# Robo Rep T661

### What scientific or technological uncertainties did you attempt to overcome? (Maximum 350 words)

This technology evolved out of the work of a medical device representative who found himself wasting copious numbers of hours traveling to hospitals to be present at operations to instruct medical practitioners on medical device usage. At the start of this project, he began to investigate the technology of telepresence, but it was nowhere near where it needed to be to substitute for him in an operating room, there were no known or novel technological approaches to telepresence for surgery rooms. That began the experimental process to come up with a robotic representative that could stand in for a medical device representative in an operating theater, allowing the medical device representative to have eyes and the ears in the operating room, and the ability to point, instruct, and communicate through the robotic device, such that they could interact with multiple physical locations, in near real time, all at once.

The technical uncertainty involved merging laser technology with visual recognition technology, a term called telepresence, and development of an iMac-based control panel, through which a very complicated system of devices, all mounted on a portable, easily assembled and disassembled system, can be operated remotely. There were a number of moving parts that had to be negotiated over a network: cameras, lasers, robotic motion, computer code to govern action/reaction, data layer based on visual recognition, associated data layer with device instructions. These provided a number of test scenarios we needed to run through, documenting many failures to overcome the clear system uncertainty involved in the merger of the hardware and software, all in a compact and modular form factor.

The project represented an ergonomic challenge in the basic moving parts of the robotic medical device representative. What was the best design for all of the functionality required by the medical device representative? While robotics has insinuated itself into many professional and manufacturing situations, telepresence in an operating theater is completely new territory. How could portability, assembly, and disassembly be packaged in with a functional robotic representative, while not impacting the real-time nature and laser accuracy which was required to be replicated and reliable to one hundred percent, in each successive application in any new operating theater.

The next block of uncertainty was the complicated networking and cabling required to connect all of the various devices that would have to be in synchronization and governance to send and receive data and not confound the problem of movement for the robotic device. The existing technology and knowledge base level at the onset of this project was limited to the functional objective usually only being accomplished using a plurality of different analog circuit boards, cameras, and servo controllers within many independent devices, and not within one integrated and compact footprint and form factor.

### What work did you perform in the tax year to overcome the scientific or technological uncertainties described in line 242?

Laser Pointer

The laser pointer presented unique telepresence challenges. We had to articulate multiple trays and drawers of surgical components that may or may not get used. Dozens of device options were experimented with, and we found we required articulation based on what is happening during the operation. We had to be able to point at different parts, describe them, how to assemble and use them, define conditions under which devices get used, and which ones do not.

Cameras

The reason we have two cameras is so one can see where the laser points and ensure they're pointing at the correct thing, and the second camera to look around the operating room and see what's going on, who's talking and other important live data. The top gimbal used two servo motors and two gear boxes in the final design where we can manipulate that laser pointer correctly. All of this was done by experimental development, systematically attempting a series of unusual servo alignment designs, experimenting with them, determining how they failed the complex merger of all our needs, then rebuilding with what we had learned.

Systems Integration

Known systems fail to control remote controllable cameras (a primary camera and an auxiliary camera) and to control a remote controllable laser pointer device. We attempted to develop a method and process to control the remote controllable cameras, and laser pointer device. We experimented with many use cases that might be beneficial to a surgical environment, which we found saves time by having a technician to work one, two, three steps ahead of the operating room users; avoids delays caused by pan, tilt and zoom of a single camera and single laser, which do not move quickly, and further this would help operating room staff identify instruments and devices more quickly. We realized that as some orthopedic operating room set-ups may be too large to be effectively covered by a single camera, especially when using a sterile implant room that is located adjacent or nearby to the operating room, we needed to design a method for deployment of auxiliary devices which would allow access to other rooms with implants and other operating tables outside the field-of-view of a main camera while minimizing the physical footprint of the apparatus.

We focused next on the user gesture signal from a gesture-sensing device (which is positioned in the operating room. The gesture-sensing device needed to be developed in such a manner that we could detect a user gesture provided by a user positioned proximate to operating room device. We would then develop a method to process the signal received and devised a process that algorithmically determined if the user gesture signal matched a predetermined user gesture stored in memory. We next devised a method to suspend transmission of an aspect of a telepresence session, depending on a match made between the user gesture signal and the predetermined user gesture. Work would continue in the next fiscal period as obstacles were still not met, and further advancements needed to be made to the footprint and portability of the device, based on knowledge gained during experimentation in 2020.

### What scientific or technological advancements did you achieve or attempt to achieve as a result of the work described in line 244? (Maximum 350 words)

We built a system to operate at least six networked devices and some gear boxes. The gear boxes are uniquely assembled into three different gimbals. There are two high resolution digital cameras and a laser pointer. We unified all of these system uncertainties into a working prototype. We performed experimental development by systematically iterating through our design challenges to strip away architectural assumptions that did not pan out in prototyping. We had knowledge — and the industry had knowledge — of how each of the component types worked individually, but not together, and there existed no tangential industry uses that bore sufficient similarity to a medical device representative telepresence.

There were many uncertainties in the engineering of the prototype. We needed a number of unique brackets and number of moving parts that were quite complex that had never been developed together before and we had to maintain the ideal of easy assembly, easy disassembly, and maintain portability.

In this fiscal period we developed a two axis gimbal to integrate with the gear boxes to meet the ability to point a laser accurately as seen in real time through a remote camera, as part of our robotic and digital medical device representative. We developed a novel and compact gear box form factor, and in doing so set new patented standards for robotics in an operating theater. The axes of both gear boxes intersected with one another. This provided a new mobility for camera movement specific to the operating theater. Roborep is creating an affordable, accessible, telepresence system to provide on-demand, real-time, technical input during operating room procedures.

The work has produced a patent for ‘Telepresence Management’.