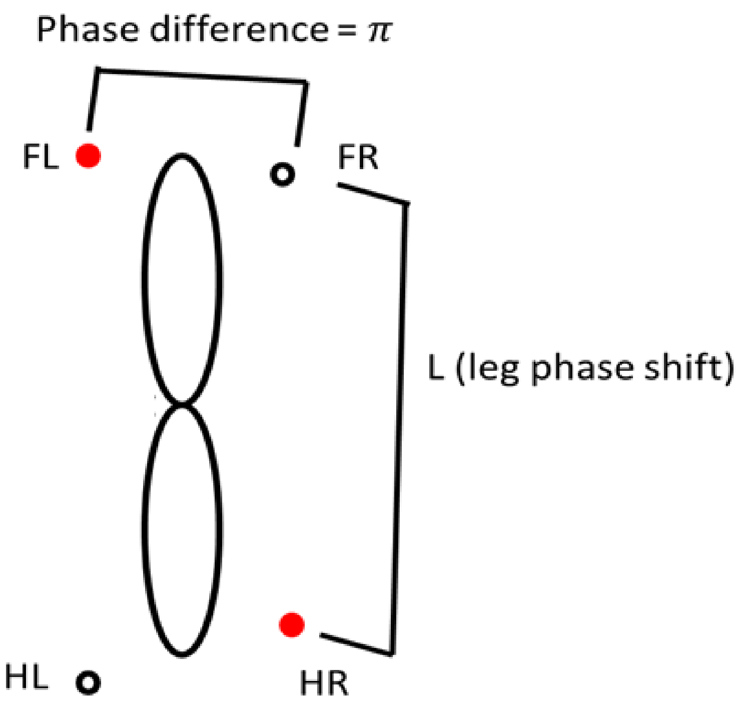
Extended Hildebrand Gait Formula – Stability Heat map

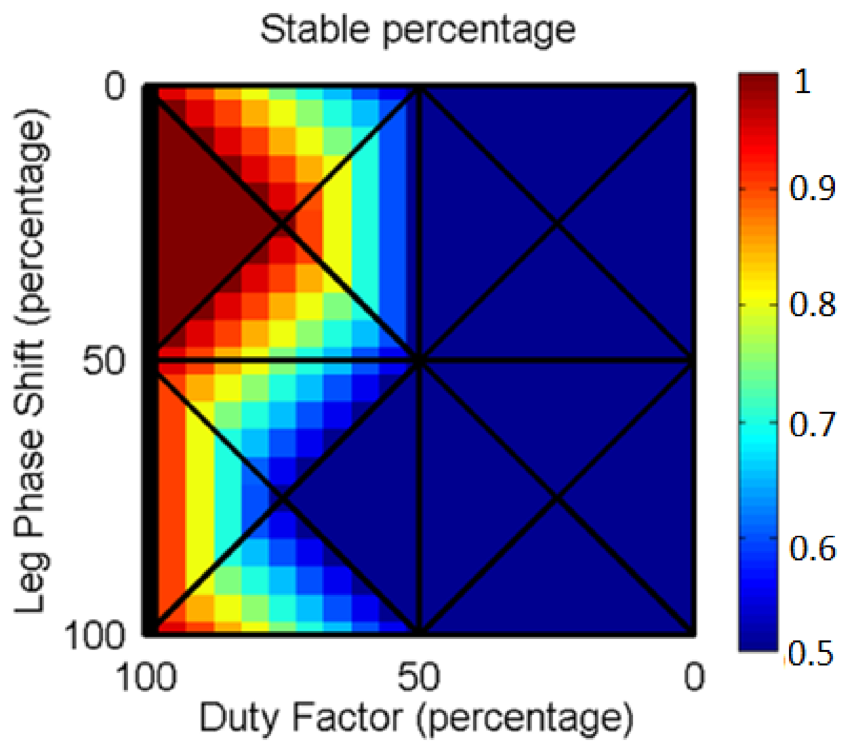
(from quadruped to hexapod, octopod…)

