Medical Image Processing in the Faculty of Engineering, National University of Singapore

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National University of Singapore

Outline of presentation

1. Visualisation and analysis of 3D dental images
2. 4D image compression
3. Virtual spine workstation

Visualisation and analysis of 3D dental images

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Objective

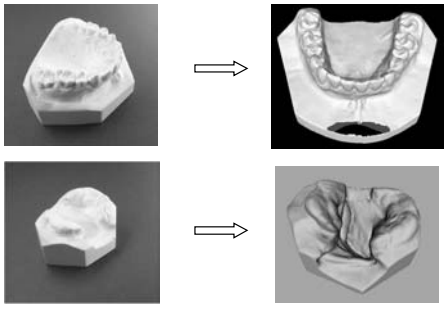
To develop computer-based techniques for the *detection*, *measurement* and *visualisation* of 3D dental features for diagnosis and treatment planning.

Application areas include
- Malocclusions (malalignment of teeth)
- Palatal deformities (cleft palates)

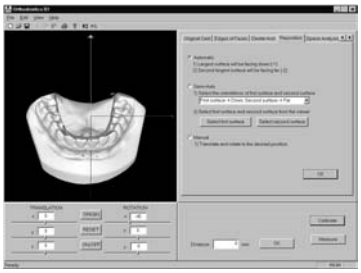
3-D data acquisition

Cyberware 3D Digitizer
- Spatial resolution: 300 μm
- Depth resolution: 50-200 μm
- Weight: 90 kg

Minolta Vivid 900 3D Digitiser
- Depth resolution: 40 to 90 um
- Spatial resolution: 200 um
- Weight: 11 kg

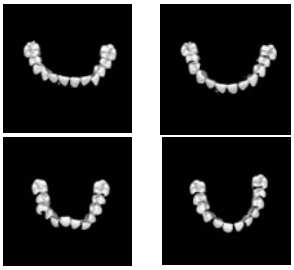


Graphical user interface



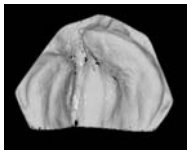
- Viewing
- 3D space analysis
- Area and volume measurements
- Tooth rearrangement

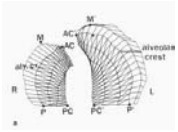
Tooth rearrangement



Before After

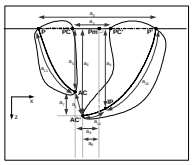
Assessment of shape changes in cleft palates (i)



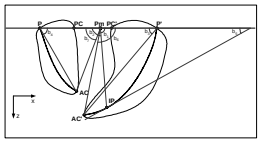


Linear, angular, area and volume measurements made on the 3D model are important in analysing the differences in the palate before and after treatment.

Assessment of shape changes in cleft palates (ii)

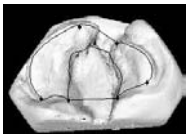


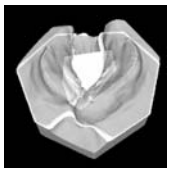
Linear measurements



Angular measurements

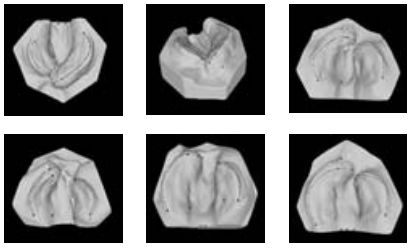
Assessment of shape changes in cleft palates (iii)





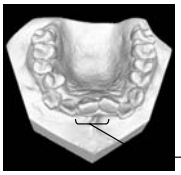
Volume measurement

Cleft palate measurements



Automated tooth segmentation

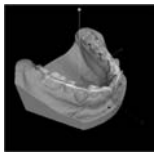
An important step in
- locating landmarks (important feature points)
- measuring orthodontic parameters
- simulating the re-arrangement of malaligned teeth



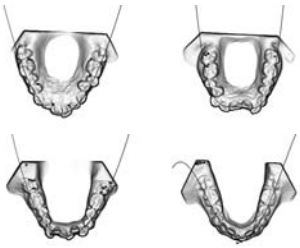
malaligned teeth

Approach

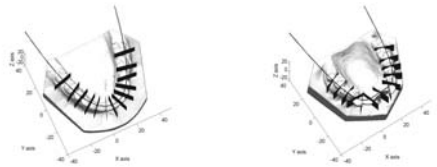
Three-step procedure - detection of
i. dental arch
ii. tooth interstices
iii. gum margin



Convert 3D image to range images -
i. reduces computational complexity
ii. allows 2D operators to be used

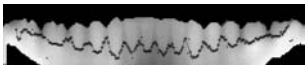


Detected dental arches

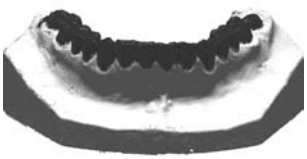


Detected tooth interstices

Detecting the gum margins

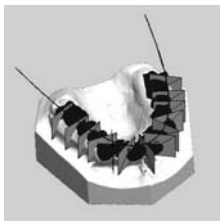


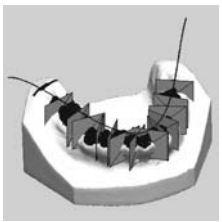
Detected valley points



3-D presentation of the separation result

Segmented teeth

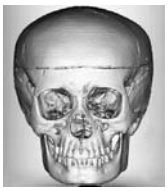




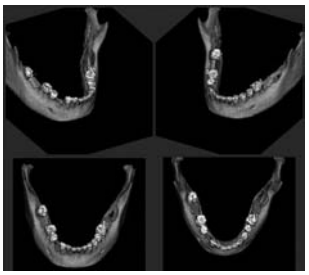
3-D presentation of the detected tooth interstices and the separated teeth from the gums, along with the dental arch

Segmentation of mandible from CT Data

Mandible segmentation is an important step prior to maxillofacial surgery and orthodontic treatment.



