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Author: Mr. Yuichiro Nada
University of Tokyo, Japan

Mr. Masahiro Fujita
University of Tokyo, Japan
Dr. Yuki Takao
Japan Aerospace Exploration Agency (JAXA), Japan
Dr. Ahmed Kiyoshi Sugihara
Japan Aerospace Exploration Agency (JAXA), Japan
Dr. Junichiro Kawaguchi
ISAS/JAXA, Japan

NOVEL COMMUNICATION METHODOLOGY FOR RADIO INTERFEROMETER SYSTEM WITH FREE-TO-JOIN-AND-LEAVE SPACECRAFTS

Abstract

This study presents a novel communication methodology for radio interferometer systems with multiple spacecrafts that can freely join and leave such system.

Conventional interferometer systems with multiple spacecrafts need both a precise control and measurement of relative distances between spacecrafts, which are basically unknown. This is a major factor that hinders the realization of the interferometer systems.

In our novel methodology, we introduce duplication of signal propagation line and phase cancellation by mixing processing on the signal aggregation point, such as a parent spacecraft or the ground station. The duplication of the signal propagation line is achieved by utilizing two signals, the target one to be observed by the system and the one emitted from the same direction as the observation target, respectively. Each spacecraft relays both signals individually and a parent spacecraft or the ground station on the aggregation point accumulates all signals and conducts the phase cancellation individually. Our methodology removes the uncertainty of relative distances between a distributed spacecraft and the signal aggregation point, the uncertainty of distances between a distributed spacecraft and the observation target, and the phase error caused by the differences in the initial phase of the local oscillator on a distributed spacecraft. Therefore, the system does not require precise control nor measurement of relative distances between spacecrafts that reduce the feasibility and availability of the conventional interferometer systems.

Also, we conduct signal processing experiments with wave propagation to verify our proposed methodology. In the experiments, we use signal processing boards equipped with a microcomputer, PLL IC, DDS IC, and FPGA. We confirm that the proposed form of communication removes the uncertainty of relative distances between a relay point and a signal aggregation point, and the uncertainty of relative distances between a relay point and the target, which is, as mentioned above, the main feature of our methodology.

Our approach enables new interferometric observations to be conducted wirelessly in real-time with multiple spacecrafts that can freely join and leave the system. Furthermore, the system is based on independent and distributed processing, and does not require the bidirectional communication and the distribution of the reference signal. These features contribute to the simplification of each distributed spacecraft.

To sum up, we aim to propose an innovative way to break away the constraints of conventional interferometry systems. This research, then, contributes to improving the feasibility and availability of

communication and observation systems utilizing multiple spacecrafts.