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Control Strategies for DRC Ladder-Climbing Event

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ARTLAB
Assistive Robotics Technology

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Event 5: Ladder Climbing

1. Forward/Backward ladder-climbing
2. Motion planning (IU)
3. Modeling ladder-climbing as modified stair-climbing (Purdue)
4. Coordinated Motion/Force control (Purdue)

Control Problem

Control objective: Moving Hubo's CoM along a plane parallel to the inclined plane of the stair/ladder.

(a) Locomotion control (biped robots)

- **(i) Preview control**
- **(ii) Convolution Sum**
- **(iii) CPG - Central Pattern Generation**

(b) Stair-Walking/Climbing

(c) Ladder-Climbing

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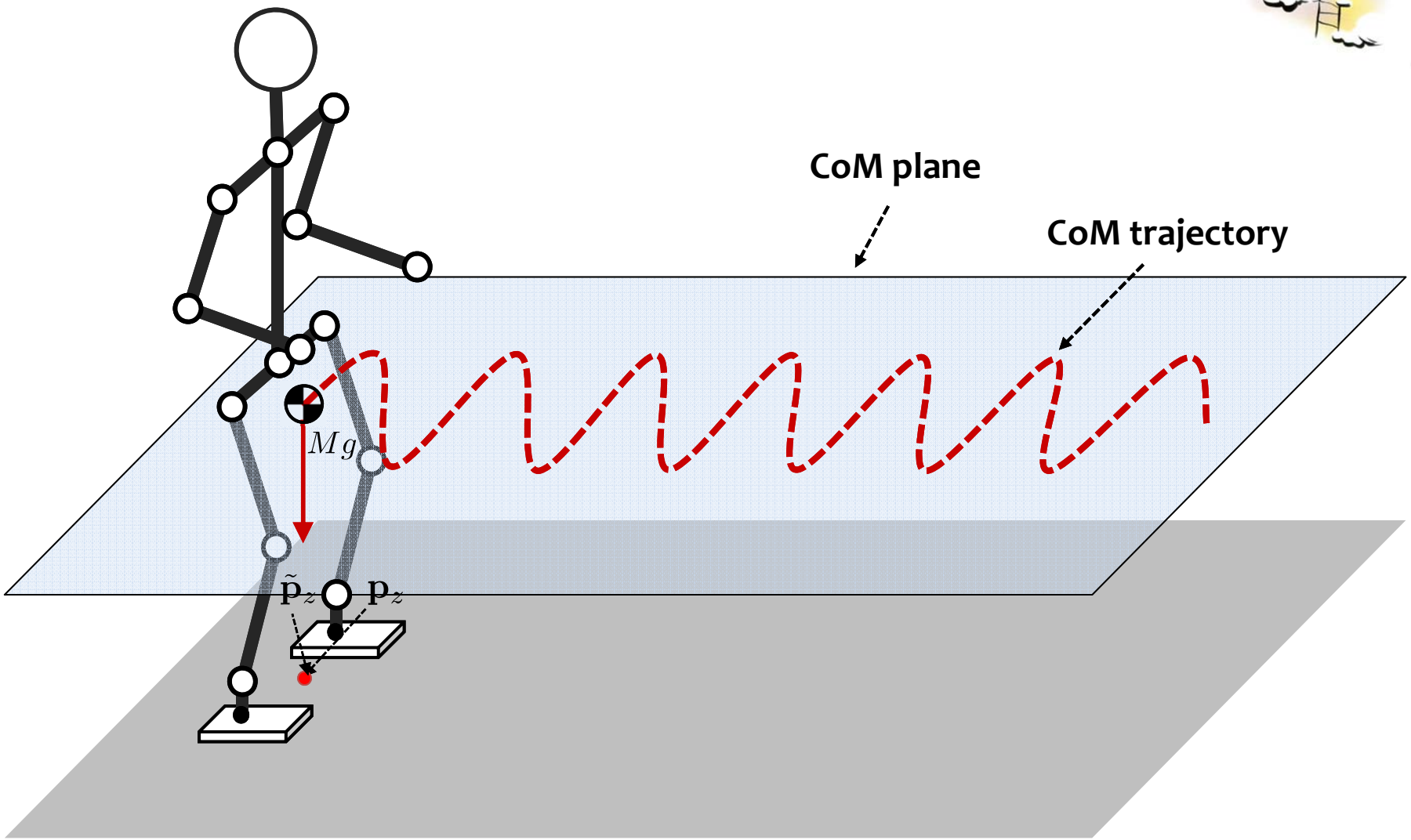
Walking on a Flat Ground



