



TWIN-TWIN

SURGICAL SIMULATOR

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THE PROJECT

PROJECT INTRODUCTION

Twin-twin transfusion syndrome (TTTS) is a rare, but major complication during monochorionic twin pregnancies. The treatment of choice for TTTS is fetoscopic laser ablation, a complex procedure only performed at specialized centers. Currently, a gap exists in the training of surgeons learning TTTS procedures as cases are infrequent, the surgery has a steep learning curve, and patient safety must take priority. Digital simulators can help fill this gap using elements of serious gaming and immersive technology to create accessible, adaptive, 3D surgical simulations that teach requisite anatomical, procedural, and skill-based knowledge. While there is significant evidence supporting the use of digital simulators in medical training, there is little evidence examining the impact of visual complexity within these simulators. Instead there is a widespread assumption that simulators featuring high-fidelity models and immersive environments—or high-complexity simulators—lead to better learning outcomes. This one-size-fits-all approach is not ideal, and learning science suggests that low-complexity simulators can play a role in helping build, or scaffold, knowledge. By using this low- to high-complexity scaffolded approach, it is hypothesized that difficulty can be scaled to increase content retention and learning gains. This project proposes a simplified surgical simulator combined with a scaffolded learning approach to help teach fetoscopic laser ablation therapy for TTTS.

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GOALS & OBJECTIVES

The primary goal of the Twin-Twin Surgical Simulator is to train Maternal Fetal Medicine (MFM) fellows and clinicians interested in learning how to perform laparoscopic laser ablation therapy to treat TTTS in monochorionic twins. To do this, the simulator will employ a scaffolded learning approach that increases the difficulty of progressive scenarios by scaling the visual-complexity of 3D models and scenes. In order to achieve this goal, the following objectives just be met:

1. Construct a visual library of 3D in-utero models including the placenta, fetuses, and uterine environment that:
 - Are anatomically correct and employ a high degree of realism in order to emulate what is seen during the real-world procedure
 - Have variable complexity in order to create scenarios in the simulator that can be scaled from lower-complexity (easier) to high-complexity (difficult)
 - Can be rearranged and used interchangeably with one another to allow for novel scenarios in use in the simulator respite repeated use
2. Design and create a series of surgical scenarios that:
 - Allow learners an opportunity to learn the anatomical, procedural, and technical skills needs to successfully complete TTTS therapy in a low-risk environment
 - Scaffold learning for participants in order to build learning gains derived from repeated use of the simulator
 - Test learners anatomical, procedural, and technical skills
3. Design and develop a functional user interface (UI) that: is easy to use and navigate; allows for the provision of added context and instruction without substantially differing from interface used during the real-world procedure; and that is aesthetically pleasing.
4. Develop a user experience (UX) that is engaging, educational, and an effective and enjoyable alternative to traditional surgical training methods.

TARGET AUDIENCE

The target audience for this simulator will be learners in the field of MFM: novice learners including year one (R1) or year two (R2) surgical residents, intermediate learners including MFM fellows, and experienced learners including established MFM clinicians—all with little exposure to TTTS therapy and other fetal laparoscopic procedures but who are interested in becoming experts in the procedure.

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DESIGN REQUIREMENTS

FUNCTIONAL & DATA REQUIREMENTS

The functional, content, and data requirements for this project are outlined in detail below:

