3D Medical Scanning System for Minimally Invasive Hernia Surgery

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Objective of the technology

- Enhance intraoperative decision making for minimally invasive abdominal wall hernia surgery.
- Provide real-time digital 3D scanning measurement of defect.
- Digitize information by storing intraoperative reconstructions of spaces, hernias, and mesh.

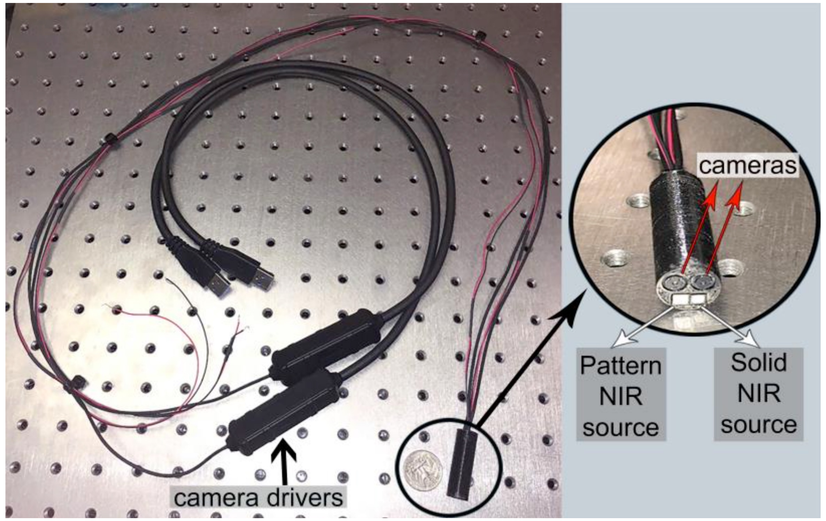


Figure 1 : *The optical scanning system and its components. A quarter is shown next to the scanning head for size reference.*

Description of the device

- A patent pending 3D scanner consisting of two near-infrared (NIR) cameras and two NIR vertical cavity surface-emitting laser (VCSEL) sources.
- Cameras have a 2.73 x 1.55 mm image area, 1.4 µm pixels, and a 70° horizontal and 42° vertical field of view.
- One of the VSCEL sources emits patterned NIR illumination using a diffractive optical element and projection optics integrated with its array, while the other emits a solid, uniform, flat-top illumination with a 75°x55° field of illumination.
- Baseline distance of 5.5 mm between the cameras, giving a theoretical accuracy of 55 µm at a 25-mm operating distance.
- NIR sources are powered by a 1.75 V, 20 mA, switchable source.

Application

- Components can be passed through the trocars and inserted in the abdominal cavity.
- Real-time patterned light illumination of the target and stereoscopic vision map out the area of interest.
- Instant software-analysis of the data using triangulation algorithms and known parameters of the projected pattern, camera, and source, to reconstruct the target area in 3D.
- Lateral distances, depth, area, and circumference can be digitally measured in a single output, with high accuracy, while taking into consideration the 3D nature of the environment.
- Documenting and storing intraoperative details such as a 3D model of the defect before and after the repair.

Conclusion and Future Directions

- Improper mesh sizing could result from irregularities in hernias, causing inconsistent overlap of the mesh.
- There are no objective methods currently for real-time 3D measurement of spaces and abdominal hernias.
- Objective technology in abdominal wall hernia repair would help the surgeon in mesh size choice by providing accurate measurements.
- Storing the digital reconstructions of the final hernia repair as part of the medical record could provide new metrics to be assessed.
- A future study will be conducted to assess the accuracy of the system by using 3D-printed models of the anterior abdominal wall designed by a computer-aided design (CAD) software.
- Operators will use the 3D medical scanning system to measure several defects varying in shape and size, and the measurements will be compared to the reference values generated with CAD to determine the device accuracy.

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