

Supervisory Interfaces

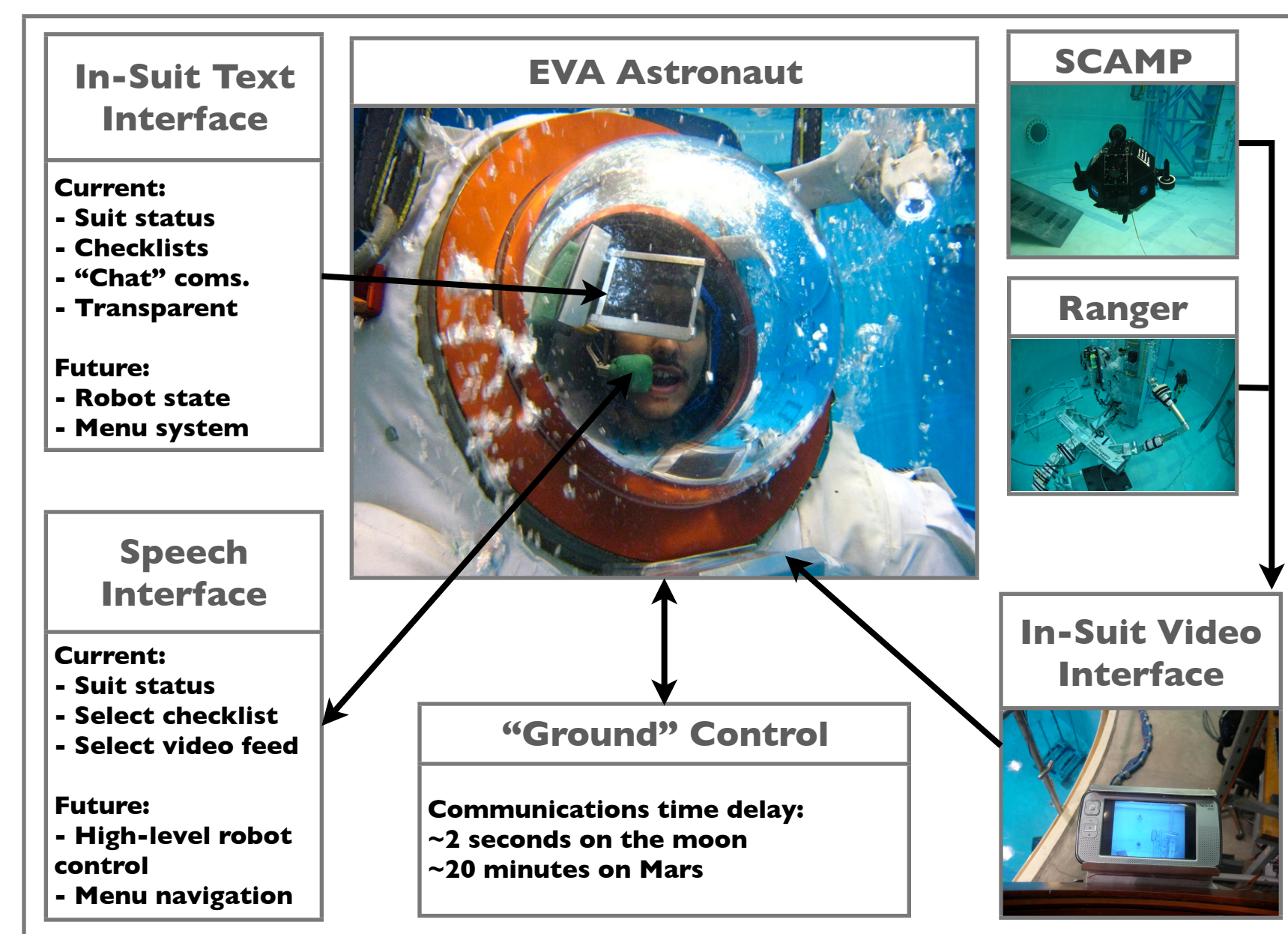
- management of semi-autonomous systems

INTRODUCTION

Future operations in space will include Extravehicular Activity (EVA) involving both humans and semi-autonomous robots working together. This research investigates human interfaces for interacting with the systems needed to fulfill this goal.

