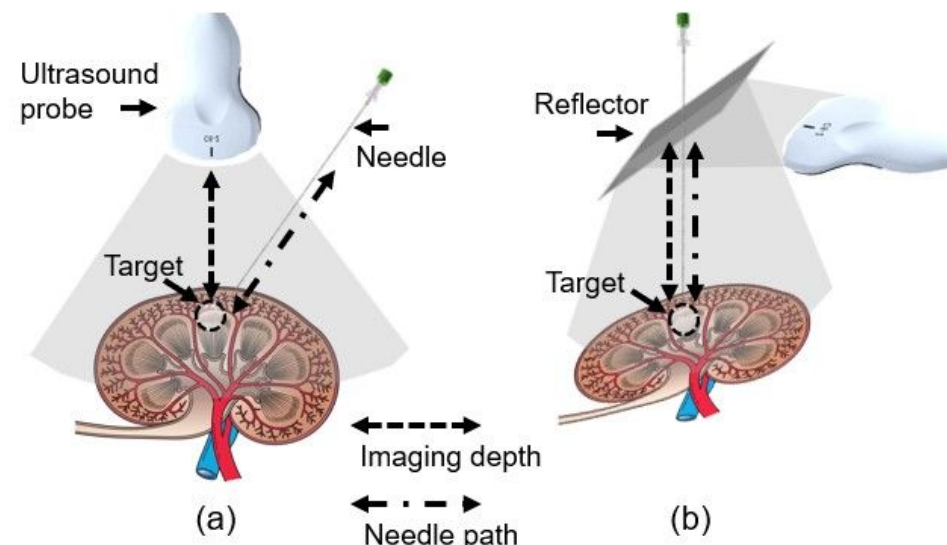


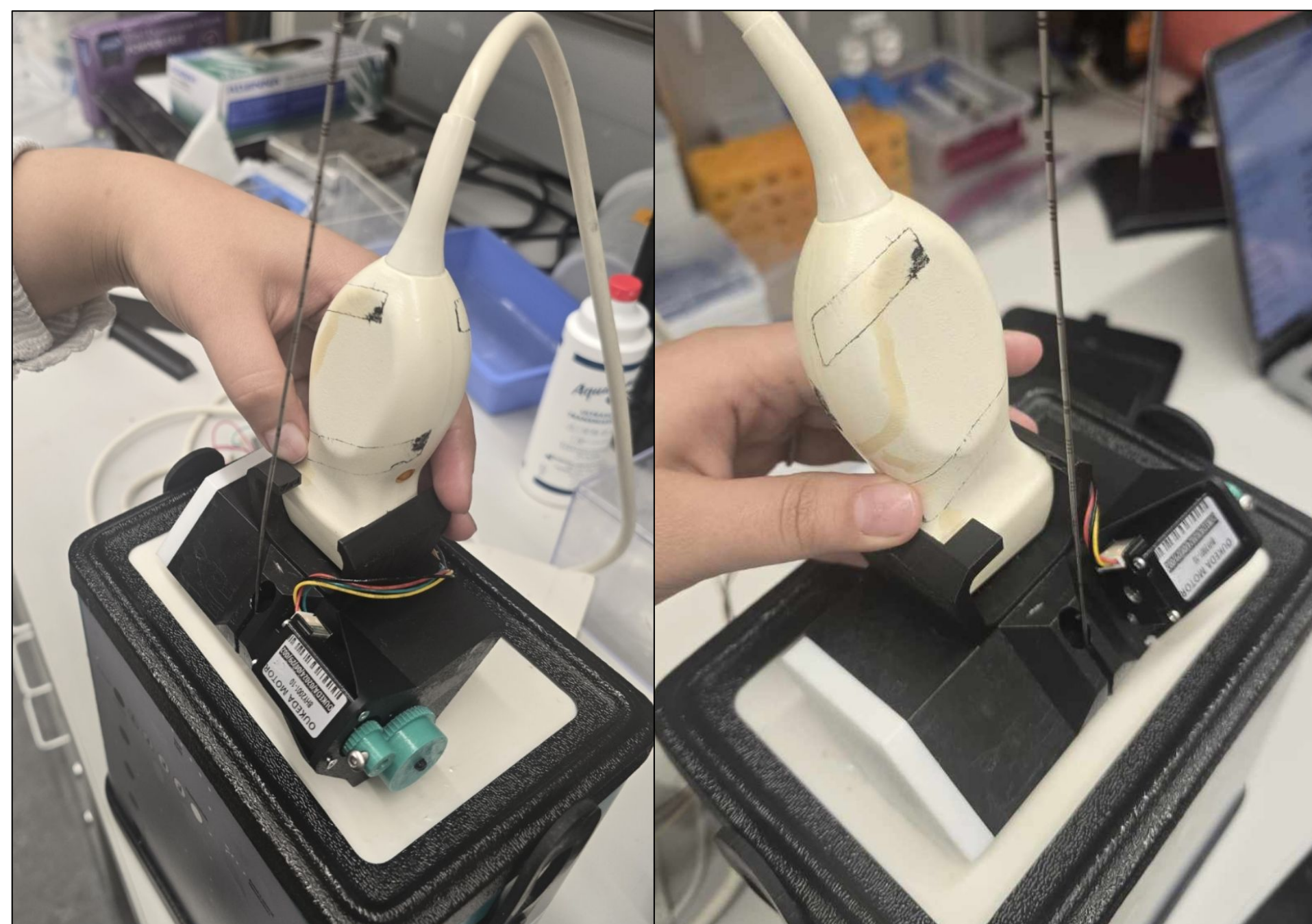
Introduction

Percutaneous nephrolithotomy (PCNL) is a surgical procedure used to remove large kidney stones that cannot pass naturally. It involves inserting a needle into the kidney, followed by surgical instruments to break up and remove the stones.

