Natural and dynamic locomotion of legged machines

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Motivation

- Dynamic legged systems have the potential to travel on terrain unreachable to wheeled robots
- More complicated control algorithms are required
- Many humanoid robots operate on walking gaits that are less natural
- An online estimation algorithm proved a more human-like walking behaviour can be realised achieving:
  - Robustness
  - Computational efficiency

Description

- Using the prior work on the online estimation algorithm, the goal of the project is the more efficient, swift and natural movement of a biped robot
- Control of the robot involves
  - Simulation of point mass model
  - Online estimation for foot placement control
  - Basic controls for stable walking

Start of project

- Legged machines control is a new area to explore
- Requires a lot of new information and concepts to sink in!
- A lot of research is required
- Concepts under research at the moment
  - LIP model for bipedal walking
  - Raibert's three part control algorithm for one-legged hopper

LIP Model for bipedal walking

- Assumptions taken to implement the model
  - All mass of the robot is at the CoM
  - Legs have no mass and they are single points on the ground
  - Robot motion constrained to sagittal plane
- Derived equations of trajectory of CoM to understand the motion
  - Assume the swing leg has no effect on system motion
- Important to add a variable for the position of the stance foot in the equations

Raibert's three part control algorithm

- Raibert suggests separating the overall walking task into three objectives
  - Torso attitude control
  - Height control
  - Forward velocity
- Stabilizing by modifying foot placement
- Robot to maintain upright posture
  - Rotate crotch joints to keep desired state based on sensor reading

Milestones - Semester 1

- By Week 10
  - Setup environment for joint control
  - Understand and be able to apply
    - Inverse Kinematics
    - Forward Kinematics
  - Further research
  - PD control (hips and knees) for posture control
- Studying for exams and finishing up coursework as I have 60 credits in semester 1 (excluding dissertation)

Milestones - Semester 2

- By Week 2
  - Further improvement of PD control
- By Week 4
  - Foot placement
  - Closed loop control
- By Week 5
  - Collect data showing overall implementation performance
- Weeks 5 - 11
  - Write thesis