and medicine. They are essentially 1) analyzing human expressions, and 2) analyzing face attractiveness.

The first is by far the most studied problem, particularly to capture human expression for animating the faces of virtual characters. A much more challenging problem is interpreting facial expressions, that is mapping expressions onto emotional states [2], [3]. The results presented are not yet convincing, since tracing backward the path from expressions (effects) to the emotions (causes), requires a shared and coherent model of the human emotions and of their effects on facial features, which psychophysiology has not yet supplied [3]. The second multidisciplinary problem, that is the analysis of human beauty and its measure, has been widely debated for centuries in human science, and, more recently, in plastic surgery and orthodontics. In the last decades, several thousands of papers on this subject have been published in these areas. The human science researchers involved in these studies are: social and developmental psychologists, cognitive psychologists and neuroscientists and evolutionary psychologists and biologists. Applying pattern analysis and computer vision techniques for analyzing beauty is a relatively new research field. The purpose of this

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paper is to survey rationale, techniques, results, applications and open problems in this emerging area.

2 Beauty in Human Sciences and Medicine

Social importance of attractiveness. What is beauty? Philosopher, scientists and artists debated the problem for centuries. A controversial long lasting question is whether beauty is objective or subjective, or if "Beauty is in the eye of the beholder", according to a sentence of the writer Margaret Wolfe Hungerford (1878). Important personages, as David Hume (1741), have supported this thesis or, as Immanuel Kant (1790), the opposite. Coming to our times, a number of recent behavioural, social and psychological studies, as well as everyday common experience, show that face and body harmony is extremely important in general social life. Looking unpleasant or different seriously affects self-esteem and can result in social isolation, depression and serious psychological disorders [35]. Thus, is not surprising that, according to a recent estimate, in the US more money is spent annually on beauty related items or services than on both education and social services [5].

Classic Beauty canons. Since ancient times, the supporters of beauty as an objective and measurable property attempted to state ideal proportions, or beauty canons, for the human body and its parts. The Greek sculptor Polykleitos was the first to define aesthetics in mathematical terms in his "*Kanon*" treatise. Marcus Vitruvius, a Roman architect, introduced the idea of facial trisection, or facial thirds, largely used in medicine and anthropometry (Fig. 1).

Fig. 1. Facial trisection, as originally described by Vitruvius

Renaissance artists, as Leonardo da Vinci, Leon Battista Alberti, Albrecht Duerer and Piero della Francesca, reformulated and documented the classic canons. Descriptions of the classic canons can be found in [6]. These canons have been used for centuries in art by sculptors, painters, and are a rough working guide for plastic surgeons.

From the classic concept of ideal proportions also stems the debate about the relevance of the golden ratio in beautiful faces. The golden ratio is an irrational number, approximately 1.618, obtained by dividing a segment into two parts, a and b, such that $a/b = (a+b)/a$. Since ancient times, the golden ratio has been used explicitly, or claimed later to have been used, by a score of sculptors, painters, architects and even