雙頻多星系 GNSS 地表位移監測技術應用

Monitoring of Ground Surface Displacements Using Dual-Frequency Multi-GNSS Technique

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摘要

在土地的過度開發與不當利用、水土保持設施年久失修老化，加上極端降雨與地震事件的影響下，坡地上的潛在風險日益增高，經常造成山崩落石、邊坡滑動、土石流及地基淘刷等嚴重災害。然這些潛在災害的肇因並非一日而生，且既有的監測方案中尚且缺少長時間尺度的地表位移觀測機制，以做到更早的趨勢因應與大面積監控，致使需要導入衛星導航系統(Global Navigation Satellite System，GNSS)來加強坡地安全監控的活用性。

為了提升坡地安全長時間尺度的全域監控能力，本計畫使用國內已研發的低成本 GNSS-IoT 自動化監測設備，實際於坡地社區試行系統化的即時監測作業，其工作內容包含 GNSS 定位解算技術研析、示範場域 GNSS 監測測試、時序監測數據分析與驗證，以及即時運算服務系統之建置四項，透過時序資料分析、觀測數據驗證，以及即時監控展示等內容來完善技術整合之成果。

研究計畫預計達成目標如下：

一、GNSS 定位解算技術研析：回顧 GNSS 定位解算技術，蒐集相關技術監測之文獻，以確保國內自主研發的低成本雙頻多星系 GNSS 設備符合坡地監測應用需求。

二、示範場域 GNSS 監測測試：實際安裝 GNSS-IoT 自動化監測於合適的坡地社區地基，並完成至少 2 站的實地設備安裝與至少三個月的觀測數據採集。

三、時序監測數據分析與驗證：比較不同解算策略之差異，產出時序觀測數據與常見的位移監測指標，並進一步比較現地既有的觀測數據，交叉驗證實證區潛在位移之趨勢。

四、即時運算服務系統之建置：完成靜態與即時運算開發，並部署自動化 GNSS 即時監測服務，透過 API 送出數據，並併同長時間尺度的位移監測指標展示於 Web 網頁中，並與本所山坡地建築管理履歷資料庫平台整合。

五、研議本技術落實應用於坡地社區防減災之作為與機制：在設備可用的觀測精度下，定義觀測期間若發現超過注意值標準範圍，則建議進行相關專業調查及現場勘驗，以利盡早執行防範處置。

關鍵詞：衛星導航系統、社區邊坡即時監測、地表位移時序分析

Abstract

Under the over-exploitation and improper use of land, long-term disrepair and aging of water and soil conservation facilities, coupled with the influence of extreme rainfall and earthquake events, the potential risks on slopes are increasing, often causing landslides, sliding slopes, soil and rock flows and foundation scrubbing And other serious disasters. However, the causes of these potential disasters do not occur in a day, and the existing monitoring plan still lacks a long-term surface displacement observation mechanism to achieve earlier trend response and large-area monitoring, which necessitates the introduction of satellite navigation systems. (Global Navigation Satellite System, GNSS) to enhance the flexibility of slope safety monitoring.

In order to improve the long-term global monitoring capabilities for slope safety, this plan uses the low-cost GNSS-IoT automated monitoring equipment to actually pilot systematic real-time monitoring operations in the slope community. Through time series data analysis, observation data verification, and real-time monitoring display, the results of technical integration are improved.

The expected results in this project are listed as below:

(1) Review and collect GNSS monitoring documents to ensure that the low-cost equipment meets the application requirements of slope monitoring.

(2) Complete at least 2 stations of field equipment installation and at least three months of observational data collection.

(3) Compare the differences of different calculation strategies, produce time series observation data and common indicators, comparing the existing observation data to cross-validate the trend of potential displacement in the empirical area.

(4) Complete static and real-time computing development, and deploy automated GNSS real-time monitoring services, and display on the Web.

(5) Develop GNSS real-time monitoring services and integrate various current observation results, construct a long-term-scale slope safety monitoring mechanism, providing complete potential displacement trend. Achieve the high-precision low-cost GNSS-IoT monitoring of slope safety monitoring applications.

Keywords：GNSS, Hillside Community Real-time Monitoring, Ground Surface Displacement Analysis