MAPS: PROVIDING QUALITY IMAGERY INTO THE NEXT MILLENNIUM.

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ABSTRACT
UK Perspectives' Millennium Aerial Photographic Survey (MAPS') is an ambitious project to produce 0.25m resolution digital colour orthophotography covering the whole of England, using digital photogrammetric techniques. UK Perspectives Limited is a joint venture between Simmons Aerofilms Limited and NRSC Limited. A total of 80,000 frames of colour imagery has been captured using traditional aerial cameras during the summer of 1999 and early 2000. The size of this project presents technical problems in data acquisition and processing, as well as the considerable managerial input and investment in new technology. Intelligent use of the latest developments in the industry is essential to reduce costs. Future developments in digital photogrammetry promise to increase efficiency further.
This imagery has proved to be of use to many different clients from large organisations such as local Authorities, Utilities and Consulting Engineers at the top end of the scale right down to individuals who wish to purchase a photographic record of their own area. Interest in the MAPS' product, has also been shown by new customers such as finance and insurance companies. In order to maximise this potential innovative sales and marketing techniques have been employed including using flexible licensing options for multi-user sites, establishing a network of distributors and making the imagery available on the internet.

1 INTRODUCTION

Digital Orthophoto Maps have increased in popularity throughout the U.K. in recent years. The increased demand for this type of mapping stems largely from the growth of the GIS industry, and the availability of high powered computer hardware and software to exploit its use. To satisfy this demand UK Perspectives' have launched The Millennium Aerial Photographic Survey (MAPS'). UK Perspectives' is a joint venture between Simmons Aerofilms Limited and NRSC Limited. The aim of this ambitious project is to produce a fully ortho-rectified photographic dataset of the whole of the U.K for volume sale primarily for the GIS, engineering design and environmental monitoring markets.

The technical specification for this project was developed with a large range of potential users in mind. This was developed with the use of a survey of customer requirements, particularly from local authorities and utility companies. The results of this processes resulted in the following specification:

- Ortho-rectified imagery
- A minimum ground resolution of 0.25m
- The imagery should be orientated to the Ordnance Survey National Grid.
- Ortho-rectified imagery provided in 1km^2 tiles
- An independent image viewer enabling the user to analyse the imagery without having to purchase GIS or commercial CAD software
- Image compression, to enable large areas to be manipulated on desktop computer systems

To produce digital orthophography at the required ground resolution of 0.25m, and to provide economic coverage the colour aerial photography was specified at a scale of 1:10,000. Although the process of producing digital orthophotography is well established and that there are a number of photogrammetric software solutions available, the biggest problem relates to the large number of images to be processed in an efficient manner to make the product economically viable.

2 ORTHOPHOTOGRAPHY PRODUCTION

2.1 Data Acquisition

The aerial photography is acquired using traditional aerial survey cameras, equipped with FMC and a 6 inch focal length. The aircraft are also fitted with a GPS flight management system to aid navigation. This system also ensures that that the specified forward and lateral overlaps of 60 and 20% respectively are maintained. The two companies have allocated five twin-engine aircraft for this work, this is principally to complete the photographic coverage of England by early 2000. Within large urban areas this specification will change slightly with regard to increasing the amount of stereo overlap, therefore providing a greater number of images to produce the orthophotography, reducing the effects of relief displacement on tall buildings. In addition to this each aircraft is fitted with another GPS antenna to provide photo centre co-ordinates, which are used in the aerial triangulation adjustment. This additional requirement means that a network of GPS base stations has to be established within 100km of the area where the photography is being acquired.

In addition to the photography and the photo centre co-ordinates a network of ground control points in the national grid co-ordinate system (OSGB36) is also required to successfully orientate the photography, to meet the projects accuracy requirements. These are established on natural points identified on the photography using dual frequency GPS receivers.

2.2 Production Process

The production process is vital to producing a cost effective product. Central to this is the design of the system itself and the efficient transfer of data between different stages of the process. Figure 1 outlines the system used at Simmons Mapping (UK) Ltd.

