VIRTUAL ASSISTANT FOR ANOMALY RESOLUTION IN LONG DURATION EXPLORATION MISSIONS: BASELINE EFFECTS ON PERFORMANCE, COGNITIVE WORKLOAD, AND SITUATIONAL AWARENESS

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This abstract 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 HRP as part of the Human Capability Assessment for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR).

Over the first two and a half years of this project, a "baseline" version of a VA called Daphne-AT has been developed and tested in both a laboratory environment at Texas A&M University and in the Human Exploration Research Analog (HERA) facility. Daphne-AT is designed to support astronauts in the detection, diagnosis, and resolution of 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 its three main functions of anomaly treatment: detection, diagnosis, and resolution [1]. The VA receives a real-time telemetry feed from the HERA Habitat Simulation System. In addition to this telemetry feed, Daphne-AT has access to a knowledge graph that is the basis of most of its answers and recommendations. Featuring several hundreds of nodes and relations obtained largely from procedures used in HERA campaigns, the knowledge graph currently contains information about three main types of entities (components of the HERA ECLSS subsystem, anomalies related to those components, and procedures used to resolve those anomalies), and relations between those types of entities.

In this talk/poster, we will discuss the results obtained in the first mission of the HERA C6 campaign, which ran from October to December 2021. Our study ran in two phases. In phase 1, each of the 4 crewmembers worked individually on 6 anomaly scenarios in HERA, 3 with Daphne-AT and three without Daphne-AT. In phase 2, the crew worked as a group on 6 more complex scenarios, again 3 with Daphne-AT and 3 without Daphne-AT. In all cases, performance was measured by the extent to which the anomaly scenario was satisfactorily resolved and the time it took the crewmember to resolve it. Cognitive workload, situational awareness, and trust in automation were measured using standard post-experiment surveys.

We will also provide an overview of the results obtained so far in our laboratory experiments [2], where a first-person 3D simulator of the HERA habitat [3] is used in lieu of HERA. All results so far show significant improvements in performance, cognitive workload, and situational awareness when using Daphne-AT vs not using it.

Finally, we will report on our progress to develop a more advanced version of the Daphne-AT assistant, and outline our plans for the last year of this project, in which we intend to conduct two additional laboratory experiments with the new version of Daphne-AT. These two studies will focus on the effects of providing explanations and taking initiative in the interaction on performance and trust.

Ultimately, this work seeks to identify standards and guidelines that can help NASA develop similar AI agents in the future. This research effort is supported by the NASA Human Research Program, Grant number 80NSSC19K0656.

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