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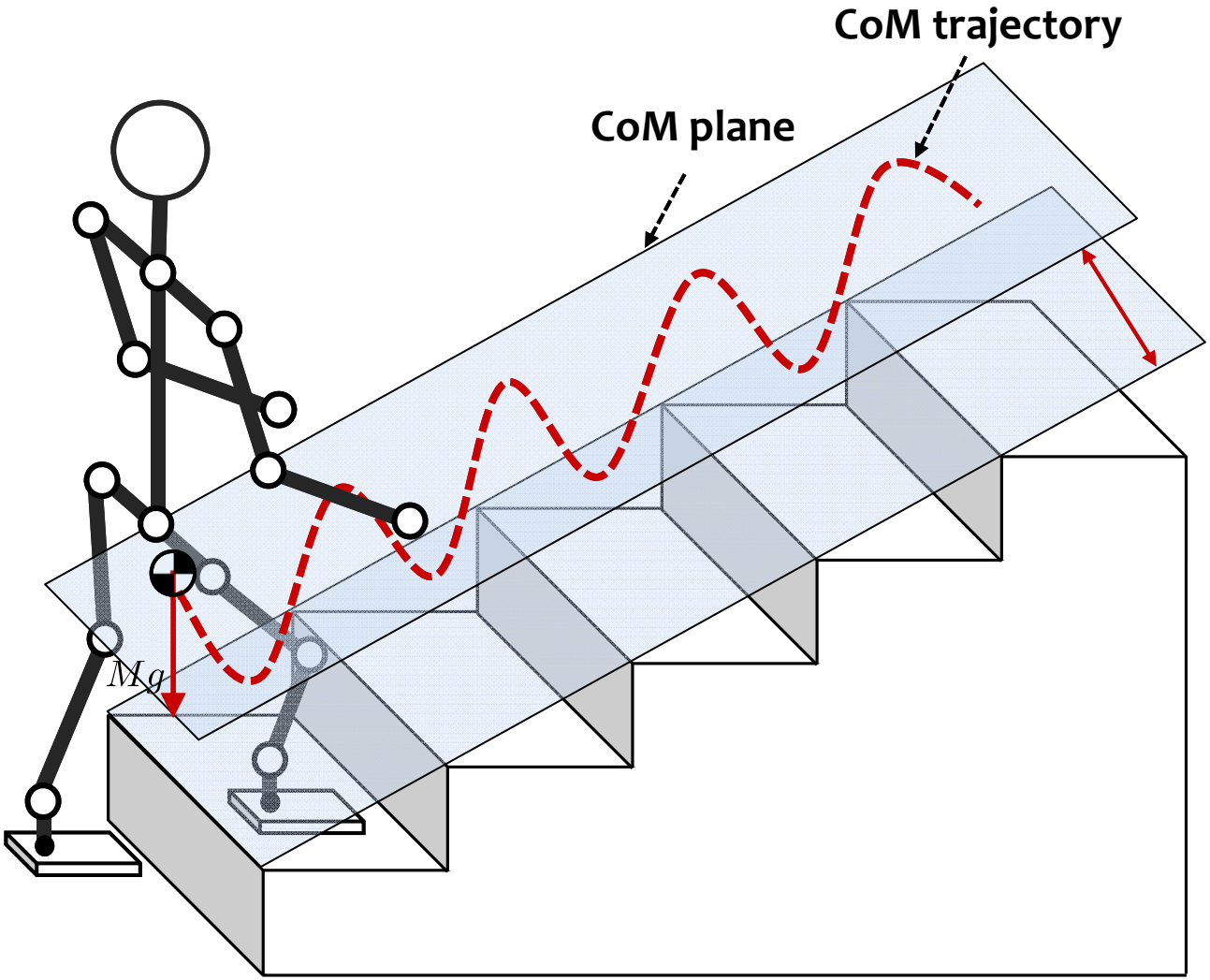
