Technology Collaboration Center
Collaboration Request

REQUEST SUMMARY

Collaboration Request ID: EXW

Collaboration Request Title: Exercise Wearables

Requesting Organization: NASA Johnson Space Center

All questions on this request are to be:

- Submitted via e-mail to Collaborations@techcollaboration.center

Any organizations interested in participating in this collaboration are to submit a proposal using the Collaboration Response form from techcollaboration.center, the Technology Collaboration Center's (TCC) website. Responses will be forwarded to the Requesting Organization for consideration

DETAILS – NON-CONFIDENTIAL

Potential Commercial Applications: exercise and fitness, medical, sport specific training like golf, animation and film industry, Department of Defense (DoD), NASA, Biomechanics, and others

Keywords: force shoes, wearable human motion sensors, kinematics, kinetics, heart rate, body temperature, tissue oxygen saturation

Purpose: NASA JSC seeks to understand exercise forces, motions, and performance aboard the International Space Station (ISS). Knowledge of the forces and motions permits calculation of joint and muscle forces during microgravity exercise on orbit. Traditional video-based motion capture is limited on ISS by the number of available cameras and the tight space available to position the cameras. A wearable system gets around these constraints. Additionally, there is considerable need to monitor and record astronauts' biometric data (i.e. exercise intensity, energy expenditure, tissue oxygen saturation, body temperature) during daily exercise sessions and EVA or other mission critical activities. Historically, biometric medical data collected during exercise or in a spacesuit is limited to heart rate and is prone to motion artifact and poor quality. Additional and improved biometric assessments would enhance astronaut health monitoring capabilities.

Technology:

- FORCE SHOES: We have developed custom shoes that measure the forces and moments that occur under the heel and forefoot during exercise. Inertial Measurement Units (IMU) are also included in the shoes to measure linear accelerations and rotation rates of the heel and toe.
- MVN BIOMECH SUIT: This suit consists of an array of small, lightweight IMUs on each limb segment. When worn by the exerciser it permits the calculation of the 3-dimensional kinematics of each limb segment.
- EARBUD SENSOR: We have worked with an industry partner to develop and improve biometric data collection capabilities including heart rate monitoring, tympanic temperature, and tissue oxygen saturation measurement capabilities.

R&D Status: NASA JSC possesses unique capabilities for maturing these technologies for remotely assessing the quality of exercise countermeasures aboard the ISS. Force shoes have been flown and assessed aboard the ISS. Wearable kinematics systems are still being researched on the ground. Improved biometric monitoring capabilities are ready to begin flight certification processes with an open ended design for continual improvement and monitoring options.

Intellectual Property (IP): This Partner relationship may produce new IP that could be jointly owned by NASA and the partner or may become the property of the partner.

Needs & Challenges: A unique challenge for an IMU on ISS is that there is no gravity vector available to determine the orientation of the sensors and therefore the exerciser. It is also unclear how the magnetometer would function, and whether it would be of use in determining sensor orientation. Collecting biometric data on astronauts' presents a unique challenge as the space environment and spacesuit are prone to signal interference and often inability to adjust the hardware once it is place on the body. Additionally, during future exploration missions, astronauts will need real time autonomous monitoring that will require the development or modification of algorithms to provide information needed to make mission critical decision.