2020 Wearable Technologies Workshop Challenge Request

Challenge Title: Human-Suit Interaction Measurement

Organization Name: NASA Johnson Space Center

Team Assignments Available: 3

Summary of the Challenge and Team Project

Background:

The Digital Astronaut Simulation group at JSC routinely uses motion capture to obtain data to drive human biomechanics models. Partnered with the Anthropometry and Biomechanics Facility, they are working to assess task motions during lunar surface operations training in ground based facilities and feasibility of those motions in the lunar environment. While external space suit motion has been well-researched, very little is known about how the astronauts move and interact within the spacesuit. The space suit prevents most of the traditional evaluation techniques due to clearance and material constraints. A method is needed to determine human position relative to the spacesuit while completing tasks. Recent systems developed include a garment embedded with fabric stretch sensors that predict torso shape and posture. Full body scans paired with suit CAD models have provided knowledge of where a person can be in the suit. However, a full-body measurement system that can be used in-suit during dynamic motions has not yet been attained.

Problem statement:

Develop a solution for measuring the position of a person relative to a spacesuit during dynamic motion.

Important design considerations (These can be discussed, and possibly negotiated, in more detail after the Team has been assigned):

a) Absolute tracking of body position is desirable (for kinematic assessment). However, it is most important to know where the body is in contact with the suit and to what extent. Suit fit varies across the body.
b) Wearable elements should be low profile and minimally affect the outcome measure.
c) The system should maintain accuracy for an extended duration and number of tasks (e.g., not subject to drift). Measurement accuracy should not be significantly affected by temperature, humidity, and pressure variations from operation inside a suit.
d) The solution should work for or be re-configurable for persons of different sizes and not restrict movement.
e) Flammability and other risks must be considered, addressed, and assessed.

f) Design of any connections and overall assembly should be robust and resistant to pulling, friction, and impact as a user enters and operates in a suit.
g) The solution could be combined with external suit measurements and computational modeling if needed.

What funding and/or resources can be provided to each Team? (The details of the payment arrangements must be negotiated with the Team.)

No funding will be available, but resources for testing will be available at the Johnson Space Center in Houston, TX. Informational resources will be available as well.

Deliverables (the final product you expect the Team to provide – such as a report, garment, user evaluation, …):

1. Functional prototype(s)
2. Any software provided as Free and Open Source (FOS)
3. Documentation describing the concept, approach, design, safety assessments, users guide, lessons learned, recommendations, and test catalog
4. Any relevant CAD files, bill of materials, and other items teams would like to provide

How will the results be used?

Functional prototypes will be tested in relevant environments to assess their applicability to current projects. Prototypes which can accurately track body motion and/or measure contact with external items (e.g., suits & harnesses) are expected to be of immediate value to the Digital Astronaut Simulation and Anthropometry & Biomechanics Facility teams. All results will benefit the development of future technologies and approaches that support success and safety of future missions.

What deliverables (if any) do you want transferred to you at the end of the project?

Any or all of the above deliverables.