Team ORBIT: Orbital Repairs by Innovative Technology

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Background

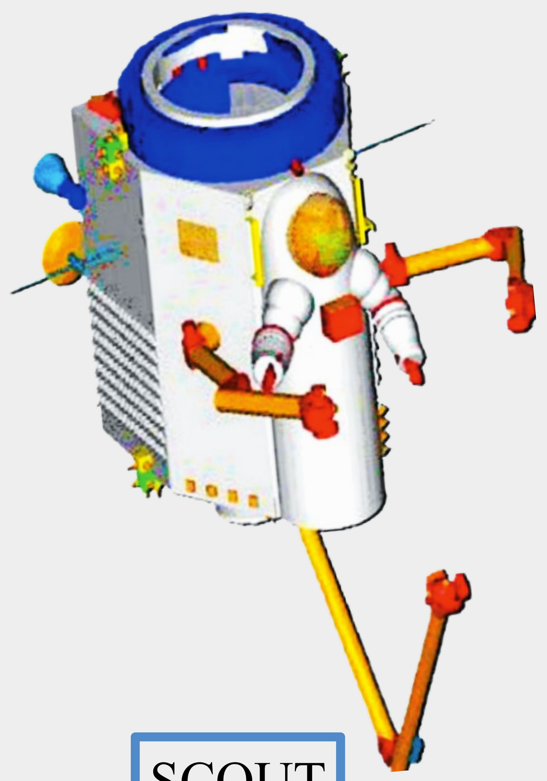
Extravehicular activities (EVAs) have historically been completed by astronauts exiting the spacecraft to repair or replace a part. Up to 30 hours of pre- and post-EVA procedures are completed to ensure astronaut health, but they still suffer from a lack of sufficient protection from cosmic galactic rays, solar radiation, and micrometeoroids and orbital debris outside the spacecraft. This research looks into two main designs of a Single Person Spacecraft (SPS) – SCOUT and FlexCraft – which were designed to offer astronauts more protection from these dangers.

Research Questions

This research aims to determine which SPS design is more ideal for conducting EVAs, along with proving Space Utility Vehicles (SUVs) a viable EVA servicing method.

Our guiding research questions:

- Is a "hands-on" or "eyes-on" design more effective?
- Can an effective control interface be developed for an SPS?
- Are SUVs a viable replacement for traditional EVA methods



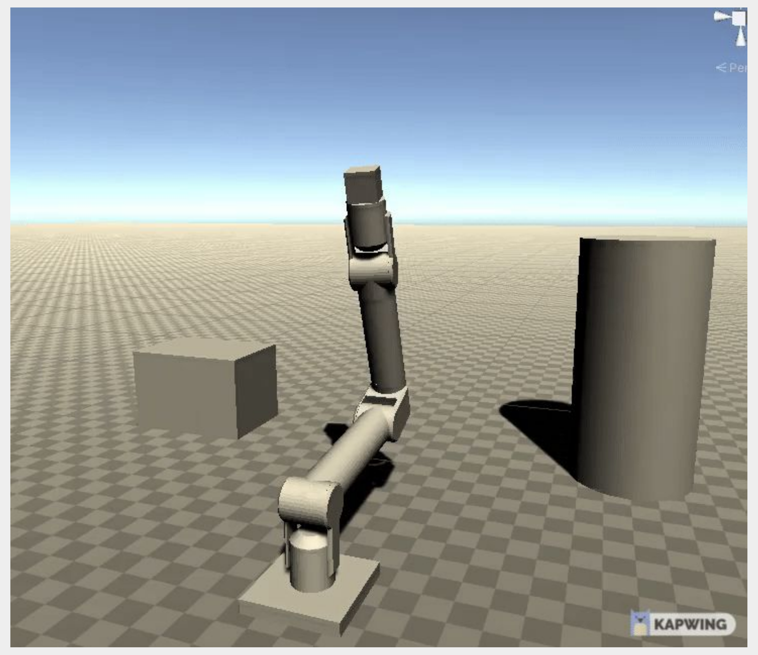
SCOUT

FlexCraft

Methodology -- Software

Complete a working simulation of the SUV in a virtual environment.

