Computational Forensics: Creating a Digital Environment for Facial Synthesis and Reconstruction

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Project Goal

Utilize geometric modeling methods to streamline manual facial reconstruction methods into a 3-D digital environment
Facial Reconstruction

Motivation: To restore the craniofacial structures and face geometries on an unidentified skull for the purpose of triggering recognition and later identification of the individual.

Domains involved:
- Forensic Science
- Anthropology
- Archaeology
- Medicine
- Computer Science
## Comparison of Manual Methods

<table>
<thead>
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<th>American Method</th>
<th>Russian Method</th>
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<td>Measures tissue thickness at anthropological landmarks. Clay or plasticine is then interpolated over the marker guidelines.</td>
<td>Determines the muscular structure of an individual and sculpts muscles, glands, and cartilage layer by layer.</td>
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<td>(+) Relies on data collected from large sample sizes over many decades of study</td>
<td>(+) Contour production immediate</td>
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<td>(-) Does not account for the underlying anatomical structure</td>
<td>(-) Requires a significant amount of anatomical expertise</td>
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<td>(-) Procedure is much more time-consuming</td>
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Computer-aided Methods

Computer-aided methods for facial reconstruction provide many advantages:

○ Increased flexibility, efficiency, speed and accuracy of results
○ Promote the testing of older facial reconstruction guidelines
○ Manual reconstruction is subjective and depends on the expertise of the modeler. A computer program minimizes this subjectivity.
Our Method

1. Digital Environment (GUI) Development using:
   ➢ VisualStudio
   ➢ C++
   ➢ OpenGL
   ➢ Qt
Method: Step 2

2. Skull Modeling:
Computing digital skull landmark locations and positioning of tissue-depth markers
Method: Step 3

3. Facial Synthesis:
Computing facial landmarks on a constrained face template and deforming landmarks to skull coordinates using an as rigid as possible surface deformation algorithm.
Results of skull modeling and facial synthesis performed on a digital male skull and male face template.
Future Work

Refining the Reconstruction:

- Modeling facial features such as the lips, ears, and nose that are difficult to determine due to the uncertainty of the shape of soft tissue structures
- Modeling the texture of the skin
- Considering the complete skull surface
- Conducting resemblance studies
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