IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advanced Satellite Services (4)

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INNOVATIVE SUB-MILLIMETER LEVEL RANGING AND RANGE-RATE MEASUREMENTS OVER SATELLITE-GROUND PHASE MODULATION COHERENT LASER COMMUNICATION LINK FOR TT&C AND NAVIGATION SYSTEM

Abstract

Space TT&C (Telemetry, Tracking and Command) and communication system is the only means of communication between space and earth for spacecraft from taking off to the end of life. Ranging, range-rate measurement accuracy and communication bandwidth are its principal parameters. Improving work frequency, noise-signal ratio and carrier-noise ratio is the main means for reaching higher measurement accuracy and communication rate fundamentally. However, the spaceflight TT&C system at the moment mainly works at microwave frequency and is restricted by "microwave bottleneck"; it is very difficult to further improve measurement accuracy and communication bandwidth and is even difficult to accomplish. On the contrary, laser technology becomes the key enabling technology for breaking the bottleneck of microwave TT&C and communication system and "illuminating the future of TT&C system" with its innate characteristics of big bandwidth, high energy concentration and immune ionosphere influence etc.

This paper has mainly summarized the main research progresses of laser ranging and integrated communication technology at the moment and analyzed the key technologies; on this basis, it has proposed an high-precision ranging and range-rate measurement system via a coherent laser communication system, which can upgrade the centimeter ranging accuracy of single station microwave system to submillimeter, at the same time, provide millimeter rate accuracy per second, it can realize high speed two one-way laser communication. This system adopts digital coherent laser communication system, makes step by step processing for the recovery clock in laser communication to get high accuracy ranging and rate signal at bit phase level, so that it can realize the integration of high speed communication, high accuracy ranging and range-rate measurement. For the influence of atmospheric turbulence on satellite-ground link, it has improved traditional adaptive optics systems and proposed multilayer conjugate correction technique based on bidirectional iterative full wave compensation to further improve measurement accuracy; it has also analyzed the source of main measurement errors and control methods. This system will reach 1

mm ranging accuracy, 1 mm\s range-rate accuracy at 10Gbps single channel transmission rate with 1E-9 bit error rate under the satellite-ground link; it is expected to be applied in China's next generation of navigation and relay system.