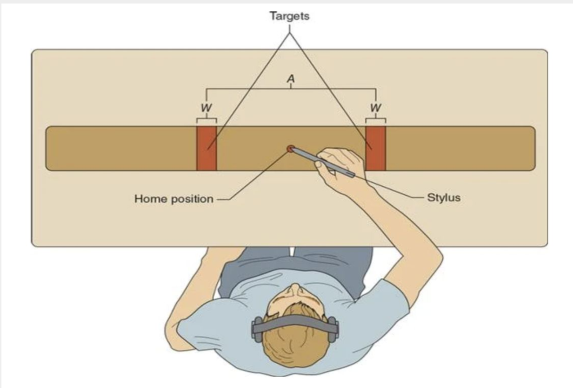
- Handle connections in ROS
- Actually render the model in Unity Gaming Engine
- Allows for compatibility with Oculus Rift for Virtual Reality
- Ideally model multiple tasks in the virtual environment, allowing for robust exploration and identification of best method



Methodology -- Hardware

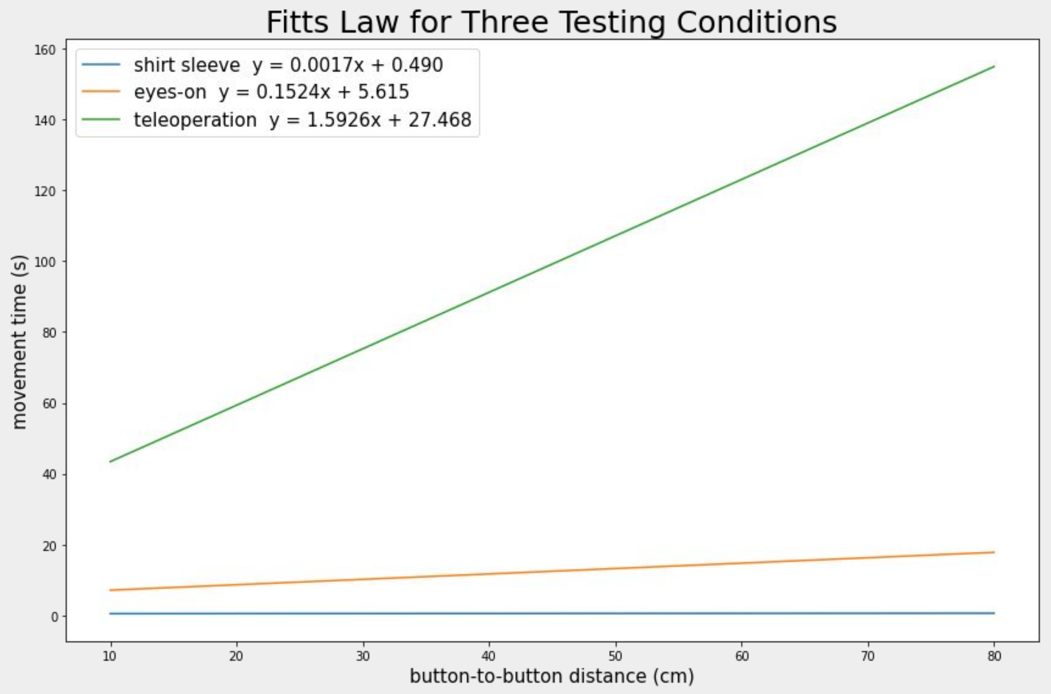
Gather data using the Fitts Law tapping test, the Cooper Harper Scale and the NASA Task Load Index

- The five environments being tested are shirt-sleeve, space suit arms, a simulation of the SCOUT arms, eyes-on robotic control, and teleoperation
- The participants perform the Fitts' Law tapping test for 20 button pushes, and are tested for the correct button pushed
- The next button is randomized on the board so that each trial is different
- These trials are done with 24 participants to gather a sufficient amount of usable data



Results

By comparing the slopes and intercepts of the linear Fitts' Law, our results show that the shirt-sleeve environment is the easiest control method. It has the smallest slope and intercept, as we would expect. For the shirt-sleeve environment, the nearly horizontal slope means that the task does not get more difficult as the distance between buttons increases. The eyes-on robotic control environment is the next easiest, and the hardest control method by far is the teleoperation environment. The non-shirt-sleeve environments also had increased errors-per-button-press.



Analysis

Our initial results suggest that control methods without the robotic arms are the fastest and the most accurate. Between the different robotic control methods, having eyes-on vision instead of teleoperation seems to play a large role in task completion time. This means that for future testing, we will likely pursue a combination of both space-suit arms and robotic controls with eyes on vision. This is similar to the SCOUT vehicle design shown in the bottom left of this poster.

Future Goals

We plan to progress to phase two of our methodology once we have completed our phase one testing. As briefly described above, phase two will entail testing a control method similar to SCOUT with both eyes-on robotic control and hands-on suit arm control. Our primary goals are:

- Design and build a satellite task mockup
- Test more complex robotic movements, i.e. replacing parts and moving objects
- Develop different hands-free control methods such as gestural or voice control for the robotic manipulators
- Simulation testing of full SPS mockup

References

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