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What is the cost per millimetre? Challenging traditional GNSS equipment for precise geosciences and engineering applications

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Surveyors, civil and geotechnical engineers are the typical users of professional grade GNSS receiver that is capable of achieving positioning accuracies of sub-centimetre and navigation accuracies of 1-2cm. When choosing the equipment for their needs, they are often faced with a dilemma with each additional frequency, constellation and feature coming at a cost, resulting in professional GNSS equipment being regarded as high-priced specialist equipment. Indeed there are many users that have discounted GNSS on the grounds that it is too expensive and too operationally complex to warrant purchase.

Having identified this situation, Nottingham Scientific Ltd (NSL) set about the development of equipment that would break down this barrier making high accuracy GNSS affordable to new users and applications and more cost effective to existing users. NSL created “STICK” which is a single frequency, multi-constellation, IMU-integrated GNSS sensor for precise movement detection of the natural and built environments and infrastructures, at approximately 1/20th of the price of a professional grade GNSS system.

STICK has been developed within the context of three European Space Agency (ESA) Integrated Applications Programme Demonstration projects that use space assets to monitor the land stability and the status of different types of infrastructure, each with its own operational challenges. However through the careful selection of components, the implementation of certain operational constraints and the use of advanced statistical data processing, sub-centimetre positioning can be achieved for monitoring purposes.

This paper describes STICK, the applications for which it has been developed, and the environments within which it is operating. We then explore the performance by directly comparing STICK to geodetic GNSS receivers setup in an operational, test bed environment. This test bed allows the receivers/antennas to be subjected to a three-dimensional displacement in the order of 1cm a day. The processing techniques that are used by the STICK monitoring service are described, including the GNSS data processing, the integration of IMU and the statistical analyses used to detect, quantify and report movement.

By considering operational cost in terms of power, installation difficulty, remote communication and processing complexity and along with device price, we summarize the final cost to the user. Comparisons with other GNSS solutions shows whether cost truly scales with accuracy and precision.

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