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The Many Faces of GPS

Although the NAVSTAR Global Positioning System (GPS) was designed to be a space-based timing and navigation system to satisfy the needs of the US Department of Defense, many of the current developments are primarily taking place in the civilian user segment. The system as originally designed did not include provision for the very accurate positioning that is performed today. This type of use of GPS resulted from a number of fortuitous developments, of which differential GPS together with the application of the interferometric principle have probably been the most important. The civilian uses of the GPS are rapidly covering the whole spectrum of terrestrial, marine, aviation and space applications. The rate at which this is happening is breathtaking and hard to keep up with (in the early nineties, the ratio of military-civilian users was about 1:3, at the turn of the century it is estimated to be 1:17). To give some idea of the very different applications for which GPS is suited, here are some of the 'surprises' which the GPS has still in store.

Water Vapour

High-accuracy GPS receivers are now commonly used to monitor earthquake, volcanic, and tectonic processes with millimetre precision. However, with suitable ancillary information, the GPS data can also be used to estimate atmospheric parameters such as the total ionospheric electron content and precipitable water vapour. GPS water vapour estimation is already proven to be capable of detecting the passages of cold fronts. But probably much more can be expected from this interesting joint venture between GPS and the atmospheric sciences. Water vapour, for instance, is one of the most important constituents of the atmosphere, as moisture and latent heat are transported through the water vapour phase. In addition, water vapour is the most important greenhouse gas. Accurate, dense and frequent sampling of water vapour is therefore of importance for climatological research as well as for operational weather forecasting.

Under Water

GPS, widely used on land and in the air, is helpless in water - an element that covers 71 per cent of the earth's surface. However, when integrated with other technologies, GPS will also be able to contribute significantly to underwater-geodesy. For instance, parallel developments in GPS and acoustic technologies will give rise to the potential to observe sea-bottom motion. GPS carrier-phase measurements can accurately determine the changing position of a sea-surface platform tens or hundreds of kilometres offshore. Precision acoustics can resolve, with a few-microsecond uncertainty, two-way travel times from an acoustic transducer to sea-floor transponders as far as ten kilometres away. Combining the two technologies will therefore enable monitoring of sea-bottom motion, thus filling the gaps in the worldwide effort to determine and to model crustal deformation.

Wireless Communication

Another exciting development which is now taking place is the merging of GPS with wireless personal communication services. Both cutting-edge technological advancements will complement each other, in a manner similar to the by now classical GPS/INS integration. Already, fleet resource monitoring and emergency notification devices are starting to make use of both technologies. Cellular telephone positioning using GPS time synchronisation is one of the techniques currently under development for vendors of personal communication services. GPS could therefore soon become a household word.

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