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WIDE-FIELD-INTEGRATION OF OPTIC FLOW FOR REALISTIC ESTIMATION SYSTEM FOR SPACE PROBES

Abstract

This study discusses the condition of Wide-Field-Integration (WFI) of optic flow to make it as a realistic guidance and navigation system for space probes. WFI of optic flow is a bio-inspired navigation system mimicking visual processing system of flying insects using their compound eyes. The basic idea has been first developed by Humbert in 2005. By integrating optic flow obtained over a wide range on image surface, estimated states are very robust for unknown environments. Furthermore, the method has the following important features: computational load is low, and a small-size light-weight low-resolution image sensor is applicable. Thus, the method is suitable for autonomous space probes.

In spite of the prominent features, the WFI of optic flow is hardly considered as a realistic guidance and navigation method for space probes. The main reason comes from the gaps between ideal conditions in the estimation theory and real hardware systems. In the theory, a spherical image surface is supposed around the vehicle's mass center, and it is assumed that optic flow can be obtained by photo receptors placed in the whole area of the spherical surface. However, in a real system, photo receptors are replaced by pixels on a flat image surface of a camera, and the camera's field of view is restricted. Thus, the states of space probes must be estimated from optic flow obtained in a restricted range including model error, and the restricted range changes the attitude of the space probe. This presentation first discusses the effect of the optic flow range on the estimation performance in numerical simulations, considering the space probe's motion (level flight, descending motion). Then, the effects of a real camera system, i.e. the number of optic flow and the frame rates, are also evaluated. Finally, this presentation reports the effects described above by using an experimental system.