UPDATING COMPLEX DATABASES - THE NEXT STEP

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ABSTRACT

Digital topographic databases are fundamental to management of an ever-increasing range of business functions within a GIS environment. It follows that currency of such databases is critical to effective use of the new technology.
The more complex the topographic information involved the greater are the implications to the updating procedures, particularly if in addition to current data, archiving of a historical perspective is a requirement. To date these matters have remained largely unaddressed by software houses generally.
The issue increases in importance daily and it is logical that OEEPE should play a leading role in promoting this follow-up activity. Such activity must focus on the use of newer technology, typically digital photogrammetry and monoplotting, and identify means to effectively apply such methodologies to complex topographically structured, multi-featured coded databases.
The recently completed OEEPE Commission 1 project "Updating of Complex Digital Topographic Databases" was a major attempt to tease out the principles involved and the difficulties to be overcome in seeking solutions. The paper outlines these and develops on its findings.

INTRODUCTION

The Updating of Complex Topographic Databases (OEEPE Official Publication No 30) project of March 1995, which I would commend to all involved in this field, addressed a number of areas of database maintenance. These covered all aspects of updating both the graphic and its attributes and explained how provision of "change only" information, archiving of an historical perspective and interrogation of the latter for specific historical points/periods, could best be accomplished.

The project examined the issues on the basis of maintaining a digital topographic database containing large scale information as this offered the greatest potential to deal in a practical way with the problems of updating complex, topologically structured, multi-feature coded data. Aside from the generalisation issue which complicates the situation, the principles established are equally applicable to a database holding small scale information.

While it succeeded in bringing to the forefront issues which few had tackled or even considered and acted as a forum to reflect the views of a number of organisations operating at the leading edge, a number of issues remained unresolved at its completion. These were focused into four key areas where software development was recommended.

i. Recording of the time/ historical dimension.

ii. Production of user friendly/ cost effective updating procedures.

iii. Development of software which can not only produce, but also accept, change only data.

iv. Improvements in data compatibility.

Although no radical new theories or methodology emerged it was particularly evident that the process generally could be greatly simplified and speeded up given a properly facilitated approach.

THE WAY FORWARD

The continuing expansion of geographic information systems (GIS) has ensured that these general principles remain very relevant and while things have moved on somewhat since this report was compiled they still form the basis for further, properly resourced research and development.

Within Ordnance Survey of Northern Ireland (OSNI) action to improve the updating operation by partly building on these recommendations, has continued and it is presumed that others have made similar efforts. Thinking here has also increasingly focused on how the full potential of aerial photography could be exploited to enhance the process.

PROGRESS WITHIN ORDNANCE SURVEY OF NORTHERN IRELAND

Within OSNI considerable advances have since been made with respect to each of the recommendations, progress here being largely dictated by the demands for up to date information in support of the Northern Ireland Geographic Information System (NIGIS). With the OSNI large-scales digital topographic database the key locational element of this continually developing multi-partner network it is imperative that this database can meet the requirements of a very diverse range of application areas, with equally diverse demands for content and currency. While there is still much to be done to produce an ideal updating flowline, enhancements which have recently been implemented have resulted in a significant increase in throughput, a very satisfactory development given the complexity of the data and consequently of the actions necessary to update them.

The main developments in respect of each of the recommendations in the earlier report have been as follows.

Recording the Time/Historical Dimension

OSNI has developed and implemented a new methodology which provides for both current and historic archiving of graphic and textual data, and in addition allows for the provision of change only data from the large scale database. The historic archive is created by marking each linestring, point and object feature within the graphic file with a date of survey and a date of deletion where appropriate. A date of revision is also given to features which have been altered but which are related to unchanged geometry. The date attributes are held within the graphic file and enable OSNI to extract deleted geometry and store this as a discrete layer within the database structure. The date of survey is taken as the date the plan was first digitised while the dates of deletion and revision are taken as the date at which the graphic file is updated by the digital updating section. There is currently a turnaround time of five working days between the date of survey of the deletion/revision and the date of digital update and additional resources will be applied to the updating process to further reduce this time delay.

