COMBINATION OF LASER AND PHOTOGRAMMETRIC TECHNIQUES FOR PRECISE MODELING AND MEASUREMENT OF HUMAN FACES

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ABSTRACT

Special medical applications such as craniofacial reconstruction require precise modeling and measurement of human faces. Many surgeons still use traditional contact method (e.g. calipers) for measuring anthropometric landmarks on human face. Our current multi-disciplinary research focuses on the development of surgical planning system for craniofacial reconstruction. The craniofacial reconstruction requires the following: imaging (non-contact, precise, rapid), 3D models (digital and physical), database, and surgical planner. This paper discusses our research works on the development of the imaging system (close range, non-contact, and real time) and measurement/3D modeling for craniofacial. The developed imaging system combines the laser scanning and photogrammetric techniques for acquiring high-resolution 3D models (and precise measurement) of craniofacial soft tissue. The results show that measurements to mm-level precision are achievable, indicating the suitability of the approach for practical craniofacial applications.

INTRODUCTION

Special medical applications such as craniofacial reconstruction require precise modeling and measurement (to mm-level precision) of human faces (Figure 1). The term craniofacial is originated from the word cranium (referring to the skull or cranium or hard tissue) and facial (referring to the face or soft tissue). Craniofacial is the most complicated part of the human body and relate to the head and face.

In practice, many surgeons still use traditional contact method (e.g. calipers) for measuring anthropometric landmarks on human face. Consequently, special automated measurement and modeling techniques are needed for craniofacial application (Halim et al, 2004).

Since 2002, a multi-disciplinary research is launched between Universiti Teknologi Malaysia (UTM), Standards & Industrial Research Institute Malaysia (SIRIM), and Universiti Sains Malaysia (USM). The research focuses on the development of surgical planning system for craniofacial reconstruction, and identifies the following modules: imaging and measurement (of soft and hard tissues), 3D models (digital and physical), database, and surgical planner.

This paper discusses research works at UTM on the development of the imaging system (close range, non-contact, and real time) and measurement/3D modeling for craniofacial soft tissue.
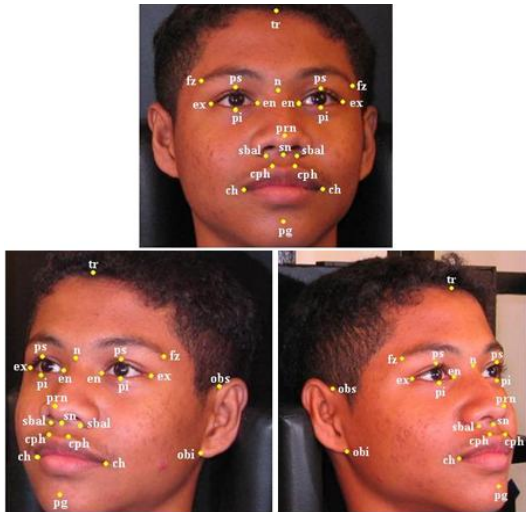

Figure 1. Human face and anthropometric landmarks

METHOD

The developed imaging system (Figure 2) combines the laser scanning and photogrammetric techniques for acquiring high-resolution 3D models (and precise measurement) of craniofacial soft tissue (Zulkepli et al, 2005).

The combination of laser (i.e. VIVID910) and photogrammetry provide rapid 3D model (via laser scanning) and precise landmark measurement (via photogrammetric) of the soft tissue.
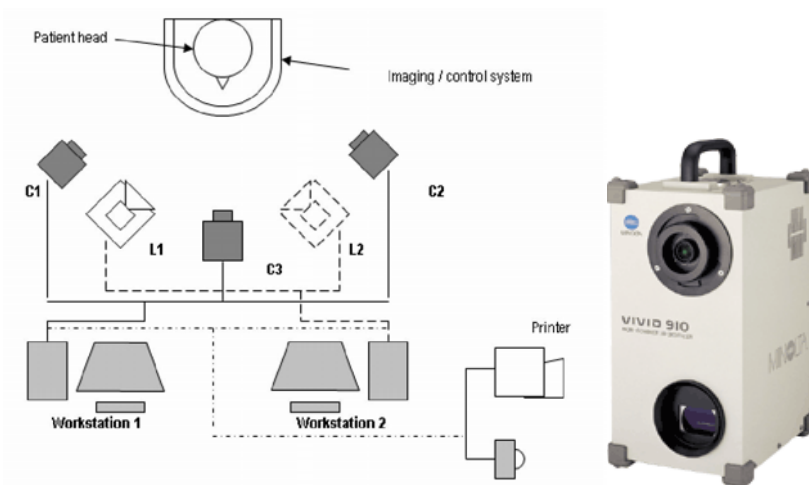

Figure 2. Imaging system

Data from laser and photogrammetry are processed separately using RAPIDFORM and DVP software, to generate 3D computer models of human faces and measurement of landmarks respectively (Figure 3). An in-house system is developed to combine the model and measurement (Halim et al, 2005).

