Juxtopia® CAMMRAD Space Challenge, a STEM Entrepreneurship Game for Advancing Cooperative Human Robot Interactions for Space Environments

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ABSTRACT

Future long duration human spaceflight missions will place human crew at large distances and light-time delays from Earth where crew help or requests may take up to months to address depending on the spacecraft's distance from Earth. Additionally, human complex tasks, which are currently assisted by Earth based Mission Control, will require minimal support from Mission control. Hence, information may not readily available; difficult to find; or presented in the wrong format to human crew members. Consequently, there is increased risk of human-system errors, frustration, and inefficiencies, which can ultimately impact crew safety and well-being.

The International Space Station (ISS), a National Lab, is a testing ground for eventual long duration missions where astronauts currently complete science tasks by flipping through paper manuals that present predefined methods of how to complete tasks (i.e., science, maintenance, medical, etc.) in a microgravity environment. While astronauts perform tasks, unexpected maintenance issues, problems, and failures are frequent occurrences that require accurate, complete and quick "fixes" by crew members. With the advancement of robot system, their value will potentially assist astronauts for ISS and during long term space missions to MARS and beyond; to assist crew with construction, maintenance, and experimental tasks. For example, Astrobee is an important step in freeing up research time by leaving the free-flyer to perform mundane chores. Astrobee can cruise the ISS to continually taking inventory of tools and equipment instead of requiring astronauts to spend their time doing this by hand. Astrobee can also monitor environmental conditions such as air quality or sound levels, which can get very loud on the ISS, again freeing up the astronauts' time while keeping them healthy.

Based on Juxtopia's preliminary research on wearable augmented reality (AR) and artificial intelligent assistant systems [1-11], Juxtopia secured a *Center for the Advancement of Science in Space (CASIS)* grant award to demonstrate the capabilities of the *Juxtopia® Context-Aware Mobile Mixed Assistive Device (CAMMRAD)* as a tool to provide on-demand assistance & instruction to astronauts while they maximize their performance on tasks onboard ISS.

Juxtopia expanded its platform to create the Juxtopia® CAMMRAD Space challenge to develop and investigate an innovative STEM intervention, as a competitive game, designed to motivate underrepresented minority middle and high school students to develop cooperative human/robot prototypes that may benefit humans during ISS exploration missions with similar benefits to human that perform tasks in austere and extreme environments on Earth. During the game students improve their proficiency in computer programming, electronics and CAD design.

In the Juxtopia® CAMMRAD Challenge, students are required to collaborate with other team members to advance the Juxtopia® CAMMRAD Space game platform. The Juxtopia® CAMMRAD platform comprises 1.) An optical see-through wearable AR Visor; and 2.) CAMMRAD Software designed to improve astronaut skill proficiency (i.e., improved accuracy and decreased time) while completing ISS National Lab activities (e.g., research experiments). Each student team will be evaluated on its capability to demonstrate the Juxtopia® CAMMRAD tailored to astronaut needs, and will include: (1) On-demand "how-to" multimedia instructions displayed on the CAMMRAD Visor; and (2) On-demand-documentation of procedures, performed in collaboration with robot systems.

Juxtopia hypothesizes that if the Juxtopia® CAMMRAD Space Challenge provides a fun engineering competition, significant numbers of "hard–to-reach" underrepresented minorities in STEM will be motivated to solve real-world problems on ISS by applying classroom learned algebra, computer

programming, and electronics concepts to complete robot and augmented reality challenges using classroom learned skills.

The Juxtopia® CAMMRAD Space challenge also has the potential to facilitate a collaboration among students to continuously improve the Juxtopia® wearable augmented reality (AR) technology for various commercial efforts by evaluating its capability to improve human tasks performance in challenging environment similar to the ISS such as humanitarian relieve personnel and first responders. Hence, results of the ISS demonstration may be used to extend Juxtopia® CAMMRAD to improve human performance on a variety of task both in Space and on Earth including, but not limited to ISS payload assembly/maintenance, medical, and science related tasks.

Principal Investigator of this project and presenter, Dr. Jayfus Tucker Doswell, is founder, president, and CEO of Juxtopia, LLC with over 15 years of experience developing augmented reality and virtual reality hardware/software systems for improving human performance®. Juxtopia is a Baltimore, Maryland Biomedical and Information Technology (BIO-IT) company with a mission of *Improving Human Performance®*.

REFERENCES
1. Azimi, E., Doswell, J., Kazanzides, P., (2012), "Augmented Reality Goggles with an Integrated Tracking System for Navigation in Neurosurgery". IEEE Virtual Reality Conference. Orange County, California.
2. Doswell, J. "Pedagogical Embodied Conversational Agents" IEEE International Conference on Advanced Learning Technologies, Joensuu, Finland, August, 2004
3. Doswell, J. T. "Building The Virtual Reality Instructor," *SIGGRAPH Conference* in Los Angeles, California, 2004.
4. Doswell, J.T., "Augmented-Reality Systems for Treating Drug Dependency." Special Issue on Wearable Computing: Works in Progress. *IEEE Pervasive Computing*, 2002.
5. Doswell, J., (2006), "Context-Aware Mobile Augmented Reality Architecture for Lifelong Learning". 6th IEEE International Conference on Advanced Learning Technologies. Theme: *Advanced Technologies for Life-Long Learning*. Kerkrade, The Netherlands.
6. Doswell, J., Blake, M.B., Green, J., Mallory, O., Griffin, C. "Augmented Reality Learning Games: 3D Virtual Instructors in Augmented Reality Environments". ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games. Electronic Arts Redwood City campus. 2006.
7. Doswell, J., Context-Aware Augmented Reality System for Medical First Responders. *Proc. In the XII Symposium on Virtual and Augmented Reality*, Rio Grande do Norte, Brazil. 2010.
8. Doswell, J., Sampson, O., Jeffrey, M. WASA MIST Wearable Assistant for Real-Time Emergency Care Providers. *The 15th Annual International Meeting of the American Telemedicine Association*, San Antonio, TX. 2010.
9. Doswell, J., Wearable Telehealth for Trauma Care Delivery in Disadvantaged Populations. *138th Annual Meeting & Exposition of the American Public Health Association*. Denver, CO. 2010.
10. Doswell, J., Anderson, M., Wilson, K., Kazanzides, P., et. al., (2012), "Wearable Augmented Reality for Medical First Response & Situational Awareness". Medicine Meets Virtual Reality (MMVR19) NextGen Conference. Newport Beach, California.
11. Doswell, J., et. al., (2012), "Using Wearable Augmented Reality to Augment Skills for Public Health Providers", 140th Annual Meeting & Exposition. American Public Health Association, San Francisco, CA.