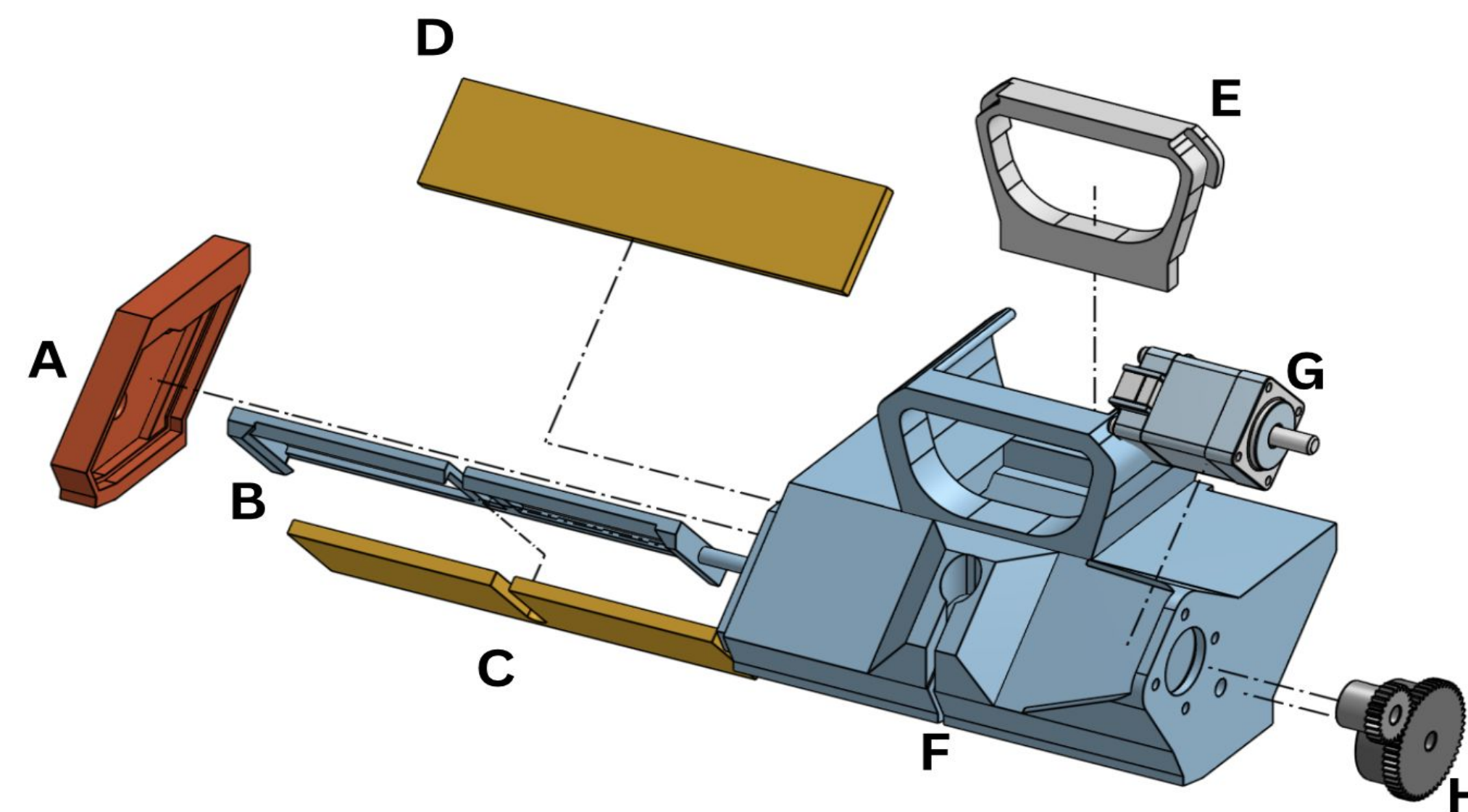


Methods

- Fully encapsulated device held similarly to a typical ultrasound probe
- Internal mirror moves $\pm 15^\circ$ to capture images
- Advanced tracking algorithm follows the needle as it bends
- Allows clinicians to focus on the procedure, not manual tracking
- Ensures efficient needle guidance with minimal reinsertion



