Human Walk with mixed Step- and Pathplanning

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Abstract

Walking is one of the most difficult problems by developing bipedal locomoted Robots. This paper describes an approach to gain smoother walk movements and to reach the specified target pose (position and angle) more precise.

1 Introduction

In the course of the thesis "step planning of a humanoid robot", the goal was to provide the agent with a more human walk from its current pose to the specified target pose. In addition, there was the requirement that the target pose is achieved in the shortest possible time. The general walking target is achieved when the following conditions are met:

- Certain foot at the target pose (left / right foot at position x / y with angle α)
- Walk speed at the target pose

In order to meet these requirements a mixed optimal path-/stepplanning was developed.

2 Benchmark

As a base we assume a onidirectional walk, parameterized by forward/sidewards step length and a turn angle per step.

By using this parameterized walk it can not be determined how long the agent takes with which parameters from pose A to B. So first of all it was necessary to benchmark potential walking curves and collect these results in a file. For each curve the resulting radius and average speed is stored. Furthermore the stability of the agent by walking the curve is recorded, so we are able to decide how risky a path should be planned.

3 Pathplanning

The path planning passes through several different sections. At first, two optimal walking curves are determined by taking the current speed and the target speed into account. After that, those two curves are connected by their common tangent. This is performed multiple times for slight variations of the optimal walking curves. Since the agent can not walk arbitraty curves, each possible solution has to be tested for validity. From the collection of valid paths the path with lowest costs is then chosen.

In each server cycle we check whether the walking target has changed. If the target pose, speed or foot has changed, the path has to be recalculated.

As long as the walking targets keep the same, we follow the previously calculated optimal path sections. In each section, we allow a certain tolerance range. If the agent is out of tolerance, the path will be rescheduled. Within the tolerance the agent follows the defined path and is slightly corrected towards the optimum.

4 Stepplanning

If the agent is within a defined area in front of the walking target, we switch from path planning to step planning. Here, the resulting positions of a foot is calculated with the parameterized walk. The deviation of the step that goes beyond the walking target is redistributed across all remaining steps of the plan, so that the last step reaches exactly the defined walking target.

For the Situation that the wrong foot would reach the target, it is necessary to plan a further step for the hole distance that's left to the walking target. The only disadvantage is, that the speed at the target could be bit lower than required.

The differences at the walking path between the old and the new calculation is shown in the following figure.

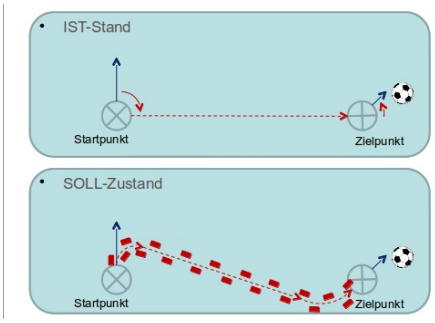

Figure 1: comparison of old and new walking path