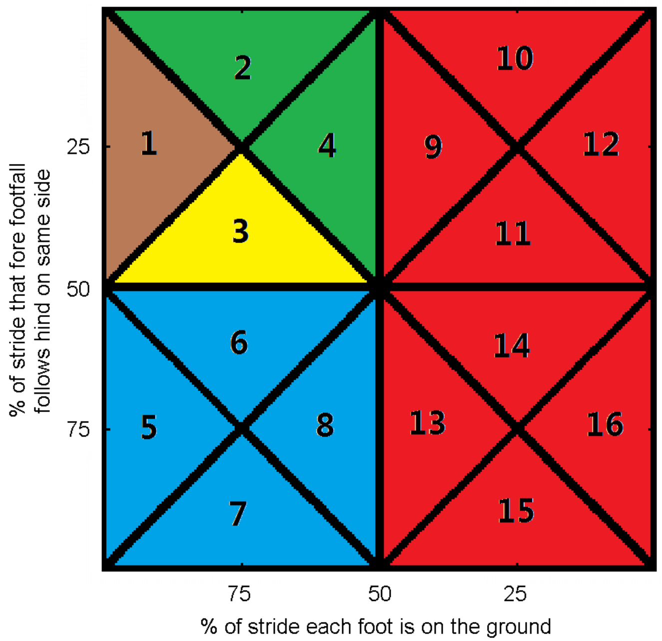
Russell Xing, Baxi

Before

Hildebrand Gait Formula







The heat map result is similar to the qualitative analysis by biologist that region 1 and 3 (from last slide) are more stable.

Quadruped

D: duty factor for each leg

From Last Week

By Mathematical Model Analysis and Simulation in poppy seeds

Region labeled in shadow satisfy the strict stability constrain

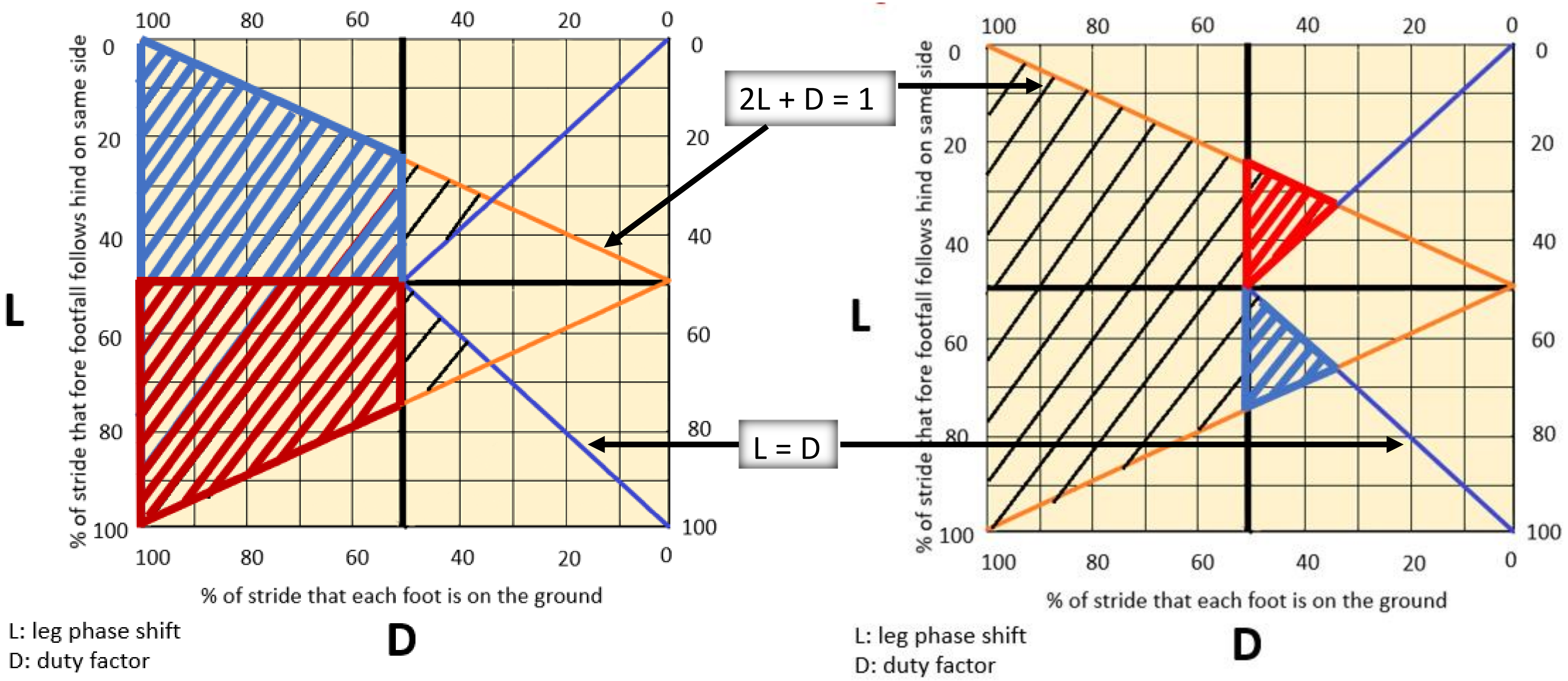
Region labeled in blue shadow is more statically stable