	FUNCTIONAL	CONTENT	DATA TYPE
NAVIGATION AND SCENARIO HUD	<i>Menu/Navigation</i>		
	Access: Home, User Profile, Settings	Icons/text for: Home, User Profile, Settings	Icons/text
	Access: Surgical Scenarios, Surgical Scenario categories (beginner, intermediate, expert) and scenario levels	Icons/text for: Surgical Scenarios; beginner, intermediate, and expert categories; scenario levels	Icons/text
	Navigation arrows to move forward and backwards	Icons/text for: Forward and Backwards arrows	Icons/text
	<i>Tutorial/Surgical Scenario HUD</i>		
	Access: Scenario Settings, Pause/Unpause Scenario	Icons/text for: Scenario Settings, Pause/Unpause Scenario	Icons/text
	View joystick/laparoscope crosshair	Icons/cursor for: joystick/laparoscope crosshair	Icon
View time elapsed in scenario	Icons/text for: time elapsed in scenario	Icon/text	
View and Access: Hint(s)	Icons/text for: Hint(s) after a certain time allotment	Icon/text	
USER WELCOME	<i>Turning simulator On</i>		
	View animated logo and loading screen	Animated Logo, logo, loading bar	Animation (2D or 3D)
	View touch screen prompt/notification	Animated hand icon, text	Animation (2D or 3D) and text
	<i>Welcome and login screen</i>		
	View welcome animation	Animated welcome text	Animation (2D or 3D)
Select: New User or Returning User	Icons/text for: New User or Returning User	Icons/text	
Audio: Notification sound	Notification sounds clip	Audio	

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USER MANAGEMENT	<i>New User Screen</i>		
	View information for new users	Text explanation for what information is collected from new users and why it is stored	Text
	Access: Create User Profile	Icons/text for: Create New User Profile	Icons/text
	<i>Returning User Login</i>		
	Input: Username and Password	Text input for: Username and Password	Text
	Access: Login and Forgot Password	Icon/text for: Login and Forgot Password	Icons/text
	<i>User Profile</i>		
	Access: Change Username, Update email address, Update password, Update user information, Log out, Delete profile	Icons/text/text input for: Change Username, Update email address, Update password, Update User Information, Log out, Delete profile	Icons/text
	<i>Settings</i>		
	Access: Text Size, Brightness, Contrast, Volume, Sound Effects, Help, Report Issue, About	Text, icons, and slider controls for: Text Size, Brightness, Contrast, Volume, Sound Effects, Help, Report Issue, About	Icons/text/slider values
<i>Creating User Profile</i>			
Input: First and Last Name, Birthdate, Gender, Employee Number, Division, Department, Position	Input/drop down selection/text fields for: First and Last Name, Birthdate, Gender, Employee Number, Division, Department, Position	Drop down selections, text	
<i>Forgot Password Screen</i>			
Input: Email Address	Text input for: email address associated with account	Text	
Access: Retrieve temporary password	Icon/text for: Retrieve temporary password	Icon/text	
<i>Scenario Settings</i>			
Access: Text Size, Brightness, Contrast, Volume, Sound Effects, Help, Report Issue, About	Text, icons, and slider controls for: Text Size, Brightness, Contrast, Volume, Sound Effects, Help, Report Issue, About	Icons/text/slider values	
Access: Quit Scenario	Icons/text for: Quit Scenario	Icons/text	

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HOME	<i>Home Screen</i>			
	Access: Tutorials, Surgical Scenarios, Remote Training, User Profile, Settings, Log Out	Icons/text for: Tutorials, Surgical Scenarios, Remote Training, User Profile, Settings, Log Out	Icons/text	
SCENARIO SELECTION	<i>Tutorial Selection Screen</i>			
		Access: Introductory, Beginner, Intermediate, and Expert Tutorial Scenarios	Icons/text for: Introductory, Beginner, Intermediate, and Expert Tutorial Scenarios	Icons/text
	<i>Surgical Scenarios Selection Screen</i>			
		Access: Introductory, Beginner, Intermediate, and Expert Surgical Scenarios	Icons/text for: Introductory, Beginner, Intermediate, and Expert Surgical Scenarios	Icons/text
SCENARIO SELECTION	<i>Remote Training</i>			
		Access: New training session, Join registered training session	Icons/text for: New training session, Join registered training session	Icons/text
SCENARIOS	<i>Tutorial/Surgical Scenario Screen</i>			
		View realistic 3D anatomical structures and environment	3D rendered models of anatomical structures and the intrauterine environment	3D objects
		View highlighted anatomical structures	Graphical 3D highlighted objects for: anatomical structures	3D objects, graphical elements
		View pop-up tutorial windows for novel structures, new techniques, and pertinent information	Icons/text/animations for: pop-up tutorial windows	Icons/text/animations (2D or 3D)
	<i>Tutorial/Surgical Scenario Completion Screen</i>			
		View time elapsed in scenario	Text/icons for: time elapsed in scenario	Icons/Text
	View accuracy at finding and ligating appropriate vessels		Icons/Text	
	Access: New Scenario, Change Difficulty, Exit Scenarios			
SCENARIOS	<i>New Training Session</i>			
		Access: Add/search for users to join new training session	Icons/text for: Add/search for users to join training session	Icons/text
	Search: usernames to add members	Text input for: usernames	Text	

