

# NATURAL COLOUR URBAN 3D MODELLING A STEREOSCOPIC APPROACH WITH IKONOS MULTISPECTRAL AND PANCHROMATIC DATA

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## ABSTRACT:

This paper presents an approach for generating urban 3D colour models using a stereoscopic technique and the commercial high-resolution satellite image data. The concept and result of the approach is presented. The paper demonstrates that it is possible to model an urban environment in natural colour 3D using the new commercial high-resolution satellite image data. The approach is fast and effective. Urban objects, including cars, can be viewed clearly in colour 3D.

## 1. INTRODUCTION

Three-dimensional (3D) information of the Earth's surface is important for a variety of geo-related applications. Geoscientists, environmental planners, engineers, mapping experts, and military officers need 3D information of interested areas for better interpreting their spatial details and understanding their environments. Such 3D information is, some time, determinant for the success of the missions.

Stereoscopic viewing of images has been the most common method for obtaining 3D information of the Earth's surface for the last 50 years (Toutin, 2001). Different optical-mechanical, analytical, and, in the last years, digital 3D systems have been developed to meet the needs for 3D information perception and extraction with aerial and satellite images.

Black and white as well as colour or multispectral image pairs from different airborne and spaceborne sensors have been utilized to view and extract 3D information for different applications. They include, for example, analogue, digital, frame and linear images, as well as satellite images from different orbit viewing angles – adjacent track, across track and alone track.

However, results of a stereoscopy based modeling of 3D urban environment in natural colour has rarely been reported, especially results from the new commercial high-resolution satellite image data.

## 2. EXISTING TECHNIQUES

In the last years, studies on 3D information generation with stereoscopic images have mostly concentrated on the generation of digital surface models (DSMs) (Al-Roussan et al. 1997, Petrie 1999, Toutin 2001). Existing techniques for urban 3D modelling are, in most cases, based on the concept of draping a 2D image over a DSM. Such techniques are good for dynamically displaying and analyzing a 3D environment on a computer screen. It is, however, very costly and time consuming to generate an accurate DSM which can show details of individual buildings.

On the other hand, many 3D systems have utilized the stereoscopic technique to directly visualize 3D information of ground objects. The most common way is to display a pair of black/white images on a monitor or print them on a paper in two of the tricolours, and then to view the image through a pair of complementary stereo glasses. However, the 3D image viewed is monocolour.

A pair of colour stereo images can also be displayed on a computer screen for colour 3D viewing. However, expensive polarized screen and polarized stereo glasses are needed to view the colour 3D. Further, when the colour image pair is printed on a paper, no 3D can be viewed because the image cannot be polarized. Very few systems have utilized stereoscopic technique and inexpensive complementary stereo glasses for colour 3D viewing.

## 3. POTENTIAL OF HIGH-RESOLUTION SATELLITE IMAGES FOR URBAN 3D

The new commercial high-resolution satellites, such as IKONOS and QuickBird, have started a new era for experts in all geo-related areas to perform large scale and detailed 3D visualization and 3D mapping of the Earth's surface, especially for urban image mapping. Different high-resolution images (panchromatic: 1m and 0.61m, multispectral: 4m and 2.4m) in different stereo models (across track, adjacent track and along track) can be provided for different 3D viewing and extractions (Fritz 1996). The geometric accuracy has been met or exceeded the designed requirements (Cook et al. 2001) and meets (US) national mapping standards for generating digital elevation models and ortho-images at a map scale of 1:24,000 (Li 1998).

To date, examples of stereoscopic viewing of the high-resolution panchromatic images have been presented by some 3D systems. However, reports on generation and visualization of high-resolution 3D colour images by combining IKONOS or QuickBird panchromatic and multispectral image data have not been seen by the author.

