Initial Plan: 3D Face Shape Analysis

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Project Description

Geneticists can diagnose many genetic disorders, such as VCFS and Noonan Syndrome, by examining the craniofacial structure of their patients. An experienced geneticist knows how to do this by sight, whereas inexperienced geneticists may require assistance so that they can learn. Since this task is trivial for a human with the correct training, would it be possible to use a computer to aid in the diagnosis, or come up with a correct diagnosis itself? Computer vision is an ill defined problem; a computer program that looks for one specific kind of object isn't necessarily applicable for an entirely different kind of object. Thus, the goal of the project is to create a program that has the capacity to recognise how the facial structure of different subjects varies, and classify different faces based on these differences.

Project Aims

The project has 2 parts:

1) **To build a 3D statistical shape and appearance model from annotated 3D head scans.**
- The first step is to registration. Meshes read in by the 3D head scanner need to be aligned so that the variance in landmark positions can be measured. To do this, we first rigidly align the landmarks on the face using Procrustes analysis. Next, Thin Plate Spline warping is used to warp the underlying 3D mesh to fit the newly positioned landmarks. Finally, the meshes need to be warped again to better fit each other using Nearest Euclidean Distance, or Iterative Closest Point.

- If possible, different registration techniques should be attempted and compared for efficiency and accuracy. Ultimately, we want to find the technique that provides the best possible results for analysis.

- Next, we need to build a 3D statistical model using Principal Component Analysis. PCA involves visualising correlations in many dimensions by projecting them into a 2D form. Code for this exists already, so it shouldn't take long to implement.

- By the end of this stage, the interim report should be delivered. It will contain an account of my experience with the appearance model stage, and any problems I may have encountered. It should also contain a projection of what I will be doing in the second half. By that point, I should have gotten to grips with the appearance model concept, and should be getting an idea as to exactly what I can do with it. I should provide a revised plan that goes into more detail about exactly what I'll be doing in the second stage of the project.

2) **To perform analysis on 3D statistical models using machine learning/classification techniques to "discover" correlations with genetic and environmental factors for craniofacial shape.**

- Cardiff's School of Dentistry has provided the sample data I am to use. We need to liaise with them to see if the analysis the program performs corresponds to how they analyse patients. The data also needs to be presented in a fashion that is both relevant and useful to them.

-The final report should contain a full account of my findings regarding the correlations discovered within the test data, such as the quirks of an automatic classifier. It may pick up details that are not relevant, or maybe details that humans don't ordinarily spot. If the classifier doesn't work as well as hoped, the report should include ideas on how it could be made better if I had more time. It should also include a set of documentation on use of the classifier, so that others can use it as well.

Work Plan

Week 1 : 1st October - 7th October	Background reading: read up on mesh processing, Procrustes algorithm, thin-plate splines, Nearest Euclidean Distance, Iterative Closest Point, , Principal component analysis. Begin work on initial project plan.
Week 2: 8th October - 14th October	Continue background reading. Get to grips with tools and data provided, i.e. matlab code and sample data. Continue work on initial project plan.
Week 3: 15th October - 21st October	Continue mesh work: read in meshes and landmarks, attempt to align meshes using Procrustes Algorithm.Continue background reading. **Deliverable: Complete initial project plan for delivery on the 19th.**
Week 4: 22nd October - 28th October	Continue background reading. Attempt warping using thin-plate spline warping.
Week 5: 29th October - 4th November	Combine thin-plate spline warping and procrustes. Start to implement second phase of mesh warping using NED or ICP.
Week 6: 5th November - 11th November	Continue mesh warping. If it's finished earlier than expected, experiment with different registration techniques until week 8. If it's taking longer than expected, use the next few weeks to make sure it's finished.
Week 7: 12th November - 18th November	Continue mesh warping, Fix bugs, ensure that the registration is complete and ready to be used for PCA.
Week 8: 19th November - 25th November	Finish the registration step.

Week 9: 26th November - 2nd December	Begin work on interim report. Begin work on PCA, just familiarisation for the first week or two.
Week 10: 3rd December - 9th December	Continue work on interim report. Continue familiarisation with PCA, begin implementation if it's fully understood.
Week 11: 10th December - 16th December	Complete registration step if not already finished. Carry on with PCA. **Deliverable: Complete interim report for delivery on the 14th.**
Christmas Recess: 16th Dec. - 6th Jan.	
Exam Period: 7th Jan - 27th Jan	
Week 12: 28th January - 3rd February	Continue with PCA: ensure that plenty of data has been tested and that some clear patterns can be seen.
Week 13: 4th February - 10th February	Complete PCA work. Begin work on building the classifier.
Week 14: 11th February - 17th February	Continue classification work.
Week 15: 18th February - 24th February	Continue classification work.
Week 16: 25th February - 3rd March	Complete a working prototype of the classifier. The next 3 weeks should be used to test it, fix any bugs, and add to tweak and modify the program. Any features added should be completed relatively quickly so that they can be tested properly.
Week 17: 4th March - 10th March	Continue classification work.
Week 18: 11th March - 17th March	Continue classification work.
Week 19: 18th March - 24th March	Finish Coding, begin work on final report. Test the program thoroughly to ensure that as many bugs are removed as possible, and that the end result is in a fit state to be used by other people.
Easter Recess: 25th March - 14th April	Continue working on final report.
Week 20: 15th April - 21st April	Continue working on final report. Work on documentation so that others can use the classifier, and so that it can be included in the report.
Week 21: 22nd April - 28th April	Continue working on final report.

Week 22: 29th April - 5th May	**Deliverable: Complete final report for delivery on the 3rd.**