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REMOTE TRAINING

<i>Join Registered Training Session</i>			
	Access: Registered training sessions - List view, Calendar view	Icons/text for: Registered training sessions - List view, Calendar view	Icons/text
	View calendar of registered training sessions	Icons/text for: Calendar	Icons/text
<i>Training Session Waiting Screen</i>			
	View waiting for training session to begin	Icons/text for: waiting for training session to begin	Icons/text
	Audio: Notification sound when users join	Notification sounds clip	Audio
	View pop-up text window when user join	Icons/text for: new users joined	Icons/text
<i>Training Session Instructor Screen</i>			
	View the screen of the trainee selected and a small floating screen from trainees webcams	Small floating screen for webcam view (similar to skype)	Coding
	Access: Video Call, Audio Call, Mute Audio, Chat, Instructor Control, Trainee Screen Select, Video Fullscreen	Small floating screen for webcam view (similar to skype)	Icons/text
	Access: text box	Text Input for: when Chat is selected	Text
	View text and photo pop-up when Trainee Screen Select is chosen	Icons/text for: when Trainee Screen Select is chosen	Icons/text
<i>Training Session Learner Screen</i>			
	View the screen of the trainee selected and a small floating screen from trainees webcams	Small floating screen for webcam view (similar to skype)	Coding
	Access: Video Call, Audio Call, Mute Audio, Chat, Instructor Control, Trainee Screen Select, Video Fullscreen	Small floating screen for webcam view (similar to skype)	Icons/text
	Access: text box	Text Input for: when Chat is selected	Text
	View text and photo pop-up when Trainee Screen Select is chosen	Icons/text for: when Trainee Screen Select is chosen	Icons/text

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USER PERSONAS

The user personas presented below represent the primary and secondary users of the TTTS surgical simulator: students and teachers. Both personas were created based on interactions and meetings with content advisors at Mount Sinai Hospital, in addition to data and insight available in the literature. Additional traits including their comfort and fears when using technology and novel learning methods have been included to help create realistic context scenarios that will inform final design choices.



DR. FRANCINE (THE FRANTIC FELLOW)

PRIMARY PERSONA

Age: 30

Profession: Maternal Fetal Medicine (MFM) Fellow

Location: Mount Sinai Hospital, Toronto, ON, Canada

Personality: Eager and excited, appears calm but is internally anxious, always doing many things at once, focused on her career and education, bullies her colleague and best friend Arthur to relieve stress

Technology Usage: Francine is comfortable and used to using technology at home, in the clinic, and to learn. A large part of her medical training at school and during residency was done using physical and digital simulators

“ I want to deliver the best patient care that I can, but there’s no way I can become an expert at this procedure in just two years. ”

PERSONAL PROFILE

Francine recently started her two-year MFM Fellowship at Mount Sinai in Toronto. Prior to her Fellowship, Francine completed Medical School at the University of British Columbia (UBC), as well as a four-year residency in obstetrics and gynecology at UBC. Francine was a motivated student and is a passionate physician with a keen interest in learning fetal medicine and interventions to help expectant mothers have successful pregnancies. To that end, she actively sought out a Fellowship position at Mount Sinai, as she knew it was one of the leading fetal intervention centres in the world. Upon arriving, she was excited to start learning how to perform the complex procedures, but quickly realized that tactile, hands-on training was difficult to come by. Simulators don’t exist for many of the procedures, and while she is happy to observe surgeries she feels unprepared to assist or perform any procedures given her lack of practice and the potential risk to patients. Francine is particularly worried about learning the fetoscopic laser ablation therapy used to treat TTTS, as it is a serious condition if left untreated, employs a complicated procedure, and opportunities to observe the surgery are limited as the condition is uncommon and she needs to share OR time with 14 other Fellows equally eager to learn. Francine wants an accessible way to learn complicated procedures on her own time. Ideally, the training method would mimic the procedure, so she could practice both technical and procedural skills.

