

Enabling a Voice Management System for Space Applications, Design and Software Development

Tara Vega, Catalina Garza, Chad Cerutti

Bioastronautics and Life Support Systems Lab, University of Michigan, MI 48104, USA

Fernando Figueroa and Lauren Underwood

NASA Stennis Space Center, Building 1100 Stennis, MS 39529, USA

Abstract— Sustainable missions, beyond low Earth orbit, will require autonomous capabilities in order to achieve NASA’s Artemis program objectives. Correspondingly, the crew must have a means to efficiently interact with these autonomous systems; this can be facilitated via voice and speech communications. Voice-based controls enable the user to access autonomous systems hands-free/eyes-free, allowing the user to better focus on critical tasks. The goal of this project was to explore the knowledge and technology needed to successfully design effective voice interfaces for autonomous systems. The main objective was to understand how a crew member, through voice interaction, could most efficiently and intuitively communicate with a notional autonomous vehicle system manager. This project leveraged prior research conducted by the University of Michigan’s Bioastronautics and Life Support System (BLiSS) team as part of a NASA Moon to Mars eXploration Systems and Habitation (M2M X-Hab) 2020 Academic Innovation Challenge. The X-Hab 2020 work from the BLiSS Team resulted in an intuitive graphical user interface/user experience that was built on an Internet of Things (IOT) platform. The Voice User Interface (VUI) design for the M2M X-Hab 2021 project leveraged this technology and incorporated a voice-based assistant and NASA’s Platform for Autonomous Systems (NPAS) software. This required technologies to convert voice to text, conduct semantic interpretations, and convert responses from the autonomous system to text and to speech; additionally, the background noise environment of spacecraft was assessed, and a relatable personality for the autonomous system to facilitate human-like conversations was created.

This work’s success was largely due to the diverse team that included expertise in Space Systems Engineering, Human Computer Interaction, Aerospace Engineering, Computer Science, Biomedical Engineering, and Applied Physics. The differing perspectives fostered elaborate discussions, resulting in the conception of three main interactions: (1) User-System, (2) NPAS-System, and (3) Environment-System. The system developed, i.e. the VUI, had to be unique, efficient, and intuitive; thus, the team crafted a personality for the system to enable human-like conversation. User surveys sent to students and young professionals were used to help determine these personality traits by capturing perspectives and expectations of the “Artemis Generation Astronauts”. To further simulate human-like conversations, the system had to be able to quickly interpret user speech and be able to integrate with NASA’s NPAS system for quick and reliable information transfer. Results of this research include (1) a working prototype user interface, that is compatible with NASA’s NPAS system; (2) software that demonstrates the ability to interpret user requests and respond appropriately; (3) the capability to implement fully expanded conversations between user and system using intuitive communication in four request categories; and (4) software and hardware recommendations that optimize the system’s ability to operate, i.e. be heard, in a noisy environment. The technologies chosen for this project’s demonstrations included the following: Raspberry Pi, RASA, Mozilla Deep Speech, Coqui, RTX Voice and Adobe XD. This work has laid the

foundation for the development of VUI's used for autonomy, and is intended to provide guidance for future VUI development.