New project to boost sat nav positioning accuracy anywhere in world

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Credit: University of Nottingham

A project exploiting Global Navigation Satellite Systems (GNSS) to establish the blueprint for the world's most accurate real-time positioning service is to run at the University of Nottingham.

The service, to be developed at prototype level, will benefit safety-critical industries like aviation and maritime navigation, as well as high accuracy dependent applications such as offshore drilling and production operations, dredging, construction, agriculture and driverless cars and drones, just to name a few.

The EU-funded TREASURE project, will integrate signals from satellite navigation systems such as GPS, launched by the US, alongside Russia's GLONASS, China's BeiDou and Europe's new Galileo system.

Combining these different satellite systems to operate together is a new development known as multi-GNSS, which is key to provide instantaneous, high accuracy positioning anywhere in the world.

The four-year project will focus on a service that will take the current use of GNSS - normally based on just one or two systems - to the next level, to provide accuracy of a few centimetres in real time, opening up a multitude of new possibilities.

Atmospheric disruption

One of the key aspects of the research is to mitigate the effects of the atmosphere, in particular related to space weather, which can often create impairing conditions that vastly reduce satellite communication and positioning accuracy.

Controlled by the interaction of the sun with the Earth's magnetic field, the ionosphere (the upper layer of Earth's atmosphere) is characterised by the presence of free electrons, which interfere with a satellite's signal passing through it.

Mainly, but not only when solar activity is high, electron density irregularities may form in the ionosphere, which can cause signal diffraction and lead to scintillation – a scattering of the satellite signal that makes it difficult for a GNSS receiver to lock onto the satellite and calculate its position.

This has a particularly disruptive effect on positioning technology especially at high latitude or equatorial regions, such as in Northern Europe or in Brazil, respectively.

Similarly, the troposphere, a lower layer of the atmosphere, also interferes with the signals. The presence of water vapour in this neutral part of the atmosphere can create an additional disruptive effect on the satellite signals, thus also affecting GNSS accuracy.

Correcting all intervening errors

The project aims to develop new error models, positioning algorithms and data assimilation techniques to monitor, predict and correct not only the effects of the atmosphere but also signal degradation due to manmade sources of interference, which can also limit positioning accuracy.

Signal processing techniques - tailored to the features of the interfering signals - will be used to improve the quality of the measurements and ultimately to generate reliable position solutions.

Moreover, TREASURE researchers will also develop new multi-GNSS real-time precise orbit and clock products, specifically for use with the new Galileo system.

Wide-ranging industry potential for precise multi-GNSS service

All these problems pose significant risks to the many public and industrial sectors that now rely on GNSS or aim to use it to overcome growing humanitarian challenges such as food or energy production.

Project lead, Dr Marcio Aquino, from the Nottingham Geospatial Institute said: "A highly-accurate multi-GNSS service could, for instance, assist demanding terrestrial applications like precision agriculture, giving farmers access to real-time precisely located data gathering and analysis to maximise food production, reduce costs and minimise pesticide use."

"On the other side of the spectrum, a deep-sea drilling platform that experiences any temporary degradation of positioning accuracy could lead to phenomenal losses right at a time when, due to the current oil production climate, companies are striving to increase operational efficiency. This industry would also benefit from such an accurate multi-GNSS service."

The importance of Galileo

By 2020, Galileo, the European GNSS system (EGNSS) will be fully operational and provide positioning data of unprecedented accuracy. Galileo will rival but, crucially, will also be interoperable with GPS, which has been the front-runner of all GNSS systems, dominating the market for over 20 years.

According to Dr Aquino: "The development of EGNSS and its integration with other satellite systems is key for Europe's competitiveness in this market, therefore the interest of the EU in funding this project."

The study will focus on two existing GNSS techniques known as PPP (Precise Point Positioning) and NRTK (Network Real Time Kinematic). Both use GPS and GLONASS, but could potentially meet future real-time high accuracy positioning demands when Galileo is fully integrated, and if TREASURE is successful.

Benefits and limitations of PPP and NRTK

The NRTK technique uses fixed reference stations operating high-grade GNSS receivers at carefully surveyed reference locations to secure accurate GNSS positioning data.

The transmission of corrections from reference locations to users is at the core of NRTK. The technique's effectiveness relies on the spatial correlation of errors between user and reference, which must be situated less than 20-30km apart - a short enough distance to allow potential signal errors to 'cancel out'.

If atmospheric variations between reference and user are strong, a greater number of reference stations may be necessary, rendering the technique less cost-effective.

Contrary to NRTK, PPP does not rely on errors 'cancelling out' between the user and a known reference station. The user operates their receiver independently of the existence of nearby stations with known coordinates.

This is achieved by incorporating external information in the solution, in the form of highly-precise satellite clocks and orbit products derived from global networks and available either for free or commercially.

However, the accurate prediction of the state of the atmosphere, also crucial for PPP, is not normally available from these global networks – overcoming this situation is one of the main objectives of TREASURE.

Creating a critical mass and testing market potential

TREASURE, funded by the EU framework Programme for Research and Innovation Horizon 2020, brings together four top universities, one research institute and four leading European companies to provide the research that will result in the ultimate high-accuracy EGNSS solution.

The project team will train and work alongside 13 Marie Skłodowska-Curie Fellows who will be earmarked as high-flying candidates for future employment in the burgeoning GNSS industry or as specialist researchers.

The Fellows will build a prototype tool to support the different PPP and NRTK needs and test what commercial interest there is to bring the future service to market.

Provided by University of Nottingham

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