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Project 4.404 | 3D Facial Analysis Streamlining for Clinical Translation

Project Leader Ms Hedwig Verhoef, CRCSI hverhoef@crcsi.com.au

Research Team Dr Petra Helmholz, Dr David Belton, Dr David McMeekin, and Mr Richard Palmer, Curtin University

Project Participants Curtin University, Dept of Health WA (Princess Margaret Hospital for Children, Cranio-Maxillo Facial Unit) – Mark Walters, Lyn Schofield; Dept of Health WA (Genetic Services WA) - Gareth Baynam

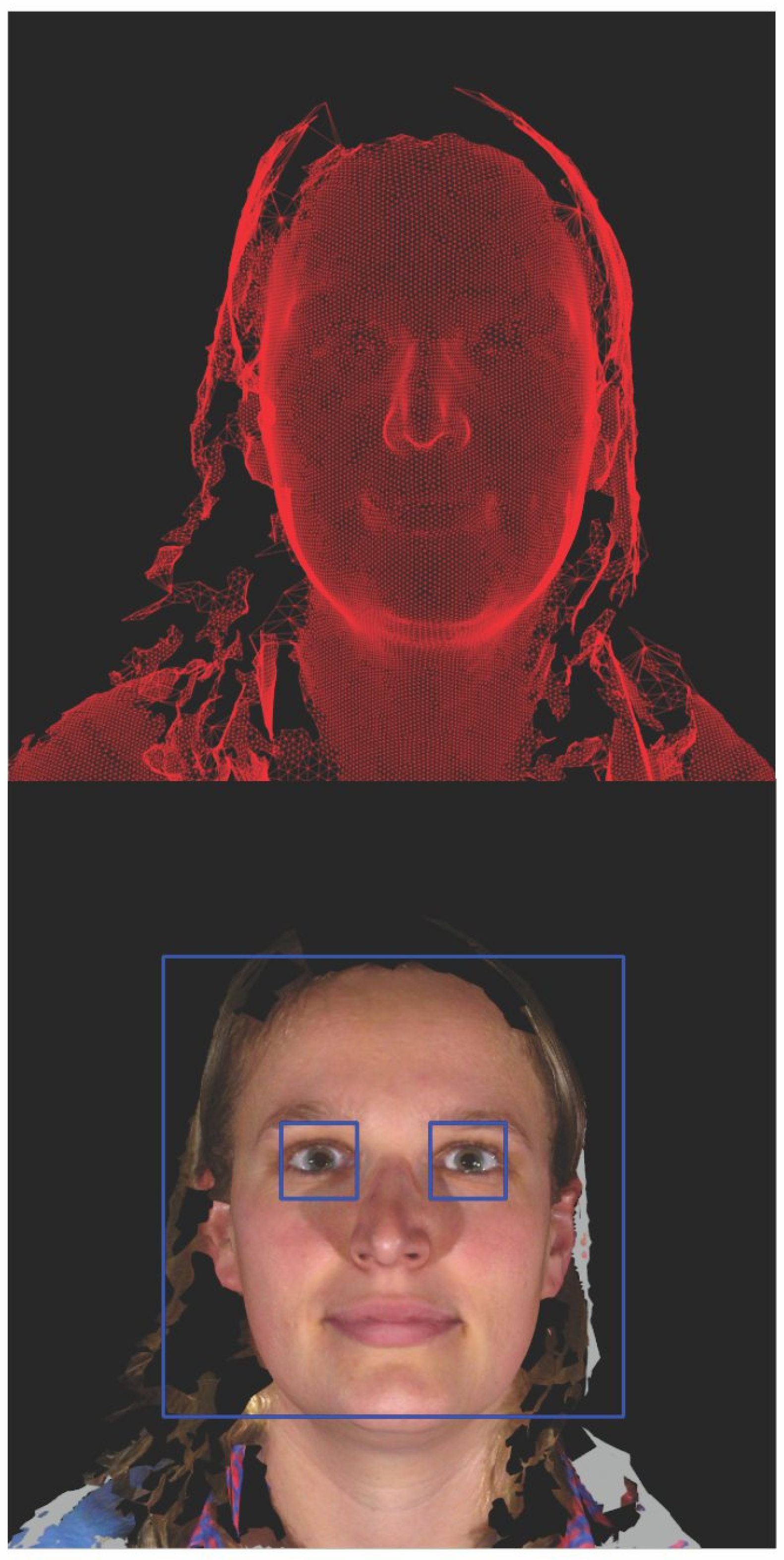
Objectives Princess Margaret Hospital (PMH) research staff manually generate image analysis input files from raw photogrammetric scans of children's faces. This project aims to automate much of this workflow to allow staff to focus on more critical aspects of patient care.

