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Semi-Autonomous Mobile Robot Navigation in Populated Environments

Mid-term Master Thesis Presentation

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Agenda

Introduction

Goals and Objectives

Approach

Work for 2nd semester

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Introduction: Wheelchair Navigation Assistance

Semi-Autonomous

Populated Environments

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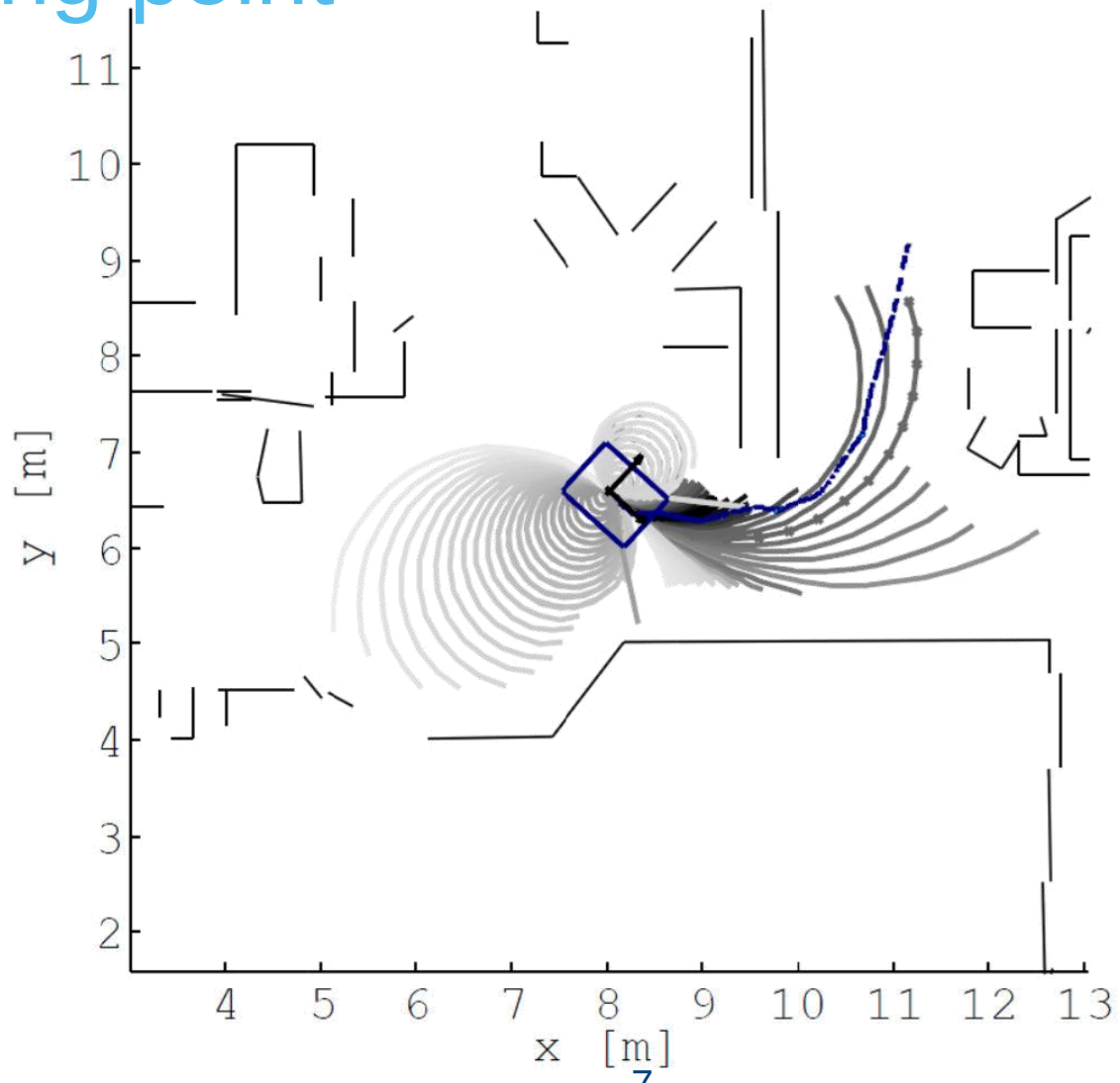
Goal

Tackle the path planning problem in dynamic environments, using a socially compliant motion planner for semi-autonomous navigation.

