論文内容の要旨

論文題目

A Study on Bi-static Remote Sensing using GNSS Signals to Classify Land and Sea area
測位航法衛星信号を利用したバイスタティックリモートセンシングによる水陸分類に関する研究

氏名　　辛　大允（しん　でゆん、Shin　Daeyun）

Due to an Increase in the demand of accurate positing and timing information anytime and everywhere. In the near future, GNSS constellation will increase the number of satellite to 30 or more, to monitor Asia region. These can be used as numerous signal sources for the use GNSS satellite based remote sensing applications. Bi-static remote sensing using GNSS reflections is a new application where GPS/GNSS signals are used for alternative purposes besides its main purpose of positioning, navigation and timing applications. This is good opportunity to discover novel technology in remote sensing.

The GNSS signals must be received and processed using a Bi-static configuration. This means the Transmitter and Receiver systems are not co-located, where the transmitted GNSS signal is reflected and scattered in a forward direction. Signals are transmitted over a wide area can be received with an unvarying signal receiving strength, regardless of global location.

The characteristics of reflected electromagnetic wave are affected by the object that reflects the signal. Bi-static scattering from the land is characterized by lower average return and lager variability of the signal compared to a signal from the sea surface. This takes place due to the large variations in the dielectric constant and surface roughness. In this aspect, reflection signal strength and characteristics are different between land and sea. The reflected signal characteristics are also affected by the polarization of the signal and the orientation of the antenna that receive the signal. GPS signal has right hand circular polarization. The polarization of the signal may change from right to left

handed when the signal is reflected. A right hand circular polarization antenna is used to receive the direct signal and a left hand circular polarization antenna is used to receive the reflect signal. A comparative analysis of the left hand circular polarization signal is conducted with respect to right hand circular polarization signal to compute the code phase delay and signal amplitude. The difference in signal amplitude from the two antennas and code phase values are used as base information to develop algorithms to identify the characteristics of reflecting materials. Most of the previous work has concentrated on Bi-static radar using Global Positioning system signals to remotely sense the earth`s surface characteristics, such as surface roughness and height.

Lots of research and experiments have been conducted in this field such as ground, bridge, tower, aircraft, and space based experiments. I reviewed previous research in this area, to develop suitable methods of observation and analysis. As part of the development process I analysis to two sets of data, collected from two contrasting environments. The first data, collected from the 300m tower experiment [Masters 2004]. And the second from the UK-DMC experiment [Greason 2007].

The experimental basis for this research is conducted over varied terrain using Cessna aircraft platforms around Kobe area on 21st February 2009. These data were analyzed to investigate sensitivity to earth surface roughness and statistically compared between land and ocean reflections according to results of delay waveform and delay Doppler map. Also the reflected signal with various antenna orientations have been collected from ground based experiments to investigate signal characteristics with different polarization.

In this paper, various studies to extend the application of Global Positioning System(GPS) signal reflections have been described using both ground and aircraft data sets. The estimation of soil volumetric contents and calculation of signal to noise ratio extracted from aircraft data set have been plotted, while flying around the Kobe experimental area. Furthermore, using the space signal processing system based on software GPS Receiver has been demonstrated and estimated surface reflection points, Bi-static Radar Cross Section with demodulate signal correlation function. These estimation results were visualized on the Google map in order to easily compare them the actual physical area. Also the signal processing method has been improved to identify differences of surface types between land and sea.

The methods have been demonstrated using aircraft experimental observations collected over Kobe, Japan. The results indicate that GNSS multipath signal as a surface remote sensing system, presents significant discrimination between reflected objects with surface roughness and Dielectric properties. This system can be utilized to

determine between land and sea as well as boundary of snow coverage and real-time monitoring spread at flooding and tsunami on a global scale.