Training Data for Landmark Densification: Face Capture

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Abstract

Current methods of training markerless face capture rely on landmarks produced by networks trained on human generated data. Inaccurate landmarks may be a cause of temporal jitter in current methods of markerless facial capture. A potential solution is to replace landmarks with contours. This would eliminate the problem of markers sliding in regions of ambiguous placement such as the jaw. A unique problem to training a model on contour placement is the lack of training data. Curves can be drawn, however, by interpolating between the landmarks on the results of current landmark placement networks as well as human-placed landmark training repositories. The landmarks are often so sparse, however, that contours would not be entirely accurate in regions such as the eyes. I am proposing the generation of synthetic data with morphable face models and variable orientation, lighting, and textures that would have complete landmark accuracy from vertex positions to accompany training data generated from real images.

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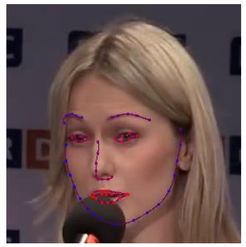
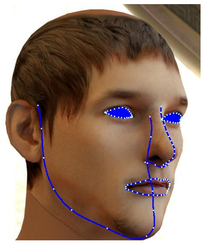
Introduction

Computer-generated face animation is popular in industry as actors can portray fictional characters, themselves at a different age, or an actor or character with similar features. Traditionally, physical landmarks are placed on a face for capture. Researchers are currently using convolutional networks to recognize facial motion from a video clip using generated landmarks. My project aims to create a database of contoured faces so networks can be trained without sliding landmarks.

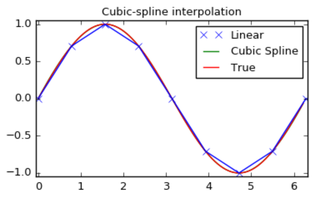
Cubic Spline Interpolation





(Left) Cubic spline interpolation on 2D landmarks generated by CNN
(Right) Cubic spline interpolation on densified synthetic landmarks – 3D Placement

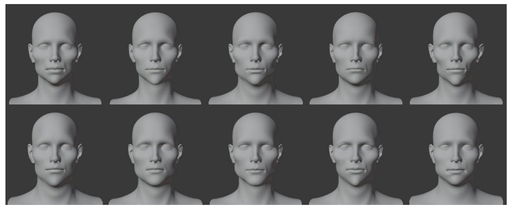
Network uses 2D coords – inaccurate eye lndmks placement and 2D Jaw Landmarks FAN Detection can place 3D markers



Cubic spline interpolation – Function approximations continuous at first and second derivatives with end point derivates equal to 0

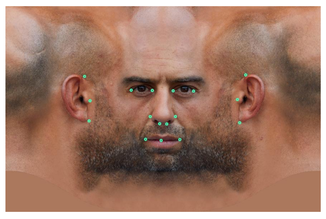
- Reliant on dense accurate landmarks
- May be enhanced by Oriented Histograms/Subpixel Canny Edge detection

Geometry Morphing

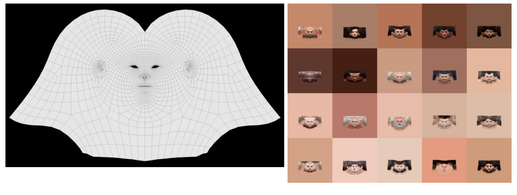


Shape keys control deformation on a mesh assigned to a float (0-1) – can be combined to create unique geometry
Used to generate randomized features with integer values showcasing intensity.
Grouped by detail weight and given a scalar value.
Issues with diversity and realism. Always will be restricted by base mesh.

Face Texture Warping



Tool for placing reduced landmarks on face textures for warping to UV Map – generates scaled texture coordinates



(Left) UV Map controls texture placement on mesh. Control points for warping
(Right) Warped face textures. Function balances between completely accurate matching and distortion

Synthetic Data Generation

1) Randomized shape keys for morphable geometry – features and expressions
2) Randomized head orientations – bone rotation (tilt, left-right, up-down)
3) Labeled vertices using vertex groups in order
4) Vertices' xys projected onto 2D plane (camera resolution)
5) Randomized lighting (HDRIS)
6) Randomized head texture from morph outputs
7) Batch render (3000 samples, 270X270)
8) Ordered landmarks and splines drawn

Continued Research

- CNN to test effectiveness of synthetic data on determining contours for real images
- Larger feature sets for geometry morphing
- Incorporating edge detection into image spline interpolation
- Possible ways to build synthetic faces without relying on image textures

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Further Reading

- Bao, M., Cong, M., Grabli, S., and Fedkiw, R., "High-Quality Face Capture Using Anatomical Muscles", arXiv:1812.02836 (December 2018)
- Bulat, A. "Hierarchical binary CNNs for landmark localization with limited resources" (2018)