

Preface to the Special Issue on Geometrical Algorithms

Dedicated to Professor A. Saoudi

1. Introduction

The impact of designing efficient geometrical algorithms on the practical aspect of computer systems for robotics application has emerged as a vital component of developing conceptual theoretical frameworks.

The design and development of efficient algorithms for intelligent systems can be conceptually classified in two basic paradigms that very closely interact with each other in a given complex situation.

1. *Task-oriented problems*: We are required to accomplish a task that requires a complex system as a part of the solution. Here the problem is to first identify the characteristics of a system that can perform a given task. Then a detailed design and development of variations sub algorithms have to be performed; then these algorithms have to be integrated into a working algorithmic structure.

2. *System oriented problems*: We are given a complex system that had been designed to perform a task, and are required to solve a particular problem. The objective could be designing an algorithm to perform a task that is not identical but related to the task for which the system is first designed.

The objective of this special issue is to bring together the research pursued by theoreticians and designers of algorithms especially in the context of computational aspects of vision and motion planning algorithms. The topics included in this special issue are:

- (1) Graph theoretical and combinatorial aspects of computational geometrical algorithms.
- (2) Computational geometry solutions of fundamental problems arising in computer graphics, pattern recognition, image processing and vision.
- (3) Algorithms mapped onto the application-specific architectures.

2. Summary of papers

In this special issue, we have a very diverse collection of papers written by researchers of universities and national laboratories. Several aspects of algorithms are

addressed in the framework of intelligent computing. We briefly discuss each of these issues and contributions made by the enclosed collection of papers in this direction.

2.1. Data structures for robot motion problems

Dattasharma and Keerthi use a classical data structure called a Voronoi diagram for a collision avoidance path planning problem which is a very important problem encountered in Robotics. More specifically, they present an augmented Voronoi road map for 3-dimensional translational motion planning for a convex polyhedron moving amidst convex polyhedron obstacles. They formally bring the details of this geometric structure and give an efficient augmentation of the road map that makes it complete.

In a related context, Sarrafzadeh and Maddila consider a motion planning problem in a discrete warehouse with movable obstacles. They consider two forms of obstacle manipulations: (1) remote (when the obstacles are moved by a remote mechanism) and (2) contact (when the obstacles are moved only by direct contact of the robot). They present results on the necessary and sufficient conditions for the existence of a motion in both for cases, and propose efficient algorithms for constructing feasible motions. Combinatorial structure of visibility graphs is probably one of the most fascinating and interesting areas of engineering and computer science. The usefulness of visibility graphs in computational geometry and robotics navigation problems like motion planning has been described in detail by Prasad and Iyengar. In their paper they focus on a fundamental class of geometric objects. These geometrical objects are building blocks for designing geometrical algorithms.

One of the most basic versions of the path planning problem deals with computing a shortest path for a point robot through a polygonal terrain in the plane. Towards this end, Rao presents a class of algorithms which has the following computational property: Planning paths faster to the expense of setting for sub-optimal path lengths.

A method presented by Rao enables a hierarchical implementation of any path planning algorithm with no increase in worst-case time complexity.

There is also a growing interest in finding efficient algorithms which will be able to answer the shortest path queries between an arbitrary pair of points in the plane. Such problems are called the full-query shortest path problems in the plane. Sridhar et al. present algorithms for the full-query problem that will construct a critical graph corresponding to the set of objects in the plane. The graph is built in such a way that the shortest path between any two points in the plane would correspond to the shortest path between some pair of vertices in the graph.

De Berg et al. describe a unique navigational algorithm for reaching a goal with directional uncertainty

2.2. Application of algorithms to specific architecture

In recent years, high-performance computing on a fast network of low-cost workstations has become a viable and an economic option compared to that on an

expensive high-performance parallel super computer for solving computationally intensive problems, such as vision tasks for an intelligent robot. Seetharaman has proposed a design strategy for mapping image processing algorithms on a SIMD to run architecture. This paper describes an implementation scheme of a clan of image processing algorithms for a vision task.

Finally Bettayeb proposes to enhance a computational scheme of the hypercube machine by introducing and analyzing a new interconnection network called the K -ary hypercube machine.

3. Dedication of this issue to Professor Saoudi

Ahmed Saoudi (1954–1993) was a Professor of Computer Science at the Université Paris 13. He received his B.S. and M.S. degrees in Computer Science from the University of Louis Pasteur at Starsbourg, France, in 1977 and 1979, respectively. He received the Ph.D and the *Doctorat d'État Es-Sciences* degrees in Computer Science from the Université Paris 7, France, in 1982 and 1987, respectively.

Dr. Saoudi was an adjunct director of Galilée Institute and director of the graduate studies at the Université Paris 13. From 1981 to 1983, he was an assistant professor at the University of Maine. From 1983 to 1984, he was an associate professor at the University of Caen, France. He spent one year at the Université Paris 11 before



Fig. 1. S.S. Iyengar and A. Saoudi (right).

joining the Université Paris 13 where he was promoted to full professor in 1989. In 1987, Dr. Saoudi spent one year as a visiting professor at the University of Illinois. In 1993, he spent three months at Purdue University where he collaborated with Professor Atallah.

Dr. Saoudi had published several papers in various areas of Computer Science such as Image Processing, Formal Language Theory, Pattern Recognition, Robotics, Design and Analysis of Algorithms, Geometric Algorithms and Parallel and Distributed Processing. Dr. Saoudi was the author of several chapters in 10 books. In his short professional life, Dr. Saoudi published over 50 refereed journal and conference papers and his work is constantly referenced by researchers.

Fig. 1 shows Dr. Saoudi with S.S. Iyengar in Paris.

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Guest Editors