Outcomes The initial goal is to produce a stand-alone application that can import raw face scan data and to perform the following functions:

- Automate the process of face detection, orientation and scaling,
- Automate the detection of facial landmarks and their position in 3D space,
- Automatically segment and export the data into a required image analysis format for further processing.

Face Scan and Representation

Facial scan data are collected as polygon meshes with vertices mapped to co-registered RGB images of the patient's face. Initial detection of the patient's face uses the Haar Cascades face detection algorithm. Heuristic knowledge of the relative location of the face is employed to reject multiple facial detections (e.g., the face of an adult supervisor). The initial face detection allows for preliminary centring and scaling of the face prior to landmark detection.

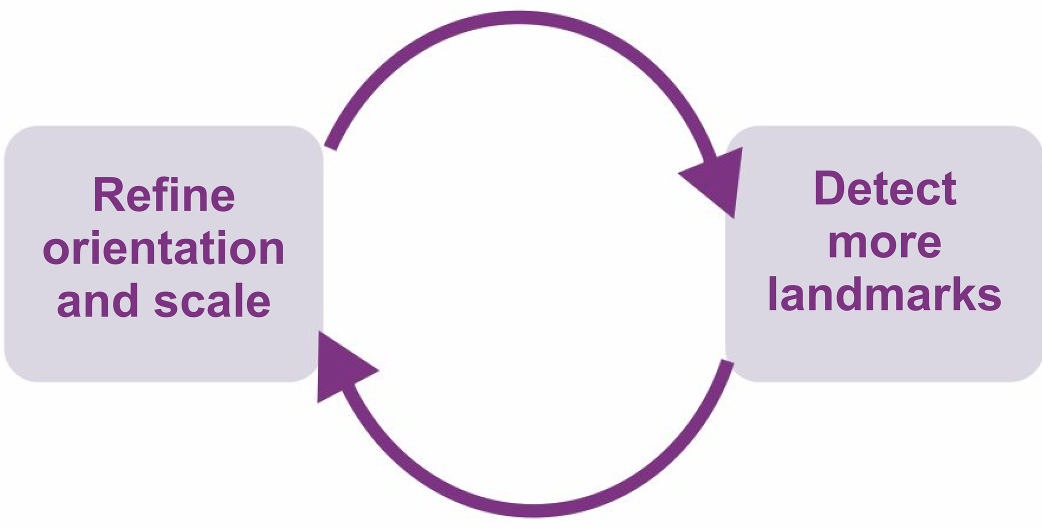


Detecting Facial Landmarks

The ordering of the detection of facial landmarks is important. Certain features are easier to detect than others (such as the eyes and the nose-tip). These features in turn provide more accurate orientation information to facilitate the detection of subsequent landmarks (the outer nostrils, mouth and chin).

