VIRTUAL ASSISTANT FOR ANOMALY RESOLUTION IN LONG DURATION EXPLORATION MISSIONS: FIRST RESULTS AND PREPARATIONS FOR HERA CAMPAIGN

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ABSTRACT

This poster provides an update on the status of a 4-year research project to investigate the impact of using Virtual Assistants (VAs) to support crew members in the context of anomaly treatment during long Duration Exploration Missions (LDEM), when access to mission control may be impractical or infeasible. This project is one of seven projects funded by NASA Human Research Program (HRP) as part of the Human Capability Assessment for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR).

As we approach the half point of this project, the first prototype of the VA has been developed and is currently being integrated and tested in HERA, in preparation for the C6 campaign currently scheduled to start in April 2021. This VA, called Daphne-AT, focuses on anomalies related to the Environmental Control and Life Support System (ECLSS). It consists of a web-based front-end featuring a graphical user interface and a natural language interface, and a set of back-end services that support the user in the three main functions needed to resolve an anomaly: anomaly detection, diagnosis, and determination of a course of action [1]. The VA receives a telemetry feed from the HERA Habitat Simulation System. In addition to this telemetry feed, the main source of data used by the VA to respond to all user queries is a knowledge graph developed primarily from procedures used in HERA campaigns. Featuring several hundreds of nodes and relations, the knowledge graph currently contains information about three main types of entities (components of the HERA ECLSS subsystems, anomalies related to those components, and procedures used to resolve those anomalies), and relations between those types of entities.

In addition, the poster will report the first results of a small pilot study conducted in our laboratory at Texas A&M University. We have developed 18 anomaly scenarios in which one or more components fail. To be able to provide a meaningful experience in the laboratory in terms of resolving the anomalies, we developed an interactive and immersive simulated environment of the HERA habitat that allows subjects to manipulate similar components to the hardware in HERA. The first VA prototype and simulator were used in a pilot study with five subjects. Subjects were provided a 2-hour virtual training session and they were guided through an example anomaly scenario. After the training, subjects participated in two in-person experiment sessions: one with Daphne-AT and the other one without Daphne-AT (counterbalanced within-subjects design). In each session, the subjects solved four anomalies. After the experiment, the subjects completed a set of surveys. Dependent variables measured include performance, cognitive workload, situational awareness, and trust in the context of ECLSS anomaly treatment, with and without the use of a VA. Preliminary results suggest that the use of Daphne-AT increases the number of anomalies successfully resolved and decreases cognitive workload during the anomaly treatment process.

The current prototype has all the basic functionality needed to support the three main tasks in anomaly treatment (detection, diagnosis, resolution) including a fully functioning question answering system, but is still relatively unsophisticated in the algorithms used to detect and diagnose anomalies, the modes of interaction supported and the kinds of explanations provided. The poster will also describe our work plan for the next two years, in which we will address those shortcomings and perform additional laboratory experiments with the goal of developing standards and guidelines that can help NASA develop similar AI agents in the future.

REFERENCES

[1] P. Dutta et al., “Virtual Assistant for Anomaly Treatment in Long Duration Exploration Missions,” in 2020 AIAA SciTech Forum, 2020.