Production of User Friendly/Cost Effective Updating Procedures

The move to the new updating procedures together with advances in software have allowed OSNI to develop a much more intuitive user interface for the updating process. The software now utilises drop down menus with 'mouse' selection to facilitate

operator interaction during the updating process, and the revised updating methodology simplifies the paperwork and file handling routines associated with recording the change information. These changes have resulted in a saving of 50% in operator time enabling faster throughput of updated information and increased cost effectiveness.

Production of Software which can not only produce, but also accept, change only data

OSNI is now in a position to supply change only information from the large scale database to NIGIS partners and it is recognised that this will provide a more cost effective method for updating customer databases rather than resupplying complete tiles. While none of the NIGIS partners has to date indicated that they are in a position to handle change only information, it is believed that now that change only data is available from OSNI, GIS vendors supporting such clients within Northern Ireland will be required to consider developing procedures to utilise that data.

Data Compatibility

Data compatibility is fundamental to successful GIS implementation and user acceptance of such systems. OSNI is acutely aware of this as NIGIS continues to develop and to further progress the issue a special NIGIS Standards Sub-committee was created to make recommendations. Issues examined were the adoption of appropriate data transfer standards for map based information, Street Gazetteer, Land/Property Gazetteer and address based data.

This sub-committee has since published its findings and recommended that National Transfer Format (NTF) Version 2.0, Level 3 as defined in British Standard BS7567, should be the NIGIS interchange format. Adoption of BS7567 by all NIGIS partner organisations will greatly facilitate data exchange between them and assuming this standard is further accepted by the Northern Ireland GIS community generally, will aid software vendors in the development of systems to handle both new and updated digital topographic data.

PROGRESS SUMMARY

In the main this progress has resulted from in-house development based on existing software and refinements to existing flowlines. It has not addressed to any significant extent improving the data collection part of the updating operation. While many advances have been made in respect of ground collection of revisions by pen computers, as far as user friendly, cost-effective large scales updating procedures are concerned it is felt that the future must still rely heavily on aerial photography.

THE IMPORTANCE OF PHOTOGRAMMETRY TO COST EFFECTIVE UPDATING

Traditionally large-scale topo-graphic data has tended to be revised using a mix of photo-grammetric and ground survey methods. The latter is inherently expensive irrespective of whether revisions are captured digitally, or manually with subsequent digitising. Aerial photography offers much greater potential and used within digital photogrammetric systems provides an increasingly effective means of carrying out the revision process using the principle of superimposition. The benefits of superimposition where the existing database is overlaid on the photographic image are considerable and particularly relevant to efficient database revision.

Superimposition is also possible through enhanced analytical systems but it is a costly upgrade, and

while digital photogrammetric systems are in themselves not cheap, the superimposition feature is purely a software function within them and thus incorporated in the purchase cost. In spite of the latter, if such superimposition is to be in stereo there are very significant introductory costs.

The question must therefore be asked "is full stereo superimposition essential for revision of large-scales data?" This leads directly to consideration of using the digital photogrammetry principles within a monoscopic solution via a digital orthophoto, a process which, depending on the availability of a suitable scanning facility within an organisation, can offer a cheaper option. While such methodology may well seem anathema to the photogrammetric purist cost is a major consideration for any organisation. Fitness for purpose is the critical factor and if a less costly system can revise a database without loss of data precision then its potential cannot be ignored. There is nothing new in this, monoplotting technology being well established. However its widespread use for revision purposes has to date been largely confined to scales of 1:25,000 and smaller.

In practical terms the principles are the same regardless of scale, but in the case of larger scales, such as 1:2500, the degree of refinement in respect of information needed to produce the digital orthophoto is more demanding.