Starting point



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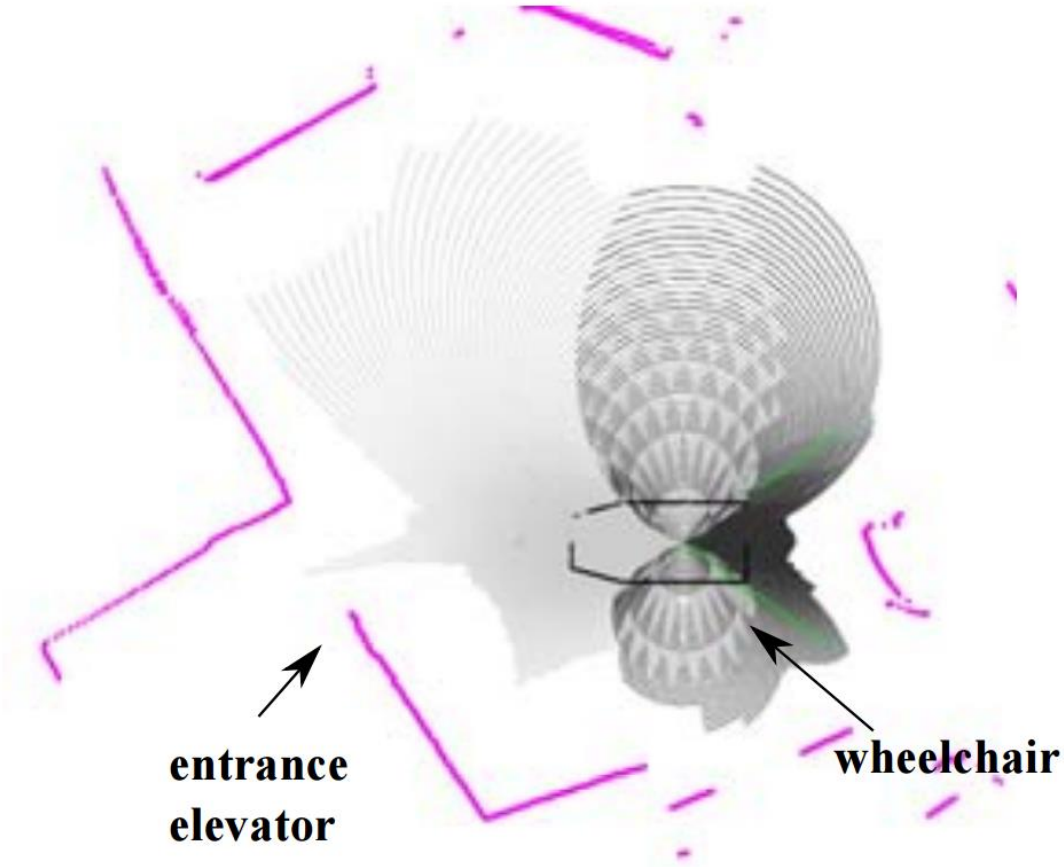
Starting point



Objectives

Find a more complex geometric form, that will form the basis for local paths.

The socially compliant path planner should be able to :

- Asses the moving obstacles around the wheelchair
- Take into account the dynamics of the wheelchair
- Fast enough so that the user doesn't feel the latency