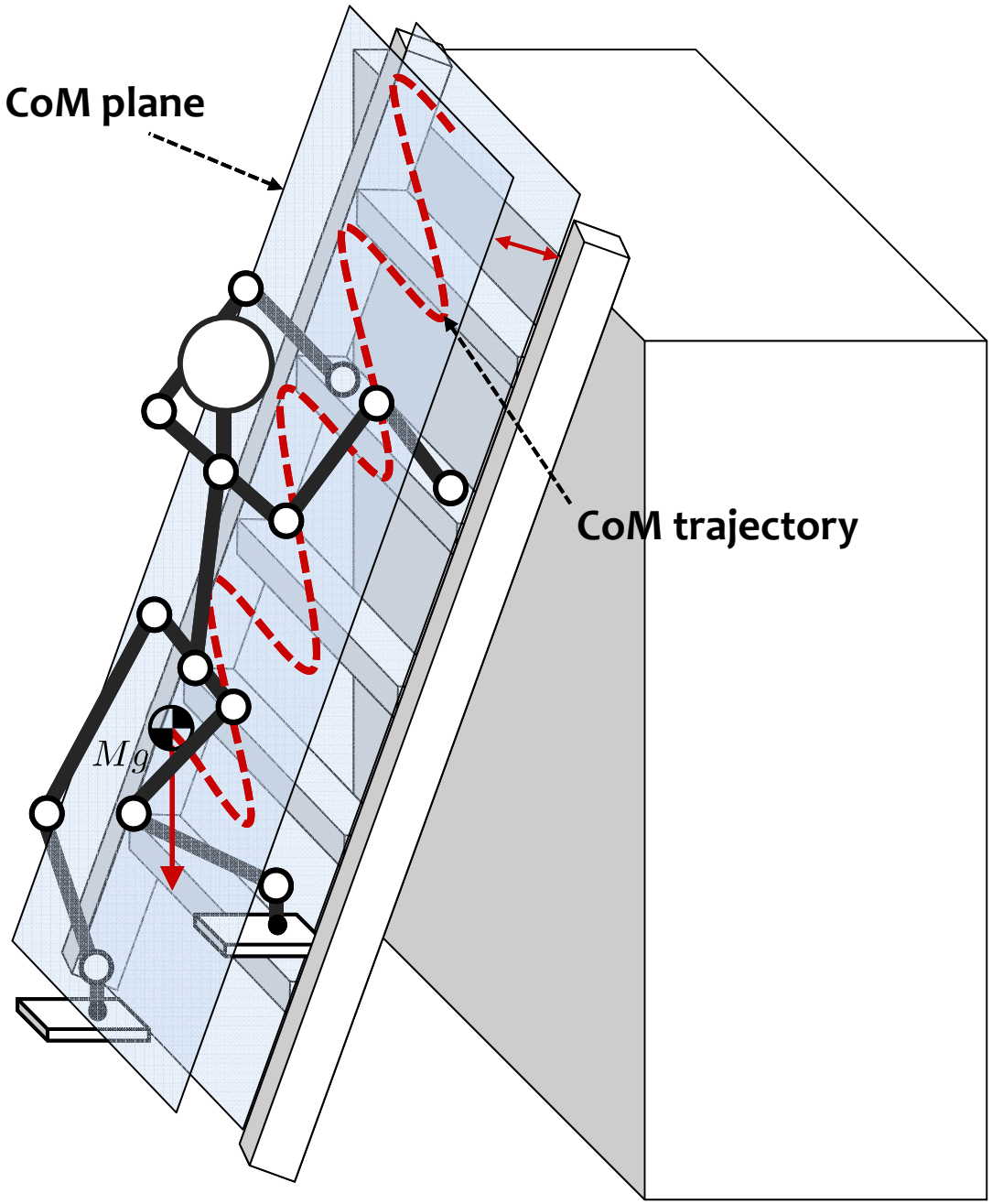
Walking on a Staircase