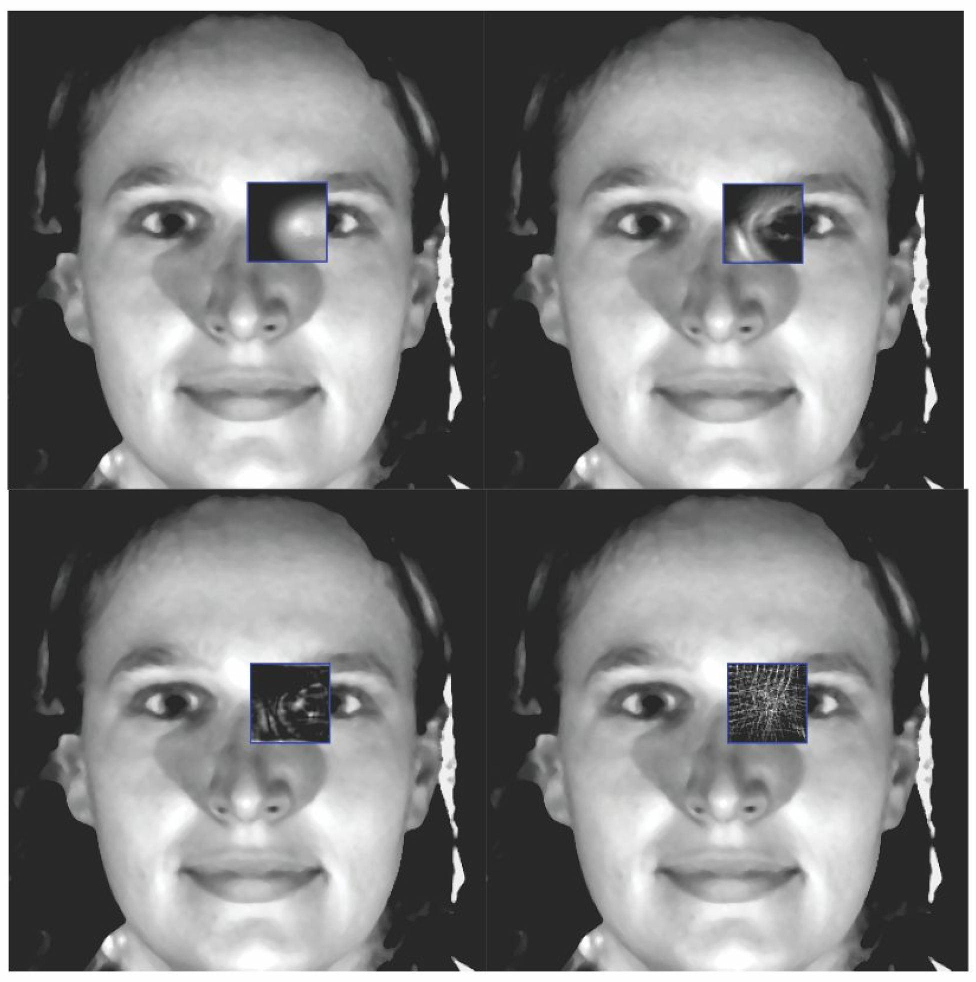
Face Model Orientation & Scaling

Since the patient's head is not constrained during the scanning process, landmark locations must be verified against one another to improve the facial orientation and scale and increase the confidence of subsequent landmark detections.



