

## Course handouts

### Robots Trajectory Planning

Jindong Tan  
Electrical and Computer Engineering  
Michigan Technological University  
jitan@mtu.edu



## What is trajectory planning

- Path Profile
- Velocity Profile
- Acceleration Profile



## Constraints

- Initial Position
  - Position (given)
  - Velocity (given, normally zero)
  - Acceleration (given, normally zero)
- Final Position
  - Position (given)
  - Velocity (given, normally zero)
  - Acceleration (given, normally zero)



## Constraints

- Intermediate position
  - set-down position (given)
  - set-down position (continuous with previous trajectory segment)
  - Velocity (continuous with previous trajectory segment)
  - Acceleration (continuous with previous trajectory segment)



## Constraints

- Intermediate position
  - Lift-off position (given)
  - Lift-off position (continuous with previous trajectory segment)
  - Velocity (continuous with previous trajectory segment)
  - Acceleration (continuous with previous trajectory segment)



## Trajectory Planning

- 13-th order polynomial
$$a_{13}t^{13} + \dots + a_2t^2 + a_1t + a_0 = 0$$
- 4-3-4 trajectory
$$h_1(t) = a_{14}t^4 + a_{13}t^3 + a_{12}t^2 + a_{11}t + a_{10}$$
$$h_2(t) = a_{23}t^3 + a_{22}t^2 + a_{21}t + a_{20}$$
$$h_n(t) = a_{n4}t^4 + a_{n3}t^3 + a_{n2}t^2 + a_{n1}t + a_{n0}$$
- 3-5-3 trajectory



## The boundary conditions

- Initial position
- Initial velocity
- Initial acceleration
- Lift-off position
- Continuity in position at  $t_1$
- Continuity in velocity at  $t_1$
- Continuity in acceleration at  $t_1$
- Set-down position
- Continuity in position at  $t_2$
- Continuity in velocity at  $t_2$
- Continuity in acceleration at  $t_2$
- Final position
- Final velocity
- Final acceleration



## How to solve the parameters

- Handout in the class

