FAST 3D MODELLING AND PRECISE MEASUREMENT OF SOFT TISSUE FOR CRANIOFACIAL RECONSTRUCTION USING LASER SCANNING

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Abstract

This multi-disciplinary research (between UTM, SIRIM and USM) focuses on medical (i.e. craniofacial) applications. Various imaging sensors/techniques are used to capture the craniofacial data (i.e. soft and hard tissues) of real patients at HUSM, Kubang Kerian, Kelantan. Soft tissue data are obtained from laser scanning (using VIVID910) and photogrammetry techniques, while hard tissue data are captured via CT scan, X-Ray and MRI. This paper describes the configuration, data capture, processing, and analysis of soft tissue data obtained from laser scanning system. The laser scan data of human faces are processed (using RAPIDFORM) to generate 3 dimensional (3D) computer model and landmarks measurement. The results show that the system is capable of producing fast 3D computer model and high precision (i.e. sub-mm level) measurement of the craniofacial.

1.0 INTRODUCTION

This research involves multi-disciplinary teams (i.e. UTM, SIRIM and USM) and focuses on medical (i.e. craniofacial) applications. In this research, various imaging sensors or techniques are used to capture the craniofacial data (i.e. soft and hard tissues) of real patients at HUSM, Kubang Kerian, Kelantan. There are 2 main parts in data acquisition i.e. soft tissue (skin) and hard tissue (skull). Soft tissues are obtain from laser scanning and 3 pairs of stereo photogrammetry, and hard tissue from CT (Computer Topography) Scan, MRI (Magnetic Resonance Imaging), and X-ray. Additional information are retrieved from dental cast. All of the outputs are stored into a database (Deni Suwardhi, 2005) as shown in Figure 1.

The combination of laser and photogrammetry provides advantages in terms of rapid 3D modeling (via laser scanning) and precise measurement (via photogrammetric) of the soft tissue (Halim & Mohd Sharuddin, 2004). A total of 102 landmarks (44-soft tissue, 25-hard tissue, 33-dental cast) have been identified for this research purpose. This paper describes the configuration, data capture, processing, and analysis of soft tissue data obtained from laser scanning system.

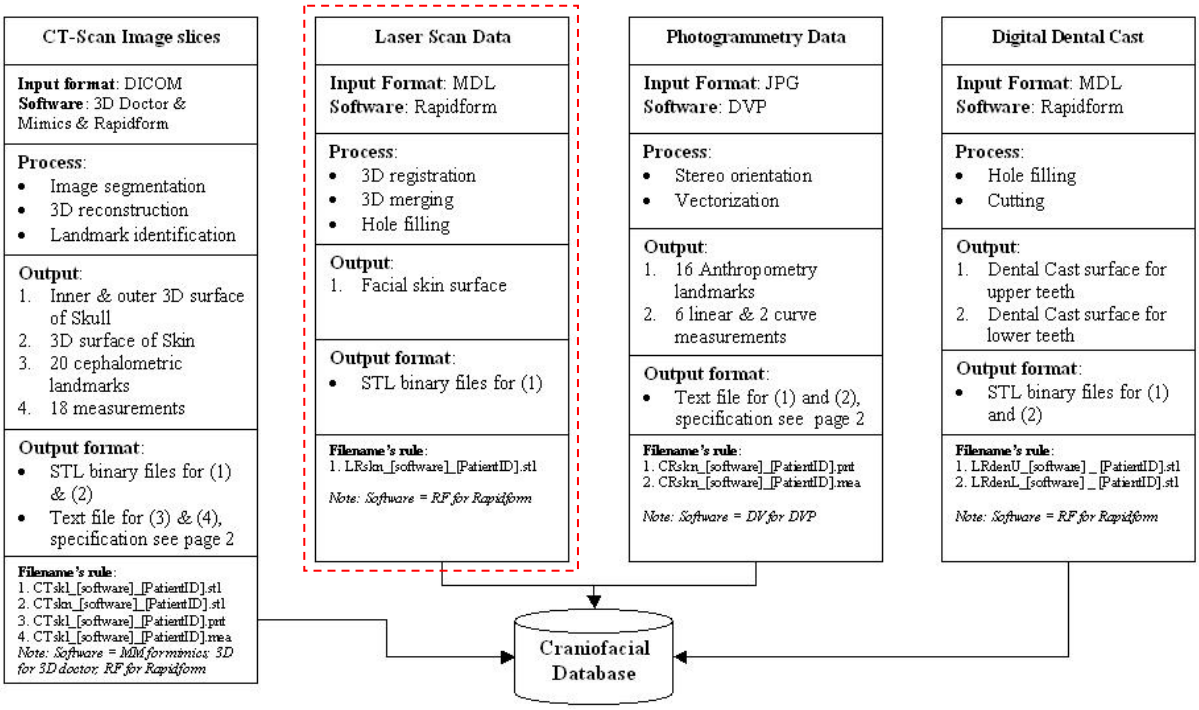

Fig 1: Sensor and data acquisition procedure (Deni Suwardhi, 2005)

2.0 LASER SCANNING AND DATA ACQUISITION PROCEDURE

VIVID910 laser scanner system (Figure 2) uses a laser beam to measure an object, and has the capability to record the whole measurement in a snap (about 0.3 sec (fast mode), 2.5 sec (fine mode), and 0.5 sec (color mode)). There are 3 main advantages of VIVID910, i.e. speed, precision, and simplicity (i.e. point and shoot simplicity for consistently excellent results). The accuracy (Z, typically) of laser scanner are within 0.008 mm using fine mode. VIVID910 employs 3 types of mounted lens, depending on the object sizes and measurement distances. VIVID910 comes with Polygon Editing Tool (PET) software for real time scanning and data processing (Halim et al, 2005).

