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A navigation strategy for an autonomous patrol vehicle based on multi-fusion planning algorithms and multi-paradigm representation schemes

Osama Zaki and Matthew Dunnigan

Abstract: This paper considers the robot navigation task as an algorithmic and representational one in a way that the performance of the navigation task cannot be measured without combining those two elements. As a result of this view, a unique new navigation strategy based on combined multi-fusion planning algorithms and multi-paradigm representation schemes is presented. An overall architecture for a new navigation strategy is also proposed. Discrete and continuous planning algorithms are combined in a hierarchical fashion. GIS models and ontology are also combined to form rich media for representing dynamic data and knowledge. Experimental results with an evaluation of the schemes are presented.

Keywords: Autonomous navigation, Dynamic GIS modelling, Motion planning

1. Introduction:

There is evidence from a literature review on autonomous robots that there is a need to enhance both; 1) the representation schemes and 2) the planning algorithms; and then 3) to produce an integration architecture for these two elements. In this paper, for the representation, multiple schemes are combined which are GIS modelling and Description Logic. For planning, multiple algorithms are modified and fused such as A-star and Bug2 algorithms. An open layered architecture is then proposed to manage and perform the navigation tasks. In addition, a simple technique is used for sensor fusion for the navigation tasks. Furthermore, Performance Key Indicators are used in both GIS modelling and performance analysis.

Logic-based representations for historical reasons have been used widely to model the state-space of a problem. However, representing the whole state-space in logical formalisms has never been compact, complete, nor explicit and it is difficult to generalize. It has been also found that logic-based planning is NP-hard and that the level of hardness depends on the precise encoding of the problem (i.e. state-space). In autonomous mobile robotics, and other applications, the environment is dynamic and modelling becomes even harder. It is not a static state-space anymore and a configuration space must be thoughtfully represented. Finding the optimal path is not just a graph search algorithm. Planning, on the other hand, has been always considered as a branch of algorithms, i.e. focusing in the algorithmic and computational issues of planning problems and on the combinatorial and asymptotic complexity analysis. However, there are other issues that are not necessarily algorithmic and rely on the models used, and the planning problem under consideration (LaValle M. S., 2006).

In this paper, neither probabilistic models nor heuristic ones were used in the representation schemes or in the planning algorithms and this is noted as a future extension. In addition, this
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