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AUTONOMOUS GUIDANCE NAVIGATION AND CONTROL (GN&C) FOR CREWED MISSIONS: ADAPTING NASA'S ROBOTIC PROGRAM'S GN&C CAPABILITIES FOR EXPLORATION

Abstract

On July 4, 2005, the Deep Impact spacecraft-Impactor probe was guided to a collision with the nucleus of the Tempel-1 comet, using an autonomous onboard navigation system, called "AutoNav." AutoNav had previously taken the first detailed images of comet nuclei, of comets Borrelli and Wilt-2 on the Deep Space 1 and Stardust missions. In ensuing years, images of comet Hartley and more images of Tempel 1 (post-impact) were successfully obtained with the same system. As NASA's only deep space autonomous navigation and guidance system, it is sensible to utilize AutoNav's deep space flight-proven capabilities for future crewed Exploration missions, since automated and autonomous onboard GNC functions will be essential for long duration deep-space crewed flight, especially in the event of communication degradation. The prime requirement for such an application will be to provide the crew with reasonable means to monitor, adjust and – if needs be – completely reconfigure the system. A first step toward a crew interface design has already been taken with the rebuilding of the AutoNav Executive. This approach is intended to be multi-mission capable, yet adaptable to diverse missions with very little modification, enabling major changes in behavior through minor parameter updates, or through very small changes in the composite sequence blocks (as opposed to software changes). This characteristic lends itself to a high level of ease-of-access to a hypothetical crew member wishing to operate the onboard navigator. This paper will describe the AutoNav system, and its previous successful uses. The overall architecture of the system will be presented, especially the Executive function where the core of the human/robotic interface will reside, including a preliminary approach to that interface design. Finally, the previous mission uses of AutoNav will be reviewed, and the lessons-learned will be shared in the context of a hypothetical crewed version of these three multiple-flyby missions, and the resulting ramifications to the design of the Exploration version of Autonav will be presented.