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ROBOT MOTION PLANNING EFFICIENCY ANALYSIS AND SOFTWARE IMPLEMENTATION

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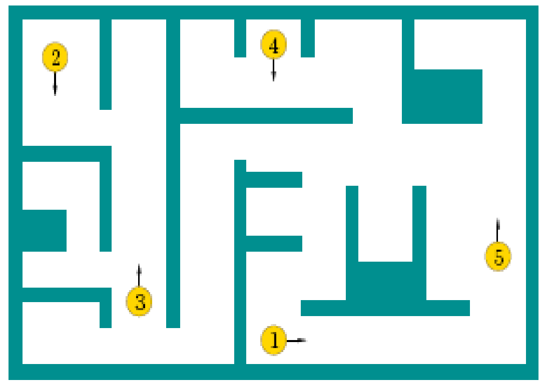
PROJECT DESCRIPTION:

Robotic motion planning is vital to the completion of any robot's task. Motion planning refers to the construction of inputs to a non-linear dynamical system that drives a robot from an initial state to a specified goal. Take for example the simple game of hide and seek. If five autonomous robots were thrown into a dark maze and were expected to find one another, How could they achieve it? Random chance is an option, but motion planning is the answer. Motion planning is the art and strategy of navigation given the expectancy of varying obstacles. So, using the previous example, the robots would search every inch of that maze until they find each other by using proven strategies such as vertical decomposition planning. Real time applications can be found on automobile assembly lines where machines use robotic arms to hold car frames in place while other robotic arms attach windshields and doors.



In this project we will study known algorithms such as the left hand rule, angle constraint approach, and vertical decomposition. We will test the efficiency and productivity of these algorithms and take it a step further by composing a software implementation for the two most efficient algorithms. In this implementation we will create a user interface that allows variation of parameters such as view mode, algorithm strategy, and maze selection. Animation of algorithm's strategy will aid in analysis of algorithms roots as well as provide a generic test bench for any motion planning situation of inquiry.

As human beings we are limited in our

SPECIFIC QUESTIONS/HYPOTHESES (TO BE ADDRESSED)

By exploring the realm of robot motion planning we can further aid researchers, thereby providing a test environment that can visually and numerically be interpreted and analyzed.

1) What algorithms are the most time efficient?
2) What algorithms use the least amount of trial errors (least memory)?
3) What are the restrictions of these algorithms?
4) How can we get the robot to have a sense of space (proprioception)?
5) How can we get the robot to find a specific target in the maze?
6) How can we get the robot to find its way through a maze and remember its path?

7) What will happen if we let the robots wander the maze randomly? How long will it take for the robot to find its way out?
8) How can we get the robot to determine what type of shape and structure it is walking around?

METHODS (TO BE UTILIZED, INCLUDING BACKGROUND RESEARCH TO BE STUDIED)

1) Background Research
   a. We will research famous 2D Road Map Algorithms such as the ones listed below:
      i. 2D Decomposition: Trapezoidal/Triangular Vertical Cell Decomposition,
      ii. Shortest Path Algorithm
      iii. Etc.
   b. 3D Algorithms (if time permits)
      i. Canny's Roadmap Algorithm
   c. Motion Planning Software
2) Methods
   a. Random Sampling
   b. Software Implementation
      i. Coding
      ii. Debugging
   c. Mathematical Formulation of Algorithm
   d. Webpage Design

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3) Y. Liu and S. Arimoto. Path planning using a tangent graph for mobile robots among polygonal and curved obstacles. International Journal of Robotics Research, 11(4):376–382, 1992.
4) J. Hopcroft, D. Joseph, and S. Whitesides. Movement problems for 2-dimensional linkages. In J .T .Schwartz, M. Sharir, and J. Hopcroft, editors,
5) Planning, Geometry, and Complexity of Robot Motion, pages 282–329. Ablex, Norwood, NJ, 1987.
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IMPACT ON THE GOAL OF CREU: (Project Impact on team members)

This project will allow the students to participate in a professional environment with deadlines and quotas to be met. The project demands time, diligence, and open-mindness from its participants. The participants will be asked not only to code and debug like they have been learning as Computer Science and Electrical Engineering majors, but to demonstrate and advance their problem solving abilities to the level of professional engineers and programmers. This project will act as a great learning experience but will also serve as a mechanism towards future employment.

STUDENT ACTIVITY AND RESPONSIBILITY

Students will be active in reading and interpreting published books and papers on motion planning. The group will meet weekly to discuss progress on algorithm analysis such as ideas for improvement and if a certain algorithm is translatable into a software language. We will spend a majority of the first half of the research project in the decision process, what direction to take towards a specific visual medium (find exit to maze, searching for targeted area on map, etc). The remaining time will be spent experimenting with varying parameters in each algorithm, measuring time needed for a decision to made, and comparing total distances traveled.

FACULTY ACTIVITY AND RESPONSIBILITY

TIMELINE:

The time line listed below is a synopsis. Once the project lifts off, every week and month will have specified detailed goals.

MONTH INTERVALS	GOALS
August-September	Research the Origin of motion planning, famous algorithms, suitable software for translation from mathematical theory to computer logic, and decide what task, strategies to analyze and compare in depth
October- December	Plan pseudo code and flow chart for coding, then begin coding software for algorithm design, focus mostly on animation of algorithm
January-March	Implement algorithm design, debug code, and create user interface that changes the numerical values of parameters in the algorithms
April- May	Final debug of entire research project. Based on research gained, write paper on robotic motion planning via animation, and based on research attained.
note:	we will have weekly meetings to review current status and progress

Budget :