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ECHOFINDER: AN AUTONOMOUS ULTRASOUND ACQUISITION PROTOCOL FOR HUMAN SPACEFLIGHT APPLICATION

Abstract

Ultrasonography can be used for about two-thirds of a list of 500 medical conditions that might occur on a spacecraft. To this day, it is the only imaging modality for the medical monitoring of astronauts. Indeed, this device is non-invasive, low-cost and allows to acquire real-time images without ionizing radiations. On board the ISS, tele-operated ultrasound sessions enable physicians to monitor, from ground, the evolution of the human body through extended microgravity exposure. As the space exploration will guide us further away from Earth, to the Moon, Mars and beyond, delays will affect real time interactions and tele-operated systems will no longer be an option. As astronauts cannot be trained to reach the level of competency of a professional sonographer, it is essential to offer them a system to perform ultrasound in complete autonomy without any background in ultrasonography.

Our protocol suggests an innovative solution based on augmented reality visualization of the acoustic window and real-time detection of the long or short axis view of any organ. Before flight, the EchoFinder software enables an expert sonographer to save the perfect 3D position and orientation of the ultrasound probe for a specific view of the organ. In-flight, an astronaut is able to retrieve the probe's position registered preflight thanks to an augmented reality visualization on the subject body. This position is then refined thanks to organ detection algorithms, which are able to guide the operator with precise adjustments to acquire the best organ view. Finally, data are sent to the ground for a future expert evaluation and diagnosis.

The system has been tested on ground with 10 novice healthy volunteers on 8 different organs. In 95% of the cases, the novice users were able, in complete autonomy, to locate the probe on top of the acoustic window and to get the perfect image of the organ in 85% of the cases. The Echofinder system will be used during an analog ground MARS mission and during a parabolic flight campaign. This tool will allow a reliable ultrasound medical surveillance during long distance space trip with no realtime link with earth. On the long run, its usage may be extended to isolated areas and medical deserts that cannot benefit from the precious tool that is ultrasonography.