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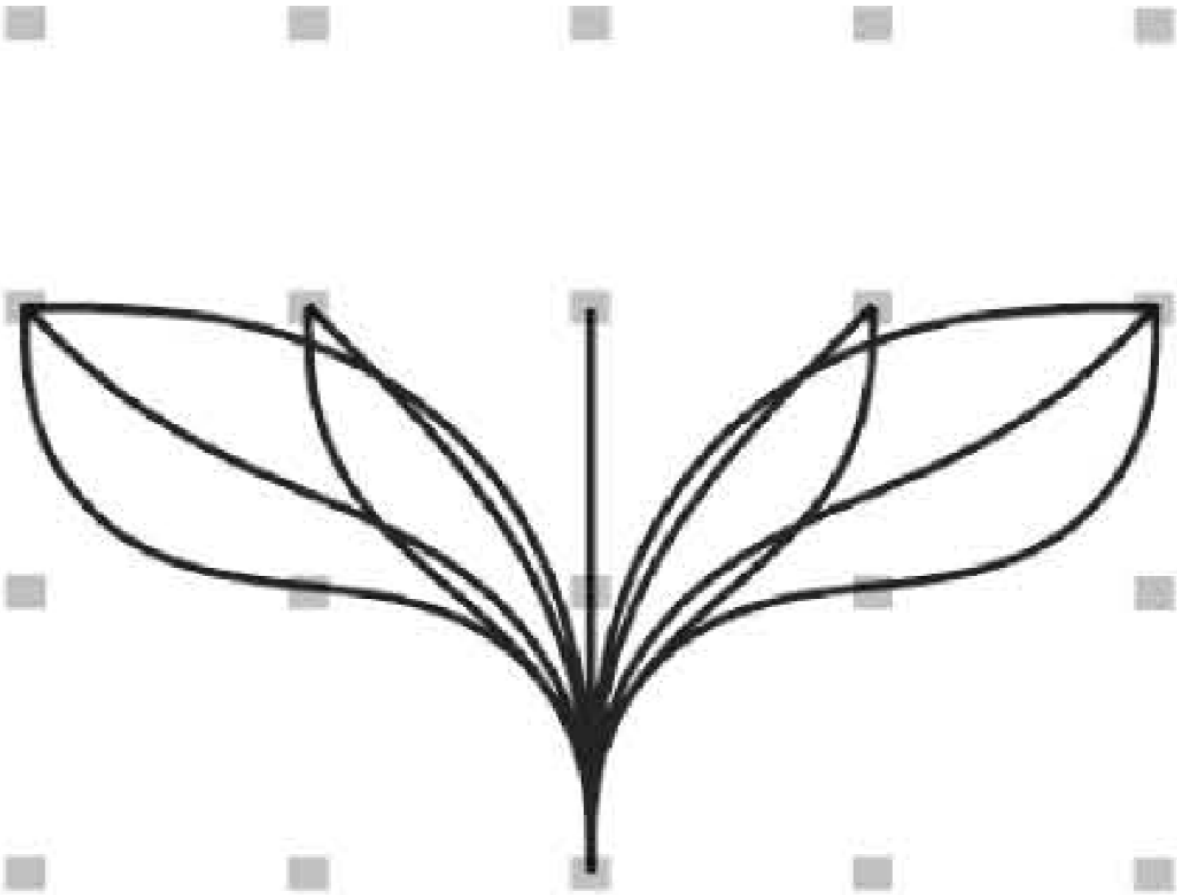
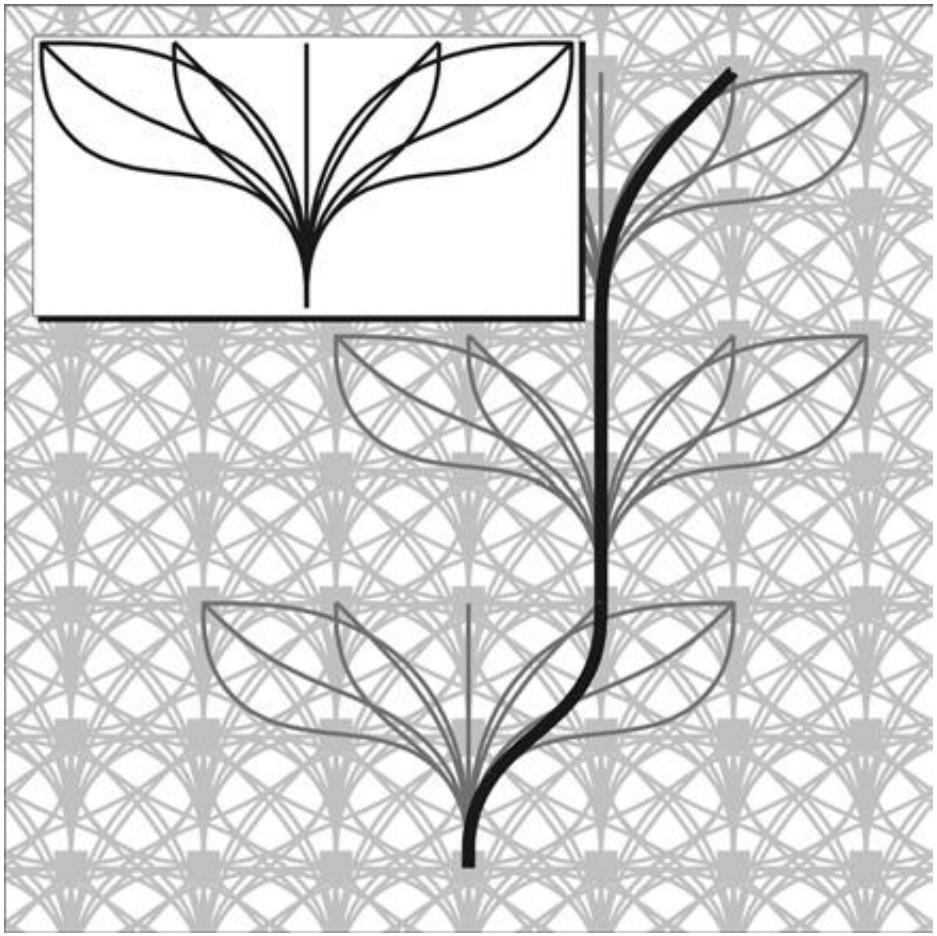
Use a more complex geometric form as motion primitive.

Work by Pivtoraiko and Kelly (2005) describe a novel approach, “State Lattice” Path Planning.

