Research of Diversity Receive for Re-entry Telemetry System

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ABSTRACT

This Paper is based on results of radio signal propagation tests that are performed on sea and ground. Other test results also are referred. Practice of polarity diversity. space diversity and frequency diversity used for re-entry telemetry system is discussed briefly. The achieved effect and existing problems in using diversity technology is analyzed. Finally, the diversity technology is evaluated with respect to engineering.

FORE WORD

Several problems hereafter in designing channel must be solved in order to receive telemetry signal from re-entry spacecraft reliably.

1. During re-entry spacecraft flight, attitude changing and rolling causes fluctuation and fading of radio telemetry signals.

2. In the case of receiving signal from far distance and low height the multi path effect causes fluctuation and fading of radio telemetry signals.

3. Because the transmission antennas on the re-entry spacecraft are limited by size and weight, it is impossible to make direction of a antenna uniform and all-directional. It causes fluctuation and fading of telemetry signals.

4. Because it is impossible that transmission antenna on re-entry spacecraft is perfectly lineal and circular polarization. polarization loss should be considered and proper treatment should be taken in designing ground receiving.

As mentioned above diversity technology is taken in designing ground telemetry receiving. It consists of polarity diversity, space diversity and frequency diversity.

POLARITY DIVERSITY

Generally, telemetry antenna of re-entry spacecraft is lineal polarization. Right-handed and left-handed circular polarization antennas are used as receiving antenna in ground telemetry station.

The ground station is able to receive two types of radio telemetry signals that their polarizing is opposite simultaneously. Synthesis with maximum signal to noise ratio is made before decoding. About 3db improvement on signal to noise ratio should be achieved theoretical.

Improvement has been proved by transmission test [1] at sea and ground. About 2-2.5db improvement is achieved, because it is impossible to make two receiving channels same exactly and to add two signals in perfectly same phase.

Because of the effect of channel changing on signal, one signal may be bad, another may be good. In this case the good signal channel should be taken separately rather than synthesizing simply [2].

During spacecraft flights, attitude changes, right-handed and left-handed circular polarization signal strength received ground changes periodically see figure 1. 2. 3. [2]

Because the receiving antenna has been in the situation of low elevation in the case of receiving signal from far distance and low height, the signal is weaker. Polarization fading makes fluctuation of signal very observable because of the affect of multi path effect.
Using polarity diversity, effect is very observable.

Specially at sea, the more effective the sea wave, the more observable the multi path effect, therefore, taking polarization diversity is necessary.

As mentioned above, taking lineal polarization antenna and polarization diversity in the case of receiving signal from far distance low height and special channel, is very useful.

SPACE DIVERSITY

With respect to telemetry ground station, changing and fluctuation of telemetry signal strength caused by multi path effect. It makes signal weaker and blank signal severely.

This multi path effect is observable specially at sea. Sometime it fades more than 10 times. In general it fades more than 5 times [1]. In order to overcome the effect of multi path effect, space diversity is taken.

According to results of tests [1], [2], du-diversity receiving antenna is used. The improvement about 5 db is achieved.

FREQUENCIES DIVERSITY

Generally, attitude of spacecraft changes isotropic antenna is required for spacecraft in order to improvement of reliability of telemetry ground station. But it is impossible that antenna is made as isotropic antenna because several limits exist. During spacecraft flight, turning around and rolling may lead that the ground station align blind area and blanking telemetry signal severely.

In order to overcome as mentioned above, it is taken in spacecraft that a transmitter with two frequency operates simultaneously. In this way faults results from antenna pattern can be cancelled. At same direction one antenna pattern may be bad, another may be good, they trade off each other. Reliability of radio frequency system is improved.

CONCLUSION

With respect to engineering, there are three types of diversity receiving technology in design re-entry telemetry system. While each has a unique and distinct role. Selecting and using them is according to different requirement and based on important of telemetry signal.

Sometime, one type of diversity is selected, sometime three types of diversity are selected simultaneously in order to improve reliability of telemetry system.

REFERENCE

[1] Test report of Radio Telemetry signal Propagation at sea.

[2] Test Report of Radio Telemetry signal Propagation for spacial Channel.