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Erosion-Inspired Simulation of Aging for Deformation-Based Head Modeling

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Abstract

Simulation of age progression of 3D head models is an open problem in the field of computer graphics. Existing methods usually require a large set of training data, which may not be available. In this paper, a method for aging simulation of models created by deformation-based modeling is proposed that requires no training data. A user defines the position of wrinkles by selecting the position of endpoints of the desired wrinkles and the wrinkles are then generated using an erosion-inspired approach. The method can be used to simulate aging of any head model, however, if used for models created by deformations of a base model, the erosion factors can be calculated only for the base model and applied to the derived models. The results show that the approach is capable of creating visually plausible aged models.

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1 Introduction

As people age, their body undergoes many physical changes. The aging process affects a human body as a whole but the changes are the most noticeable in the face. In childhood, the head grows and changes its shape. In adulthood, the size of the head does not change in a significant manner but the head shape continues to change, although at a much slower pace. However, the most significant change of an adult face is the formation of distinct wrinkles and the change of the appearance and elasticity of the skin.

Modeling of face aging is an important tool for the creation of visually plausible models of middle-aged or elderly people for the use, e.g., in animation, virtual reality or computer games. Procedural creation of a realistic model of a wrinkled face can also be useful for the use in forensics and creation of an identikit of a crime suspect.

Most of the existing face aging methods work on 2D images or photographs and require large training sets. Available 3D solutions usually require training data as well and concentrate on the modeling of the aging process by the simulation of wrinkles or the skin appearance changes. Most of the methods use textures to simulate wrinkles, however, especially deep wrinkles change

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the shape of the skin so significantly that it may be reasonable to require an actual alteration of the mesh to make the face more plausible when viewed from an angle.

This paper presents a method for the simulation of aging of a 3D model of an adult human head for the use in creation of an identikit of a crime suspect. A 3D identikit can be created, e.g., using a deformation-based modeling method proposed by Martínek and Kolingerová [8]. The proposed method uses an erosion-inspired approach for the aging simulation. Each vertex of the mesh is assigned an erosion factor, which determines the magnitude of the face deformation. The wrinkles are defined by a zero erosion factor, while the regions that should be enlarged are assigned a positive factor. Other regions that should be preserved are also assigned erosion factor of a zero value. In the case the mesh is not detailed enough for the required deformation, a local subdivision of the mesh is applied in the eroded regions.

The main contributions of the proposed solution are:

- The method does not require any training data.
- The same aging parameters can be used for all models created from a base model using a deformation-based modeling method.
- Subdivision is applied only in the affected regions, if the original mesh is not detailed enough.

The paper is organized as follows: Section 2 presents the state-of-the-art methods in the field of face aging simulation. Section 3 describes the proposed solution and Section 4 presents the results of the proposed algorithm. Finally, Section 5 concludes the paper.

2 Related Work

Aging is a very complex process. Many methods exist that offer an approach for the simulation of aging. While most of the methods work on 2D data (e.g., [11], [5], [9], [12]), being able to simulate the aging on 3D models is vital for computer graphics applications, such as animation, gaming or movie industry.

Aging of an adult is accompanied by the formation of wrinkles that deepen with age, by the changes of appearance and characteristics of the skin and also by a subtle change of the shape of the head.

Model-based methods represent the face as a point in n-dimensional space and the aging process is captured as a curve in the given space. The methods usually require large training data sets containing a series of scans for multiple persons at different ages, for which the identity of the person and his of her age is known. A representative of this approach is a method proposed by Scherbaum et al. [10]. They simulate the aging on 3D scans of children faces. The approach requires that all the scans have the same number of points and a known correspondence between the points of models of different ages.

Other group of methods concentrate on the simulation of biological processes causing the aging of the skin. The methods ([3], [4]) simulate the optical characteristics of the skin by modeling the individual layers of the skin and simulating the physical changes during aging. The methods can produce a detailed and realistic results but are very computationally expensive.

Many methods focus their efforts on the creation of realistic wrinkles, as wrinkles are the most obvious sign of the aging process. Boissieux et al. [2] proposed a physically-based method for the creation of wrinkles. They represent the skin with a volumetric model and simulate the wrinkles as a result of contracting muscles using the finite element method (FEM). Wang et