Direct Integration of Photogrammetric Systems and Spatial Database Management Systems with Active Validation

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1 INTRODUCTION

Photogrammetric systems are valuable and important data sources for GISs. They collect reliable 2D/3D geoinformation for GIS databases. Currently, the trend toward the integration of photogrammetric systems and GIS databases is increased significantly. Various integrated systems in different levels of integration have been introduced to the market. Integration of photogrammetric systems and GIS databases has great benefits which some of them are mentioned here. This integration makes it possible to use information from GIS databases in the process of automatic or semi-automatic data acquisition and updating. It reduces time and costs of producing and maintaining high quality and up-to-date information in spatial databases. Also by using these systems, map generation in different scales would be possible. If active validating and on-line data structuring tools are provided and applied in these systems, the quality of geoinformaion will be increased significantly and the gains of efficiency become considerably greater. Quality and consistency of data are very important, because they effect on the reliability of the results of GIS analysis. However, a few of the existing integrated systems have tools for on-line and automatic 3D data structuring and quality controlling. So in this research this issue is considered and in the section 2 development of a direct integrated system with active validation is explained.

2 DIRECT INTEGRATION OF PHOTOGRAMMETRIC SYSTEMS AND SPATIAL DATABASE MANAGEMENT SYSTEMS

For developing the desired integrated system with on-line and automatic 3D data structuring and validating tools, after evaluating the requirements, it would have been needed to evaluate other activities and recommendations in this field. Then the results of this evaluation were used in developing the system. From the evaluation, it was resulted that active or on-line validation using rule-based processing is needed to efficiently support the more complex data models coming into use (Woodsford, 2004). A strong candidate for supporting rule-based processing is object-oriented technology. In this way, a rule-based system is developed for on-line and automatic validating and applying consistency constraints on data in an object-oriented environment.

In this research a system called OISDBPS(On-line Integrated Spatial Database and Photogrammetric System), has been designed and implemented. The developed system has five main parts that are: (1)main interface, (2)spatial database that can store spatial data and its attributes and also consistency constraints,(3)a rule-based system for controlling consistency and quality of data, (4) data structuring part that contains algorithms of checking and correcting structural errors of data and (5)data visualization part. In this paper the developed system is described with more emphasis on the development of a rule-based system for controlling consistency and quality of data. The rule-based system which is presented here consists of a user interface, a knowledge acquisition module, a rule-based engine, and a database. It should be mentioned that in the presented system topological relationships are used for detecting and correcting structural and topological errors. For designing this system, objects and constraints are modeled with consideration of the requirements of the system. In this system, data is structured and consistency of the produced data is controlled with respect to the stored information in the spatial database. This process is performed at the time of data producing and digitizing in the 3D/stereo environment of the photogrammetric system. For this purpose, algorithms of detecting errors are applied and the correcting process would be performed at the same time if it is needed. After this process the produced 3D geoinformation will be stored in the database directly. Figure 1 illustrates this process in the developed system.

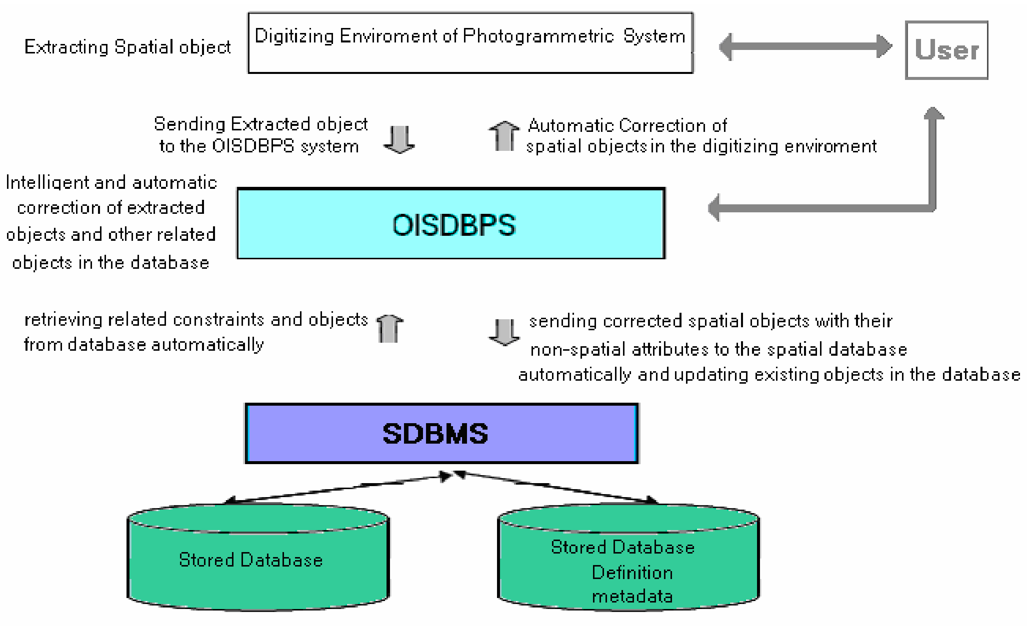

*Figure*1: Process of Correcting spatial data in the developed system

For detecting and correcting errors and controlling the consistency and quality of spatial data, consistency constraints are used. Consistency or integrity constraints are the conditions that should be held for the data in the database to be consistent. Since many of integrity constraints such as semantic constraints are application-dependent, it is needed to create new constraints or change the existing constraints with respect to the application and then store them in the repository again. So in the system stored rules can be changed or even new rules can be created by an expert user. For simplifying the definition of the rules, a user interface window is provided (as illustrated by figure 2).

