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DESIGN AND DEVELOPMENT OF SMART ARCHITECTURE FOR LUNAR BASES

Abstract

As part of the Artemis mission, NASA aims to return humans to the lunar surface and pave the way for eventually developing a sustainable lunar economy by constructing infrastructures. Given the challenging and harsh lunar environment for astronauts due to micro-meteoroid impact, solar radiation, lunar dust, and lack of atmosphere, autonomous robots play a key role in lunar construction. Effective Guidance, Navigation, and Control (GNC) of these robots will require reliable Position, Navigation, and Timing (PNT) services to assist them in construction and other lunar surface operations. However, currently, the moon lacks GPS and earth-independent terrestrial navigation systems to make construction possible on the moon. In addition, at least centimeter level accuracy is needed for the robots to perform construction operation to build stable lunar structure. LunaNET will offer an Earth-independent navigation system in lunar orbit and on lunar surface. Nevertheless, the accuracy of LunaNET has yet to be tested. Further, most lunar surface activities will happen on the lunar south poles, making it difficult for the robots to estimate the pose of the construction materials/building blocks due to poor lighting conditions and dust. In addition, these activities require heavy computing for robots to perform the tasks autonomously.

To address all these challenges, we propose SMART architecture consisting of smart sandbags, smart computing architecture and Mobile Control Towers (MCTs) to assist the robots and other lunar surface assets in performing end to end lunar construction operations. Smart sandbags embedded with sensors as building blocks form a sensor network to assist the robots in mapping the lunar surface and GNC. Smart computing unit (Tile unit) with multiple SoCs form a distributed network (tile network) to forecast, monitor, plan, and schedule the nominal and off-nominal events in the lunar surface operations. In addition, the distributed network connects with the sensor network, robots, and other surface assets to provide services such as heavy computing, health diagnosis and named few services. Mobile control towers create a Mobile Control Environment (MCE) for providing services such as illumination, communication, localization, navigation, and power for robots to do construction work. We have developed the sensor network with smart sandbags and the distributed network to assist the robots in construction small scale lunar structures such as wall, superadobe structures. We will evaluate the accuracy of pose estimating and examine the number of smart sensors and their configuration to support the robots in construction along with MCTs.