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USER GOALS

Francine would like to:

- Be adequately prepared to complete fetal interventions once she completes her fellowship
- Practice both the technical and procedural skills needed during a fetoscopic laser ablation procedure using a simulator
- Be taught in person from local experts and remotely by other leading experts in the field so that she has a broad understanding and perspective of the procedure
- Practice on her own time, with minimal trainer instruction so that she can ensure she is well prepared but isn't taking senior physicians away from patients and other learners

FRUSTRATIONS AND FEARS

Francine believes:

- That current training methods for interventional fetal procedures aren't enough, and that she may leave her Fellowship without the requisite skills needed to treat some complications
- That she may be bothering her senior physicians and colleagues when asking for additional training or opportunities to observe complex procedures she isn't comfortable with



DR. TERRY (THE TACTILE TEACHER) SECONDARY PERSONA

Age: 54

Profession: Maternal Fetal Medicine (MFM) Specialist, Clinician Scientist, and Clinical Supervisor/Teacher

Location: Mount Sinai Hospital, Toronto, ON, Canada

Personality: Affable with both patients and colleagues, goal driven, focuses on the bigger picture rather than the fine details, loves yogurt

Technology Usage: While not an expert, Terry is comfortable using most digital technology, especially in clinic and while teaching. He is especially interested in digital simulators

“ I wish I could train more specialists, but I can't be everywhere at once, and there just aren't enough surgeries for observation to suffice as practice... ”

PERSONAL PROFILE

Terry is one of the leading experts in fetal medicine and interventions, and one of the pioneers behind the fetoscopic laser ablation procedures used to treat Twin-Twin Transfusion Syndrome (TTTS). Since developing the surgical technique over a decade ago, Terry has been eagerly awaiting an increase in the availability of the surgery and the number of capable surgeons; however, access to effective training has been a major impediment to this becoming a reality. Currently, the main method of training MFM Fellows and interested specialists in the TTTS procedure is observation combined with learning in the OR on consenting patients; however, this method is inefficient as surgical opportunities are rare, and unsafe as

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patients are not provided with the best possible care. Terry isn't pleased with the current training model and wants to be involved in the development of a novel tool that uses current digital technologies to effectively and safely train future surgeons. He hopes to use this digital simulator domestically and abroad, so that MFM specialists/perinatologists around the world can treat TTTS.

USER GOALS

Terry would like to:

- Move forward toward his retirement confident that his colleagues and the future generation of specialists understand and are proficient at treating TTTS with fetoscopic laser ablation
- Help Fellows studying MFM surgical interventions learn in a safe, effective manner using a state-of-the-art digital simulator
- Remotely guide and train learners using the simulator, allowing other specialists across the world to be trained in their own hospitals without the need for expensive courses and travel

FRUSTRATIONS AND FEARS

Terry believes:

- That current training methods lack the realism needed to effectively train learners
- That the digital simulator still may not be enough, and that there will still be a gap in the training future specialists

