A Mobile Device Based Multi-agent System for Structural Optimum Design Applications

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Abstract. This paper will discuss a design, implementation and evaluation of a multiagent system (MAS) for a structural optimum design application (SODA) on mobile devices. The paper commences by defining the relevant concepts of SODAs and MAS. It will then present an architecture and framework combining both. It will explore in detail an implementation running on a mobile device and compare that to a version on a standard PC. The computational evaluation results obtained from a simulation on an actual mobile device indicate that running a complex system on such a device is feasible and usable. Finally, the paper suggests that current mobile devices can be used as more than data displays, and their processing power can be efficiently utilised.

1 Introduction

In recent years, mobile phones received an increasing attention from various scientific communities due to their pervasive nature and because the standard products today are essentially small, mobile computers. Hence it makes them a tool worthy of consideration, especially for applications where the user cannot be expected to purchase an expensive interface or where mobility is of importance.

In this paper a design and implementation of a multi-agent system for structural optimum design on mobile devices is reported. The application presented is the result of a research project on automated structural design, more specifically a tool to assist in the design of power cable trusses (steel constructions of sizeable dimensions that are used extensively for the delivery of electrical power to households). Originally the application was conceived as a tool to be run in advance of a construction as an advisory to the structural designer. Preliminary results of the existing PC based implementation have however suggested that the application can be extended to server as an *on site* tool to render assistance ranging from providing estimates on material requirements to feasibility studies for small and medium sized construction projects.

2 Structural Optimum Design Applications (SODAs)

Traditionally structural optimum design was primarily concerned with searching for both the optimum properties for individual structural components (topology)

R. Meersman, Z. Tari, and P. Herrero (Eds.): OTM 2008 Workshops, LNCS 5333, pp. 118–127, 2008.

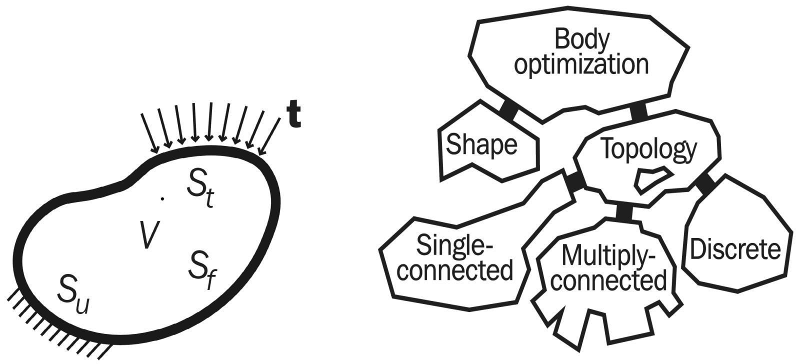

Fig. 1. A deformable body (left), the topology optimisation problem (right)

as well as the optimisation of the shape of the overall structure (geometry). Recent research attention has shifted towards topological optimisation. In this section we introduce a general formulation of *optimum design*, more specifically of *optimum design in mechanics of continuum* [2].

Definition 1 (A deformable body). *Let a deformable body of volume V be enclosed by a surface S. The part St of this surface is subject to traction t, the part S_u is fixed and the remaining part S_f is free. See Figure 1 for an illustration.*

Generally, optimisation problems for bodies described in Definition 1 can be distinguished as belonging to either of the following categories: *Shape optimisation* (See Definition 2) and *topology optimisation* (See Definition 3).

Definition 2 (Shape optimisation). *Let a deformable body of volume V be enclosed by a 3 dimensional environment with at least two defined points $p_1, \ldots,$ p_i. Furthermore assume that the body is required to occupy all i points in space simultaneously. Assuming there is more than a single solution to this problem then it can be subjected to a number of requirements with respect to the spacial coordinates (other than the i points) occupied by the body.*

The *requirements* mentioned in the Definition above can range from aesthetic considerations to practical, physical or spacial constraints. In our case and the presented case study the requirements are spacial and physical in nature.

Since we can take the material of the body as a constant when searching for the optimum shape we can concentrate on finding the best configuration for the free surface S_f making *shape optimisation* the easier one of the two categories.

Definition 3 (Topology optimisation). *Let $P = \{p_1, \ldots, p_i\}$ and $Q = \{q_1, \ldots, q_j\}$ be disjoint set of spacial coordinates. Let furthermore V be a deformable body occupying all points in P and none in Q. Topological optimisation is then the best possible arrangement of V over the remaining spacial coordinates.*