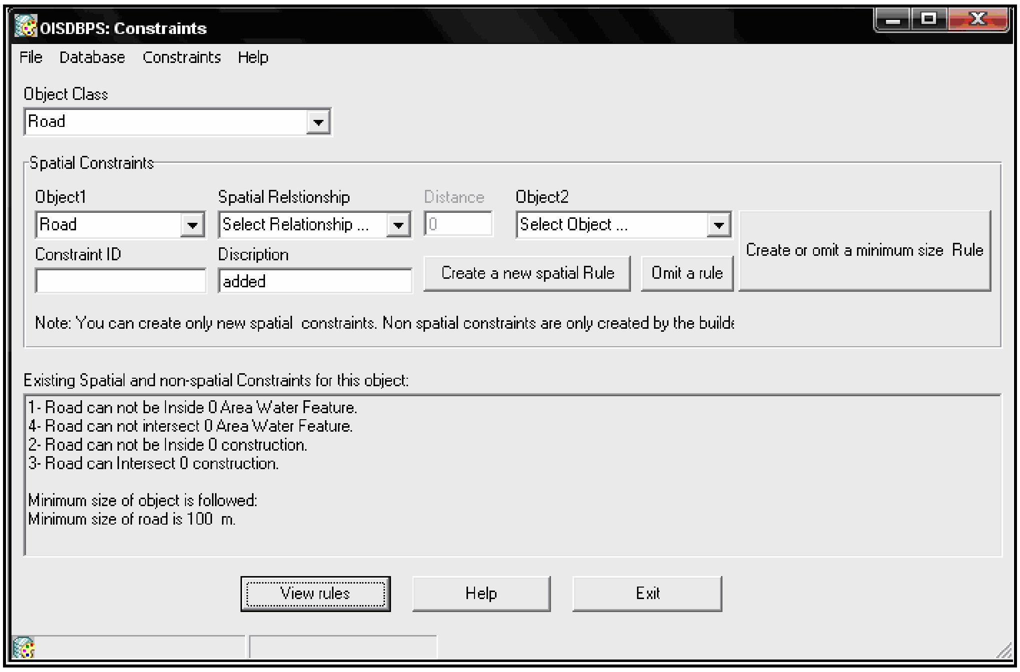

Figure2: User interface window for definition of the rules

After specifying the rules, they are stored in the database. The stored rules can be enforced on data entry in different problems. These rules can be used by any user for different problems but only expert users can change or create new rules. This makes it possible to use knowledge of experts that is stored in the database in the form of rules even by a user without this knowledge. Number of user defined rules for a problem can be even more than 1032 in this system. The rules are in the form of: Rule(first object, permission and relationship, second object).

For example:

Rule1 for road object class can be like below:

Road _rule_No.1(Road,not intersect,Construction) → Road can not intersect Construction.

The defined rules are stored in the database of the developed system and they are automatically applied on data. Figure 3 shows an example of applying consistency constraints on data simultaneously with digitizing feature from 3D photogrammetric model.