MX-2 EVA INTERFACE ARCHITECTURE

The Space Systems Laboratory has a spacesuit analogue for neutral buoyancy testing, the MX-2. A new interface architecture has been developed that increases the situational awareness of the suited astronaut with in-suit computer interfaces. This also reduces the dependency on ground-operators.



Speech Interaction

The EVA astronaut can use speech to get vital information, navigate through menus, select cameras and in the future perform high-level robot control. This gives a hands-off, eyes-off interaction capability, which allow the astronaut to keep working while interacting. The system currently has a ~90% command recognition capability.

Visual Feedback

Current EVA astronauts carry a cuff checklist in booklet form containing tasks and procedures. By making them electronic, checklist can be triggered by EVA status and include interactive features. Video feeds aid in supervising robots and other astronauts, and graphical interfaces will give rich information on EVA systems.

Direct Interfaces

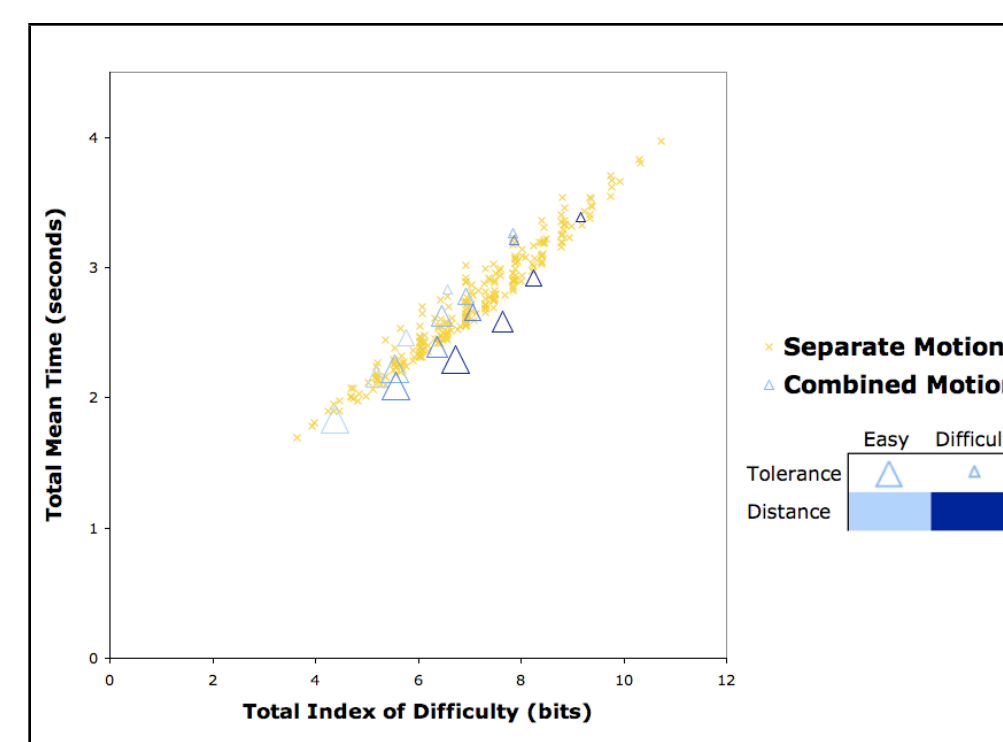
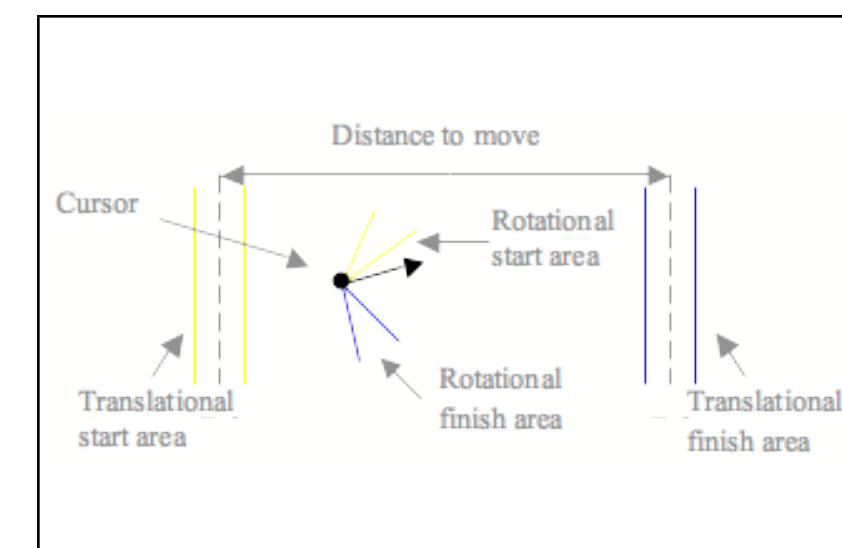
- low-level direct control of robotic systems

