

# EXPLORING HIGH-RISK FIRE AREA FOR VICTIMS USING AN AUTONOMOUS MOBILE ROBOT

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## OVERVIEW

Replacing humans with robots, or at least assist them, in the search and rescue operations is a necessity given the risks and dangers human rescue forces might be exposed to.



## MOTIVATION

Indoor fire situations are among the demanding fields for aid of specialized robots for assisting in the operations. The major risk to fire victims is smoke inhalation and its consequences, not the fire itself. Due to the high density of the smoke in indoor fires, visibility is very likely to be extremely limited making it highly hazardous for fire personals to explore. Other dangerous factors are possible leakage of poisonous gases and structural collapse.

## OBJECTIVES

The main area of interest in this work is to develop a navigational exploration strategy, that requires low cost sensing, and can tolerate high error rate by utilizing the minimum amount of sensor information required. Also, as topological features are not sufficient for path guidance in hazardous unstructured environments, we aim at relative geometrical features that can be sufficient for accomplishing the given tasks. The developed solution will need to operate in single or multi-robot coordinated mode.

## DESIRABLE OUTCOMES

- Develop/adapt a suitable navigation and exploration strategy for unknown or partially unknown environments with minimal sensing requirements.
- Construct a topological map for the environment with the corresponding "relative" geometrical structure.
- Devise a suitable cost/gain function for frontier selection based on sensors feedback about the fire sources and heat emanating from the surroundings.
- Extend the developed strategy to multi-robot exploration.

## SIMULATION ENVIRONMENT

The strategy developed in this research will be implemented and tested using the Urban Search and Rescue Simulation (USARSim). It is the result of collaborative research efforts among a number of research institutes. Below are the main features of USARSim:

- USARSim is a high-fidelity multi-robot simulator built on top of the Unreal game engine.
- It is an open source simulator that is available for research and education.
- USARSim has built-in models for various popular robots with a variety of sensors.
- USARSim is highly extendable given that its users can:
  - Model their own robots.
  - Add more sensors to existing robots.
  - Use one of the available NIST environments (Yellow, Orange, or Red).
  - Model their own test environment using Real Editor.
- USARSim is platform-independent and can operate on Windows, Linux or MacOS.



NIST Yellow arena

## RESEARCH ROADMAP

Model testing environment

Implement Single robot exploration strategy

Implement frontier selection function

Extend to coordinated multi-robot mode

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