**Motion Planning**

Given an environment, we find a valid path for an object (robot) from a start position to a goal position.

However, motion planning is computationally difficult. Therefore, we use sampling-based planners like Probabilistic Roadmap (PRM), which randomly samples an environment to build a roadmap of configurations to find a solution. However, they still have problems such as narrow passages.

**User-Guided Planning**

User-Guided Planning has the potential to solve narrow passages because of the combination of a planner’s automation with a human’s skill at global scene analysis.

- Planners are fast, but usually take the obvious route, which is sometimes detrimental.
- Humans have a natural sense of motion planning
- Combined, both make up for what the other lacks.

**Related Work:**

Region Steering is a user-guided planning technique where the user specifies a region to the planner and designates it as an avoid, attract or neutral to guide the planner through an optimal or safe path.

User-guided technique lets a user input an approximate path to seed the sampling-based planner by utilizing a 2D mouse, 6D haptic device, or 6D camera flight with keyboard and mouse.

- gives positional input to sampler, which then assigns orientation and corrects invalid configurations

**Method: Path Steering**

User can create paths with several input devices

- Mouse 2D
- Camera 3D
- PHANToM 3D

**Experiments**

Set up:

Used: Mouse 2D

Used: Camera 3D

Environments used for testing:

- Heterogeneous
- S-Tunnel
- L-Tunnel
- Bug-Trap

In these environments user input-time, planner time, amount of edges and configurations are taken into account.

- For the automated planners the only input were the environment and query. All planners had a limit of 10,000 nodes, to ensure they would finish within our timeframes.
- For Path Steering, the user drew the path and ran it until it solved, with the same node limitations as above.

From our experiments, we can see that the User-Guided Path Steering technique:

- Achieves a better result than any automated planner by itself.
- Allows the human component (user) to limit the sampling space to the input path.

**Preliminary Results**

- *NOTE: Only experienced undergraduates participated in Path Steering. Also, our method supports PHANToM® haptic path capture, but we were unable to test it due to time constraints.*

**Conclusion**

We have presented a motion planner that combines human intuition and planner automation to better solve various motion planning problems, including narrow passages.

We have shown that a human’s natural motion planning abilities lead to a drastic improvement in time, reducing planning time to a few seconds, and the average combined time to less than a minute.

**Future Work:**

We would like to improve our approach of the motion planning problem by

- Allowing the user to input multiple paths
- Comparing path steering with region steering to compare user burden and effectiveness
- Improving our method’s robustness to account for inexperienced users

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