INTRODUCTION

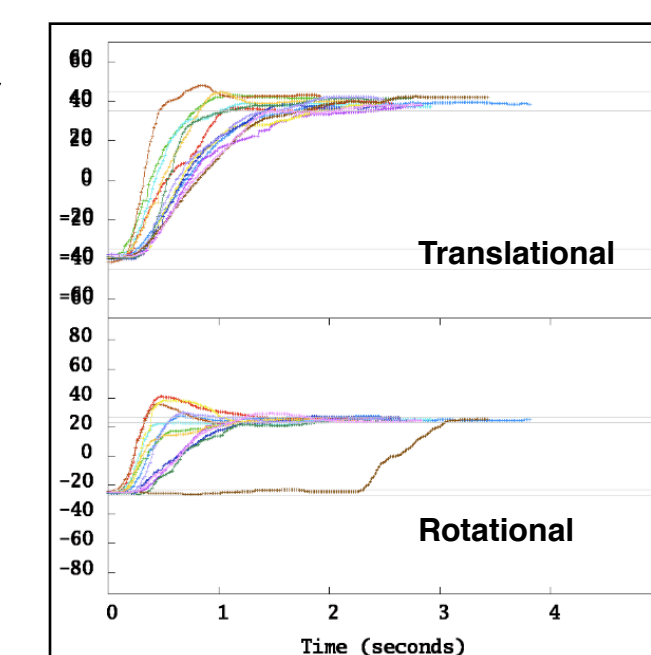
Although robotic systems are becoming more autonomous, there is still a need to have humans take direct control, for example for very challenging tasks or in an emergency. This teleoperation has until now been performed by ground controllers or astronauts inside the spacecraft, using two hand-controllers. By modeling human performance in controlling robots with these and different input devices, efficiency and safety can be increased in space operations.

HUMAN PERFORMANCE MODELING

Controlling robots involves both translating (moving from side-to-side) and rotating motions. The effect of distance moved and the tolerance on motion has been well established for translations by Fitts' law, but less so for rotational and combined motions. The study involved 39 subjects, some performing one Degree Of Freedom (DOF) rotations and translations separately and some at the same time. Each subject performed 16 trials 12 times.



The results indicate that the combined motion can in general be modeled by adding its components. The economy of scale of the combined motion is thought to be counteracted by the need to simultaneously finish with both position and angle within tolerances.



12 out of 13 subjects also chose to rotate and translate at the same time (example shown), which was confirmed by a significant interaction ($p < 0.01$) between respective tolerances and distances. This study is an important step towards ultimately modeling human capabilities in 6 DOF direct robot control.

