Robotic vs. Human Arms

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Introduction & Background

- Robotic surgery used for small incision, minimally invasive operations.
- Some lack confidence in the technology due to fears of and misconceptions of automated materials.
- **Benefits:** The EndoWrist instruments that perform on the patient allow for 360-degree rotations and smaller incisions, which leads to minor scarring, a quicker recovery time, as well as many other impressive outcomes.
- **Risks:** No long-term effects have yet been observed and, in some cases, open surgery has shown to be more beneficial.

Figure 1. Bin Fang Using Teleoperation on Robotic Arm.[1]

Purpose: Create a Data Glove Which Captures the Motion of the Arm and Hand Translated through a Robotic Arm.

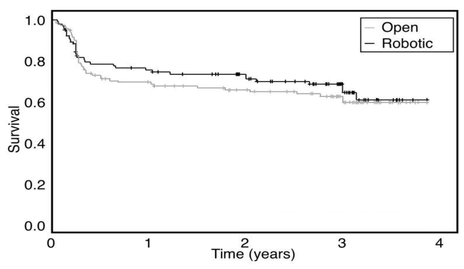

Figure 2.
Graph of Joshua Montroy's Study: Depicting the Survival Rate of Surgeries.[2]

Purpose: Compare Robotic vs. Open Prostatectomy Surgeries.

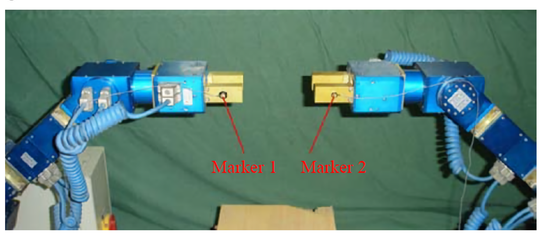

Figure 3.
Dual Arm Robot Used in Jun Zhou's Study.

Purpose: Present accurate coordination control by testing the trajectory of a dual arm robot.

Statement of Purpose

In the execution of this project, the aim is to help mitigate any fears or misconceptions related to automated systems and increase their credibility.
This was accomplished by building a small-scale, inexpensive robotic arm, and using it to compare robotic to human precision and accuracy.

Hypothesis 1

If the robotic arm moved the block prop within the tape with more precision and accuracy than the human subjects, then the robotic arm would be better equipped to perform certain motion-related tasks.

Hypothesis 2

If an improved robotic arm completed the same trials the original robotic arm completed with more precision and accuracy, then the improved robotic arm would be better equipped to perform certain motion-related tasks.

Materials & Methods

Materials

- **Lynxmotion AL5D Robotic Arm**, **Poster Board, Eight Sequences**, **SSC-32 Servo Sequencer**, **One Block with Tabs, One Shape-Specific Block**

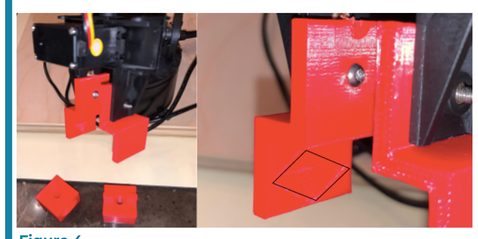

Figure 4.
Lock and Key Gripper Added onto Regular Gripper and Blocks Used.

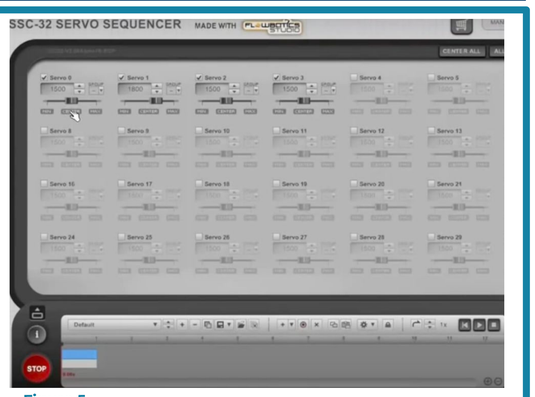

Figure 5.
SSC-32 Servo Sequencer.

