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A Simple Framework for Assessing Facial Attractiveness Using Computer Vision and Machine Learning Technique

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ABSTRACT: Facial symmetry is a key component in quantifying the perception of beauty. In this paper, we propose a set of facial features computed from facial landmarks which can be extracted at a low computational cost. We quantitatively evaluated the proposed features for predicting perceived attractiveness from human portraits on four benchmark datasets (SCUT-FBP, SCUT-FBP5500, FACES and Chicago Face Database). Experimental results showed that the performance of the proposed features is comparable to those extracted from a set with much denser facial landmarks. The computation of facial features was also implemented as an augmented reality (AR) app developed on Android OS. The app overlays four types of measurements and guidelines over a live video stream, while the facial measurements are computed from the tracked facial landmarks at run time. The developed app can be used to assist plastic surgeons in assessing facial symmetry when planning reconstructive facial surgeries.

KEYWORDS: Facial attractiveness, Face perception, Evolutionary psychology, Beauty, Facial features.

INTRODUCTION

The human face is central to many aspects of social interaction. It forms the basis from which humans are able to process, recognize and draw information from one another. Even from infancy, humans are able to demonstrate a preference for faces perceived as attractive. Indeed, there have been several studies suggesting that individuals deemed as being attractive are more likely to achieve prestigious occupations, to have better prospects for personal fulfillment and to benefit from additional social advantages in their everyday lives. These observations have subsequently garnered the attention of researchers, in seeking to determine whether attractiveness can be considered objective or subjective. Several studies, both in the fields of psychology and medical science, suggest that facial attractiveness can indeed be quantified.

Humans have evolved in such a way that they are able to perceive subtle deviations in what would be considered a normal facial structure. Facial symmetry and averageness have consequently been identified as key components in this perception, and several attempts to produce metrics for these elements have been proposed. The development of these attractiveness metrics has led to the development of several tools that can theoretically determine facial attractiveness based upon the proposed empirical data.

Recently, automated machine learning methods of assessing facial attractiveness using beauty metrics have been proposed. These proposed frameworks focus on developing systems which automatically assess facial attractiveness based upon the facial proportions and specified landmarks typically associated with facial beauty. It is thought that automated technology capable of the quantifiable analysis and measurement of facial attractiveness could have many applications including anxiety recognition, entertainment, virtual media, cosmetics, orthodontics and plastic surgery.
Given that facial symmetry has the potential to contribute greatly to the perception of facial attractiveness, the impact of facial asymmetry can lead to significant emotional and psychological distress. The UK Equality Act 2010 states that a severe facial disfigurement should be treated as a disability. In these cases, reconstructive plastic surgery is often

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considered necessary. In undertaking surgery to resolve facial asymmetry, surgeons will often manually determine the differences between the two sides of the face, simply by examining the patient subjectively. Working in close collaboration with the patient, surgeons tend to use the contralateral normal side as a guide rather than using the well-studied metrics discussed above. While the implementation of technology has not been widely acknowledged in this area, there is certainly the potential for it to be very helpful.

II.LITERATURE SURVEY

The survey was hosted on Qualtrics, a secure survey hosting website. It collected basic demographic information, including age, ethnicity, country of residence, education level, household income, employment, and gender(s) to which respondents experience romantic or sexual attraction. Transgender female respondents were asked the age at which they began hormone therapy, transition history (social, legal, medical, and/or surgical). They were also asked what gender-affirming procedures (facial bony surgical, face and neck soft tissue surgical, facial non-surgical, body surgery, top surgery and bottom surgery) they have accessed, are interested in accessing in the future, or have health insurance coverage. Non-transgender female respondents were asked for their gender identities, and whether they had rhinoplasty or orthognathic surgery performed for either reconstructive or cosmetic purposes. Plastic surgeons were asked how many FFS that have involved rhinoplasty or orthognathic surgery they have performed in the past 10 year.

The survey was distributed to individuals who self-identify as transgender females through regional and national organizations, medical schools, engagement with social media platforms, including Facebook groups with members interested in FFS. Respondents were encouraged to share the study with other potentially interested individuals. The study was shared on Reddit (13), a social news aggregation website, with community specific discussion boards, by a member of the public. The response rate is incalculable because there is no sampling frame.

