

ACS 2022 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Research In-Progress

Development of a 3D User Interface for Twin to Twin Transfusion Syndrome Surgical Simulator

Daniel Montero; Alvaro Quevedo; Bill Ko; Bill Kapralos; Rory Windrim; and David Rojas

University of Toronto, Toronto, ON, Canada; University of Ontario Tech University, Oshawa, ON, Canada

Introduction: Monochorionic diamniotic twins occur in approximately 1 in 300 pregnancies, of which 15% suffer from Twin-to-Twin Transfusion Syndrome (TTTS), with a fetus mortality rate of 85% when left untreated. Fetal laser ablation (FLA) is a minimally invasive treatment for TTTS with a 70% survival rate. Currently, TTTS training focuses on procedural training while lacking the ability to practice navigating the womb or identifying problematic vessels safely. Simulators can offer a safe realistic environment to develop the necessary skills to perform this procedure. In this paper, we present a simulator for FLA training that consists of a virtual environment and four degrees of freedom 3D printed low-cost haptic interface.

Methods: The TTTS 3D user interface (3DUI) consists of a haptic interface that captures the movements made by the trainee operating the fetoscope. The TTTS 3DUI provides vibrotactile haptic feedback cues when navigating in the virtual womb and is connected to a virtual simulator that provides spatial-visual feedback to perform the procedure. The TTTS 3DUI employed a 3D printed spherical flexure joint to map the real fetoscope movement into the simulation. The mechanism captures position and orientation information through a triple-axis magnetometer, accelerometer, and gyroscope sensor. Face validity was tested with an expert surgeon and 3 trainees.

Preliminary Results: The preliminary face validity test showed that the simulator accurately replicates the experience of performing the real-life procedure. Participants suggested the simulator has adequate realism for the training of the FLA procedure. Particularly the functionality and realism of the virtual environment were highlighted as the simulator strengths.

Next Steps: The next steps include incorporating force feedback into the simulator and increasing the number of placentas with different vessel connections in the virtual environment. In addition, we will test the content validity of the simulator using simulator-generated metrics and its capacity to help master the FLA skill.