VIRTUAL ASSISTANTS FOR ANOMALY TREATMENT– LESSONS LEARNED AND PATH FORWARD

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Virtual Assistants (VA) have been proposed to increase situational awareness and reduce cognitive workload during critical tasks. Responding to urgent spacecraft anomalies during Long Duration Exploration Missions (LDEM), when there is no immediate access to mission control, is an excellent example of this use case. While human-agent interaction has been studied in some relevant tasks, the mechanisms by which a user's trust, cognitive workload, and performance increase or decrease are not fully understood and need to be explored if we are to use this technology in future missions.

To study these challenges, a "baseline" version of a virtual assistant called Daphne-AT was developed. Daphne-AT is designed to assist crewmembers in treating in-flight anomalies related to the Environment Control and Life Support System (ECLSS) during LDEM. So far, two studies have been conducted with the baseline version of Daphne-AT [1]; one in the lab [2-3] at Texas A&M University and another one as part of the NASA Human Exploration Research Analog (HERA) C6 campaign. This poster discusses some of the challenges encountered during these two studies related to the human-agent interaction and describe our work and upcoming studies designed to address the challenges encountered.

One of the most defining aspects of standard virtual assistants is their natural language (NL) interface. In this poster, we will describe our implementation of a NL interface in the Daphne-AT assistant and discuss some of the major operational hurdles we faced when testing this interface in HERA. Ultimately, these hurdles led us to abandon this NL interface for the C6 campaign. Early testing at HERA led to the identification of new requirements such as hands-free communication with the agent while handling hardware, and a wake word to trigger the communication with the VA. In addition, the performance of the speech-to-text system decreased significantly when moving from the lab to HERA, likely due to echo inside the habitat. An ad-hoc dictionary of homophones (e.g., "two", "to", and "too") had to be added to a natural language processing system to account for the differences in the frequency of common terms with respect to other contexts and use cases.

Another aspect limiting the study of human-agent interaction in this context is that the baseline version of Daphne-AT is completely reactive and cannot take into account input information provided by the user, such as observations that could help with the diagnosis. We are currently developing a more sophisticated version of Daphne-AT that supports a more interactive diagnosis process where the crewmember and Daphne-AT could engage in an iterative hypothesis-testing process to identify the root cause of an anomaly via experimentation. For example, if the signature of an anomaly is compatible with two competing root causes (e.g., a clogged filter vs a malfunctioning sensor), Daphne-AT would ask the user to inspect the filter visually to provide additional evidence not present in the telemetry feed. It could then fuse this evidence with the data-driven evidence and provide an updated diagnosis. Over the next year, we plan on conducting two experiments to study the changes observed when using this new version of Daphne-AT with respect to the baseline in terms of performance, cognitive workload, situational awareness and trust. Specifically, we plan to quantify how these measures are affected when implementing various aspects in the virtual assistant, such as providing explanations of the answers provided by the agent, taking initiative in the dialogue, or fusing crew-provided information to offer better diagnoses. This research effort is supported by the NASA Human Research Program, Grant number 80NSSC19K0656.

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