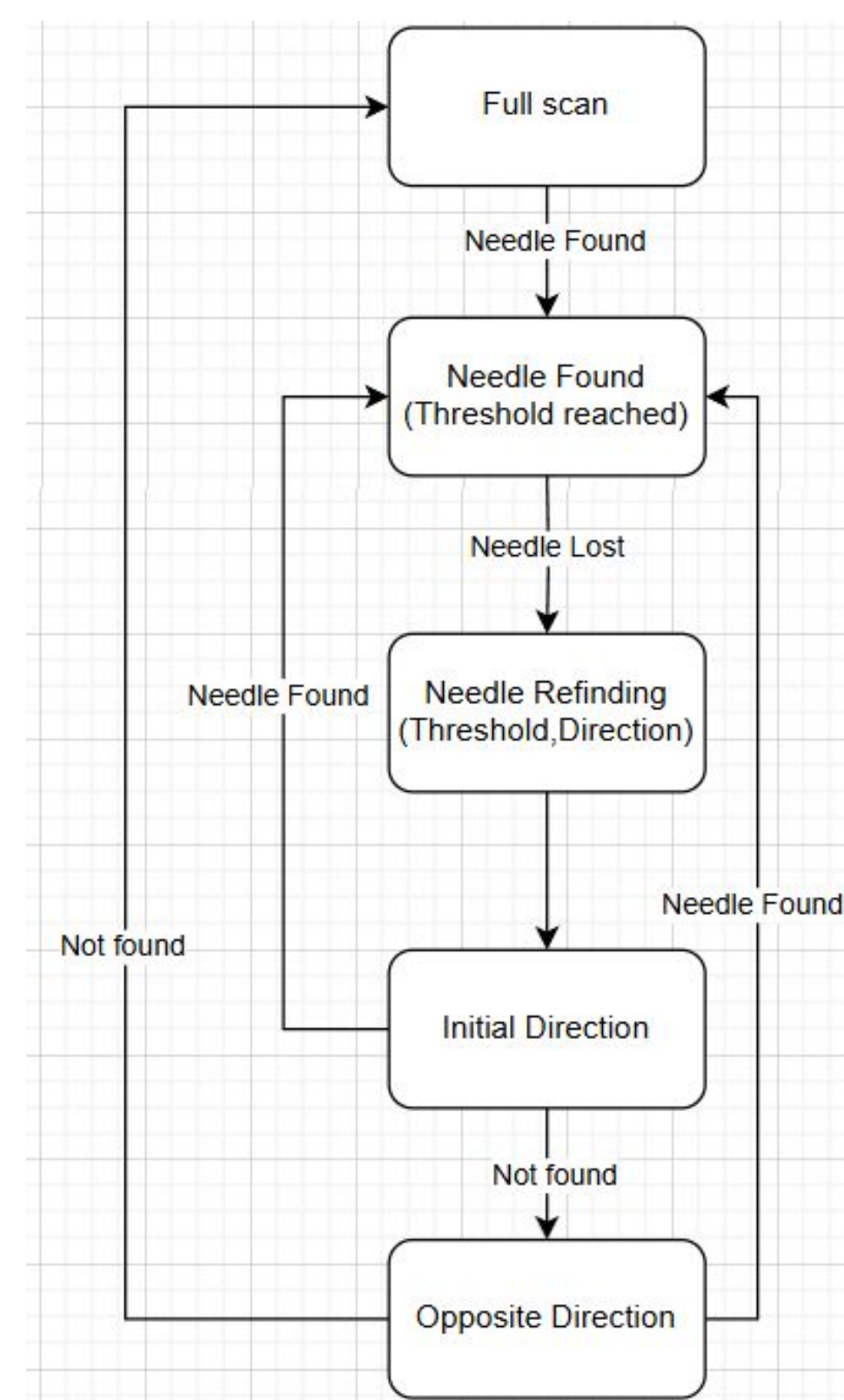
Full Device Overview



A- Device Cap
B- Mirror Holder
C- Rotating Mirror
D- Stationary Mirror

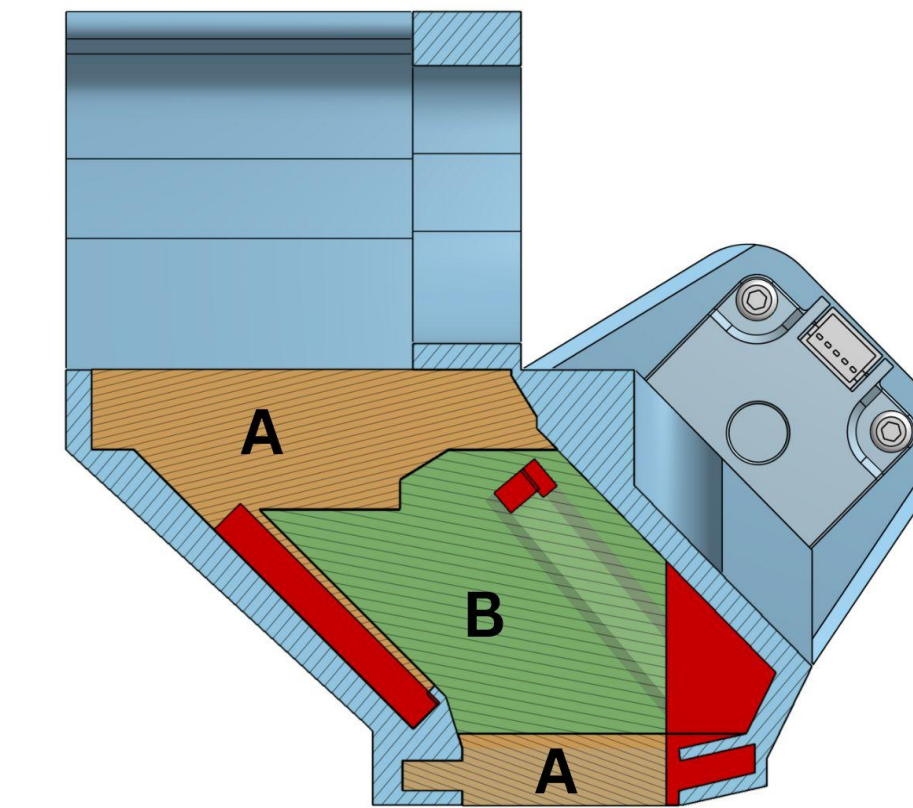
E- Ultrasound Probe Holder
F- Needle Slot
G- Stepper Motor
H- Gear Train

Control



The control system tracks the needle's last known direction and first searches that way when the needle is lost, switching directions if not found.