Methods

Phase One:

- Trial vs. sequence
- Move the block onto the **center** of the taped boundaries
- Measure the distance in millimeters from the **center** of the boundary to **where the block was placed**
- **All trials were timed**

Execution:

- 27 human participants, so 27 robotic trials
- Difficult recruitment
- Names were left out of the study
- **Control**- elbow- start, end

Phase 2:

- The robotic arm needed to be **enhanced**
- Changed the gripper to a **lock and key** model
- **Orientation**
- **Metaphorical scale**

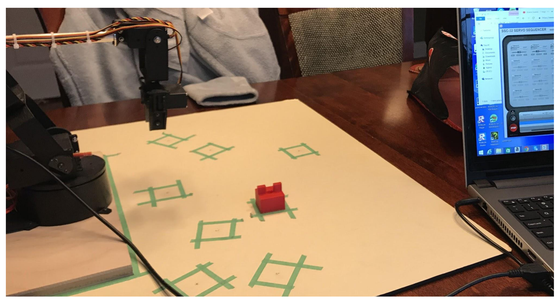

Figure 6. Materials Used in Study.

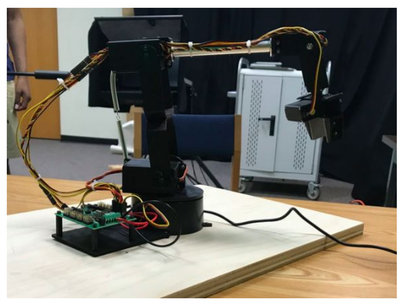

Figure 7. Lynxmotion AI5D Robotic Arm.