Five main stages apply to the updating process using the mono-plotting system:

- acquisition of appropriate, up to date, vertical air photography
- scanning of the resultant aerial film to produce the digital raster image
- incorporation of digital elevation data to produce the digital orthophoto
- superimposition of the existing vector database for updating from the digital orthoimage
- subsequent databasing of the updated result

While some of these are largely independent of the scale of the database to be revised, others have a major influence on the accuracy of the final updated product. Taking each of the above stages in turn the following observations apply.

i. Aerial Photography

Given the right flying conditions, a properly specified aerial camera and appropriate flying parameters, there is no problem in acquiring suitable vertical aerial photography. Until digital aerial cameras come into common usage the digital photogrammetry process will commence with film, or diapositives, produced in this way.

ii. Scanning

This operation has a major influence on the accuracy of the final updated product and in digital photogrammetry the accuracy achievable increases in direct relation to the resolution of the scanning process. The smaller the pixels produced the more accurate the result. This in turn directly influences the standard of the eventual orthophoto and consequently governs the match achievable with the vector database at superimposition. Most proprietary scanning systems will include software for input of camera parameters, etc and to deal with all aspects of the orientation and scanning operations. The desired result is a digital image, incorporating all this necessary input, at a suitable resolution and in the required co-ordinate system.

While scanning accuracies in the order of 14-20 microns would appear necessary for successful revision of large scales data, more practical work needs to be done in respect of using such results in a production

updating environment to establish if this really is the case. A lesser specification could well produce acceptable results in a monoplotting system, depending on the nature of the area under revision.

Digital Elevation Model (DEM)

Here again the accuracy of the resultant digital orthophoto is influenced significantly by the quality of the DEM used in its generation. Indications are that contour information, for example, would need to be in the order of one to five metre vertical interval to produce an orthoimage of suitable accuracy for large scales revision work. However while this may be necessary in areas of large height variation it may be possible to get by in a lot of less undulating areas with a more relaxed vertical interval such as 10 metres.

Alternatively a suitable DEM can be produced automatically using previously generated height control. However there are indications that editing of some 20% to 30% of points could be necessary and this requires a stereoworkstation facility. Obviously there are aspects here which require greater examination in terms of the large scale updating task if the less expensive monoscopic route is pursued.

Whatever method is used quality of the resultant digital orthophoto is fundamental to its successful use with superimposition of the vector database. This is doubly so as the orthophoto is a marketable product in its own right.

Updating from the Digital Orthophoto

Given a digital orthophoto of suitable quality then superimposition and temporary warping of the vector database for consequent updating is relatively straightforward in principle. However in most cases a building for example will be seen in some sort of perspective view with perhaps two sides visible at ground level, zooming in with accompanying blurring of the raster image, coupled with shadow, can make for quite difficult accurate interpretation of features for update. Further assessment of the inherent problems here is desirable.

Databasing

While updating of topographical features can be considered feasible the degree to which such work can accommodate the attribute aspects of the updates is where the possibility of significant benefits exists. Given complex large scale, topologically structured, multi-feature coded data requiring update there are a lot of issues remaining to be addressed if the monoplotting revision option is to be really cost effective in the widest sense.

Other Considerations

Particularly in stages (ii) and (iii) above the major concerns are to produce a digital orthophoto which will enable revisions to be extracted to the required accuracy. Further assessment of the potential of monoplotting for large scales update must also examine an even more radical scenario. This involves use of a straightforward digital representation of the aerial photograph to provide a sufficient revision answer over a localised area when the vector database is overlaid and warped to fit. If it works it will certainly be cost effective but it must be proven to produce the required accuracy.

CONCLUSION

Considerable development is still needed to produce really efficient updating procedures for complex large scale digital topographic databases. Significant progress is evident and fuller handling of the complexity aspect at data capture stage appears to offer the best future line of research. This applies particularly

in the photogrammetric field where even the most radical of ideas need to be tested. Traditional stereoscopic photogrammetric principles are still totally valid but should not be allowed to blind us to other less sophisticated, but totally legitimate possibilities. OEEPE has a key role here and a project along these lines is being proposed by Commission 1 for consideration in the near future.

References

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