State Lattice Path Planner



State Lattice Path Planner



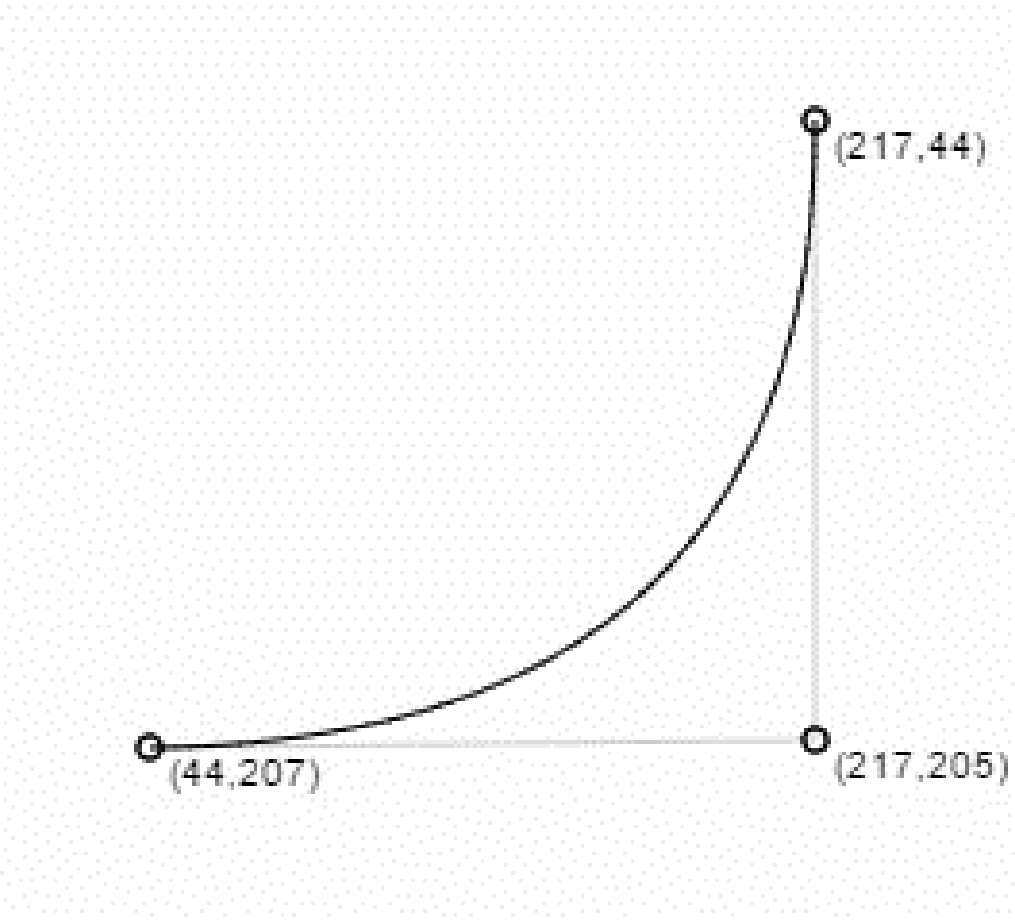
State Lattice Motion Primitive

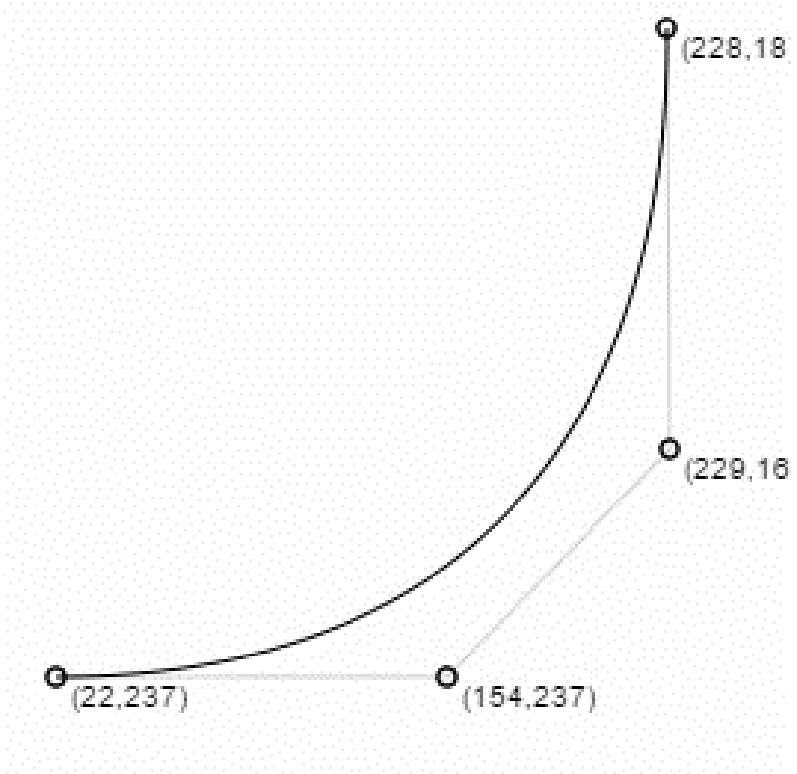
Motion primitives should be more complex than circular arcs.