Backward Climbing on a ladder

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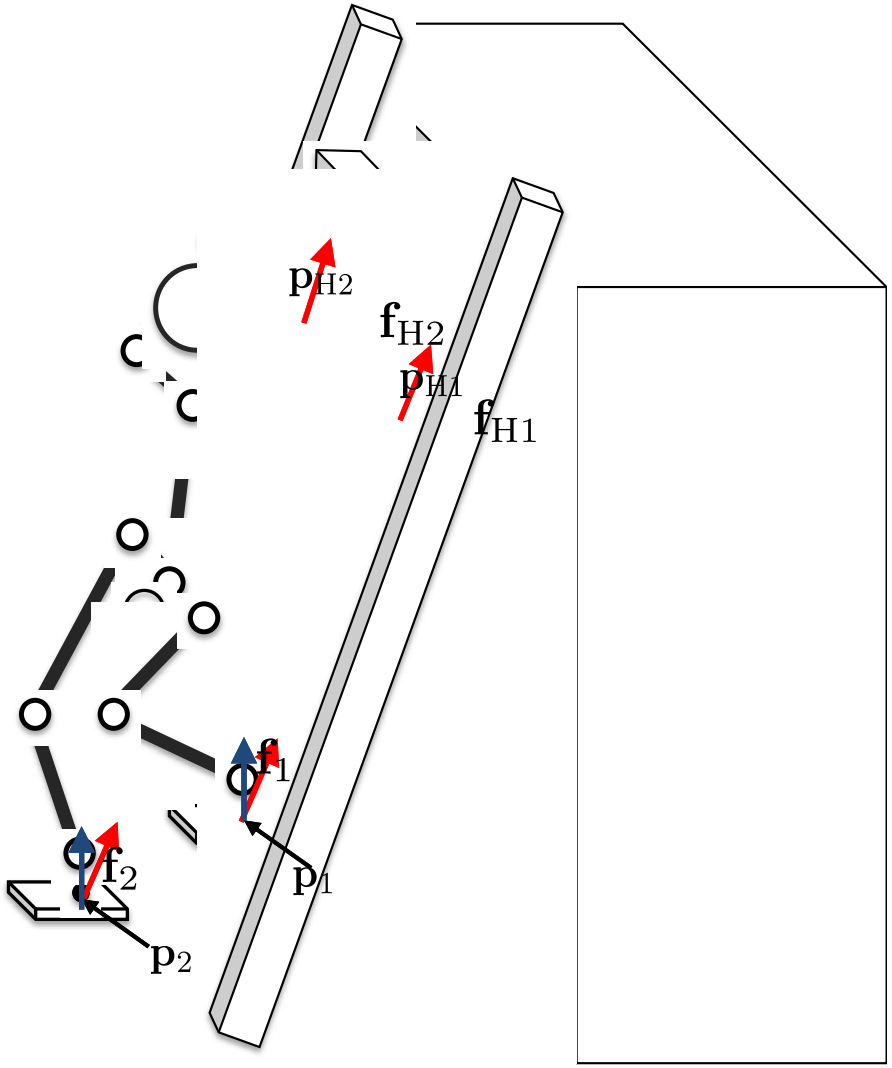
Forces at Each Limb Contact



