SUB-METRE RESOLUTION AND HIGH POSITIONING ACCURACY

Mapping Towns from QuickBird Imagery

QuickBird imagery offers the highest spatial resolution so far available from a commercial satellite. Resolutions as low as 60cm, combined with high positioning accuracy, make it well suited for mapping urban areas. The authors present examples.

Key requirements for making an appropriate choice of satellite images are:

- geometrical resolution
- availability of multispectral bands
- specification of multispectral capabilities
- achievable positioning accuracy
- revisit rate (varies with latitude but is usually 2-3 days. VHR satellites with steered sensors can revisit the same scene more often but at different viewing angles)
- area covered by a single frame.

Good Accuracy

If it is to be used in a GIS for the extraction of thematic layers imagery first needs to be subjected to ortho-correction. With QuickBird data and using commercial software it is possible to achieve accuracies of the order of 1 metre RMSE, sufficient for topographic mapping at scales of 1:10,000 and less, even better for thematic mapping. Once the imagery has been ortho-rectified, consumer-level image processing software can enhance the image for feature extraction using contrast stretching and sharpening functions.

Colour and Clarity

For those satellites with multi-spectral capabilities, resolution of multispectral bands is typically four times less than that of the panchromatic. For feature extraction at the highest resolution it is possible to use the panchromatic band only. In most cases this band not only covers the visible range (0.4-0.7 Âµm) but stretches into the near-infrared, increasing information content and clarity of the image. Ideally the panchromatic band is fused with three of the other bands, resulting in either a natural or false-colour image with the colour content of the multi-spectral bands and the geometrical precision of the panchromatic. Either the user can effect this data fusion or the data can be supplied already merged. Without any further analysis this kind of imagery is well suited as a background in GIS applications. All the examples below use pan-sharpened natural colour imagery from QuickBird. The scale of the printed images varies according to the kind of information we are looking at.

Residential Areas

Figure 1 shows a small portion of an image of Madrid. The detailed shapes are easily identifiable unless concealed, for example, by vegetation. Terraces, balconies, fine architectural details and ancillary structures on rooftops are clearly visible. Note that colour is an important discriminatory tool. An estimate of the height of the buildings can be made from the lengths of the shadows. The 11-bit radiometric depth of each band enables easy detection of details in shadowed areas.

Commercial Areas

Commercial areas, including shopping centres, major company headquarters and large public infrastructure buildings such as hospitals can be easily extracted from the image but it can be very difficult to discriminate between types of such objects. Figure 2 shows a hospital in Rome, Italy but the area is not easily distinguishable from shopping centres; both types of commercial area have large buildings of regular shape with mainly flat roofs and large car parks. In Figure 2 the helicopter-pad may provide a clue to the actual use of the area, whilst in industrial areas clues may be provided by features such as large storage areas, truck parking, large industrial machinery and specific infrastructure such as tanks or tall chimneys.

Road Networks

Roads are very clearly visible in almost all types of scenes, although pavements are not easily detectable. In Figure 3, a scene covering Vienna, one may easily see many of the road markings even though they are much smaller than the 60cm-pixel size, because they contrast greatly with the dark background. In QuickBird imagery even the lines of a tennis court pop up clearly. Changes in the colour of

asphalt due to traffic movement or resurfacing can be readily detected. An urban railway runs along the right side of the bridge. Cars may be distinguished from heavy vehicles such as trucks, although vehicle type cannot be identified. There are several factors that have an impact upon the detection of road features.

- High collection angle may cause concealment of narrow roads by buildings of a height of four or more storeys.
- Buildings create heavy shadows in images recorded during wintertime; however, 11-bit colour depth enables the uncovering of hidden details using local-contrast stretching.
- Very narrow streets can be hard to detect in the historic centres of old towns, and overhanging trees can also conceal roads.

Trains and Trams

Figure 4 shows a fragment of railway yards in Kiev; the trains themselves are easy to see and certain kinds of rolling stock can even be identified. The ability to identify single tracks depends somewhat on the terrain; they may be seen in the high-contrast areas in the lower part of the scene but are harder to spot in the upper part. Tramlines are not normally visible but can often be detected by the presence of other features in their vicinity, such as barriers, platforms and the trams themselves.

Green Spaces

Urban parks and their features, such as paths, pools, artificial features and formal gardens, can be easily detected in the scene of Lisbon as depicted in Figure 5. Even shrubs and single trees can be mapped and tree types can be identified; false-colour images can help in this regard. The boundaries of private gardens can be mapped to a fairly good level of approximation. Leisure facilities such as sports fields, outdoor swimming pools and golf courses can be clearly identified.

Other Scenes

In port areas it is possible to distinguish individual containers and their associated machinery, as well as the state of loading of the ship moored alongside. In airports runway markings show up clearly and it is possible to distinguish major aircraft types. Changes in the urban environment can also be easily mapped; here two â€˜five-a-sideâ€™ fields and a roller-skating rink have replaced a football field. Many features and objects are too small to be detected from satellite images, for example, utility poles, traffic lights, antennae and narrow lanes. Nevertheless, additional information reveals the presence of small features: shadows over bright terrain can aid in the detection of poles and cables. Since satellites generally record areas at the same time of day (sun-synchronic) the images cannot be used for consistent, sequential over-day monitoring, such as to track traffic flow during rush hour, or specific events.

Final Remarks

In general, the best solution for feature detection in urban areas is to start with pan-sharpened images, natural or false colour, with a collection angle below 15Â° and collected from March to November to limit the influence of shadows. The thematic scale achievable depends on the specifications and geometric accuracy required, but in any case QuickBird images can be enlarged up to scale 1:1,000.