Design and Development of an Advanced Tissue Imaging Device for Surgical Oncology

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Introduction

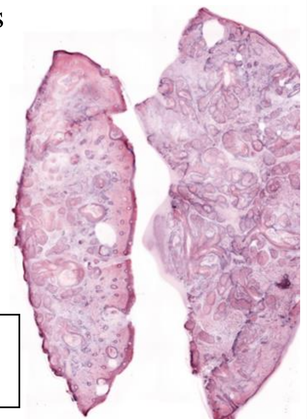
Incomplete tumor removals remain a prevalent problem in cancer surgical treatments. The Machine-Learning Assisted Gigantic-Image Cancer Margin Scanner (MAGIC-SCAN) is a diagnostic imaging device in development to tackle this issue. Designed to detect residual cancer cells in excised tumors within just 15 minutes, MAGIC-SCAN could give surgeons real time insight into whether cancerous tissue remains in the body. By improving the accuracy and speed of margin assessments, this technology has the potential to greatly reduce the rate of incomplete tumor removals and improve surgical outcomes.

Methods

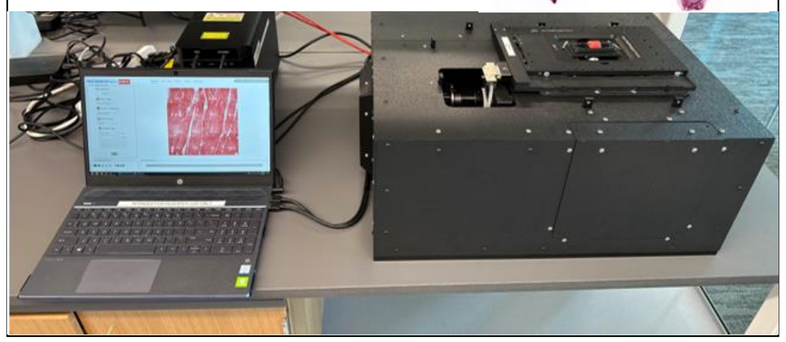
The current research and development phase has many different aspects; I primarily focused on sample imaging and handling. My contributions have included designing and 3D printing components for research devices and experimental setups, assisting with chemical experiments related to the histopathology process, and contributing to a camera attachment that helps determine the location of the sample. I helped develop strategies to mark specific tumor regions with fluorescent dyes visible to the naked eye and used multiple 3D modeling programs to fabricate parts and model tumor samples for imaging .

Improving Tumor Imaging

For many of histopathology experiments, we used the Instapath Luci model. The Luci model can be used to see the cellular makeup of tissue samples and is able to transform tissue samples into microscopic digital images within a few minutes. However, this can only be done with small tissue samples that sit flush on the imaging plate. MAGIC-SCAN aims to work with large tumor samples and uneven surfaces (ex. biopsies related to breast, colon, and prostate cancer). This brings about many new obstacles to problem solve. I focused on marking the location of the tumor using fluorescent dyes visible to the human eye.

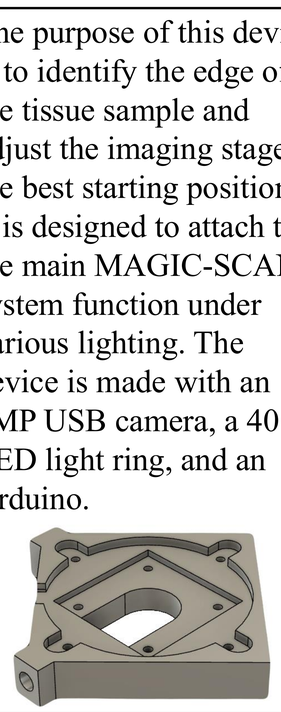


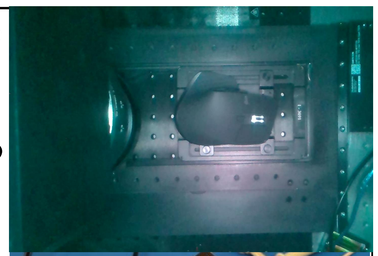
Pictured below is the Luci model scanning a skin tissue sample. To the right is the histopathology image of the sample

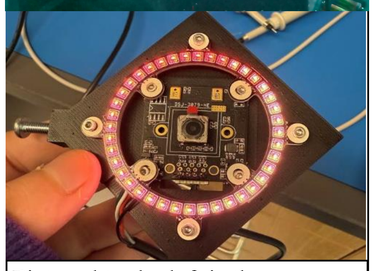


Sample Positioning

The purpose of this device is to identify the edge of the tissue sample and adjust the imaging stage to the best starting position. It is designed to attach to the main MAGIC-SCAN system function under various lighting. The device is made with an 8MP USB camera, a 40 LED light ring, and an Arduino.



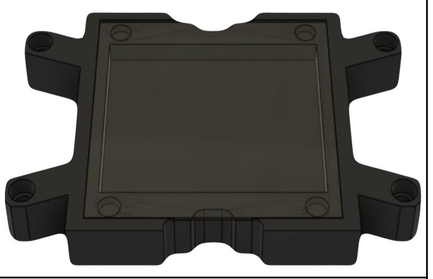




Pictured to the left is the camera assembly fusion360 model, to the bottom right is the printed and assembled piece, and the top right is an image taken when the camera is attached to the MAGIC-SCAN machine.

Design Support

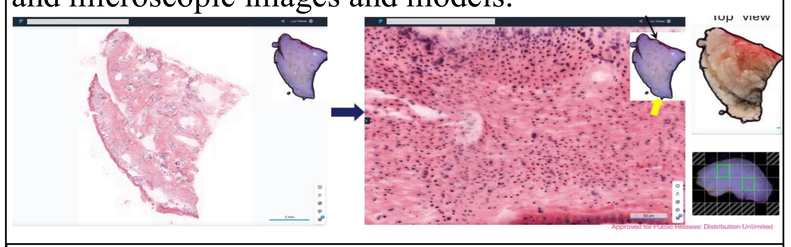
Throughout this project, I collaborated with members of my lab by providing support on their tasks primarily through 3D printing and modeling. This included adding a stabilizing piece to 3D scanner, calibrating cameras and learning how to use 3D scanning programs in the process, designing a larger sample holder, printing pieces related to chemical experiments, and one point even designing the MAGIC-SCAN and Tulane Logo using Fusion360.



Pictured above is a Fusion360 model of a sample holder with a 10cm x 10 cm glass slide

Dye Marking

Using a variety of florescent dyes, we marked meat samples to see how it would appear on the microscopic image. The dye will be applied to the location of the suspected tumor. We also experimented with stitches in the meat to help to help with tissue orientation in 3D and microscopic images and models.



Tissue images demonstrating how you ID suspicious areas and then direct sampling for permanent histology

Conclusion

The MAGIC-SCAN project has the potential to transform intraoperative decision-making by delivering accurate, high-resolution cancer detection within a short timeframe. Continued development will focus on refining imaging accuracy and sample handling procedures. This project has allowed me to advance my chemistry, 3D modeling, and prototyping skill and exposed me to oncology research and careers. This project has deepened my technical expertise, allowed me to explore research aligned with my passions, and reaffirmed my commitment to advancing diagnostic technologies.

Acknowledgements

The author acknowledges the support of the Summer Undergraduate Cancer Research Experience (SUCRE), the Louisiana Cancer Research Center (LCRC), LSU Health Sciences Center New Orleans (LSUHSC-NO), Tulane University, Xavier University, and the National Science Foundation (NSF).

This research project was supported by the Stanley S. Scott Cancer Center.