Modelling the terrain using a laser scanner; 150,000 points per second.

Retiring GPS Base Stations

Terratec AS

Since GPS found its way into positioning, differential processing has been *the* way to high precision. Technological advances and large-scale international collaboration have now made it possible to get sub-decimetre accuracy (95%, 3D) without reference stations. Terratec is aiming to be the technology leader in this new way of positioning.

THE USE OF REFERENCE STATION services, or even ones own reference stations, has been part of the game for most hydrographic surveyors for almost two decades, and for some applications it will still be the preferred solution. Even though GPS satellite signals have remained more or less unchanged since the system was introduced, there have been both organisational and technological advances allowing for new positioning strategies to emerge. On the organisational side, the International Global Navigation Satellite Systems (GNSS) Service (IGS) is one of the most significant actors. GPS (and at many locations also GLONASS) signals are continuously tracked from more than 300 stations, making it possible to accurately estimate satellite orbits and clock corrections. The clock and orbit products freely available from the IGS have proven very reliable and form the backbone of the processing strategy known as precise point positioning (PPP). It is this technology that has brought Terratec AS (↖1) into the hydrographic business.

The Beginning

Terratec AS was established in 2004 as a continuation of the mapping and geodetic activity of Fjellanger Widerøe Geomatics. Since it was founded, Terratec has grown both in revenue and staff, and is now a company of almost 50 specialists in fields such as geodesy, surveying, photogrammetry and IT in general. Terratec's operational interests are based around georeferenced data acquisition, mainly from aircraft: typically aerial photography for mapping purposes, or LIDAR ('laser scanning') for accurate elevation models. Except for the lack of water between the aircraft and the surface to be observed, there are many similarities of aerial and hydro-

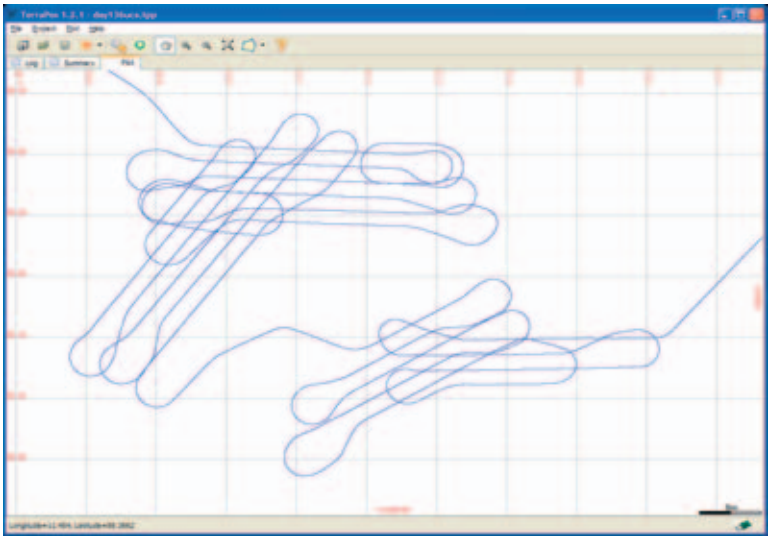
graphic surveying, particularly the need for accurate positioning and orientation of sensors at all times.

A Search for Efficiency

Terratec's search for a more efficient positioning strategy led them to the Norwegian University of Life Sciences (UMB) where Dr Ola Øvstedal and a team of researchers already had a PPP project underway. One of the partners in this project was the Norwegian Hydrographic Service (NHS), the government organisation responsible for surveying the Norwegian coastal and polar waters. They were searching for better ways to georeference their marine surveys. A first-generation PPP software was already implemented and incorporated in the production line at the NHS. Terratec, in co-operation with the NHS, decided to restart the PPP software project, not only to improve their production line but also with the intention of making PPP a product itself.

PPP

The main principle of PPP is easy and actually quite close to the way an ordinary autonomous GPS receiver computes its position in real-time. The major difference is that instead of broadcast satellite orbits, precise post-mission orbits are used in PPP. However, this is only half the story. When working with undifferenced observations (i.e. not using base stations), the challenge lies in removing or modelling all effects affecting the signal on its way from the satellites down to the receiver, and other artefacts such as receiver and satellite hardware biases and clock errors. Most of these effects cancel out in a differential approach. In PPP, everything from satellite yaw rotation when the satellite searches for sun for its solar panels, via ionospheric and tropospheric refraction, down to earth tides and ocean loading must be taken into account. One important strategy in this aspect is the handling of ionospheric refraction through an ionosphere-free combination of L1 and L2 observations. This is very efficient and is based on the fact that refraction in the ionosphere of the GNSS signal is proportional to signal frequency. Having two signals with different frequencies then makes it possible to rule out the effect. This strategy, however, has the side-effect that phase ambiguities will not be integers, excluding the possibility of producing a so-called 'fixed solution'. Thus, to let the float ambiguities converge, one will need a certain amount of observations, typically a few hours of logging. This is a limiting factor when it comes to land applications, where total blockage of all signals normally has to be expected. However, at sea or in the air, this is normally not a problem at all, making PPP a first choice in marine and aerial applications allowing for post-processing.



TerraPOS screenshot.

TerraPOS

In the spring of 2005, Narve Kjørsvik had just completed his PhD at the UMB and joined Terratec to work full-time on the development of the software later to become 'TerraPOS'. With a basis in the experiences from the first implementation of PPP done at the university and with valuable 'real-life' experiences from the NHS and Terratec's own production lines, the new software took form as a second-generation PPP processing tool. In order to be able to replace the differential approach with PPP, precision was a key factor in the project. When aiming at centimetres, almost no error source is too small to be neglected. With the ambition for more than an in-house software tool, robustness and ease of use were also important. A third and very important focus was to implement the methodology in a very general way, allowing for future changes such as new signals or systems such as GALILEO or COMPASS, or even other processing strategies. After a period of testing, both in marine and aerial production lines, the software was considered mature enough for the market and was commercially introduced in November 2006.

Reaching out

In the year that has passed, Terratec has found a market for TerraPOS mainly in the fields of application it was initially developed for: marine and aerial data acquisition. On the marine side, primarily the 'home market' in Norway and Europe has been attained up to now, whereas, for aerial applications, the American market has also been important. The nature of PPP is truly global, being independent from local infrastructure and with the results presented in the International Terrestrial Reference Frames. This implies that the market for TerraPOS is also global. Terratec is now in the process of building up an international dealer network. In addition, this part of turning science into business needs attention.

Even Brøste, Terratec AS
even.broste@terratec.no

1. www.terratec.no