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Title: Comparison of On-Orbit Manual Attitude Control Methods for Non-Docking Spacecraft Through Virtual Reality Simulation

Abstract: On-orbit manual attitude control of manned spacecraft is accomplished using external visual references and some method of three axis attitude control. All past, present, and developmental spacecraft feature the capability to manually control attitude for de-orbit. National Aeronautics and Space Administration (NASA) spacecraft permit an aircraft windshield type “front view”, wherein an arc of the Earth’s horizon is visible to the crew in de-orbit attitude. Russian and Chinese spacecraft permit the crew a “bottom view” wherein the entire circular Earth horizon disk is visible to the crew in de-orbit attitude. Our study compared these two types of external views for efficiency in achievement of de-orbit attitude. We used a Unity Virtual Reality (VR) spacecraft simulator that we built in house. The task was to accurately achieve de-orbit attitude while in a 400 km circular orbit. Six military test pilots and six civilians with gaming experience flew the task using two methods of visual reference. Comparison was based on time taken, fuel consumed, cognitive workload assessment and user preference. We used ocular parameters, EEG, NASA TLX and IBM SUS to quantify our result s. Our study found that the bottom view was easier to operate for manual de-orbit task. In a second study we compared three different devices to control attitude - a 3-DoF Flight stick, physical buttons and virtual buttons with haptic feedback. While the flight stick was fastest in terms of de-orbiting, physical buttons were most economical in terms of fuel consumption. Additionally, we realized that a VR based system can work as a training simulator for manual on-orbit flight path control tasks by astronauts (both pilots and non-pilots). Results from our study can be used for design of manual on-orbit attitude control of present and future spacecrafts.

Press coverages: https://timesofindia.indiatimes.com/city/bengaluru/study-finds-bottom-view-faster-and-easier-for-manual-spacecraft-operations/articleshow/112053345.cms

https://www.wionews.com/science/us-or-russian-spacecraft-which-is-user-friendly-indian-astronauts-research-study-gives-details-747329