(i) laser   (ii) photogrammetry
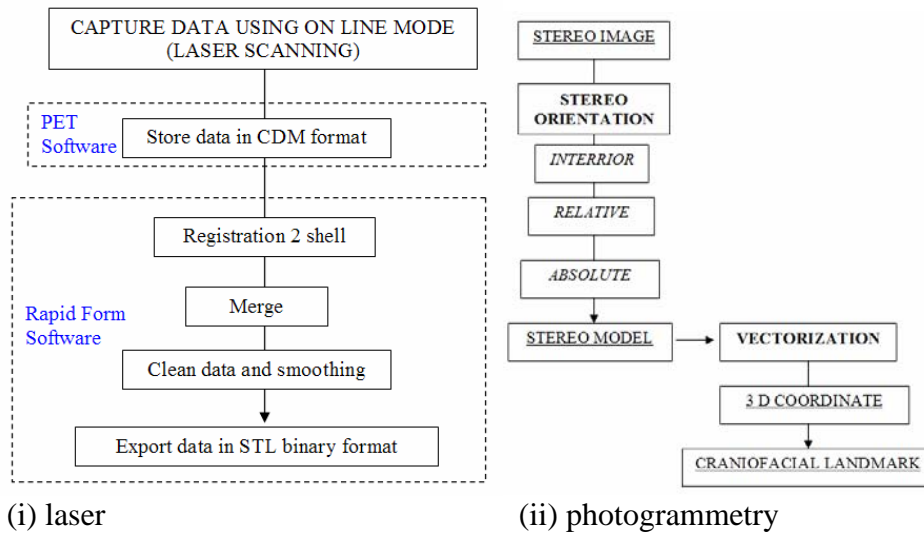
Figure 3. Data processing

RESULTS

Figure 4 shows the 3D model and measurement. Comparisons of 10 landmark measurement between caliper, photogrammetry and laser are summarized in Table 1. The differences for laser-caliper ranges between 0.1mm to 2.0mm, and for photogrammetry-caliper are within 0.9mm to 2.9 mm.

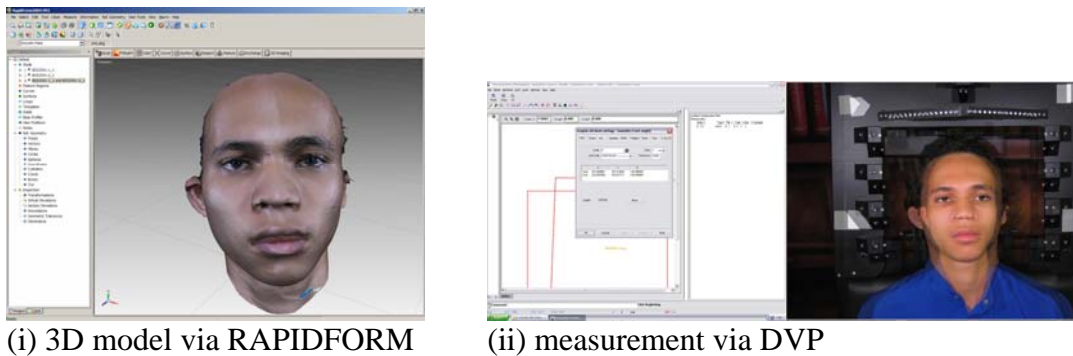(i) 3D model via RAPIDFORM   (ii) measurement via DVP

Figure 4. Results

CONCLUSION

More on-going tests are underway with real patients. The results show that measurements to mm-level precision are achievable, indicating the suitability of the approach for practical craniofacial applications.

Measurement Points	Calipers [A] +/- 0.05 (mm)	Photo [B] (mm)	Laser [C] (mm)	Diff 1 [B-A] (mm)	Diff 2 [C-A] (mm)	Diff 3 [C-B] (mm)
1 ~ 2	96.55	98.26	97.43	1.71	0.88	-0.83
6 ~ 7	60.25	58.68	57.08	-1.57	-3.17	-1.60
10 ~ 11	62.65	63.64	63.50	0.99	0.85	-0.14
4 ~ 3	63.90	61.04	65.94	-2.86	2.04	4.90
3 ~ 9	43.10	41.05	44.05	-2.05	0.95	3.00
1 ~ 3	56.70	54.96	58.52	-1.74	1.82	3.56
2 ~ 3	55.40	54.32	55.88	-1.08	0.48	1.56
10 ~ 3	45.30	44.40	46.40	-0.90	1.10	2.00
11 ~ 3	42.95	41.92	42.15	-1.03	-0.80	0.23
9 ~ 5	20.90	19.80	20.98	-1.10	0.08	1.18

Table 1. Comparison of results

ACKNOWLEDGEMENT

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