Based on cubic Bézier Curves :

- Start, end pose derived from placement of control points
- “DOF” left to influence a desired objective function

Quadratic vs cubic Bézier Curves





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COP : motion primitives

$$\underset{x,\,y}{\text{minimize}} \quad f(x,y) = \int_0^1 \kappa(t)^2 dt \tag{1a}$$

$$\text{subject to} \quad [x_1, y_1] = [x1, y1], \tag{1b}$$

$$y_2 = \tan(\theta_1)(x_2 - x_1) + y_1, \tag{1c}$$

$$[x_{end}, y_{end}] = [xend, yend], \tag{1d}$$

$$y_{end-1} = \tan(\theta_{end})(x_{end-1} - x_{end}) + y_{end}, \tag{1e}$$

$$\kappa(t)^2 \leqslant \kappa_{max}^2, \tag{1f}$$

$$lb_x \leqslant x \leqslant ub_x, \tag{1g}$$

$$lb_y \leqslant y \leqslant ub_y. \tag{1h}$$

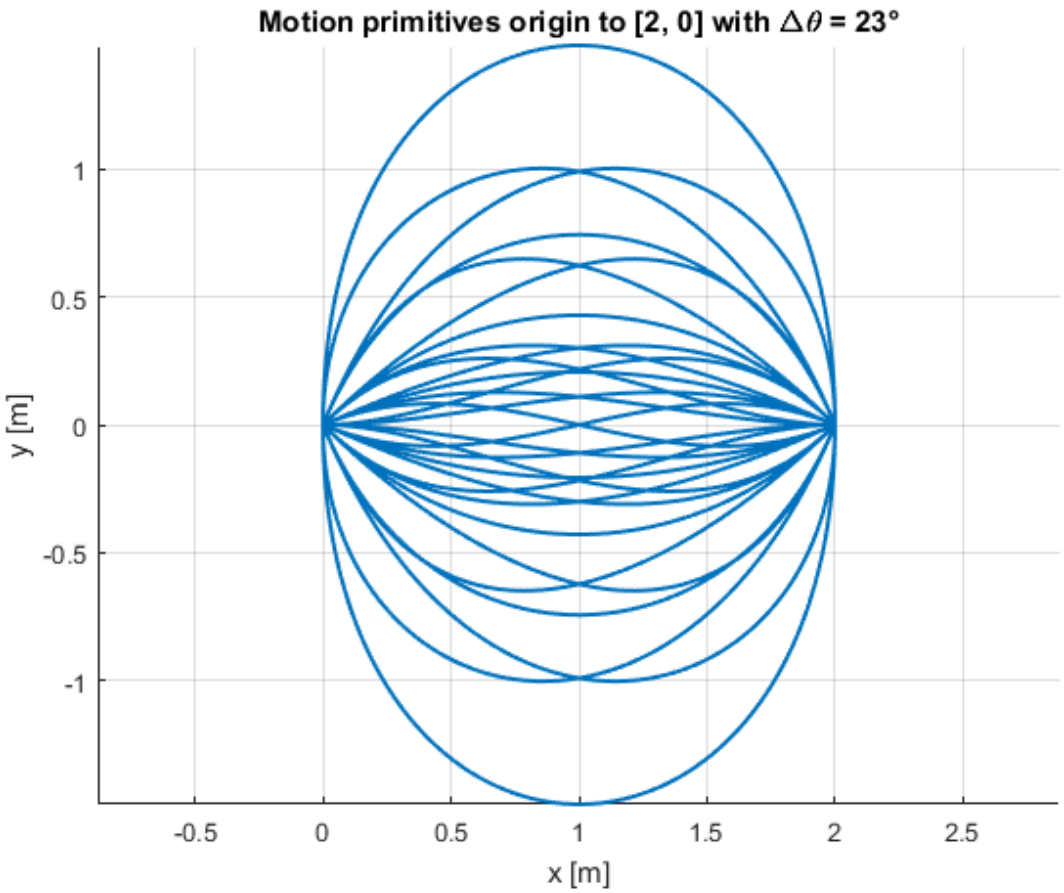
With :

$t = 0 : \Delta t : 1$, dimensionless parameter for the construction of the Bézier Curve

