

**OBJECTIVE ASSESSMENT AND FEEDBACK GENERATION IN
DENTAL SURGICAL SIMULATION: A FRAMEWORK BASED
ON CORRELATING PROCEDURE AND OUTCOME**



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ABSTRACT

Fine motor skill is indispensable for a dentist. As in many other medical fields of study, the traditional surgical master apprentice model is widely adopted in dental education. Recently, virtual reality (VR) simulators have been employed as supplementary components to the traditional skill-training curriculum, and numerous dental VR systems have been developed academically and commercially. However, the full promise of such systems has yet to be realized due to the lack of sufficient support for formative feedback. Without such a mechanism, evaluation still demands dedicated time of experts in scarce supply. With the aim to fill the gap of formative assessment using VR simulators in skill training in dentistry, this thesis presents a framework to objectively assess the surgical skill and generate formative feedback automatically. VR simulators enable collecting detailed data on relevant metrics throughout a procedure. Our approach to formative feedback is to correlate procedure metrics with the procedure outcome in order to identify the portions of a procedure that need to be improved. Prior to the correlation, the procedure outcome needs to be evaluated. The scoring algorithm designed in this thesis provides an overall score and identifies specific errors and their severity. Building upon this, we developed techniques to identify the portion of the procedure responsible for the errors. Specifically, for the errors in the outcome the responsible portions of the procedure are identified based on correlation of location of the error. For some types of feedback one mode may be more suitable than another. Tutoring formative feedback are provided using the video- and haptic- modalities. The effectiveness of the feedback systems have been evaluated with the dental students with randomized controlled trials and the findings show the feedback mechanisms to be effective and have potentials to use as valuable supplemental training resources.

KEY WORDS: SURGICAL SIMULATION / FORMATIVE FEEDBACK / AUTOMATED OUTCOME ASSESSMENT / FORCE FEEDBACK / VIDEO-BASED FEEDBACK

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