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# TOWARDS A RELIABLE OFFLINE PERSONAL AI ASSISTANT FOR LONG DURATION SPACEFLIGHT

**Abstract**

Future crewed missions to the Moon and Mars will have to contend with significant bandwidth and latency limitations, resulting in restricted ground support delivery and a lack of direct supervision. In search of a solution, AI-based personal assistants are gaining increasing attention for their ability to provide astronauts with contextually relevant information in real-time. Notably, experimental deployments of the Crew Interactive MObile companion (CIMON) aboard the International Space Station (ISS) have yielded promising results by providing astronauts AI supported access to procedures and manuals. Yet current solutions lack flexibility.

Recent advancements in the domain of generative-pre-trained-transformers (GPT) show that AI tools leveraging large language models (LLMs) are capable of engaging in human-like conversations and addressing complex questions across a broad range of topics. However, models, such as GPT-4, rely solely on their training data and an online connection. Consequently, their responses to questions not covered in the training data may lack factual accuracy, a factor that is especially critical in the safety context of future space missions.

To bridge this gap, we propose utilizing knowledge graphs (KG's) as explicit knowledge representations validated to contain only accurate information, which can be accessed and edited via offline available GPT models like Mixtral-8x7b using retrieval-augmented-generation (RAG). This approach aims to address the issue of incorrect or false information associated with GPT models.

Whilst KG's structure data into graph-like formats, they can generally not be queried directly using natural language. Instead, GPT models are necessary for facilitating natural interaction between the data and astronauts.

Additionally, we propose the use of Augmented Reality (AR) cues, which allow computer-generated

data to be superimposed on real objects in the environment. Consequently, information can be displayed in an intuitive manner through the use of Head-up Display (HUD) technology. This enables images, procedures, audio, and 3D files stored in the Knowledge Graph (KG) to be seamlessly interlinked and displayed. Reflecting on these advantages, this paper proposes a novel offline available system based on space- KGs that can be accessed and edited via a GPT model using RAG in combination with AR technology to overcome the drawbacks of currently available systems. By identifying key technical challenges and proposing potential solutions, we lay the groundwork for AI-based personal assistants designed to support astronauts during long-duration missions. Finally, we outline future work and additional applications, including employing the technology for Eurocom- and mission control support.