Fig 2: Konica Minolta VIVID910 laser scanner

The laser scan data of human faces are processed (using RAPIDFORM) to generate 3 dimensional (3D) computer model and landmarks measurement.

3.0 LASER SCANNING PROCESSING PROCEDURE AND SOFT TISSUE

The process comprises of four steps: scanning of human face, three dimensional image registration, three dimensional modeling of human face and automatic measurement of anthropometric landmark (Zulkepli Majid, 2004). Then the data are cleaned and smoothed using Rapidform 2004. After that, the data are converted into STL binary format (contain only point and wireframe exclude texture). Figure 3 shows the procedure of processing laser scanning data.

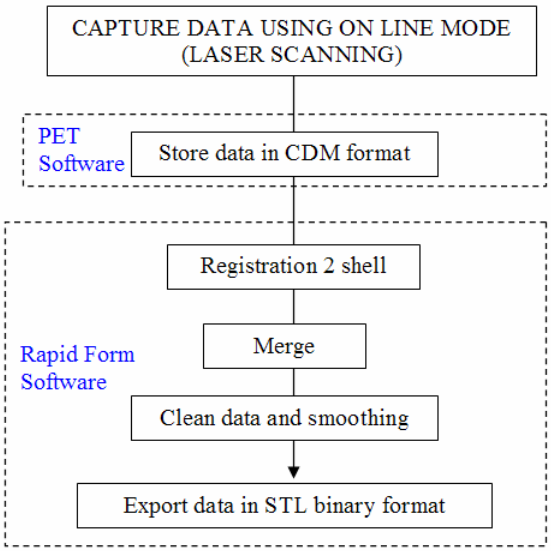

Fig 3: Konica Minolta VIVID910 processing procedure

The procedure consists of taking images using 2 laser scanners, registration of 2 shells, merge, clean data and smoothing (Figure 4). The end result from Rapid Form is a STL binary format of the soft tissue (face).

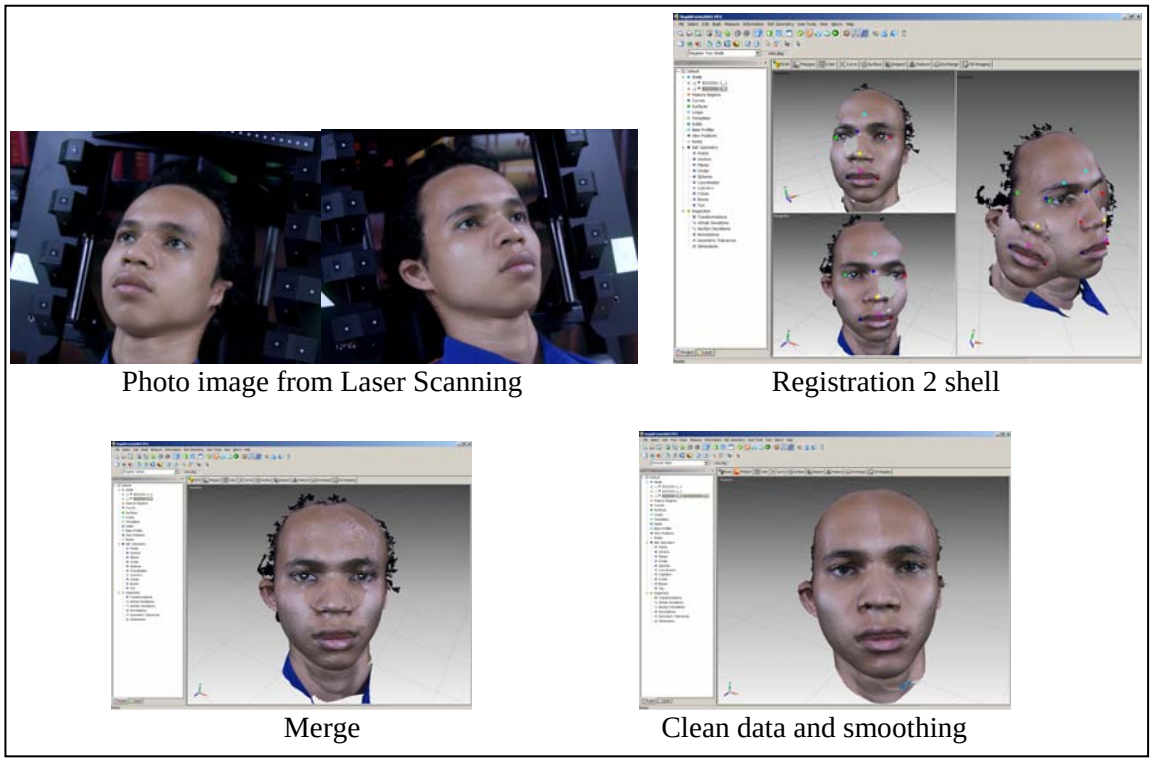

Fig 4: Rapid form processing procedure

Landmarks are measured using auto measure mode. Landmarks are identified manually using texture image (3D surface) and measurement are done using 3D landmarks (Figure 5). Using laser scanning, we are able to get the complete measurement of face.