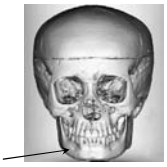
Skull reconstructed from CT data



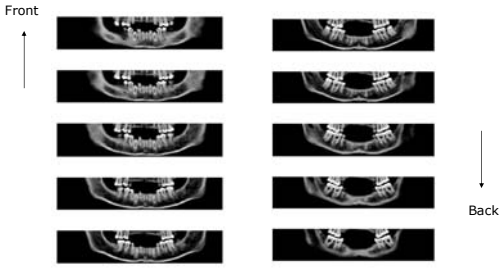
Segmented mandible from four viewpoints

Extraction of mandibular nerve canal

In many maxillofacial surgical procedures (e.g., dental implantation), it is important for the surgeon to know the precise location of the mandibular nerve canal (inferior alveolar neurovascular canal).

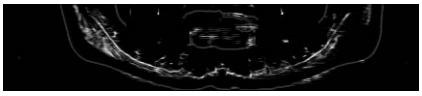


Computation of panoramic CT images (iv)

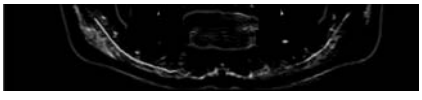


A set of panoramic CT images

Extraction of mandibular nerve canals



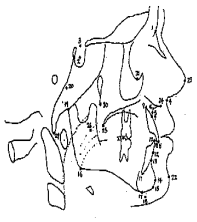
Hollow canals detected by gradient orientation analysis.



Nerve canal extracted by line tracing.

3D landmark detection

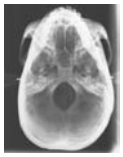
Cephalogram landmarks are characteristic reference points that are used to characterize the geometry of the skull.



Three common projections:

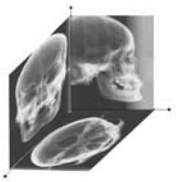
Lateral view

Posteroanterior view



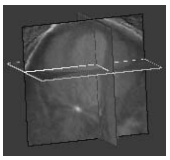
Basal/Axial view

Using three projections will improve the accuracy and robustness of detection.



Lossless Motion Compensated 4-D Medical Images Compression

A/Prof AA Kassim
Dept of ECE

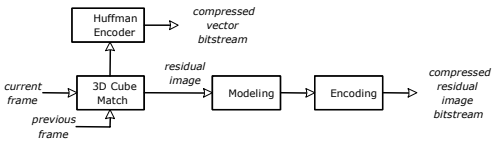


Frame *1*

····· Frame *N*

4-D medical images need to be compressed losslessly.

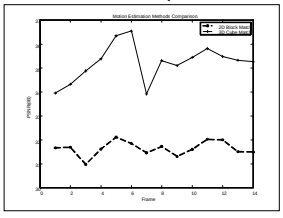
Proposed Compression Scheme

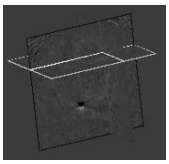


Add preprocessing module before the modeling and encoding parts of normal lossless compression scheme.

Preprocessing Module – motion compensation

- *2-D Block Match*
- *3-D Cube Match (2-4 dB increase more than 2-D)*





Residual image of 3D

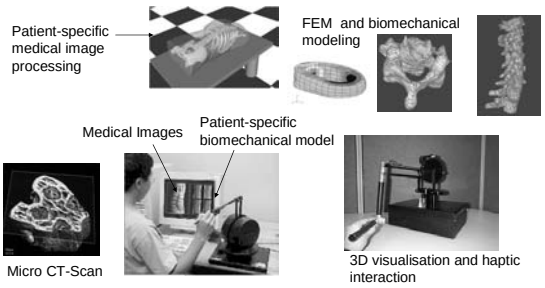
Using 3-D Cube Match to do the preprocessing part and then apply lossless compression on the residual image.

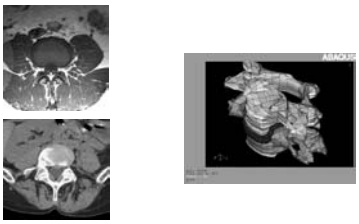
Virtual Spine Workstation

From images to biomechanics
For image-guided spine surgery

Multidisciplinary Collaboration: NUS, IBE, NUH

**SH Teoh, SH Ong, CK Chui, CH Yan,
HK Wong, SC Wang**





Multi-Modality Scanning ⇨ Fusion & Modeling

- Fusion of medical image data (CT and MRI)
- Development of anatomical and biomechanical models for the spine.
- Development of human interface (graphical and interactive-haptic system)