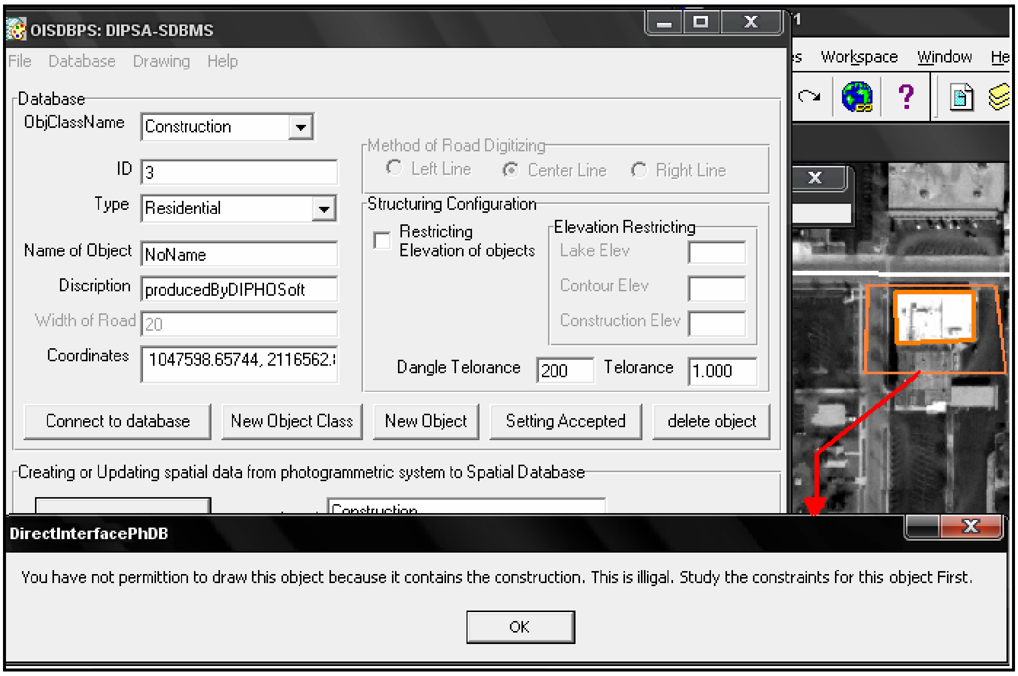

Figure 3 : An example of applying consistency constraints on data simultaneously with digitizing feature from 3D photogrammetric model.

As it is mentioned, this system is developed for acquisition and maintenance of reliable 3D geo-information. This system uses Oracle as its spatial database system and its constraint database which is an object relational DBMS and it has high interoperability, security and powerful functions. On the other hand, this integrated system applies Photomod photogrammetric system because of its popularity and accuracy and also its 3D stereo environment. In this developed system, algorithms are applied for the process of data structuring and correcting. All parts of the presented system were built using Visual Basic 6.0. This system uses Oracle as both its spatial database and constraint database. For sending, retrieving and updating data in the Oracle database, SQL commands were used in VB6, too. The visualization part of this system that visualized the stored 3D geoinformation in the spatial database was also built using Visual Basic 6.0 based on MapObjects(ESRI). It should be considered that the stored spatial data in the database can be visualized in other ways such as using ArcSDE(ESRI), Microstation(Bently) and VRML, too.

For testing this system, aerial images of Shiraz (scale: 1:5000 , 2004) were used. The results of tests have shown that the produced and stored geoinformation by OISDBPS system is fully structured and consistent (figure 4).

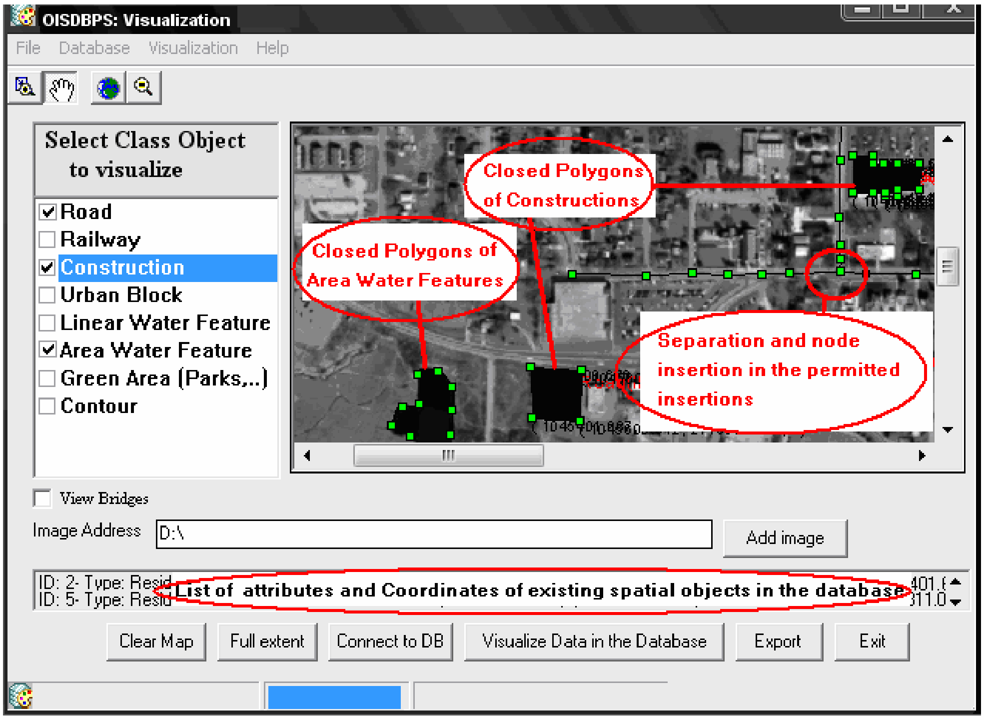

*Figure*4 : The produced and stored geoinformation by OISDBPS is fully structured and consistent.

3 CONCLUSIONS

This paper illustrates the design and implementation of a direct integrated system with active validation for producing fully structured and consistent data. Testing the presented system and evaluating the results, shown that the produced and saved information in the database by means of this system is consistent and structured efficiently. In addition, time of producing spatial structured and consistent information for GIS databases is reduced significantly. Using this system for producing and storing structured and consistent data is economic, too. This system also can be used in the process of data producing and updating using other photogrammetric data acquisition systems.

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