

Robotic System for Central Line Placement

Design Specifications

High-level design specifications:

- The robot should be able to perform needle insertion, guidewire and catheter advancement.
- The robot should be able to adapt to variations in patient anatomy.
- The robot should be able to reduce the risk of infections (by having sterilisable components).
- The robot should be able to integrate with a wireless ultrasound probe.

Low-level design specifications:

- The robot should have a minimum workspace of 10cm x 10cm.
- The robot should have 2 rotational degrees of freedom and 2 translational degree of freedom.
- The robot should have a precision of at least 0.1mm in all movements with an accuracy of 90%.
- The robot should be able to insert a 18-gauge needle at a angle of 30-40 degrees (see [2]) and a depth of 2-3 cm (refer to [3]).
- The robot should be able to advance about 10-15 cm of a 50 cm guidewire (see [4]).
- The robot should be able to insert a guidewire with a diameter of 0.035 inches (see [2]) through the needle .
- The robot should be able to insert a catheter with a size 8.0 French (refer to [2]).
- The robot should be able to indicate the remote center of motion.

Assumptions

- The clinician scans the region of interest using ultrasound and decides the needle insertion site and angle
- The guidewire is straight and not “J” shaped
- The adapted Seldinger technique for the robot does not use a dilator
- Rate of infections introduced by insertions is greater than retractions; hence the robot automates the former

References:

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2. Wang, Henry E., and Thomas A. Sweeney. "Subclavian central venous catheterization complicated by guidewire looping and entrapment." *The Journal of emergency medicine* 17, no. 4 (1999): 721-724.
3. Tse, Audrey, and Michael A. Schick. "Central line placement." In *StatPearls [Internet]*. StatPearls Publishing, 2022.
4. Heffner, Alan C., and Amalia Cochran. "Overview of acute and emergency central venous access in adults" in UpToDate, UpToDate Publishing, 2022.