Feature Extraction of GNSS Signals Based on Signal Processing Techniques for Land Deformation Detection

2021 7th International Conference on Space Science and Communication (IconSpace) | 978-1-6654-2523-0/21/$31.00 ©2021 IEEE | DOI: 10.1109/IconSpace53224.2021.9768725

Norliana Binti Khamisan
Faculty of Electrical&Electronic Eng. Technology
Universiti Malaysia Pahang, Pekan Campus, 26600
Pekan, Pahang
norlianakhamisan@gmail.com

Kamarul Hawari Bin Ghazali
Faculty of Electrical&Electronic Eng. Technology
Universiti Malaysia Pahang, Pekan Campus, 26600
Pekan, Pahang
kamarul@ump.edu.my

XU Jiang
Beijing Homcom Technology Co. Ltd., Beijing 100098,
Beijing, China
xujiang@homcom.cn

***Abstract*— The Global Navigation Satellite System (GNSS) refers to a constellation of satellites that provide position and time signals from space that allow a receiver to determine location. These GNSS signals can be used to determine the position and time of an object such as a human, a vehicle, and many other objects. Moreover, in this study, GNSS signals were used to determine the soil geophysical movement based on the signal positioning of the receiver station. A signal processing method has been applied to find the best feature extraction method for normal and abnormal signal classification. A set of GNSS signals has been acquired from a land deformation monitoring station in China that contains 3 months of the continuous GNSS signal. The signal is then processed and extracted using time series analysis and statistical approach to determine the normal and abnormality of the soil movement. There were three (3) periodic terms involved in the GNSS signal processing which velocity, distance, and acceleration. These 3 properties were used to analyze the normal and abnormality of soil movement that will be contributed to a landslide. Finally, the experimental results have proved that the feature extraction method on GNSS signal was found to be able to produce significant features to detect normal and abnormal land deformation.**

Keywords—Signal Processing, Land Deformation, GNSS Positioning, Feature Extraction

I. Introduction

Land deformation involves phenomena that are characterized by a large wavelength and local displacements characterized by a small wavelength. Likewise, the movement of the earth's crust is also one of the phenomena of land deformation. In addition, several geophysical factors consequence the land deformation of the earth's surface. Such phenomena include groundwater exploitation and nearby faults, earthquakes, precipitation data, land subsidence, and also ground fissure deformation data. Besides, topography (arrangement of the shape and features of the Earth's surface), geology (rock composition) and hydrology (distribution of water in an area), geological instabilities at different depths are also factors that include how soil movements can occur. Take an example of the causes of land deformation by groundwater exploitation. In general, underground water is an important factor in maintaining soil balance. Nevertheless, excessive exploitation of groundwater can reduce aquifer head pressure, which will destroy the initial balance and stable soil conditions. Hence, due to this groundwater overexploitation, there can cause surface degradation, soil cracks, and other environmental problems. All these causes will change their physical parameters. Fig. 1 denotes land deformation induced by landslides and groundwater exploitations.

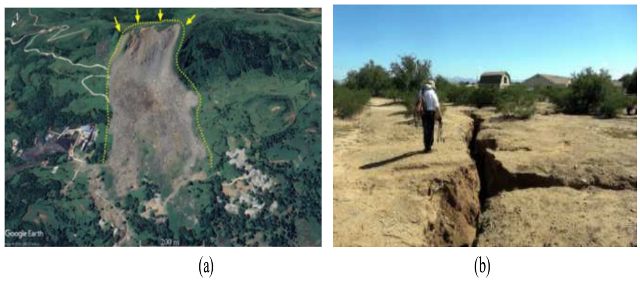

Fig. 1. Land deformation caused by (a) landslides and (b) Groundwater exploitation[1,2]

Therefore, it is essential to utilize monitoring technology to detect the position of landform changes on the earth's surface. This is to facilitate the monitoring of land conditions on earth as land subsidence has a major impact on the infrastructure, economy, and society. Nowadays, there are a few current land deformation monitoring technologies including Interferometric Synthetic Aperture Radar (InSAR) [3,4], Ground-based LiDAR[5,6], and COSMO-SkyMed Data [7,8]. Nevertheless, there are some drawbacks to these techniques. For example, the InSAR method produces various patterns and magnitudes of deformation in the resettlement zone. Thus, GNSS monitoring has been proposed as the complement based-monitoring to improve the precision of orbit determination of InSAR processing using the GNSS measurements. Besides, the InSAR method difficult to eliminate the atmospheric delay due to the temporal un-correlation feature, where the accuracy of InSAR deformation monitoring needs to be influenced by the difference of the two SAR images. By using GNSS-based monitoring, it performs the atmospheric correction in SAR interferograms, including directional considerations in the atmospheric delay. Therefore, this has motivated to apply GNSS in this research.