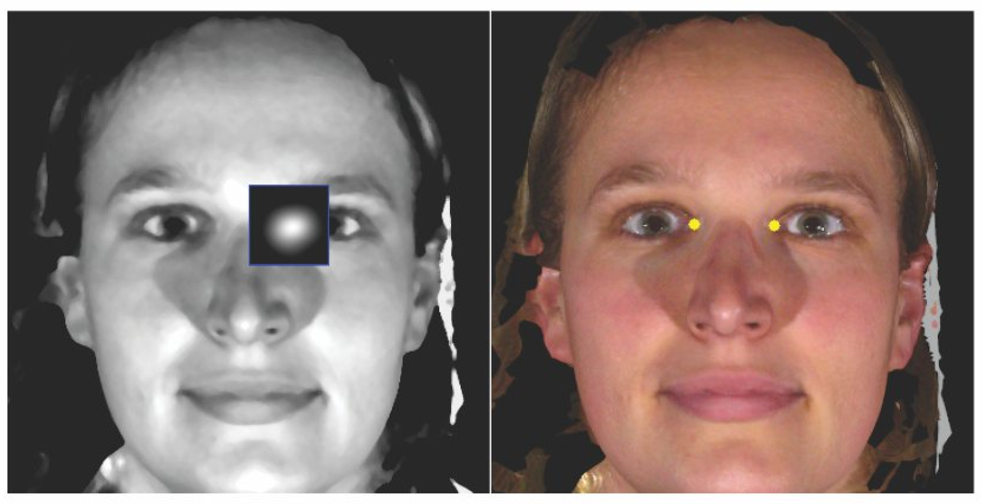
Inner Eye Detection

Because of the level of accuracy required, different custom algorithms are needed to detect each of the different landmarks. Once the patient's pupils have been detected, the inner eye detector uses a weighted combination of several different features derived from the RGB and depth map of the face.



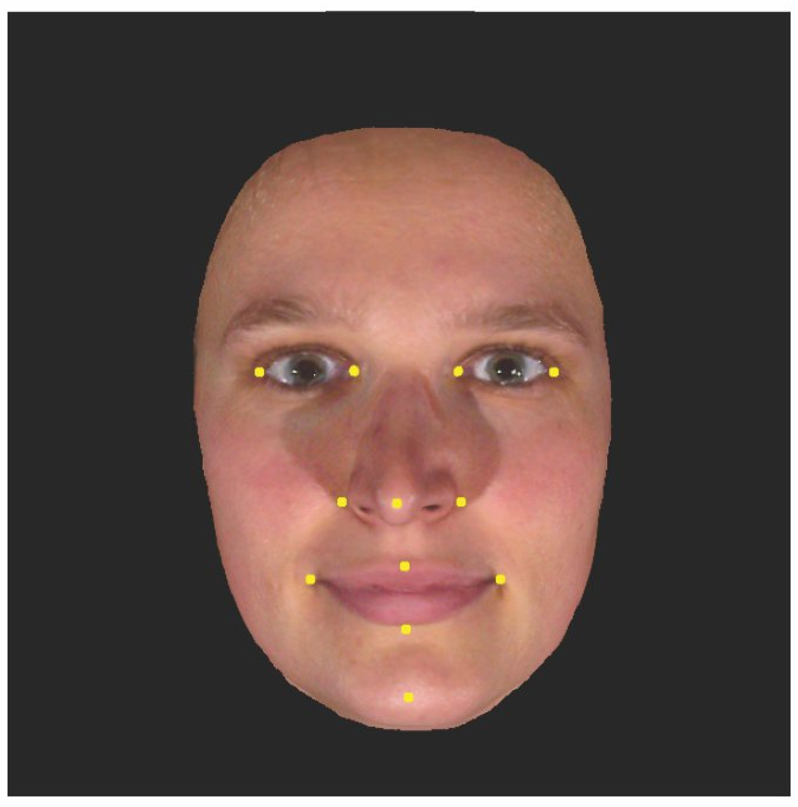
Pinpointing the Landmark

Once the different features have been combined using a weighted Gaussian, the point of the inner eye can be identified as the maximum of the response map.



Facial Segmentation

Once all landmark locations have been identified, areas of the face that are distant from these points can be segmented out. This will be achieved by evaluating a metric that combines distance to the landmarks over the 3D facial mesh with the angle that the surface normal at each point in the mesh makes with the view plane normal.



Summary

3D FAST will deliver significant efficiency gains over the current facial capture and visualisation process. It also offers a solid platform for the integration of further functionality to assist in the automated identification of craniofacial deformities and as a surgical planning and follow-up tool.