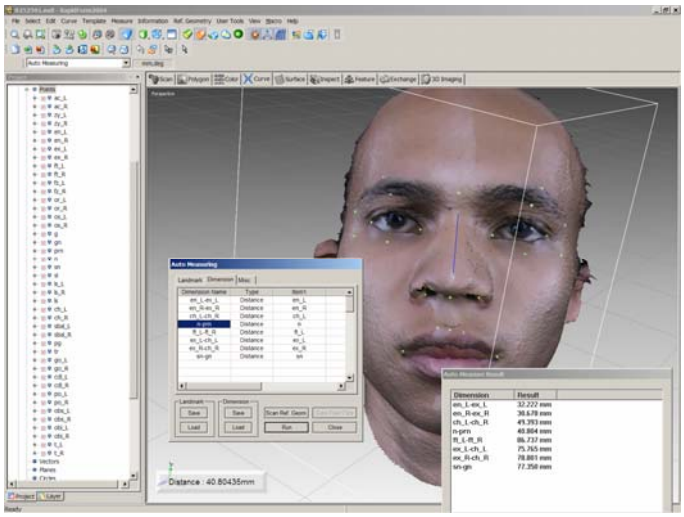

Fig 5 : Landmarks measurement

For craniofacial reconstruction there are several advantages .i.e. fast data retrieve, fast modeling and can be used as RP (rapid prototyping) in case of prosthetic part.

4.0 END RESULTS

Output from various sensors (CT scan, laser scanning, stereo photogrammetric and Dental cast) are stored directly into the database (Figure 6). By combining the hard and soft tissue, 3D modeling of patient information via landmark and detail of soft and hard tissue can be easily retrieved.

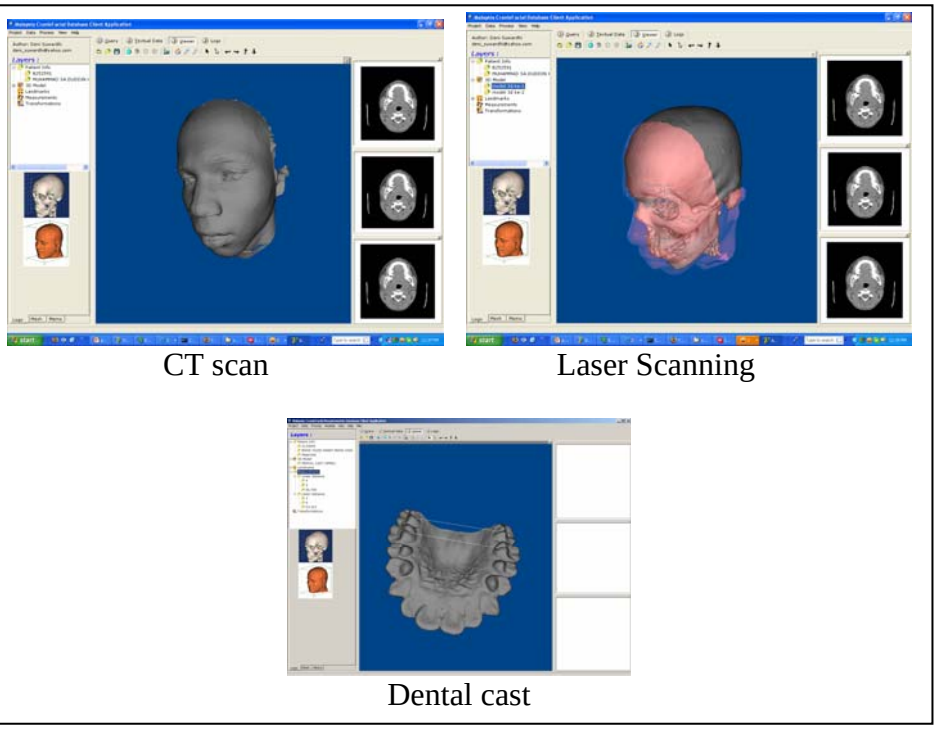

Fig 6: Measuring in database (Deni Suwardhi, 2005)

5.0 CONCLUSION

The results show that the system is capable of producing fast 3D computer model and high precision (i.e. sub-mm level) measurement of the craniofacial. The results are acceptable in medical applications for craniofacial reconstruction. From laser scanning, the following information are retrieved: 3D surface, texture, 3D point Cloud and wireframe.

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