Entwicklung und Implementierung eines digitalen Funktionsgenerators in VHDL

Markus Hartlage

FH-Bielefeld

March 31, 2022

FH Bielefeld
University of
Applied Sciences

Konzept

1. Stance phase
   - Movement of the foot on the ground
   - Foot moves backwards (respective to walking direction)
   - Backwards movement forces the robot body to move froward
2. Swing phase
   - Movement of the foot through free space without ground contact
   - Foot moves forwards
   - Start- and endpiont are on the ground for transition from and to stance movement

Swing trajectory constraints

- General swing phase constraints
  - Start position
  - End position

Swing trajectory constraints

- General swing phase constraints
  - Start position
  - End position
- Constraints due to the robot design
  - Working space for each joint of a leg
  - Minimal required swing height
  - Acceleration and speed of joint drives

Swing trajectory constraints

- General swing phase constraints
  - Start position
  - End position
- Constraints due to the robot design
  - Working space for each joint of a leg
  - Minimal required swing height
  - Acceleration and speed of joint drives
- Environmental constraints
  - Position and size of obstacles

Trajectory planning methods – Global approaches I

- Roadmap
  - Corners of obstacles are connected by straigth lines to form the shortest path along the obstacles
  - Obstacles must be known as polygons
- Cell decomposition
  - Free space divided into cells
    - Exact decomposition
    - Approximate decomposition
  - Obstacles must be known
  - Neighbouring cells are represented in a graph
  - A path in the graph represents one possible trajectory

Trajectory planning methods – Global approaches II

- Potential field
  - Free space is discretized in a mesh
  - Obstacle points and start point are weighted repelling
  - Goal point is weighted attracting
  - Trajectory is defined by a gradient descent
  - Problem of getting trapped in local minima
  - Obstacles must be known

Trajectory planning methods – Local approaches

- Self defined trajectory
- Selecting additional constraints (e.g. approach angle)
- Defining via points
- Connencting via points by different methods
  - Linear
  - Linear with parabolic blends
  - (Cubic) splines *(one proposed approach by* **zeng***)*
  - Elliptic *(approach used by* **paskarbeit** *on HECTOR)*
- Collisions with obstacles must be handled or avoided

Deciding for one approach

- In order to implement a trajectory generator one of these methods has to be chosen
- This decision is highly dependent on the robot it has to genereate trajectories for
- If the robot has a notion of it's surrounding space, a global approach is possible
- Otherwise a local approach has to be used and collisions have to be handled
- Since the global approaces use a discretisation of the space and therefore have to compute many possible paths to choose one for each step
- Using a naive local approach requires little computation and allows reusage of a path
- A notion of the surrounding space in combination with a local approach can be used to minimize collisions by coosing optimal goal positions

Sources