Planning and Executing Humanoid Gaits in a World of Stairs

Candidate: Michele Cipriano
Thesis Advisor: Prof. Giuseppe Oriolo
January 21, 2020

SAPIENZA
UNIVERSITÀ DI ROMA

Master Degree in Artificial Intelligence and Robotics
Department of Computer, Control and Management Engineering
Sapienza University of Rome

Introduction

Abstract. Humanoid Robot Locomotion Problem. Approach + Block Scheme.

Variable Height CoM IS-MPC

3D Motion Plan. Variable Height CoM Motion Model. MPC Formulation (ZMP constraints, stability constraints, algorithm+BHuman).

Experiments: Normal Staircase. Simple Staircase. Multiple Staircases (Up/Down).

RRT-based Footstep Planning

Problem Formulation: R1, R2, R3. How the planner works (briefly). NAO's catalogue of primitives.

Experiment: Obstacle Avoidance.

Elevation Map Generation

`elevation_mapping`, features, how it works (briefly). Settings: NAO + Xtion + *World of Stairs*.

Experiments: Generated Map + Stair Climbing in Unknown Environment.

Video

Conclusion

Results. Future Works.

Q&A

References

- A. Zamparelli, N. Scianca, L. Lanari, and G. Oriolo, "Humanoid Gait Generation on Uneven Ground using Intrinsically Stable MPC," *IFAC-PapersOnLine*, vol. 51, pp. 393–398, 01 2018.
- P. Ferrari, N. Scianca, L. Lanari, and G. Oriolo, "An integrated motion planner/controller for humanoid robots on uneven ground," in *18th European Control Conference, ECC 2019, Naples, Italy, June 25-28, 2019*, pp. 1598–1603, 2019.
- P. Fankhauser, M. Bloesch, and M. Hutter, "Probabilistic terrain mapping for mobile robots with uncertain localization," *IEEE Robotics and Automation Letters (RA-L)*, vol. 3, no. 4, pp. 3019–3026, 2018.