

Lunar Exploration (3)
Lunar Concepts (3)

Author: Mr. Lei Huang
BITTT, China

Ms. Danijela Ignjatovic Stupar
International Space University (ISU), France

LUNAR NAVIGATION SYSTEM DESIGN

Abstract

In recent years, "back to the moon" becomes a research hot spot. Professor Johann-Dietrich Woerner, the Director General of the European Space Agency proposes a Moon village on the far side of the Moon. Along with the Lunar manned mission planning, a Lunar navigation system is also need to be considered as well, which will be acted as a basic infrastructure for the Moon base and Moon village.

This paper is focusing on the possible exploration activities for the Lunar surface in the next one or two decades, to design a satellite constellation for communication (data relay) and positioning purpose. The constellation will be built in three steps.

The first step is for the Lunar polar area exploration, a three-satellite constellation will be built to assure the nonstop coverage for the polar area. Two methods named "single satellite frequency positioning" and "single satellite real-time frequency and ranging positioning" can be used for positioning for Lunar target (user). All the two methods need to know the velocity of the user as a precondition and could not get precise positioning result.

The second step is for the Lunar global exploration, especially for the far side of the Moon, only six satellites are used to achieve the global coverage for the Moon (including three former satellites). If high-resolution Lunar terrain map can be used by Lunar user and two-way (uplink and downlink) communication between the satellite and user can be performed to get the clock bias, the expected position accuracy could be better than 1km (1σ).

The third step is dedicated to colonization of the Moon, specifically to build the Moon base and Moon village on the Lunar surface. Unless the Moon base and village will be built near the equator area, the positioning service will be good enough for most of the use, just like GPS used on the Earth. If two-way communications can be performed with the navigation satellites to get the clock bias, the expected position accuracy will be better than 100m (1σ).

In our Lunar Navigation System, all the satellites are identical. They both have the navigation function and data relay function. So in this paper, navigation payload design and communication subsystem design are also discussed.