Bayesian Implicit Sentiment Aware Mission Planning with NLP and BIM Semantic Maps

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Background

- Building information modeling (BIM) is often used in construction robotics as a source of spatiotemporal semantic information.
- Most prompted NLP-enabled intelligent systems research focuses on **what** the task is, not **how** to complete it.
- An immense potential lies within the implicit semantic information from BIM and natural language prompts for robot mission planning.
- We introduce a safety heuristic through ***repulsive potential fields*** created from BIM data that can be augmented with implicit semantic information.

Problem Statement

Cost Function: $C(\pi) = w_1(D(\pi)) + w_2(A(\pi))$

Distance Cost: $D(\pi) = \sum_{k}^{K} d(s_{k-1}, s_k)$

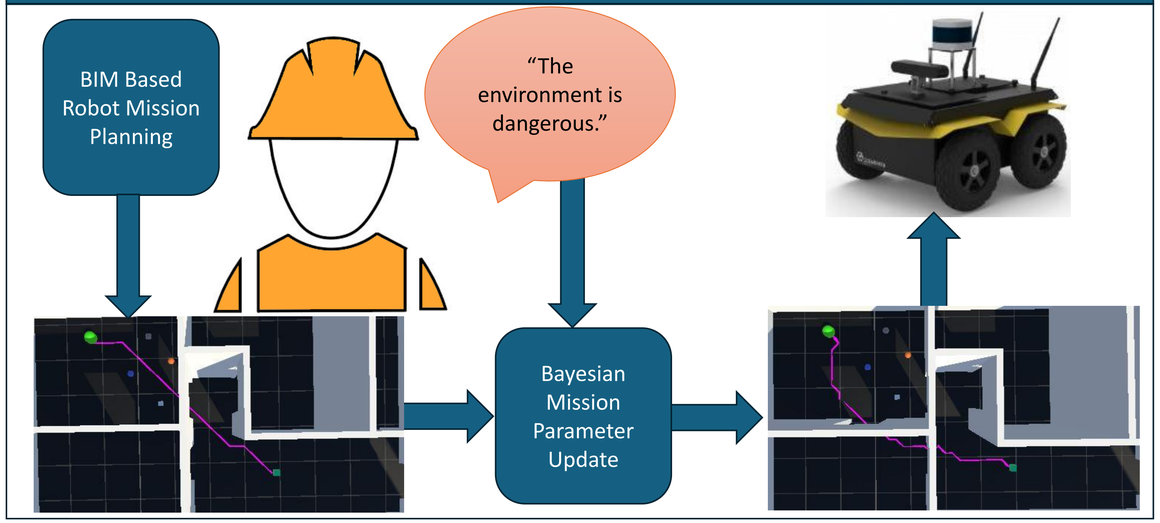
Avoidance cost: $A(\pi) = \sum_{k=0}^{K} \alpha_k a(s_k)$

Potential Field: $a(x, y) = e^{-D(x,y)}$

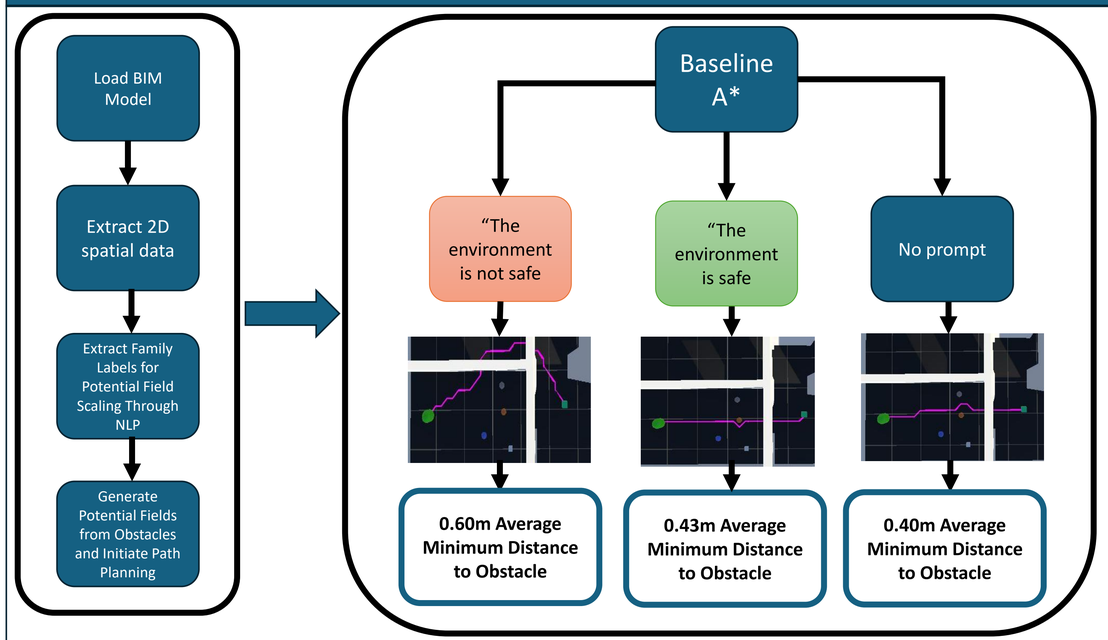
Optimal Path: $\pi^* = \text{argmin } C(\pi)$

MHA*: $f(s) = g(s) + h(s)$

Overview



Experimentation



Results

50% more object avoidance at a cost of 19% increase in path length when encountering dangerous prompts

7.5% increase in obstacle avoidance at a cost of 0.06% longer path when encountering safe prompts

Improvement in object avoidance throughout all prompts and experiments

Discussion

- The method can be used to augment any heuristic, and it is not limited to potential-based safety heuristics.
- LLMs can hallucinate and be unstable.
- Heuristic definition and tuning can drastically affect the performance and behavior of the planning algorithm.
- Future work will explore multi-prompting scenarios and handling conflicting prompts and authority levels.

Acknowledgments

NSF CAREER Award CMMI #2047138 and a scholarship funded by DUE #1930546 financially supported this project.