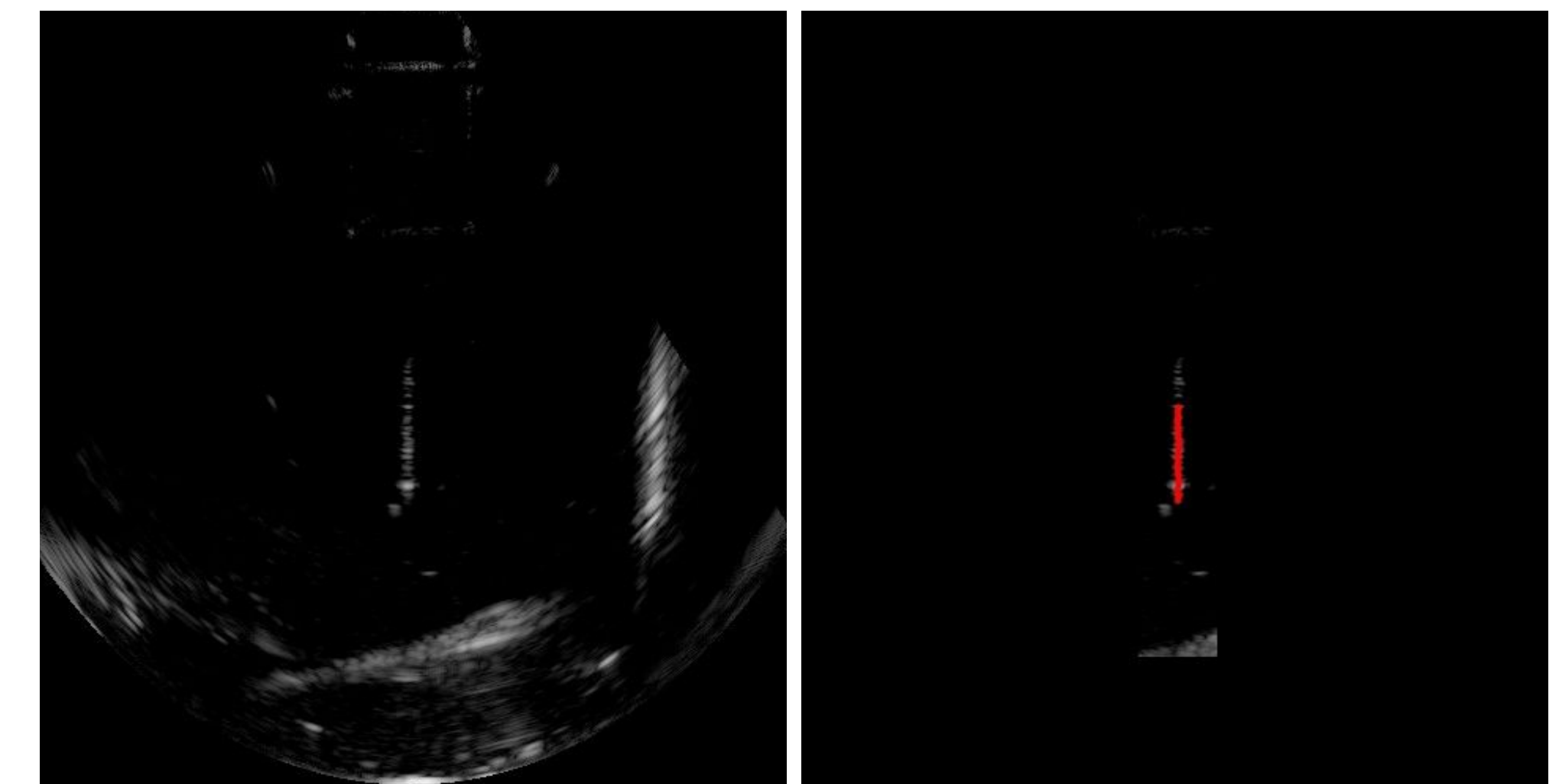
Materials



The device is encapsulated by a hybrid 3% agarose and olive oil solution. This ensures that it is fully waterproof and will not leak any oil while also allowing the mirror to rotate through oil for images in several planes.

A- Agarose
B- Olive Oil

Needle Tracking



These are some example images taken from image processing. The image on the left is taken with the device and the right image is the most processed image. It shows where the algorithm believes the needle is.

Future Direction

In the future, modeling the needle bend could help improve detection accuracy. Additionally, placing the device in a vacuum chamber after filling it with agarose may help eliminate air interference and enhance image quality.