



**UNIVERSITI PUTRA MALAYSIA**

**RESOLVING SPATIAL CONFLICTS IN COMPUTER-GENERATED  
COLLISION DIAGRAMS FOR ROAD ACCIDENT ANALYSIS**

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**By**

**AHMAD RODZI MAHMUD**

**Thesis Submitted to the School of Graduate Studies, Universiti  
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Degree of Doctor of Philosophy**

**October 2002**



*Dedicated to my wife, Kausar, Khaulah and the rest of the  
families.....*



Abstract of thesis presented to the Senate of Universiti Putra  
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Doctor of Philosophy

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**Chairman : Professor Ir. Dr. Radin Umar Radin Sohadi**

**Faculty : Engineering**

This research deals with the depiction of road accident scenes using symbols. When cartographic symbols are presented, there may be situations where they are either too close or overlapping. Manual intervention is thus needed to rearrange the symbols to avoid confusing the user. This condition, known as spatial conflict, is part of the problem in cartography especially in the process of automated generalization.

When a collision diagram is drawn to show the road user movements (RUM) that indicate the nature of vehicle maneuver in road accidents at a particular site, the position of the event is often re-located because of the type and size of symbols used. The changes made are always tentative, iterative and subjective. It is



also a time consuming process, as the draughtsman need to decide the right and accurate symbols to be presented. These processes are needed, as the symbols are usually close or overlapping against each other. The diagram may not be much helpful to the traffic engineer if no intervention is being made to re-position the symbols. A clear and informative diagram is necessary to determine the predominant type of road accident, and for proposing the best remedy. Therefore, the procedures in the creation of Collision Diagram involve an iteration process which are subjective due to an array of human factors involved in making decisions. As a result, inaccuracy occurs in presenting the right position and the right symbols. Hence this work focuses on the automation process for resolving the spatial conflict.

The methodology proposed in this work is motivated by several approaches used in arranging objects in the form of circles within a limited space. Instead of plotting in rows, square or hexagons, the methodology implemented introduces some enhancement in geo-computation work to avoid wasting space and at the same time attempts to preserve topological relationships. An algorithm for resolving the spatial conflict in cartographic terms was designed and tested. Implementation of this technique enhances the methodology of creating Collision Diagrams, and maintains the topological relationships between the symbols. The

work undertaken is part of the phases in “knowledge construction process” specifically to solve spatial conflict issues.

The approach taken had enhanced the traditionally solution of re-arranging the position in rows to avoid any overlapping cases. Hence, the study contributes a methodology in resolving spatial conflict in the process of automated generalization. The output of this work is a spatial-conflict removal module written in Pascal. The data for this system is an accident database taken from a format generated by a package known as Micro Accident Analysis Package (MAAP) used by the Royal Police of Malaysia. The system module created from this work will assign a proper symbol for each accident event and will automatically refine its location. The format of the data being generated is in the form of relational database, which is easily transferred for further analysis in the Geographical Information System (GIS) environment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra  
Malaysia sebagai memenuhi keperluan untuk ijazah Doktor  
Falsafah

**MENYELESAIKAN KONFLIK RUANG DALAM RAJAH  
PERLANGGARAN JANAAN-KOMPUTER UNTUK ANALISIS  
KEMALANGAN JALAN RAYA**

Oleh

**AHMAD RODZI MAHMUD**

**Oktober 2002**

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Penyelidikan ini berurusan dengan penggambaran kemalangan jalan raya melalui kegunaan simbol. Apabila symbol kartografik ini di persembahkan ada kemungkinan pada keadaan tertentu ianya terlalu rapat atau bertindihan. Simbol-simbol ini perlu di susun semula secara manual untuk mengelakkan kekeliruan kepada pengguna peta. Keadaan seperti ini dikenali sebagai perselisihan data ruang. Ia adalah sebahagian dari permasalahan di dalam kartografi terutamanya dalam proses automasi generalisasi.