The distribution to non-transgender female respondents was initiated through Facebook advertisements, and Qualtrics panel, to target respondents, with similar demographics distribution after responses from at least 100 transgender female individuals were received.

Plastic surgeons involved academically or clinically in FFS were first contacted by email in May, and a subsequent follow-up email was sent in June 2019.

III.PROPOSED METHOD

DLIB (DIGITAL LIBRARY)

Dlib is a general purpose cross-platform software library written in the programming language C++.Itsdesign is heavily influenced by ideas from design by contract and component-based software engineering. Thus it is, first and foremost, a set of independent software components. It is open-source software released under a Boost Software License.

Since development began in 2002, Dlib has grown to include a wide variety of tools. As of 2016, it contains software components for dealing with networking, threads, graphical user interfaces, data structures, linear algebra, machine learning, image processing, data mining, XML and text parsing, numerical optimization, Bayesian networks, and many other tasks.

DEEP NEURAL NETWORK

Deep neural networks have recently become the standard tool for solving a variety of computer vision problems. Whereas training a neural network is outside the OpenVX scope, importing a pretrained network and running inference on it is an important part of the OpenVX functionality. The concept of the Graph API of nodes representing functions and links representing data is very convenient for implementing deep neural networks with OpenVX. In fact, each neural network unit can be represented as a graph node. OpenVX has a special data type representing tensors to provide data exchange between these nodes, and the nodes themselves are implemented in the OpenVX Neural Network Extension. Another way to import a neural network into OpenVX is by using the OpenVX Kernel Import Extension. The Kernel Import Extension can take a pretrained network model and load it into OpenVX as a single node. One of the data formats that can be used is Neural Network Exchange Format *(*NNEF), the standard also developed by the Khronos Group. See Chapter 10 for details on how to import a pretrained neural network into OpenVX.

OPENCV

OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real-time computer vision.[1] Originally developed by Intel, it was later supported by Willow Garage then Itseez (which was later acquired by Intel[2]). The library is cross-platform and free for use under the open-source Apache 2 License. Starting with 2011, OpenCV features GPU acceleration for real-time operations.

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NUMPY

NumPy, which stands for Numerical Python, is a library consisting of multidimensional array objects and a collection of routines for processing those arrays. Using NumPy, mathematical and logical operations on arrays can be performed. This tutorial explains the basics of NumPy such as its architecture and environment. It also discusses the various array functions, types of indexing, etc. An introduction to Matplotlib is also provided. All this is explained with the help of examples for better understanding.

MATPLOTLIB

Matplotlib is an amazing visualization library in Python for 2D plots of arrays. Matplotlib is a multi-platform data visualization library built on NumPy arrays and designed to work with the broader SciPy stack. It was introduced by John Hunter in the year 2002.

One of the greatest benefits of visualization is that it allows us visual access to huge amounts of data in easily digestible visuals. Matplotlib consists of several plots like line, bar, scatter, histogram etc.