Results & Analysis

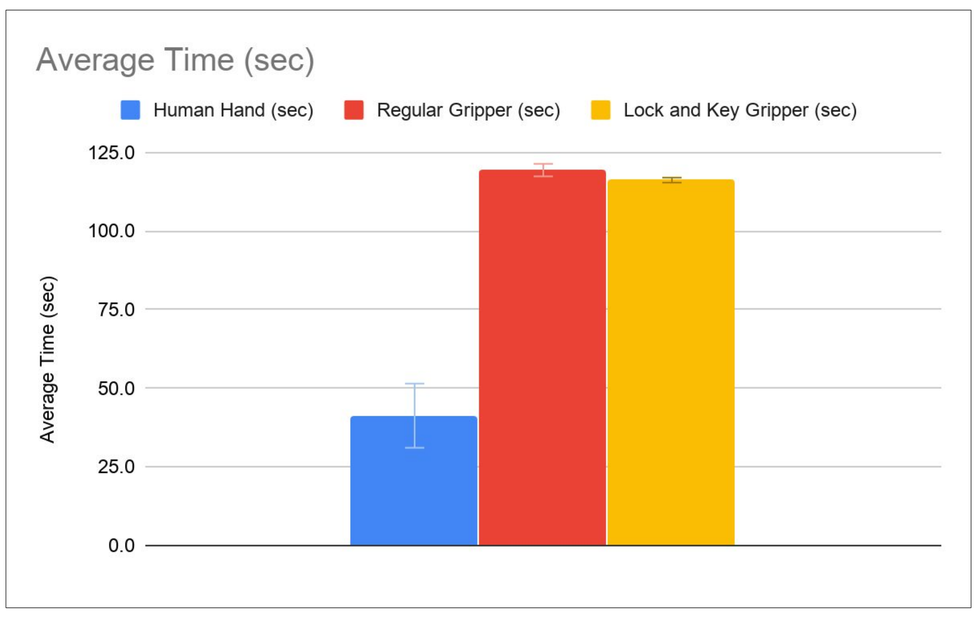

Figure 8. The Graph Illustrates the Average Time Trials

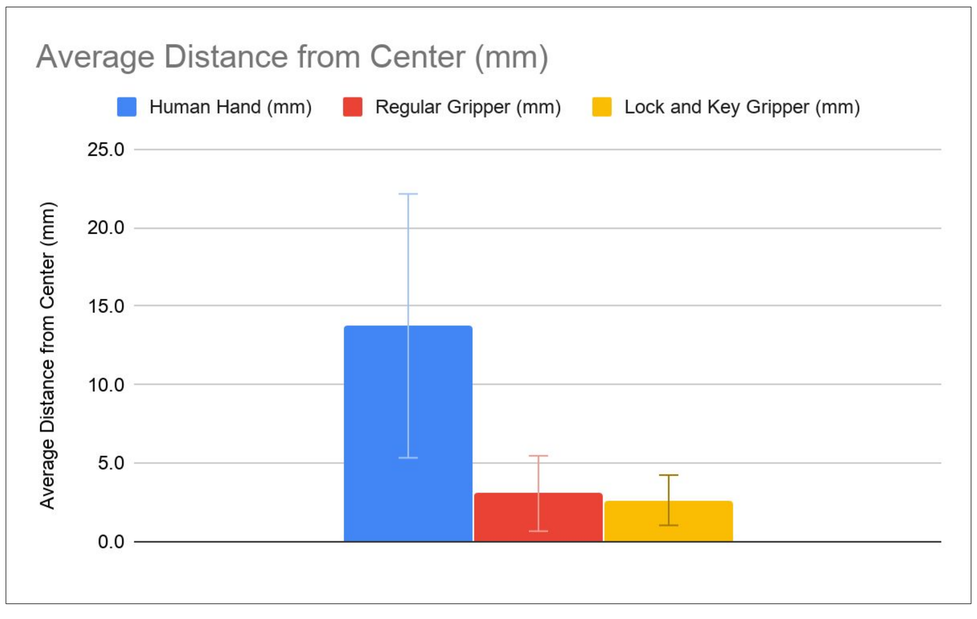

Figure 9. This Graph Illustrates the Average Distance from the Center of the Taped Boundaries

Discussion

- Time was not the focus of this study.
- The participants went at a pace of their choosing.
- The robotic arm completed the trials at a saved sequence speed -- robotics being controlled through human decision making.
- If the trials were made faster, then the data would be less accurate.
- There would be more shakiness caused by overshoot and a higher probability of the arm collapsing.
- A slower pace was necessary to minimize the likelihood of these outcomes.
- It can be inferred that human fatigue would have been observed if a heavy object was used over a longer period of time, which then could have been connected to surgeons standing during operations.
- This project is an engineered based project.
- However, an apparent medical field connection can be made.

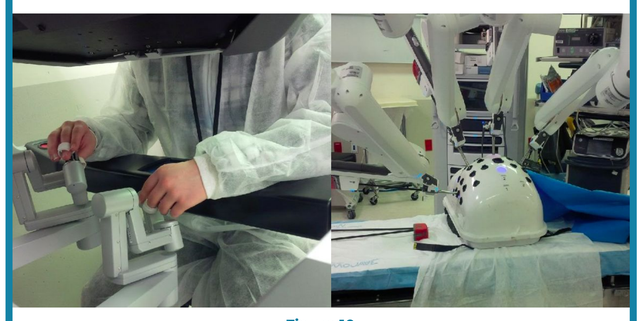

Figure 10.
This picture depicts me performing "surgery" on a silicon flap.

Impact

By the small-scale robotic arm illustrating more precision and accuracy than the human participants, this study gives patients more security, the medical field more credibility, and enables more trust with automated systems in our society.

Future Research & Conclusion

- The robotic arm trials exploited human error.
- By advancing or increasing the effectiveness of a machine, the output efficiency will also increase.
- The lock and key gripper was screwed onto the robotic arm to make the trials more precise and accurate.
- The regular gripper allowed the block to be picked up in slightly different orientations each time.
- The lock and key gripper eliminated this error.
- Even though the Lynxmotion AL5D Robotic Arm is a small-scale, inexpensive, and relatively basic, unadvanced platform, it displayed a significant amount of precision and accuracy.
- While these results cannot be explicitly applied to robotic surgery, they do suggest a connection to the viability of automated systems in a medical setting. Although this work is promising, future work must be done to validate the results of this study.
  - More participants
  - More advanced platform
  - Feedback control system -- eliminates overshoot
- Research, college, biomedical/premedical path.

References

(1) Fang, Bin, et al. "A Novel Data Glove using Inertial and Magnetic Sensors for Motion Capture and Robotic Arm-Hand Teleoperation." *The Industrial Robot*, vol. 44, no. 2, 2017, pp. 155-165.

(2) Montroy, Joshua, et al. "Long-term patient outcomes from the first year of a robotic surgery program using multi-surgeon implementation." *Canadian Urological Association Journal*, vol. 12, no. 2, 2018, p. 38+.

(3) Zhou, Jun, and Yueqing Yu. "Coordination Control of Dual-Arm Modular Robot Based on Position Feedback using Optotrak3020." *The Industrial Robot*, vol. 38, no. 2, 2011, pp. 172-185.