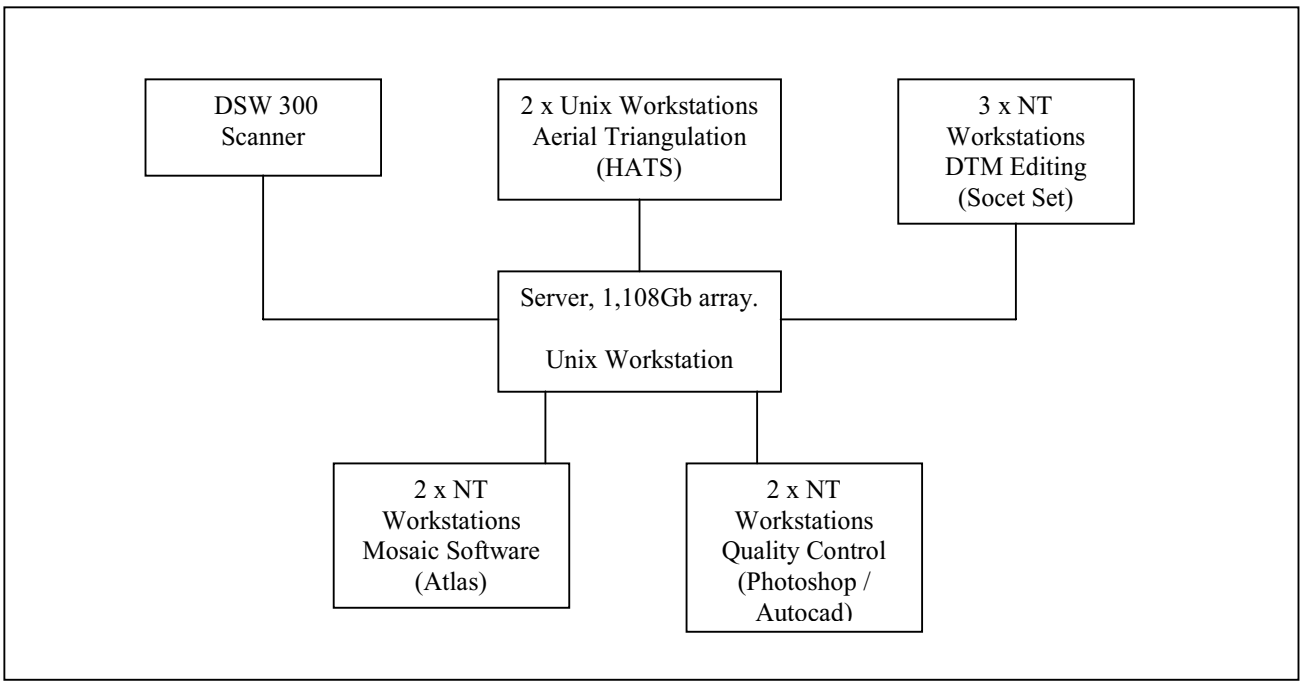

Figure 1. Digital Orthophotography Production System.

The system is built around a central server, powered by a unix system. This single digital environment allows the easy flow of data between each of its components. The systems software is based around LH Systems Socet Set. This also allows easy communication between the DSW scanner and the digital photogrammetric software. The only departures from this are the Atlas software used to create the orthophotography, and photoshop and Autocad to enable quality control checks to be made.

Despite the large amount of storage space the system requires careful management, particularly with regards to continual data flow between each stage. Careful planning will ensure that enough work is available for the operators at each stage and avoid large amounts of data to build up in the system. This system has proved to be very flexible and efficient and with the introduction of some simple programs, some of the more mundane tasks can be automated to run overnight.

2.2.1 Scanning. To meet the requirement of 0.25m pixel size, each individual frame has to be scanned at a resolution of 15 microns. This produces very large volumes of data. The LH Systems DSW 300 has the advantage that it is able to scan negative roll film, and therefore operate 24 hours a day. It also has the advantage that it is compatible with Socet Set, and that the inner orientations are done during the scanning stage. This may not seem much of an advantage, however when a block of about 200 images is being prepared it saves a lot of time and removes what is a very tedious task. Once the imagery is scanned they are archived onto 35Gb DLT technology, run from the unix server.

2.2.2 Aerial Triangulation. A single colour image scanned at 15 microns uses 755Mb of disk space, therefore it is not practical to use the full sized imagery during the aerial triangulation process. The original images are compressed into an NTF format, which reduces their size to 10% of the original. This means that large blocks of 150 images can be computed at any one time. The HATS module of Socet Set is used to automatically generate the tie points, edit the blunders and observe the ground control points. The final adjustment of these observations, together with the GPS photo-centre co-ordinates is computed in BLUH bundle adjustment software, and re-imported into the Socet Set system. It has been noted that using good quality scanned imagery flown with the aid of a GPS flight management system, enhances the automatic tie point generation performance.

2.2.3 DTM Generation. Several existing DTM products are available on the market, but were rejected on the grounds of cost, and accuracy. Deriving our own terrain model from the compressed stereo images has the advantages that we can directly control its quality and that we are also able to sell it as a commercial product in its own right. The DTM is generated as a TIN, at grid intervals ranging from 5m up to 25m depending on the type of terrain, using the Socet Set software. The generated DTM' s are then edited using the interactive editing tool within the Socet Set to produce a terrain model suitable for the generation of the orthophotography. In complex urban areas the TIN model has the advantage of being able to directly digitise break lines to model complex topography.

