2024 HDR Scholarship - CSIRO Industry PhD (iPhD) scholarship

Improving large infrastructure risk management using next generation Interferometric SAR validated with innovative GNSS sensor systems

Applications close: when position is filled

The Scholarship

This scholarship is funded by CSIRO and Industry collaborator Kurloo Technology, with the student primarily based at Curtin University (Perth, Western Australia). The objective of this project is to develop and test new methods to integrate next generation satellite radar (InSAR) monitoring for ground motion with Global Navigation Satellite Systems (GNSS) positioning devices. This research scholarship is specifically focussed on supporting a student to work on cutting edge research in collaboration with Kurloo and CSIRO with a pathway to commercialisation of the research outcomes. The industry engagement component of the scholarship will include an industry placement with Kurloo Technology (Brisbane, Queensland). A suitable candidate can start any time after 1 January 2025.

The Project

Background

The motivation for developing this improved system has evolved from a series of catastrophic infrastructure collapses which include tailings dam failures such as those at Brumadinho (Brazil) in 2019 and Cadia (Australia, NSW) in 2018, extending to hazards from sink holes that have caused significant infrastructure damage both globally and nationally. These incidents have led to InSAR-based remote monitoring of dam walls, however these monitoring solutions have limitations. For example, 3D motion cannot be resolved using current InSAR systems and measurement errors remain. The aims of this project are to test InSAR monitoring from next generation satellite SAR systems, which will then be combined with ground-based Kurloo GNSS devices (Figure 1) to develop an automated and integrated 3D monitoring system. An example of the potential for InSAR deformation monitoring of infrastructure is shown in Figure 2 where subsidence (up to 20 mm/yr) at the construction site at Optus Stadium in Perth is shown, along with uplift of the freeway bridge over the Swan River (+4 mm/yr).

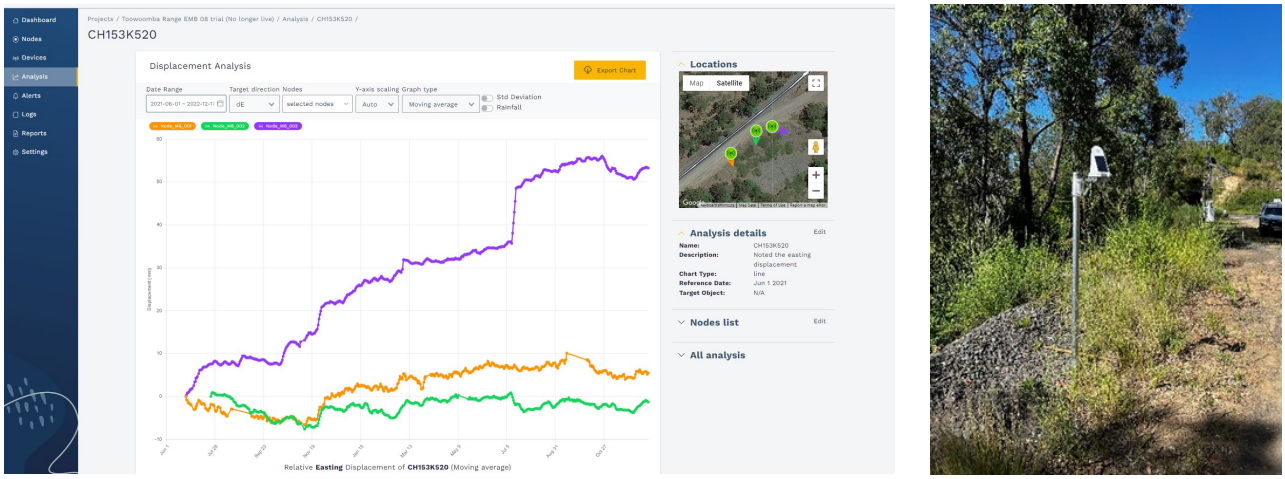

Figure 1: Example of Kurloo displacement monitoring to Embankment on the legacy Toowoomba range. Daily readings were taken for three GNSS sensors on the embankment for 14 months, providing certainty of stability during periods of high rainfall and automatic alerts when visual inspection was required.

Research program

The primary objective is a develop and optimise the combination of new-generation InSAR satellite data and ground based Kurloo GNSS sensors into a holistic system to remotely monitor natural and anthropogenic induced hazards that threaten human infrastructure and lives. The research program will comprise the following stages.

1. Compile and evaluate the different data sets, with preliminary data processing and analysis.
2. Formulate the algorithms that will optimise the integration of the InSAR and Kurloo GNSS data.
3. Refine and test the optimised system in different locations and applications, and develop methods to automate the system with a path to becoming operational.
4. Plan commercialisation of the new system.