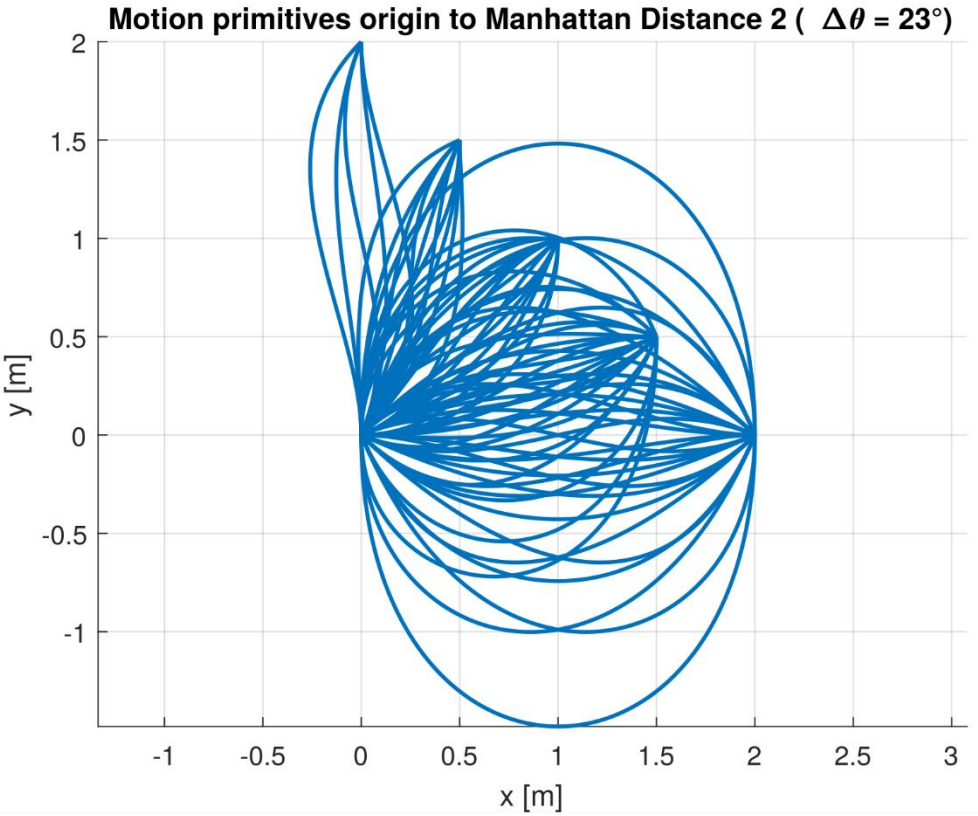
$B(t) = BezierCurve(x, y, t)$

$\kappa(t) = \dfrac{B'(t) \times B''(t)}{\|B'(t)\|^3}$, curvature

State Lattice : Example fixed position



State Lattice :
Generation of possible motion primitives



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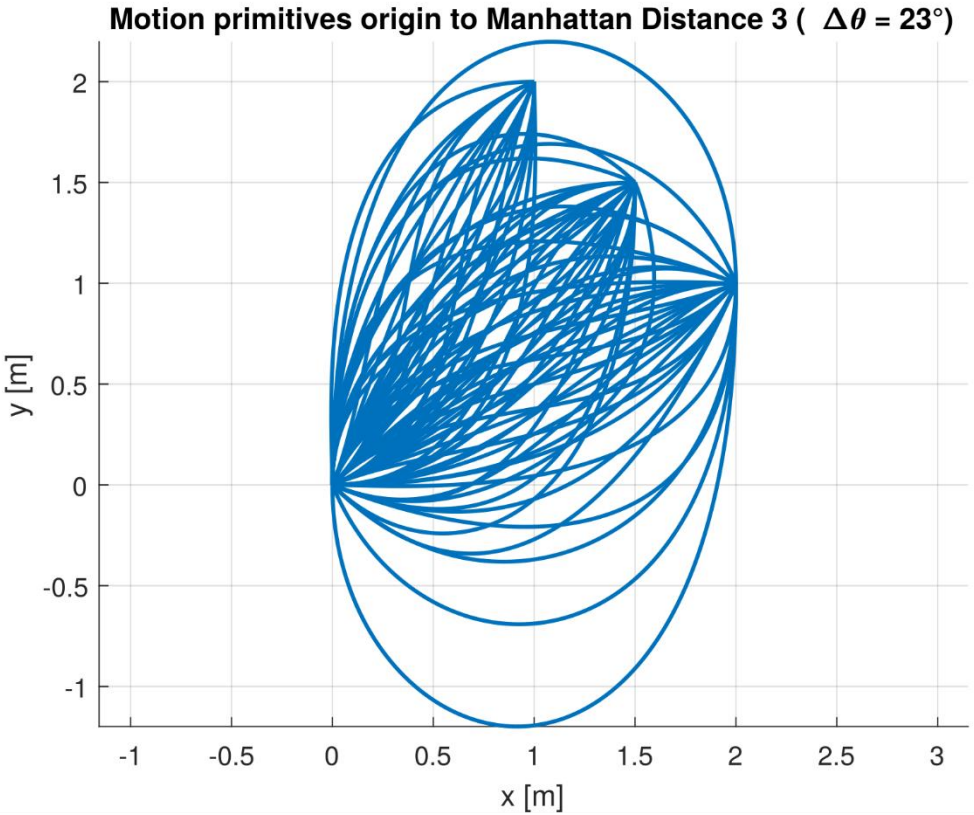
State Lattice :
Generation of possible motion primitives