2.2.4 Orthophotography Production. The orthophotography is produced using Socet Set and Atlas digital photogrammetric software. The Atlas software is favoured in many areas as it is quicker in generating the $1km^2$ tiles. However Socet Set is preferred in urban areas, were the operator is able to determine the seam line around the centre of each image, therefore defining which part of each image to use in the orthophoto production. This avoids the effect of buildings on individual tiles being cut in two. During the orthophoto production process the operator carefully chooses the image best suited to producing a particular tile. In this way the effects of relief displacement on tall buildings can be minimised. The 1 km^2 tiles can be compressed using ER Mapper or Mr Sid software depending on the clients requirements. Alternatively the imagery can be supplied with the UK Perspectives Geo Viewer. The final tiles are archived onto 35GB DLT tape.

2.3 Quality Control

As with any major survey project, quality control is a vital element. The most crucial factor is the image quality. This is important for two main reasons. Firstly the scanned image quality has a major effect on the final product. If the original scanned imagery is of a poor quality then the final tiles will look poor as they are made directly from this imagery. Secondly the image quality has an influence on many other processes. For example poor quality imagery will result in unsuccessful tie point generation and unsatisfactory DTM production. These two processes of correcting tie point observations and editing DTM' s are both operator intensive, therefore if the automatic processes can be improved by improving the image quality, considerable savings could be made.

Considerable time has been spent in improving image quality, principally by spending time on the scanner, as there is no substitute for an experienced operator. A large project such as MAPS' will inevitably have a large number of films taken over a period of several months it is difficult to maintain a high level of consistency. In addition the imagery is scanned from the original negative, which may contain localised blemishes. These maybe small lighter patches, caused by uneven exposure of the negative, or dark areas towards the corners of the format where image quality is always likely to deteriorate. In extreme cases this will cause a problem during the mosaic process particularly between adjacent flight runs. The consequence of this is that the scanning and image quality control process has to be carefully monitored. Photoshop is used for quality control and dodger, a program supplied with the DSW scanner is used to maintain image quality. Dodger is in effect the electronic equivalent of photographically dodging a film to produce a set of contact prints. By carefully monitoring the scanning process it ensures that good quality, homogenous set of imagery is available for aerial triangulation, DTM generation and orthophoto production.

Quality checks are also made on the final $1km^2$ tiles, both for geometric accuracy and aesthetic quality. The positional accuracy is checked by independent GPS surveys co-ordinating points of detail. In addition each tile is checked for visible seam lines caused by a mismatch of colours or the displacement of features, such as buildings cut in two. The tiles are also loaded into Autocad and edge matched with each other to ensure that a continuous mosaic is formed.

3 FUTURE DEVELOPMENTS

The development of the orthophoto mapping system is an ongoing process. It is largely dependant on its own success to generate revenue through increased sales to re-invest in new technology and staff. There are obvious improvements that can be made in terms of increasing the specifications of the Unix and NT workstations, and to upgrade the network. These improvements would obviously increase productivity. In addition in terms of the Socet Set software, improvements could be made to the tie point generation and DTM collection strategies, and running aerial triangulation blocks of 500 images would prove to be much more economical. The LH Systems DSW 500 scanner is now on the market, with improvements in scanning time compared to the DSW 300. In the longer term the scanning process, will be replaced by digital aerial cameras.

4 MARKETING & SALES

The move from relying on competitive tendering for contract work to marketing a product and brand promotion provides the company with a new marketing challenge. Through the company UK Perspectives, MAPS' is promoted to the professional mapping markets, primarily to local authorities, utilities, engineering design and environmental monitoring companies. A marketing and brand promotion strategy, as well as a pricing structure have been developed. To the commercial markets MAPS' is supplied on a 1 km^2 tile basis, with no minimum purchase order. It is available with a single or multiple user corporate license. A sliding scale of discounts is applied to larger areas at district and regional levels. In addition to this a network of distributors has been established to promote the MAPS' product and in the near future it will be available on the internet, for individual purchase. This marketing effort is vital to the success of the project as it is only through increased sales that the company is able to continue to invest in new technology and staff.

5 CONCLUSION

UK Perspectives' MAPS' project is an ambitious project, aiming to produce orthophotography of the whole of England by the middle of 2001. The product is primarily aimed at the professional mapping market. However the aim is to make the imagery available on the internet to individuals and therefore promoting the use of digital photography to a much wider audience, enhancing the customer market for UK Perspectives. The design, operation and management of the photogrammetric system capable of coping with the scale of the MAPS' project, is vitally important to the projects long term success. To be successful in the longer term will require the system to be continually developed and new technologies adopted as they prove their economic viability.

REFERENCES

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