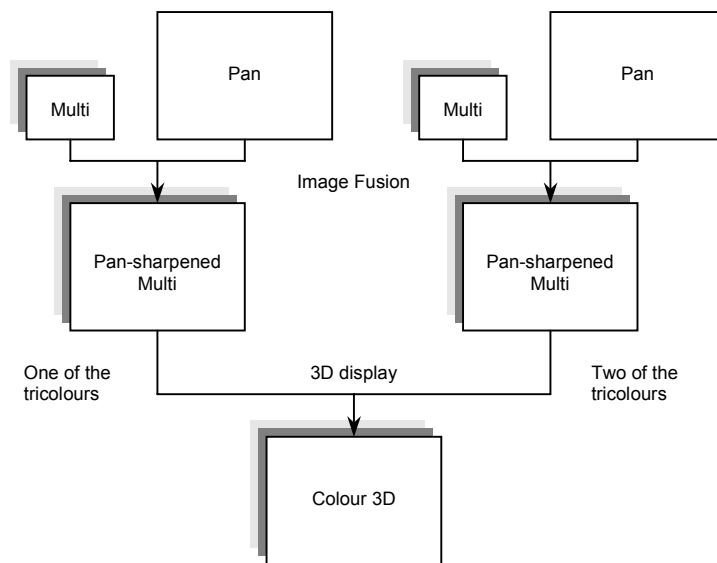


Figure 1. Flowchart of the generation of colour 3D anaglyph image

#### 4. A NEW APPROACH

To better utilize the available high-resolution multispectral and panchromatic satellite images and to explore a more effective way for detailed colour 3D visualization at a lower cost, this paper presents a new approach to the generation of natural colour 3D stereoscopic images. The general concept of this approach is shown in Figure 1. The determinant step for this concept is the generation of well fused pan-sharpened natural colour images.

#### 5. RESULT

Figure 2 shows a natural colour anaglyph image generated with IKONOS panchromatic and multispectral data. Different from existing 3D images, the 3D colour anaglyph image can be displayed on a screen and also printed on a paper. 3D colour information can be viewed with a pair of inexpensive complementary glasses. Moreover, the image generation process is simple and fast, so that near-real-time urban 3D colour modelling is possible.

#### 6. CONCLUSIONS

This study has demonstrated that it is possible to model an urban environment in colour 3D using the new commercial high-resolution satellite image data. Urban objects, including cars, can be viewed clearly in colour 3D. The process speed of such colour 3D images is fast and the colour 3D viewing does not require expensive polarized screens and glasses. The colour 3D image can be printed on a piece of paper. The application potential is large.

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#### REFERENCES

- Al-Roussan, N., Chen, P., Petrie, G., Toutin, Th., and Valadan Zoj, M.J., 1997. Automated DEM extraction and ortho-image generation from SPOT level-1B imagery. *Photogrammetric Engineering and Remote Sensing*, Vol. 63, pp. 965-974.
- Cook, M.K., Peterson, B.A., Dial, G.; Gibson, L., Gerlach, F., Hutchins, K., Kudola, R., Bowen, H.S., 2001. IKONOS technical performance assessment. *Proceedings of SPIE - The International Society for Optical Engineering*, v 4381, Algorithms for Multispectral, Hyperspectral, and Ultraspectral Imagery VII, Apr 16-19 2001, Orlando, FL, p 94-108.
- Fritz, L.W., 1996. The Era of Commercial Earth Observation Satellites. *Photogrammetric Engineering and Remote Sensing*, Vol. 62, No. 1, pp. 39-45.
- Li, R., 1998. Potential of High-Resolution Satellite Imagery for National Mapping Products. *Photogrammetric Engineering and Remote Sensing*, Vol. 64, No. 12, pp1165-1169.
- Pertrie, G., 1999. Automatic DEMs and orthoimages from SPOT stereo-pairs: SPOT DEMs of Jordan. GIM International, pp. 76-79.
- Toutin, Th., 2001. Review article: Elevation modeling from satellite visible and infrared (VIR) data. *International Journal of Remote Sensing*, Vol. 22, No. 6, pp. 1097-1125.



Figure 2. Natural colour anaglyph image generated with IKONOS panchromatic and multispectral data. The image shows a part of the campus of the University of New Brunswick, Canada.