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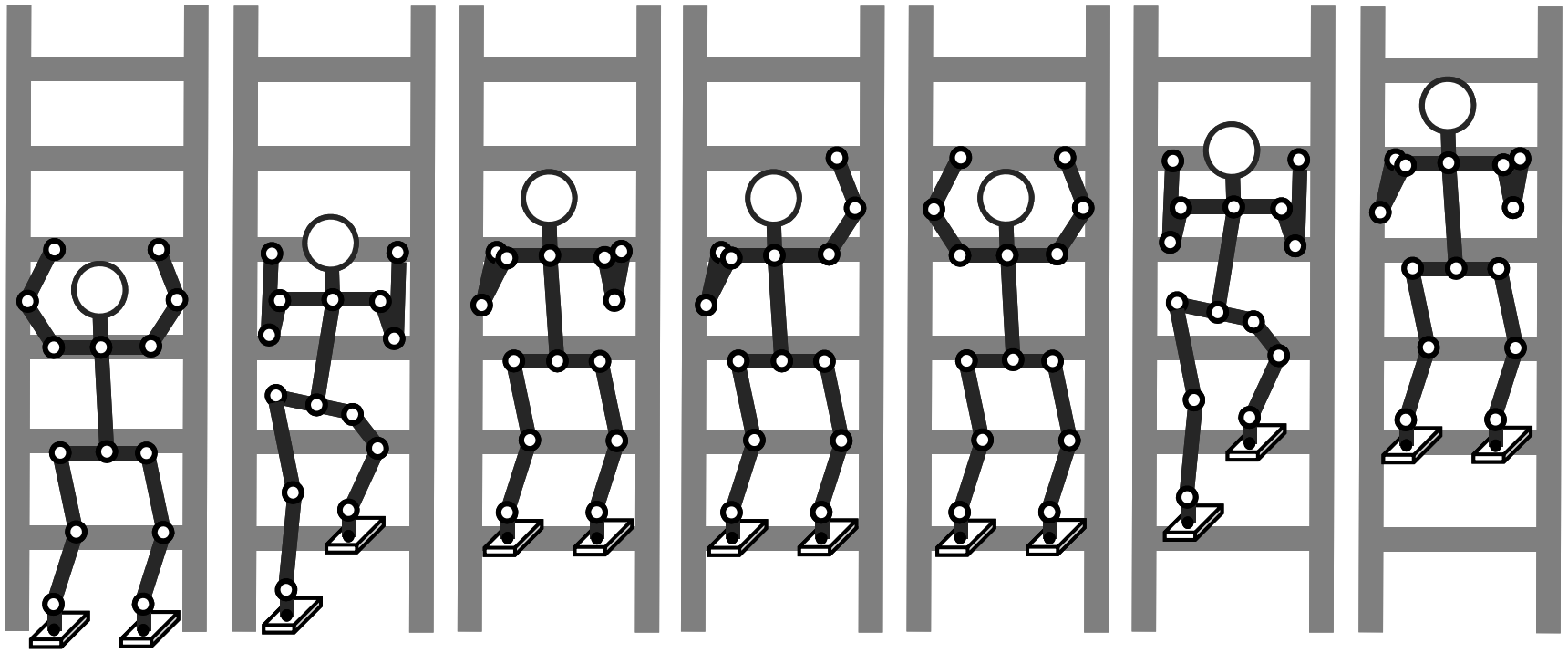
Cyclic Motion of Ladder Climbing

No. of Contact Points:

4 → 3 → 4 → 3 → 4 → 3 → 4 → 3 → 4 → 3 → 4 → 3 → 4



A → B → C → D → E → F → G

cycle

Coordinated Motion & Force Control

(1) Force Control on a limb

- Force can be only exerted in a certain direction - along the plane.

(2) Position Control on a limb

- Control position such that the legs and the hands don't hit the rungs.
- PID, Computed Torque Technique

(3) Coordinated Position and Force control

- Limbs in contact are force-controlled, and limbs in the air are position-controlled.

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Simulation and Control on Hubo-II