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CONTEXT SCENARIOS

USING THE SIMULATOR FOR THE FIRST TIME

FRANCINE PERSONA

1. After an afternoon spent observing fetal interventions to treat TTTS in the OR, Francine feels like putting what she learned from watching to the test. Francine remembers that the MFM team at Mount Sinai recently finished the development of a fetal laser ablation surgical simulator, so she heads to the simulation lab to try the new tool.
2. Upon reaching the lab, she is happily surprised to see that the simulator doesn't look too different from the digital surgical tools she's used during her Residency and medical school training. Francine turns the simulator on and, once loaded, it notifies her that it is a touch screen device. It then prompts her with a notification sound and text to select one of two options: new user or returning user. Since Francine has never used the simulator before, she selects new user. She is then asked to create a user profile, and the simulator explains it will be used to help log her progress and highlight her strengths and weaknesses after completing a scenario in the simulator. It will also be the profile remote users see when they see her use the simulator online with learners and instructors from other MFM centers around the world. Excited by the options of working on her own and with other MFM specialists, Francine eagerly completes her user profile.
3. After completing her user profile, the simulator prompts Francine with text asking her if she would like to complete a tutorial to introduce her to the controls. Although Francine has used simulators to train before, she feels she could use a refresher and is interested to see how it compares to her past experiences, so she opts to complete the tutorial. Upon starting the tutorial, the simulator notifies Francine that all progress will be automatically saved to the user profile she signed in with.
4. The tutorial presents Francine with a scenario, explaining via text that the simulator represents the intrauterine portion of the procedure, after the laparoscope and laser wire have already been inserted. Knowing that the insertion is common amongst many fetal procedures, Francine is comfortable focusing on the intrauterine section of the surgery.
5. After introducing the scenario, the tutorial begins and Francine can see the intrauterine environment. On her screen, Francine sees a HUD that contains touchable icons for Scenario Settings, Pause/Unpause, the time elapsed in the surgical session, and a crosshair of where her laparoscopic joystick is pointing. The tutorial prompts Francine with text, graphics, and a notification sound to use the laparoscope to explore the uterine environment. As she looks around, she notices several highlighted structures. Navigating towards the structures using the laparoscope, Francine realizes that once she is close enough a text box appears explaining what the structure is and its relevance to the procedure. Many of the structures indicate that they serve as reference points and landmarks; however, Francine notices that some structures lining the uterine wall are distinctly highlighted.
6. Approaching these structures, Francine realizes that she is observing the placental vessels linking the mother with the fetuses. From her knowledge of TTTS and her experience observing the procedure in the OR, she knows that some of these vessels are the target of the laser ablation therapy. Hovering over the distinctly highlighted vessels with the laparoscope confirms this for Francine, as text appears indicating that these vessels must be ligated to treat the condition.
7. The tutorial prompts Francine with text, graphics, and a notification sound to aim the laparoscope at these vessels and trace slowly along the distinctly highlighted path while pressing a button on the laparoscopic joystick—this button will fire the laser needed to ligate the vessels.

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8. Moving slowly, Francine traces the path of the vessels while firing the laser as she observed her surgical supervisors do during previous sessions in the OR. While tracing within the path, the laser remains green; however, if she strays outside of the suggested line the laser flashes red to indicate her error. Francine is pleased the path of the vessels is highlighted on screen, as she is still unsure how to identify the vessels by on her own.
9. Upon ligating the indicated paths, the Tutorial ends, and a screen appears congratulating Francine, and offering a summary of her progress. Within the summary, the simulator lists the time Francine took to complete the procedure, and her accuracy at finding and ligating the appropriate vessels. The tutorial explains that moving forward, each time Francine enters a new surgical scenario the procedure will be different in terms of the arrangement of structures. Additionally, difficulty will scale for Francine as she progresses, with lower complexity scenarios to start and higher complexity scenarios with additional complications as she completes more procedures. As she moves forward, additional tutorials will become available to explain more advanced techniques and complications.
10. Satisfied with completing the tutorial and feeling like she understands how the simulator works, Francine exits the tutorial from her progress report and logs off her user account before powering off the machine. She's excited to return the next chance she gets to dive into actual scenarios and become more comfortable with the procedure.