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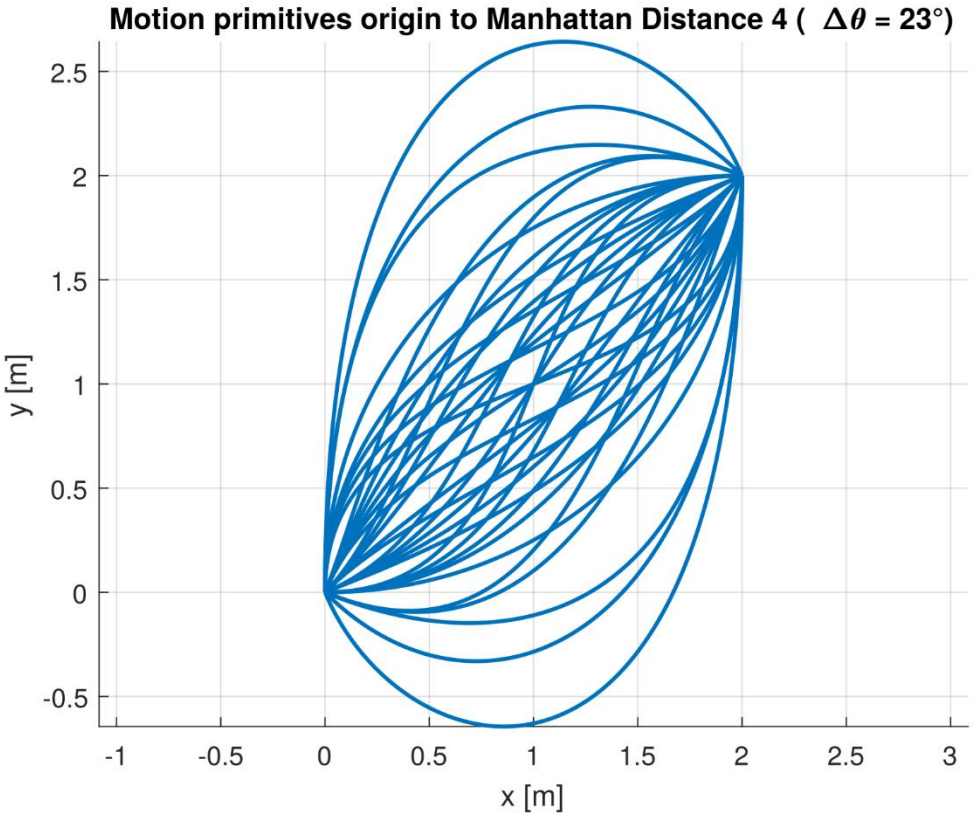
State Lattice :
Generation of possible motion primitives



