Multiple-pulses in Air

Early in 1997 I did research on gaining insight into the error sources of airborne Lidar. As you may have read in the editorial in this issue of *GIM International,* 1997 was the year that a highly detailed nationwide Digital Elevation Model (DEM) of the Netherlands was built, up to one height point per 16m^2, making use of the new technology of airborne Lidar. The accuracy specifications of the so-called AHN were: 15cm root mean square error (RMSE) and 5cm systematic error. Yes, it was ambitious! Twelve years back, Lidar was still in its infancy and many operational hurdles had to be overcome. The AHN project was completed in 2003.

'The Netherlands is flat as a coin. Why you need such a detailed DEM?' some foreigners laughed, especially those living in mountainous areas. The answer is quite simple: when 40% of a country's territory is situated below sea level, every decimetre counts in the struggle to keep feet dry. In the meantime, error sources have been understood and remedies developed to avoid them or to get rid of them. Airborne Lidar has matured, as witnessed by our Product Overview (see page 16).

Today, upgrading the AHN to one point per square foot (10 points/m^2) with an accuracy of 5cm, both RMSE and systematic error, is in progress and will result in AHN2. The centupling of resolution and tripling of accuracy in a cost effective way has been enabled by recent advances, most significantly multiple-pulses in air (MPiA) technology. MPiA allows the firing of the next laser pulse before the reflection of the previous pulse has been received. The pulse rate of single-pulse in air systems is determined by the ratio of the speed of light and two times the flying height; e.g. at 1km, the maximum pulse rate is 300,000km/s divided by 2km; that is 150,000 pulses/s; at 2km this number diminishes to 75,000. The basic advantage of MPiA becomes clear when surveying at higher altitudes. It reduces acquisition time (and hence costs) and also reduces occlusion by relief variations; the latter enables the reduction of the width of across overlap. Furthermore, air turbulence at higher altitudes is less severe than closer to the ground, so the flight is more comfortable and the crew can stay in the air longer. MPiA technology is beneficial for capturing data on large areas, such as creating high accuracy nationwide DEMs, flood risk mapping in delta areas and mapping of coasts.

Are there any disadvantages? Higher altitudes will magnify the effects of errors in the angular measurements of the inertial navigation system (INS) resulting in larger error ellipses of the pulses hitting the ground. However, resolve is in the air; INSs are becoming more accurate by the year.

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