Using Robots to Save Lives during Emergencies

NRI: INT: COLLAB: Interactive and collaborative robot-assisted emergency evacuations

CNS-1830390, 09/18/18

Alan R. Wagner, Penn State; Minghui Zhu, Penn State; Hai Lin, Notre Dame

Goals

- Develop deployment algorithms to optimize evacuation time and safety
- Synthesize motion controllers to avoid high-density areas
- Evaluate with crowds of people

Challenges

- Emergencies are dynamic, unexpected
- Environment is unstructured, difficult to navigate
- People are confused, distracted, emotional

Scientific Impact

- Algorithms and motion controllers developed offer new methods for rapid robot deployment and reaction
- HRI evaluations provide insight into how people react in high stress situations

Broader Impacts

- Save lives in a wide variety of different environments
- Developed course modules related to robot guided emergency evacuation; Exhibits with children; Undergraduate engagement
- Trying to quantify impact experimentally now.

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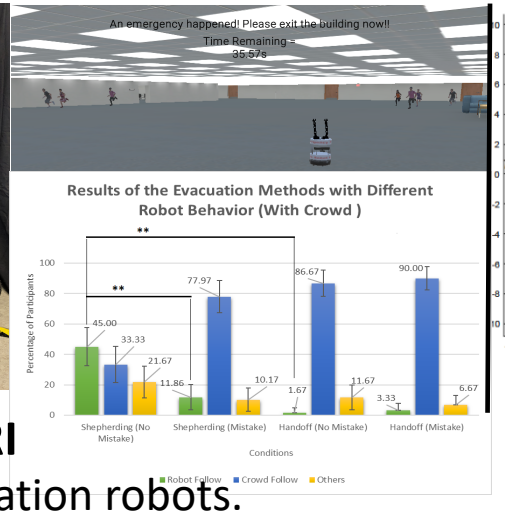
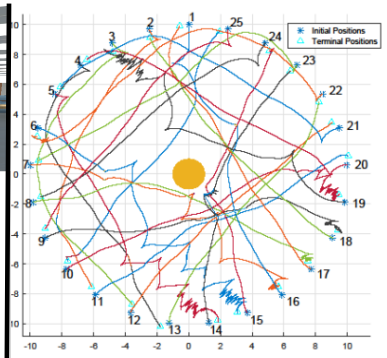
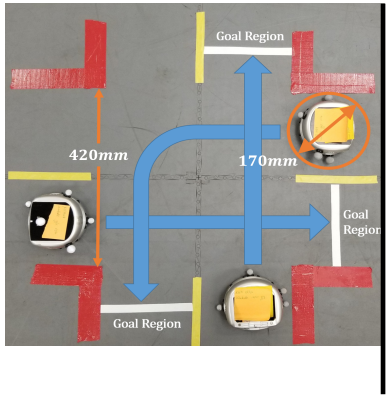


Solutions: HRI

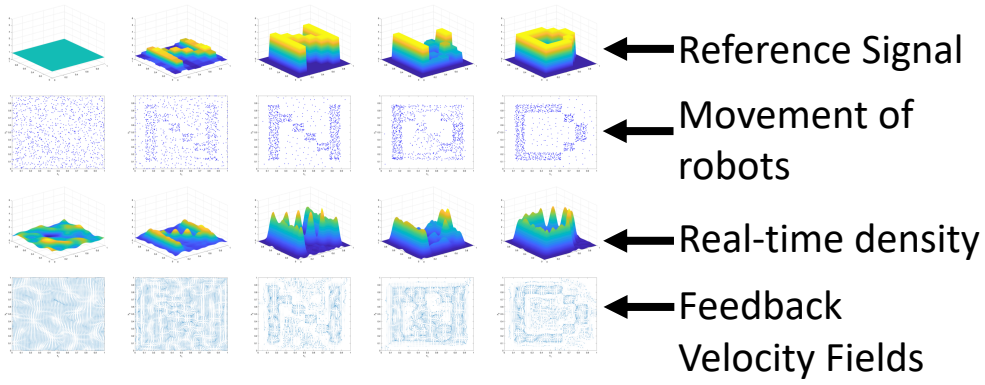
- Build evacuation robots.
- Test in realistic environments with different group sizes.
- Simulation testing to guide hypotheses
- Evaluate robot, understandability, authority, human-responses.





Solutions: Motion Controllers

- Created a scalable distributed algorithm integrating decoupled optimal feedback planning and distributed conflict resolution.
- Collision avoidance and finite-time arrival are guaranteed.
- Complexity indep number of robots



Solutions: Deployment Planning

- Optimally deploy robots using SpaTeL to create reference densities, density feedback control based on PDEs to generate velocity fields for individual robots.
- Novelty: Top-down, provable, closed-loop, decentralized.