

Development of A Dental Implant Navigation System in Thailand

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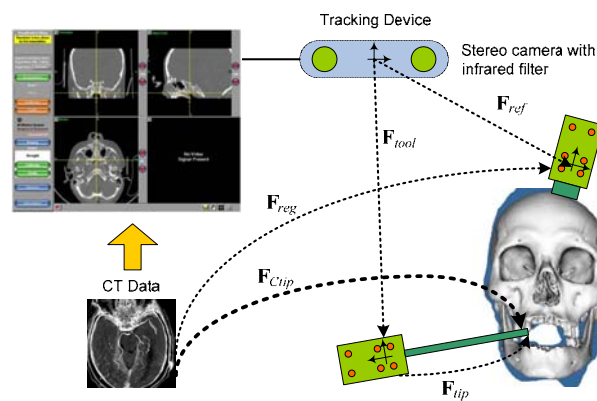
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PURPOSE: Dental implant is one of the most popular methods of tooth root replacement used in prosthetic dentistry. Computerize navigation system on a pre-surgical plan is offered to minimize potential risk of damage to critical anatomic structures of patients. The methodology is based on Computer Integrated Surgery (CIS) interventions which includes preoperative and intraoperative procedures. The preoperative surgery requires the 3D views of raw images obtained from CT scanning, while the target pathway guidance is beforehand generated. The intraoperative procedure on instrument tracking system is the main objective to study. The focus is on optical tracking system using a stereo camera with calibration, and a set of specially designed fiducial markers attached as references on the dental hand-piece tool and patient's jaw. The task is commonly to determine the position of fiducial markers, such as infrared-emitting diodes or retroreflective spheres, to be attached to the instrument with high accuracy and minimum position tracking error. In addition, specially designed fiducial reference marker will be performed together with the adequate length and correct angle of the surgical tool. All retrieved important parameters are associatively registered with respect to preoperative anatomical CT data structures and surgical path planning. The benefit of this developed navigation system is to be the prototype of low cost system utilized in dental implant intervention for general patients.

METHODS: Basically, navigation system consists of navigation path from CT data to the tool tip of the instrument F_{Ctip} . The relationship F_{Ctip} can be calculated by

$$\mathbf{F}_{Ctip} = \mathbf{F}_{reg} \mathbf{F}_{ref}^{-1} \mathbf{F}_{tool} \mathbf{F}_{tip} \quad (1)$$

where F_{reg} is the registration transformation with respect to the CT data frame and reference frame, F_{ref}^{-1} is the inversion of the reference transformation with respect to the camera frame, F_{tool} is the tool transformation with respect to tool's marker frame the camera frame, and F_{tip} is the tool tip transformation with respect to the tool's marker frame and tool tip. This relationship has a lot of influence in the navigation system as illustrated in Figure 1.



$$\mathbf{F}_{Ctip} = \mathbf{F}_{reg} \mathbf{F}_{ref}^{-1} \mathbf{F}_{tool} \mathbf{F}_{tip}$$

Figure 1 Navigation system diagram (redrawn [1])

RESULTS: A prototype of a dental implant navigation system with respect to the high accuracy of optical tracking is ongoing development. This prototype includes guided information consisted of three dimension coordinate positions and orientations of the surgical instrument with regards to CT images of patient's anatomy. The experiment is performed to evaluate the efficiency of algorithms to examine some standard error pattern. In addition, the accumulated errors of the various tracked positions are determined in terms of some associated relationship. Figure 2 illustrated the prototype of a dental navigation system.

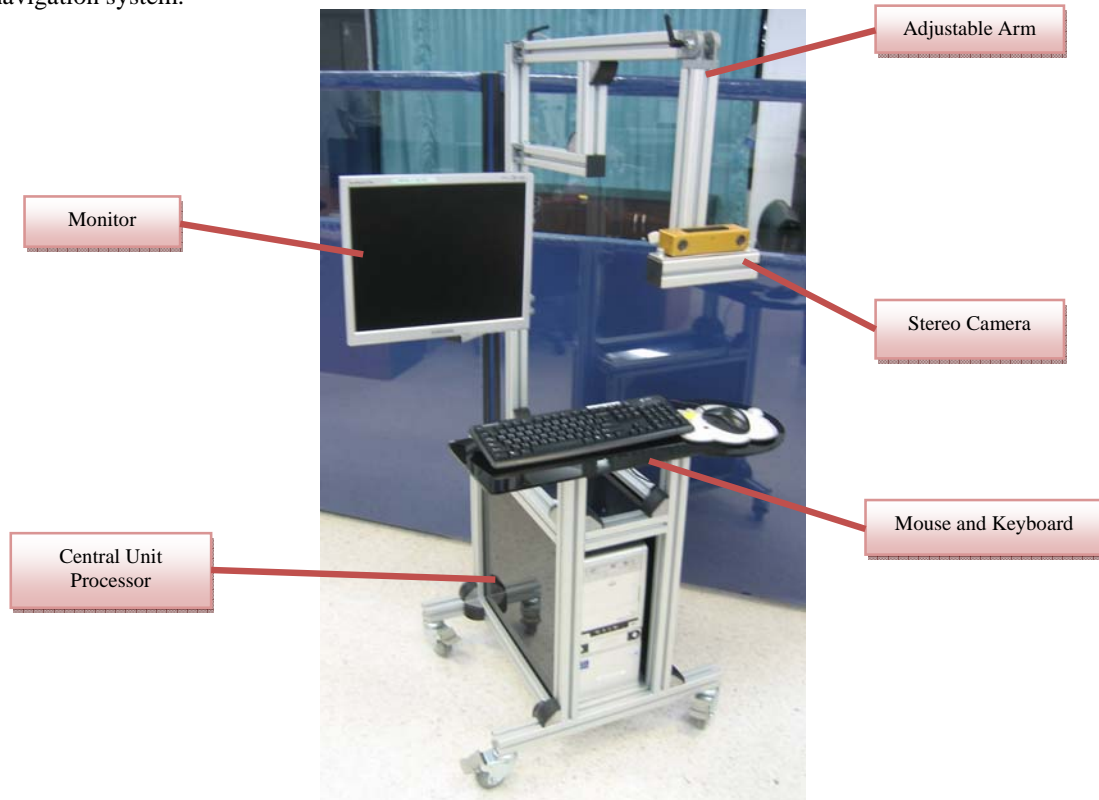


Figure 2 A prototype of a dental navigation system.

CONCLUSION: This paper gives a systemic introduction about our ongoing project, the dental navigation system in Thailand. The experiment is performed to evaluate the efficiency of algorithms. Comparison between the expected results and the real world position is recorded in order to find some standard error pattern. The accumulated errors of the various tracked positions are determined in terms of some associated equations. Furthermore, the appropriate angle with respect to the marker pattern movement is calculated and recorded to approach the possible value in the reality environment.

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