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A New Parameterised Feature-based Generic 3D Human Face Model for Emotional Bio-robots

Xu ZHANG[1,a], ShujunZHANG[2,b], Kevin HAPESHI[2,c]

[1]CED Group of Rolls-Royce UTC, Faculty of Engineering and the Environment, University of Southampton, Southampton, SO17 1BJ, UK
[2]School of Computing and Technology, University of Gloucestershire, The Park, Cheltenham, GL50 2RH, UK

[a]Xu.Zhang@soton.ac.uk, [b]szhang@glos.ac.uk, [c]khapeshi@glos.ac.uk

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Abstract

To represent various human facial expressions is an essential requirement for emotional bio-robots. The human expressions can convey certain emotions for communications of human beingswith some muscles' positions and their movements. To design and develop emotional robots, it is necessary to build a generic 3D human face model. While the geometrical features of human faces are freeform surfaces with complex properties, it is the fundamental requirement for the model to have the ability of representing both primitive and freeform surfaces. This requirement makes the Non-rational Uniform B-Spline (NURBS) are suitable for 3D human face modelling. In this paper, a new parameterised feature based generic 3D human face model is proposed and implemented. Based on observation of human face anatomy, the authors define thirty-four NURBS curve features and twenty-one NURBS surface features to represent the human facial components, such as eyebrows, eyes, nose and mouth etc. These curve models and surface models can be used to simulate different facial expressions by manipulating the control points of those NURBS features. Unlike the existing individual based face modelling methods, this parameterised 3D face model also gives users the ability to usethe model imitate any face appearances. In addition the potential applications of the new proposed 3D face model are also discussed. Besides emotional bio-robots, it is believed that the proposed model can also be applied in other fields such as aesthetic plastic surgery simulation, film and computer game characters creation, and criminal investigation and prevention.

1 Introduction

Emotional bio-robots is one of the important areas of bionic robots applications. To represent human facial expressions is an essential requirement for building emotional bio-robots, because the expressions can help bio-robots to communicate with human beings emotionally. This requirement raises the demands for three dimensional (3D) human face modelling.

With the rapid development and applications of 3D modelling techniques, a lot of research have been carried out to study human faces and to build 3D face models for various applications [1-4], especially for emotional bio-robots, aesthetic surgery, crime detection and computer game etc. One intuitive approach of modelling human faces is using scanned 3D data. It is a type of active stereo vision methods. The data obtained using 3D scanners - so called "clouds" - is a complete set of 3D information including 3D coordinates, colours, and textures rather than the profile images of an object. The number of points in "clouds" varies from hundreds of thousands to millions. Based on these "clouds", different algorithms are developed to build the corresponding 3D models [5-8].

Another 3D modelling method is the triangular patches method which is a surface approximation method. Although each triangle can be expressed in a 2D plane, numerous triangles in 3D can be connected together to approximate an arbitrary surface. A famous triangular patches face model is CANDIDE[9], which uses hundreds of triangles to represent a 3D human face with several simple