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Author: Mr. Francisco García-de-Quirós
EMXYS (Embedded Instruments and Systems S.L), Spain, fgarciaq@emxys.com

Prof. Gianmarco Radice
University of Glasgow, United Kingdom, Gianmarco.Radice@glasgow.ac.uk
Dr. Jose Antonio Carrasco
EMXYS (Embedded Instruments and Systems S.L), Spain, joseacarrasco@emxys.com

A RADIO-FREQUENCY BASED NAVIGATION METHOD FOR COOPERATIVE ROBOTIC COMMUNITIES IN SURFACE EXPLORATION.

Abstract

When considering small robots working in a cooperative community for Moon surface exploration, navigation and inter-nodes communication aspects become a critical issue for the success in a real mission scenario. For this paradigm to succeed, it is necessary however to deploy the required infrastructure for the robotic community to achieve efficient self-location as well as relative positioning and communications between nodes.

In this paper, an exploration mission concept in which two cooperative robotic systems co-exist is presented. This paradigm hinges on a community of robots that provide support in terms of communication and navigation to second robotic community that is devoted to the exploration goals. The work focuses on the role of the robotic community dedicated to the support and, more specifically, on the aspects concerning the positioning and navigation methods implemented in RF microwave bands, which are combined with the communication services.

An analysis of the different methods for range and position calculation are presented, as well as the main limiting factors for precision and resolution, such as phase and frequency noise in RF reference carriers and drift mechanisms such as thermal drift and Random Walk. The effect of carrier frequency instability due to phase noise is categorized in different contributing bands, and the impact of these spectrum regions are considered both in the absolute position and in the relative speed. Furthermore, considerations about Kalman filter techniques used to obtain position and speed from phase difference among transmission and reception carriers and Doppler frequency shift measurement are also presented.

An scenario of use for this concept is proposed and key metrics in terms of mass and power consumption of the required payload hardware are also assessed. For this purpose, an application case involving a RF communication network in C Band is described, in coexistence with a communications network used for the single robots both to communicate within the community and with the support system.