USING THE SIMULATOR AFTER REPEATED SCENARIOS

FRANCINE PERSONA

1. Several weeks after completing the tutorial, Francine has used the TTTS simulator a number of times, finishing some of the introductory procedures. Feeling a little more confident in her ability to successfully move the laparoscope, guide the laser, and correctly identify problematic vessels along the placental wall, Francine heads to the simulator lab determine to try a harder difficulty setting.
2. Upon reaching the lab, Francine turns on the simulator and logs into her account. She notices that underneath the input area for her username and password, there is a "Forgot Password" button. Luckily, she picked a easy to remember (but secure) password and logs in without issue. Upon logging in, she is taken to the home screen where she can select from one of six options: tutorials, surgical scenarios, remote training, user profile, settings, and log out. Francine selects generate scenario and is taken to a new screen that has several difficulty settings: introductory, beginner, intermediate, and expert. Confident in her progress and interested in how large the learning curve is, Francine decides to skip the beginner scenarios and selects the intermediate procedures. The simulator prompts Francine with text and a notification sound indicating her logs show she hasn't completed any of the beginner scenarios, but Francine decides she'd like to push ahead nonetheless.
3. Once the scenario loads, Francine notices an immediate difference in the uterine environment. Visibility is reduced due to the colour of the surrounding amniotic fluid, and Francine finds it difficult to navigate. From her time observing TTTS surgeries in the OR, Francine recalls there being a specific method to increase visibility; however, she is unsure of how to perform this using the simulator.
4. After spending significantly longer than she ever had in the introductory scenarios trying to navigate and find the placental vessels, Francine is beginning to feel disheartened. An icon flashes on screen that reads "hint". Francine selects the icon, and a text box appears on screen reminding her that visibility within the uterus is directly related to the stage of pregnancy. As pregnancy progresses, the amniotic fluid becomes cloudier and visibility is reduced. To remedy this, surgeons perform an amnioinfusion at the beginning of the procedure, replacing a portion of the amniotic fluid with clear liquid. The text indicates what buttons on the laparoscopic joystick to press to simulate the

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amnioinfusion and reminds Francine that these concepts and controls were introduced during the beginner scenarios.

5. Following the prompts from the hint, Francine performs an amnioinfusion and immediately notices how much clearer her surgical field of vision has become. However, realizing that she missed important information by skipping ahead to the intermediate scenarios, Francine selects Scenario Settings on the HUD and opts to quit this session early to tackle a scenario more in line with her current skill level.

USING THE SIMULATOR TO TEACH REMOTELY

TERRY PERSONA

1. Terry is excited. He just finished his fourth cup of yogurt, it's 9:00 a.m., and he is about to teach an overseas obstetrician from Cybertron, Dr. Optimus, how to perform the laser ablation therapy used to treat TTTS. The best part? Terry is at Mount Sinai, and Optimus is still at the Cybertron perinatal center—neither of the doctors needed to travel as the new simulator enables remote training.
2. Terry heads to the simulation lab and turns on the TTTS simulator. Upon turning on, the simulator notifies him that it is a touch screen device, and then prompts him via text and a notification sound to choose one of two options: new user or returning user. Terry is familiar with the simulator set-up and controls as he was involved throughout its development and he already has a special user profile as he is an instructor, so he selects returning user and logs in.
3. Upon logging in, Terry is taken to the home screen where he can select from one of six options: tutorials, surgical scenarios, remote training, user profile, settings, and log out. Excited to connect with Optimus, Terry selects remote training.
4. Terry is taken to a new screen where he can either add users to his training scenario by searching for their user profile or join a registered training session via the calendar function. Remembering that he and Optimus had been planning this session for some time, Terry selects the calendar function and selects the appointment.
5. After selecting the appointment, Terry is taken to a screen that says “waiting for all scenario attendees to join”. Looking at his phone, he realizes that in his excitement he arrived several minutes early, so he has no problem waiting for Optimus to arrive. Terry hears a notification sound from the simulator, and sees a pop-up message that Optimus has joined. The webcam on the simulator's computer monitor turns on and the waiting screen changes so that Terry can see Optimus face in a small window and Optimus's screen displayed in front of him. There are also several text buttons and icons to change the training to a video call, an audio call, mute audio, and a button that says Instructor Control. By default, the video icon is selected.
6. Terry can see that Optimus's screen is showing them four options for difficulty settings: introductory, beginner, intermediate, and expert. Terry recalls that Optimus has already completed the tutorial all new users are prompted with when making an account, but aside from that this is their first attempt at performing the procedure. Terry waves to Optimus and greets them before suggesting that they get things underway and dive into the introductory scenarios.
7. Optimus agrees, and the two begin an introductory scenario. Terry notices that Optimus seems to have picked up on the controls presented in the tutorial well, as they are navigating the intrauterine environment without much issue. As this is an introductory scenario, highlights and guides are still built into each scenario, so Terry watches as Optimus approaches the highlighted vessel structures that require laser ablation.
8. Once Optimus navigates to the highlighted vessels, Terry asks Optimus to stop and explain the

