Granular floor plan representation for evacuation modeling *

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Abstract. In this paper we describe the architecture of a simple evacuation model which is based on a graph representation of the scene. Such graphs are typically constructed using Medial Axis Transform (MAT) or Straight Medial Axis Transform (S-MAT) transformations, the former being a part of the Voronoi diagram (Dirichlet tessellation) of the floor plan. In our work we construct such graphs for floor plans using Voronoi diagram along with the dual Delaunay triangulation of a set of points approximating the scene. Information supplied by Delaunay triangulation complements the graph in two ways: it determines capacities of some paths associated with edges, and provides a bijection between graph vertices and a set of regions forming a partition of the floor plan. We call the representation granular for this reason.
We provide an exposition of the representation of fire scene that aids egress time calculations, discuss the algorithm of construction of this representation and briefly discuss the applicability of network flow models (e.g. the Ford-Fulkerson method or the push-relabel method) in our setting.

1 Introduction

ICRA project (http://icra-project.org) aims to build modern engineering tools to support fire commanders during fire operations. In this paper we focus on the problem of modeling evacuation process. While there are various questions one may want to ask regarding evacuation, e.g. related to finding optimal (static or dynamic) evacuation plans, in this paper we focus on the problem of evacuation time estimation and bottleneck analysis. There are four ICRA modules that are being developed that are relevant to evacuation modeling.

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- **fire and smoke localization module**, which determines the placement and spread of fire and smoke,
- **occupant localization module**, which aims to estimate occupant density in various parts of a buildings or determine occupant locations,
- **building topology construction**, which builds a geometric network of the fire scene,
- **evacuation module**, which estimates the egress time, determines bottlenecks and is used in setting priorities during find and rescue operations.

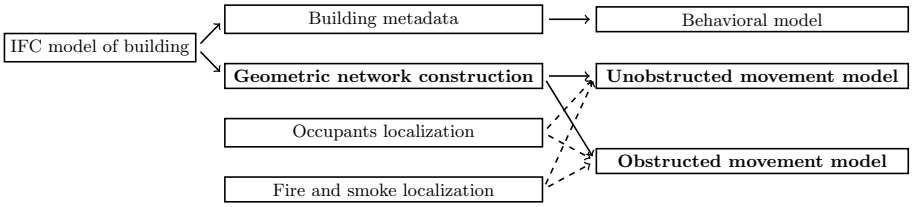

Fig. 1: This figure summarizes the inputs to various models in the evacuation module. For simplicity we treat various localization modules as direct inputs. The focus of this paper is on geometric network construction and movement models.

In our exposition we discuss the typical model of an evacuation process from fire protection engineering literature [3, 1], the desired fire scene representation, and finally the algorithm of geometric network construction that aids egress time estimation. We stress that the discussed egress model is based on a fine network representation and models occupants globally (as groups of people rather than tracking each individual during the simulation) [5]. See e.g. [5],[4],[2] for discussion of alternative approaches.

In our earlier paper we discussed a simplified model coupling a partial behavioral model (accounting for typical pre-movement times) and a traffic model. We provide a clearer exposition of the representation of fire scene and briefly discuss the applicability of network flow models (e.g. the Ford-Fulkerson method or the push-relabel method) in our setting.

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