IV.EXPERIMENTAL RESULTS

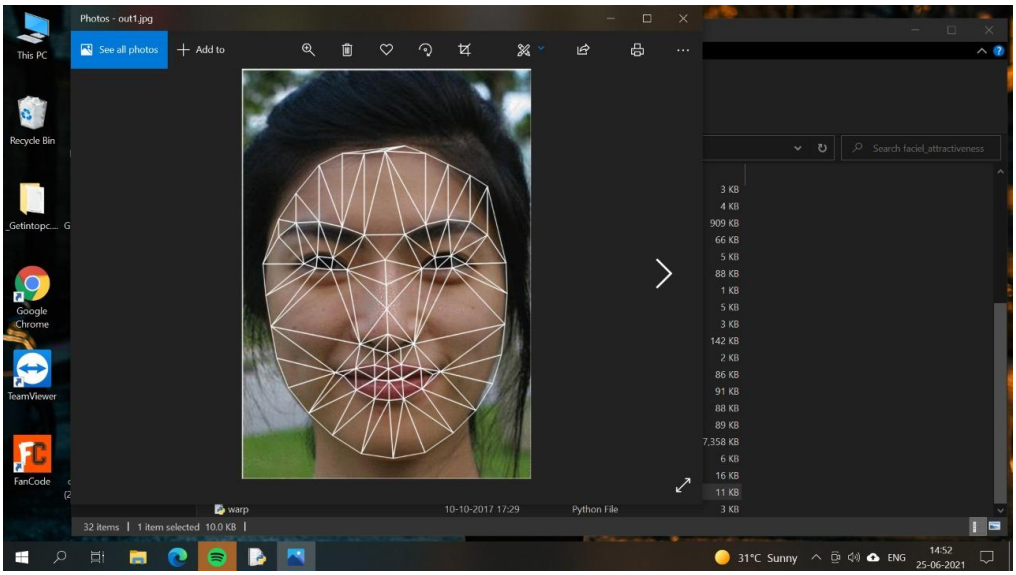

Figure 1

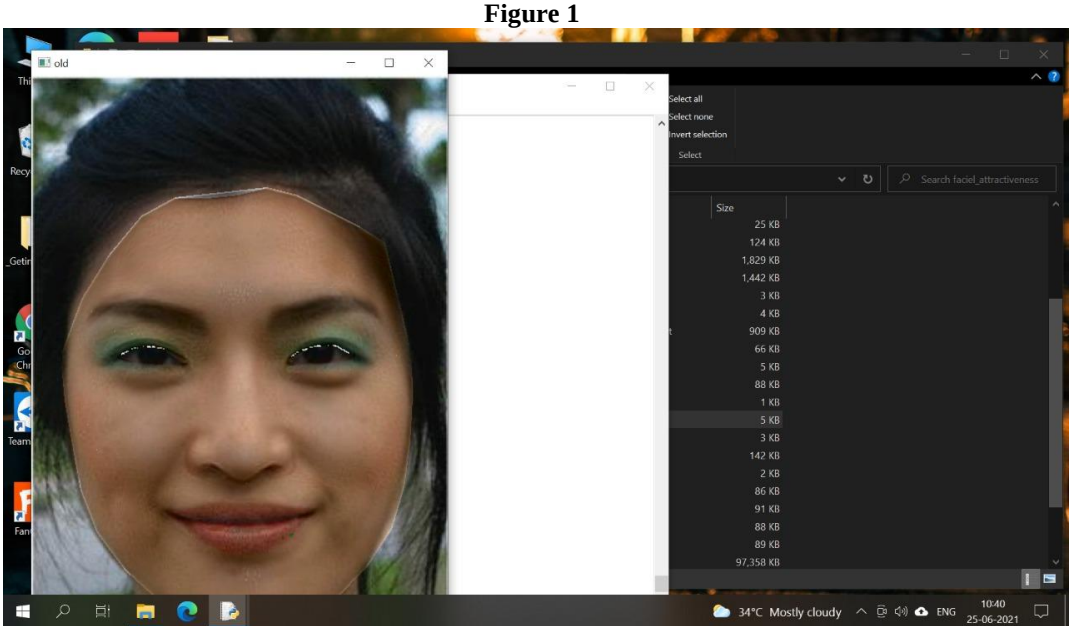

Figure 2

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V.CONCLUSION

Being more or less attractive has important social consequences and people do generally agree on who is and who is not attractive. Beauty is not just a simple social construct—attractiveness appears to be ingrained in our biology. While some aspects of face perception might be innate, other aspects are clearly influenced by experience; it seems unlikely that individuals are born with a representation of what a perfect partner looks like.
Structural and other aspects of human facial appearance are linked to preferences (§2). If a trait reliably advertises some benefit to the perceiver, then we would expect individuals in a population to find that trait attractive. It is clear that individual differences in preferences for some traits will prove adaptive and so are consistent with evolutionary theory. We document several potentially adaptive individual differences in human face preferences as well as other factors that may lead to variable preferences (§3). Research on human facial attractiveness has benefited greatly from an evolutionary/biological perspective, both in terms of documenting what traits are likely to be important and in predicting individual variation. Work on facial attractiveness is also integrative, combining theories and methods from behavioural ecology, cognition, cross-cultural research and social psychology.

The proposed features are extracted from the facial landmarks. As a result, the accuracy of the landmarks extracted from the Google Face API has significant impact on the quality of the proposed facial features. In addition to the proposed geometric features, color and texture information could also potentially provide additional useful features for beauty score prediction. However, a set of identified significant landmarks depend upon a particular dataset used, which is a limitation of our approach. Moreover, the larger database of faces allows to elicit more significant features, which underscores the need to have larger and more diverse face datasets for facial beauty research.

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