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approach they are going to be taking. He asks about why these vessels require attention, and how Optimus plans on guiding the laser over each. He also uses this as an opportunity to ask how Optimus might identify which vessels require ligation and teaches some of the characteristic signs to look for.

9. Satisfied with Optimus's answers and understanding, Terry asks Optimus to proceed, and watches as they perform the laser ablation on the first few vessels. Optimus pauses and asks Terry if he has any feedback or thoughts, and Terry states that, for the most part, they are doing quite well; however, there is something he would like to demonstrate. Optimus happily agrees, and Terry selects the Instructor Control button at the bottom of his screen. Terry now has access to the laparoscopic joystick attached to his simulator, which he uses to show Optimus some of the intricacies of performing the laser ablation procedure.
10. Passing control back to Optimus by deselecting the Instructor Control button, Terry continues to watch as they perform the procedure. Occasionally Terry takes a moment to test Optimus's knowledge or demonstrates another technique and explain his rationale. Terry is pleased with Optimus's progress, and how well the training sessions seem to have gone. Similarly, Optimus expressed how easy using the simulator remotely was, and how excited they were when they heard Terry was the trainer.
11. Finishing the scenario, Terry gives Optimus an overview of their performance, and indicates some areas they can work on. This verbal feedback is complimented by the completion screen that appeared on Optimus's screen, highlighting the elapsed time and degree of accuracy for the vessel ablation. Terry suggests that Optimus practice on their own and work through the remainder of the introductory scenarios before they meet again remotely. Optimus thanks Terry, and the two log off the simulator. Terry powers down the simulator, even more happy than before he started the training. Time to get another yogurt.

SAMPLE WIREFRAME

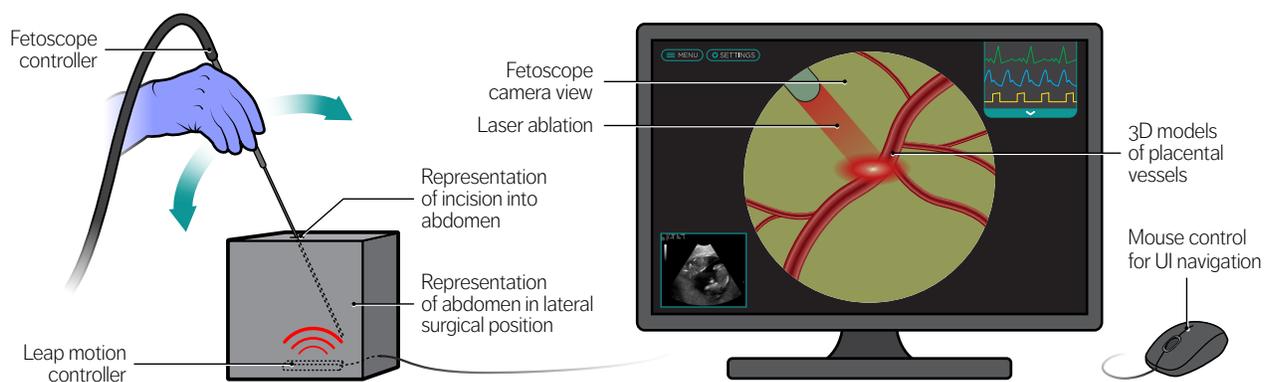


Fig 1: A wireframe of the proposed control setup and UI for the TTTS surgical simulator.

PRODUCTION SCHEDULE