Apabila rajah pelanggaran di lukis untuk menggambarkan sifat pergerakan kenderaan yang terlibat, lokasi bagi kejadian

tersebut biasanya disesuaikan dengan jenis dan saiz simbol yang tertentu. Perubahan yang dibuat biasanya bersifat sementara, berulang kali dan tidak menentu. Ia juga adalah satu proses yang mengambil masa yang lama kerana pelukis pelan perlu membuat keputusan untuk memilih simbol yang betul dan tepat. Proses ini diperlukan kerana simbol-simbol biasanya terlalu rapat atau bertindihan sesama sendiri. Rajah seperti ini tidak membantu kepada jurutera trafik sekiranya tiada campurtangan dilakukan untuk mengubahsuai kedudukan simbol-simbol tersebut. Satu rajah yang jelas dan bermaklumat adalah perlu bagi menentukan jenis kemalangan paling utama dan seterusnya boleh digunakan untuk mencadangkan cara terbaik memperbaiki permasalahan tersebut. Oleh itu kajian ini di fokuskan untuk menyelesaikan perselisihan data ruang dalam proses automasi generalisasi.

Kaedah yang di utarakan dalam kajian ini di motivasikan melalui pelbagai pendekatan dengan menyusun objek-objek berbentuk bulatan dalam satu ruang yang terhad. Kaedah yang dilaksanakan telah memperkenalkan beberapa peningkatan dalam kerja geo-hitungan untuk mengelakkan pembaziran ruang dan dalam masa yang sama memelihara hubungan topologi sesama objek. Ini adalah pengganti kepada kaedah pemplotan mengikut barisan, segiempat sama dan hexagon.



Pendekatan ini telah mempertingkatkan penyelesaian secara tradisi dimana kedudukan simbol diletak mengikut baris untuk mengelakkan pertindihan. Oleh yang demikian kajian ini telah menyumbang satu kaedah dalam menyelesaikan permasalahan pertindihan data ruang dalam proses automasi generalisasi. Hasil pengeluaran dari kajian ini adalah modul penyingkiran konflik dataruang. Ia telah dibangunkan dalam bahasa pengaturcaraan Pascal. Data untuk sistem ini adalah berpunca dari pangkalan data kemalangan yang diambil dari format yang dikeluarkan oleh Pakej Analisa Mikro Kemalangan Jalan Raya (MAAP). Pakej ini digunakan oleh Polis diRaja Malaysia. Modul sistem yang dibentuk dapat menentukan simbol yang sesuai bagi setiap kes kejadian dan secara automatik akan memberi lokasi yang lebih jelas kedudukannya. Format data yang dihasilkan adalah dalam bentuk pangkalan data berhubungkait di mana dengan mudah boleh dipindahkan untuk analisa lanjut dalam keskitaran sistem maklumat geografi (GIS).

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Jazallakallah hu khoiran kasira

Ahmad Rodzi Mahmud



## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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AHMAD RODZI MAHMUD

Date :

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## **GLOSSARY**

Aerial Photos	Photograph taken from Aerial Camera, a form of remote sensing equipment to capture image of the earth features
Algorithm	A logical step-by-step procedures in programming tasks
AutoCAD	A computer aided drafting software by AutoDESK
Blackspot	A location considered as prone to road accident
Boolean	A special logic of great utility in computer data processing, based on <i>and/or</i> operators and <i>true/false</i> values
Collision Diagram	A map of a accident blockspot showing the approximate positions and manoeuvres of the vehicles involved
Data Structure	A way of organizing information
DXF	An AutoCad data exchange file
Entities	Things in real world
Fatal	At least one person was killed or died within 30 days
Geocomputation	Geometrical computation to address spatial analysis problem, knowledge construction and data mining in geography. Aims to enrich geographic with a toolbox of methods and model
Generalization	A cartographic process in eliminating visual complexity of maps
GIS	Geographic Information System
Head-on	Crash type involving vehicles from adjacent approaches at an intersection or mid-block
Knowledge Discovery	To provide some means of exploratory data pattern

MAAP	Micro Analysis Accident Package
Manoeuvring	Vehicles movement such as making U turns, reversing, emerging from a driveway/laneway/footpath/median, etc.
Mosaic	A set of aerial photographs being assembled to form a photomap
Near intersection	Less than 10 m from intersection but not within intersection
Objects	Classified items in the geographic database
Pedestrian	Person other than a driver, passenger, cyclist or motorcyclist
Photogrammetry	The science of making measurements on photographs
Relational	A type of structure of a database storage which consist of rows and columns
Database Representation	A set of conventions about how to describe a set of things (geographic features)
RSRC	Road Safety Research Centre, Universiti Putra Malaysia
RUM	Road User Movement
Spatial Conflict	Symbols drawn overlapping on each other that is useless for visual analysis
Topology	Properties of geometrical figures that are invariant under continuous deformation (adjacency, containment, overlap)
Visualisation	Spatialised representations of non-geographic phenomena.