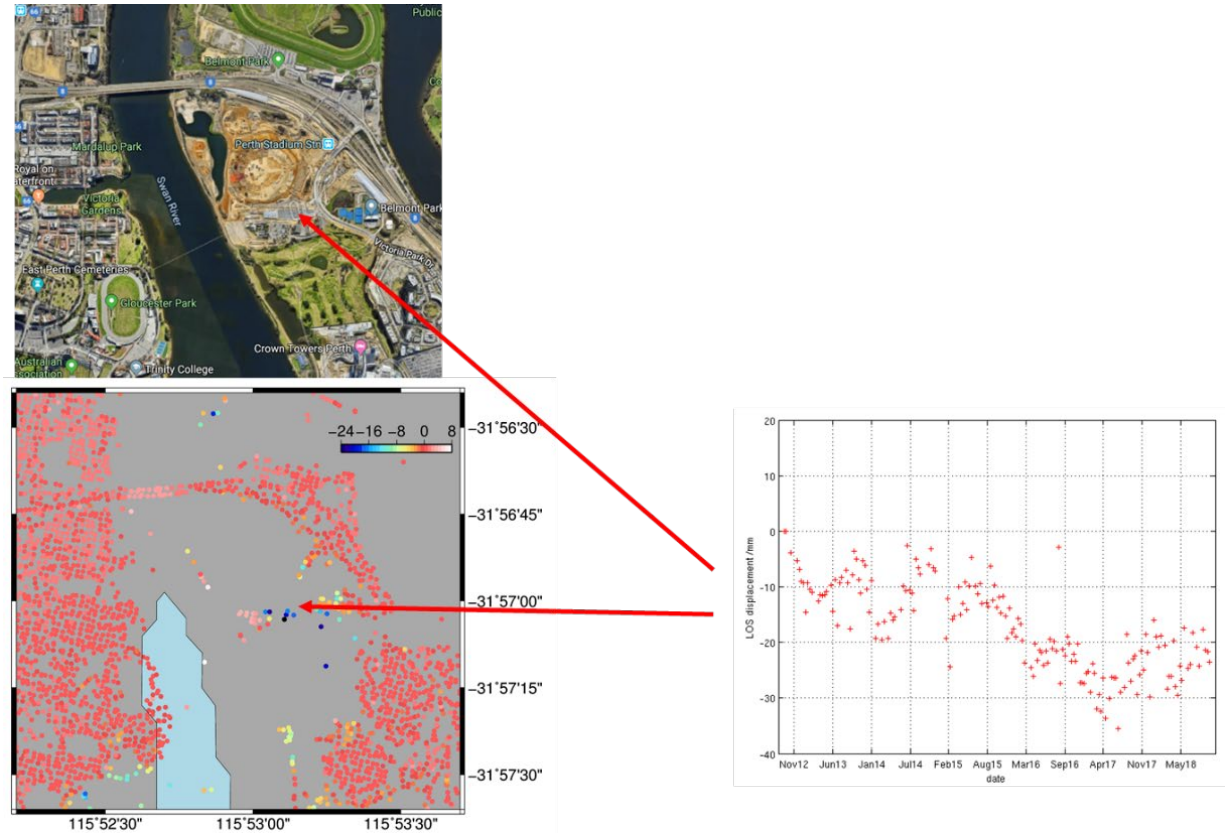

Figure 2: Example of InSAR displacement monitoring in Perth during the construction of Optus Stadium. Top left is Google maps image of Optus Stadium under construction, with freeway and bridge visible; bottom left is processed and analysed pixels from the TerraSAR-X InSAR time series, with the time series for a specific pixel shown below. Units are mm/yr (velocity) in the plot bottom left, and mm (displacement) on bottom right. TerraSAR-X data supplied by the German Aerospace Agency (DLR)

Project impact

The project's impact is broad, where we will seek to harness next-generation SAR datasets from commercial companies to demonstrate the extra value these systems can provide in the development of combined ground monitoring systems. This would be an advance from the current situation where mostly open access ("free") global coverage SAR data from European Sentinel-1 is used to conduct remote surface movement monitoring. The new technology will overcome the problems where Sentinel-1 in Australia only collects data from one viewing geometry (descending orbital passes), which limits the rigor of ground motion estimates because it does not enable a decomposition of movement vectors in the east-west and up-down vector components. These commercial services are rarely validated with independent on-ground measurements. In contrast, this project will develop an InSAR monitoring validation system through integration with the Kurloo GNSS devices which will result in a holistic system that provides robust 3D deformation measurements with high reliability.

Industry focussed

The project will be a collaboration with industry partner Kurloo where the student will develop the integration of InSAR and GNSS to develop a monitoring system that enhances the use of Kurloo GNSS devices. Kurloo manufactures their devices locally, so this industry experience will expose the student to an innovative Australian business that provides a GNSS sensor monitoring service from production of hardware to online delivery of results.

The placement will provide regular contact with the industry supervisor and access to research staff at Kurloo across the range of the business, enabling attendance at industry conferences and workshops. The Industry Engagement component will include time spent at Kurloo (Qld) working with Kurloo staff and systems to understand how Kurloo works to help develop optimization with InSAR and commercial pathway for the research outcomes.