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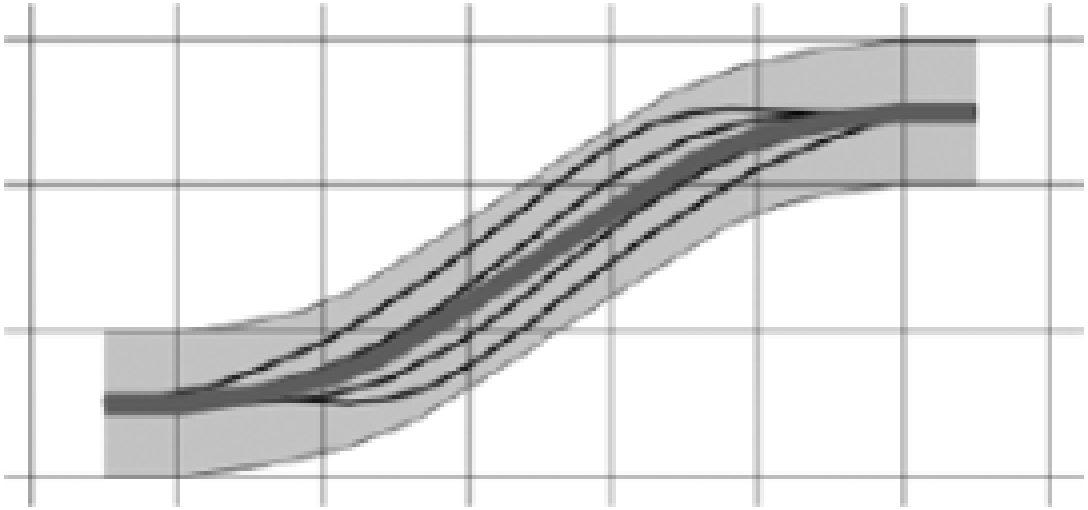
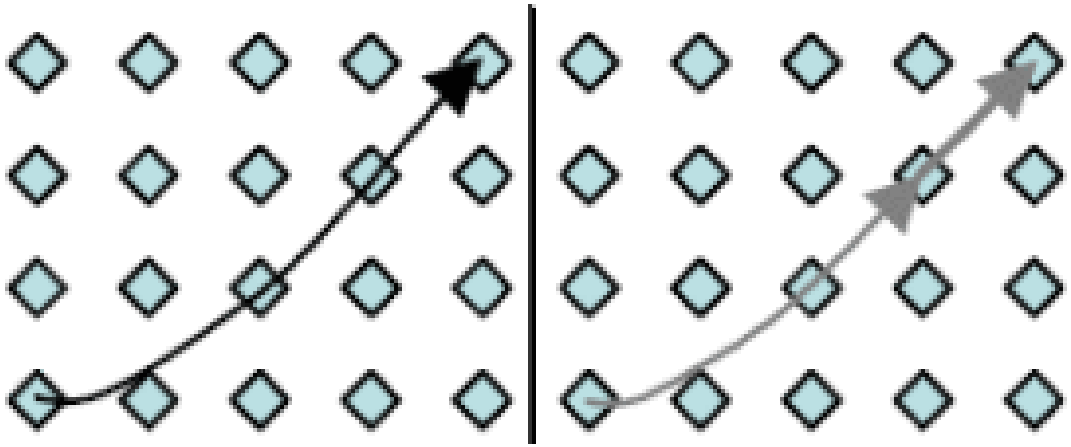
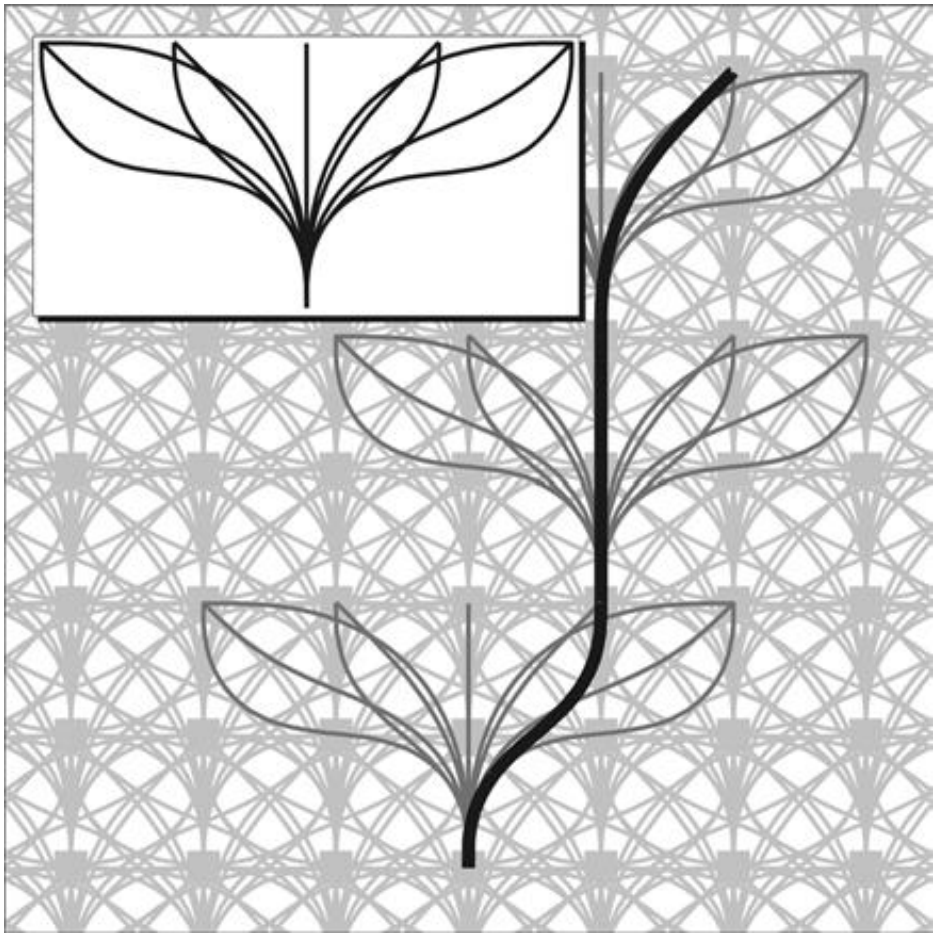
Motion Primitives are unique





State Lattice Path Planner



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Path Planning (uncertainty)

Multi-resolution grid

Context based navigation and templates for certain tasks

End of the presentation

Thank you for your kind attention