Astronaut Procedure Tracking

Ames Research Center

Human-Computer Interaction Group

This project is in cooperation with NASA Ames Research Center, Moffett Field CA. Within NASA Ames, this team will work with the Human Computer Interaction (HCI) Group that specializes in researching, designing and developing software for spaceflight operations and analog missions.

Project Description

Problem Statement

Astronauts onboard the International Space Station (ISS) currently follow detailed step-by-step instructions (or procedures). Procedures are often difficult to follow -- there are many complicated steps, insufficient details, and training for the task which occurred many months previously. However, astronauts are able to call back to ground personnel for assistance -- they can ask questions and show videos of their ongoing work to the ground support, who in turn has access to a team of experts for the task. In future exploration missions, astronauts will have to work more autonomously from ground personnel. On the way to and on Mars, the communication between Earth and spaceships is restricted (due to distance and bandwidth limitations). They will have to complete their assigned tasks without continuous assistance from the experts on Earth.

Project Objective

The HCI Group would like to investigate methods of supporting astronauts as they perform and complete tasks more autonomously from Earth. In order to do this, we first need to be able to track an astronaut's progress as they complete procedures, identifying when they complete steps, if the steps are completed correctly, and if they have deviated from the procedure. Being able to do this would then allow us to determine which appropriate interventions would best be suited to helping astronauts complete their task.

There are many possible procedures that could be analyzed. For this project, we will investigate an intravehicular activity (IVA) procedure. These procedures include tasks such as: assembling hardware, completing scientific experiments, conducting maintenance, taking pictures, and using hand-held instruments to take measurements. On the ISS, many of these tasks are completed while the astronauts are in view of video cameras, providing ground support with direct views of their progress.

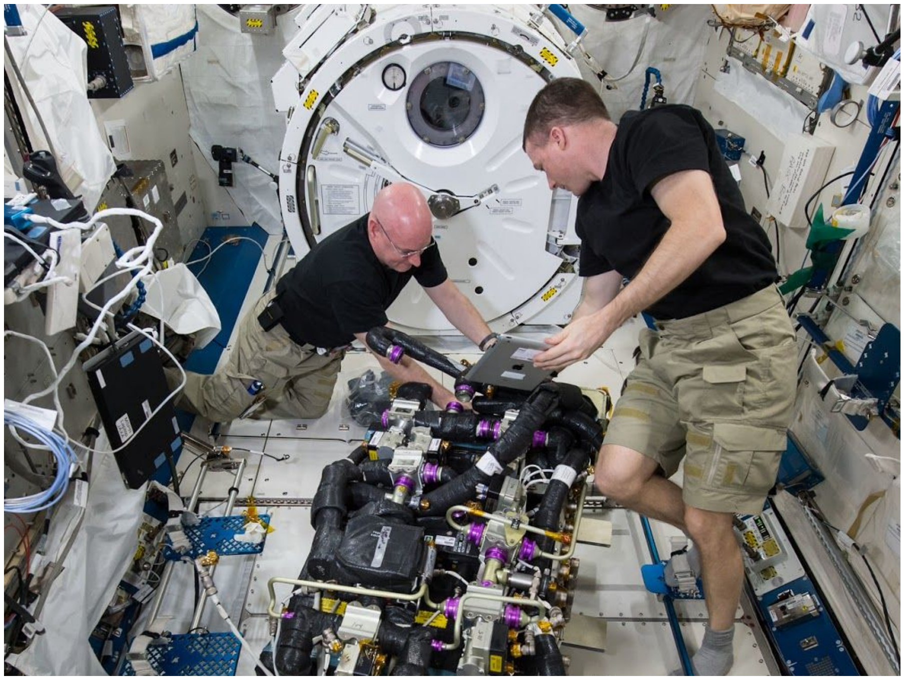

Figure 1: NASA astronauts Scott Kelly (left) and Terry Virts (right) work on a Carbon Dioxide Removal Assembly inside the station's Japanese Experiment Module. Virts is holding an iPad which contains procedures that Kelly is following to complete the complex maintenance task.

Figure 2: Photos from British astronaut Tim Peake, taken while training for a late-2015 mission to the International Space Station. This photo set shows off an Earth-copy training set of one of the tool boxes in use aboard the International Space Station.

Example Snippet of Procedure

There are many different IVA activities, and examples of NASA ISS procedures can be seen here. A snippet of such a procedure is:

1. Remove nut securing Blind Gland to Hatch Plate Assembly (dome side) (Ratchet, 3/8" Drive; 7/16" Socket).

    Temporarily stow.

2. Translate to rib side.
3. Place piece of tape on Hatch under "TEST" to mark alignment for replacement window.
4. Remove fasteners (two) securing indicator assembly (Ratchet, 3/8" Drive; 5/32" Hex Head).

    Temporarily stow.

Once the project commences, the team will work with NASA mentors to create a procedure that is akin to a NASA IVA task but also reasonable in length for capstone demonstration. Examples of analog spaceflight tasks which may be considered are bicycle maintenance, electric generator interior inspection, and desktop computer assembly.

Proposed Solution

Through the use of real-time video analysis and sensor information integration, the team will create a system that will track which step the astronauts are working on and their current progress within the step. The solution must use video analysis of the camera feeds and can augment that information through the use of a network of sensors (IoT, Internet of Things), instrumenting the tools and suit of the astronaut. The team will be expected to demonstrate the system as they simulate their own maintenance task.

Constraints:

- Able to operate with low power and limited bandwidth
- No access to "cloud" resources

Example tools:

- Allen wrenches (hex keys)
- Wrenches and/or a ratchet with sockets
- Needle nose pliers
- Flat-head and Phillips screwdrivers
- Adjustable wrench
- Camera
- Storage bags

NASA Mentors

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