Research Direction

- where we are going from here

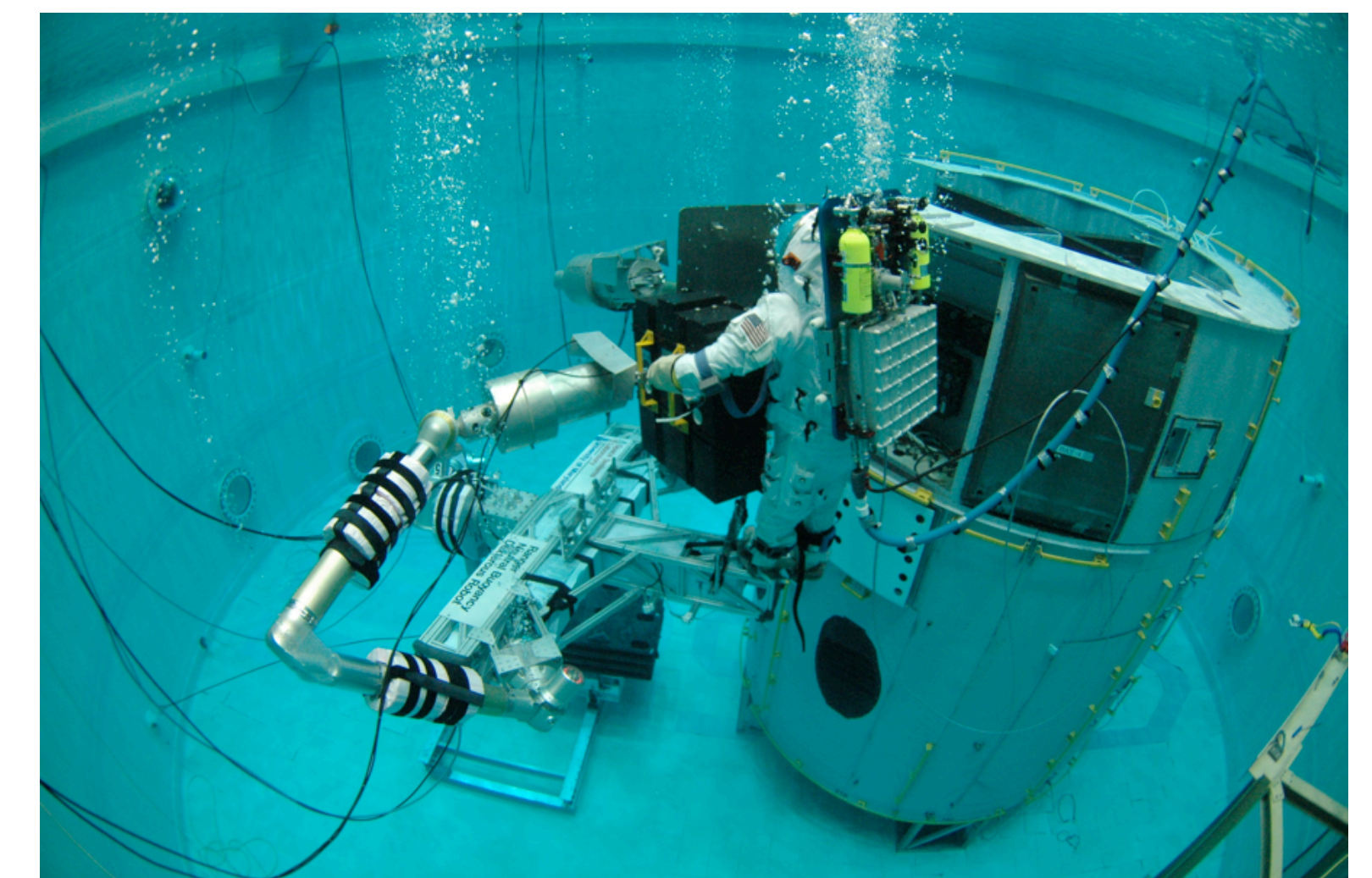
EFFECT OF SPACESUIT ON DIRECT INTERFACES

Can you perform direct control of a robot from a spacesuit? On Mars especially the communications delay and small crew size means that the EVA astronaut should be able to help and intervene directly in the robots work. This study will compare shirt-sleeve performance with that of subjects using a spacesuit glove in the SSL glovebox.



HUMAN-CENTERED OPERATIONS ARCHITECTURE

The ultimate goal of this research is to improve human-machine interaction in space operations. This will be achieved by modeling human control capabilities, applying this knowledge to both direct and supervisory interfaces and by empowering the EVA astronaut as a capable robot supervisor. It is hoped that this will lead to improved planning and execution of space operations in the future.



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