Region labeled in red shadow is less statically stable

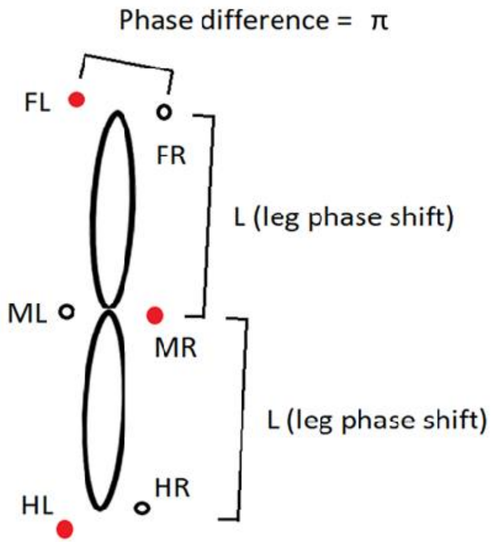
Region labeled in green shadow satisfy the loose stability constrain

Region labeled in blue shadow is more stable

Region labeled in red shadow is less stable

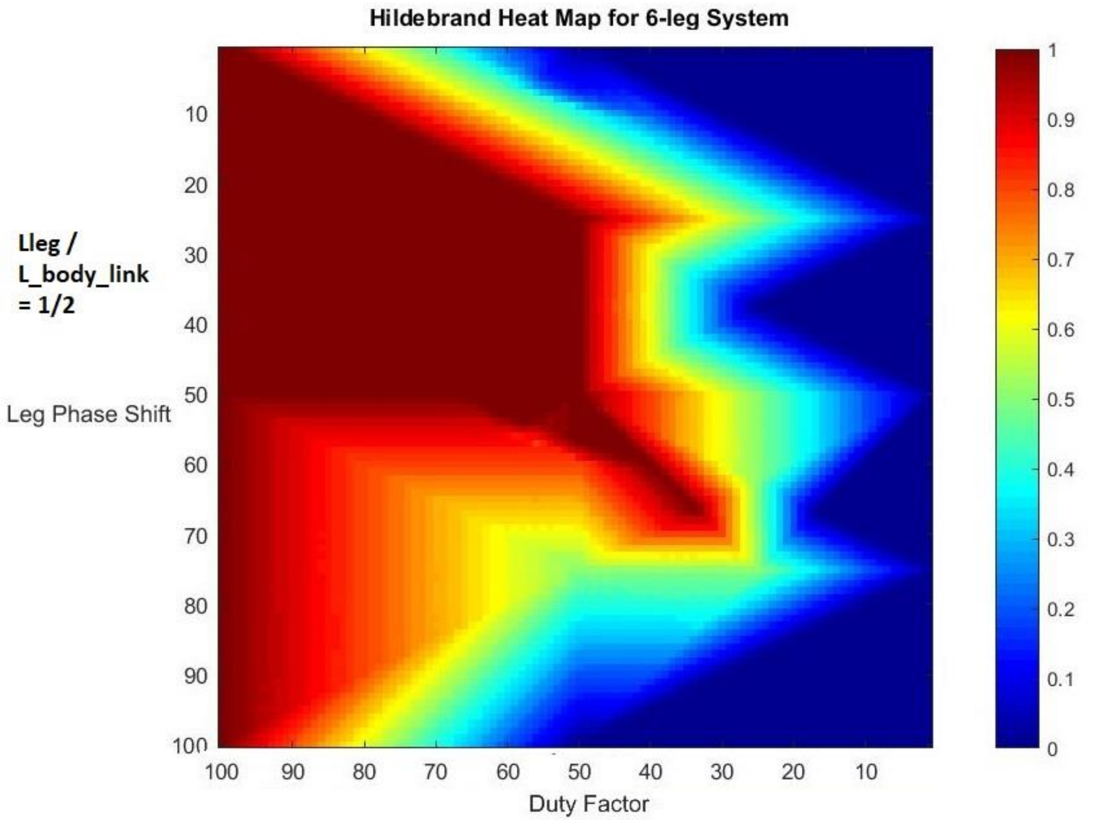


Hildebrand Gait Formula



Hexapod

D: duty factor for each leg

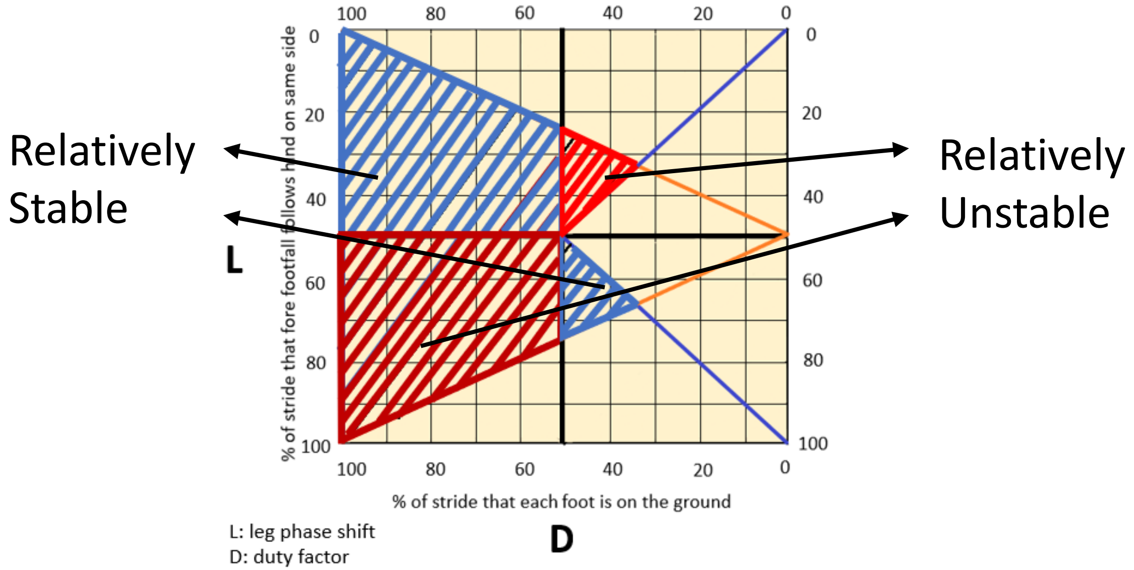


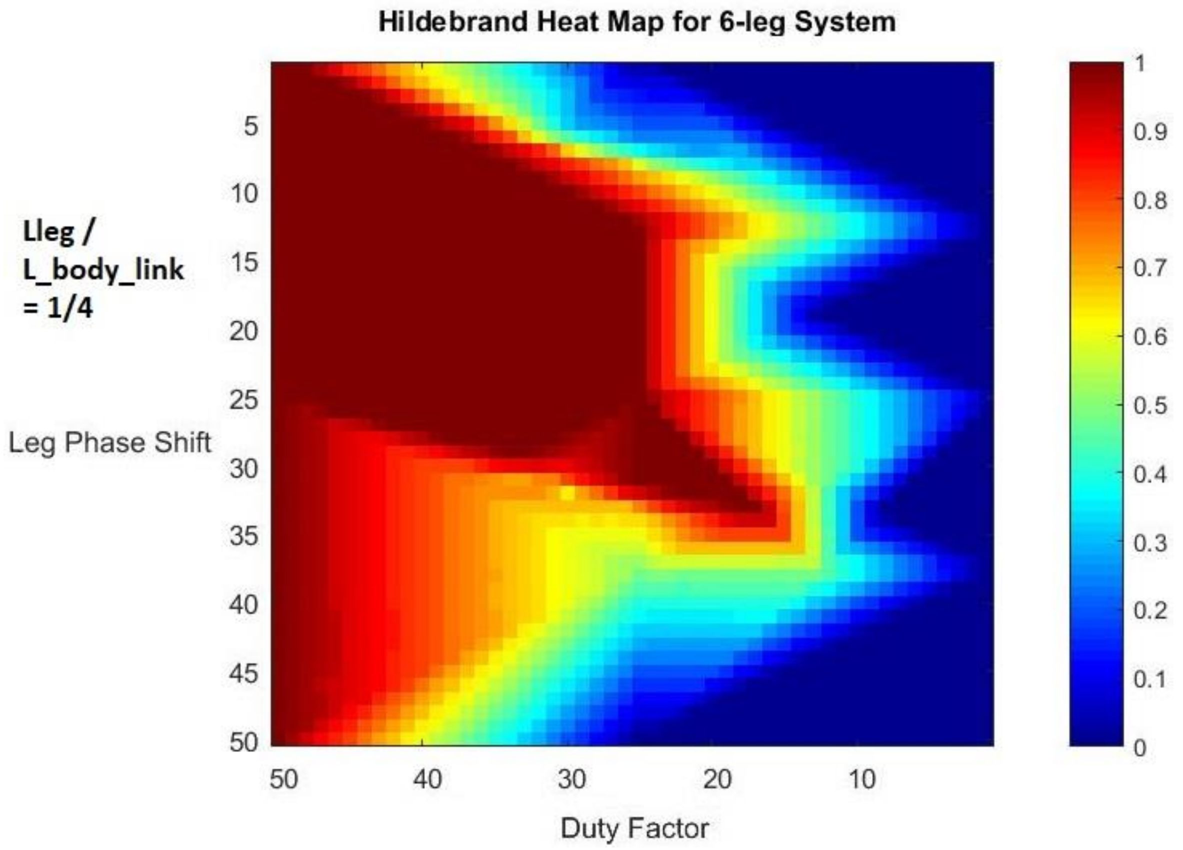
Iteratively Stability Percentage Calculation

1. Set Lleg/L_body_link ≈ 1/2,
2. When D(duty factor) = 1/100, L(leg phase shift) = 1/100 * 2π,
3. Every Δt (= 2π/300), check whether the center of mass is in the polygon which is built by the robot's legs on the ground,
4. Calculate the percentage of stable configuration(the CoM is in the polygon) over the total cycle:

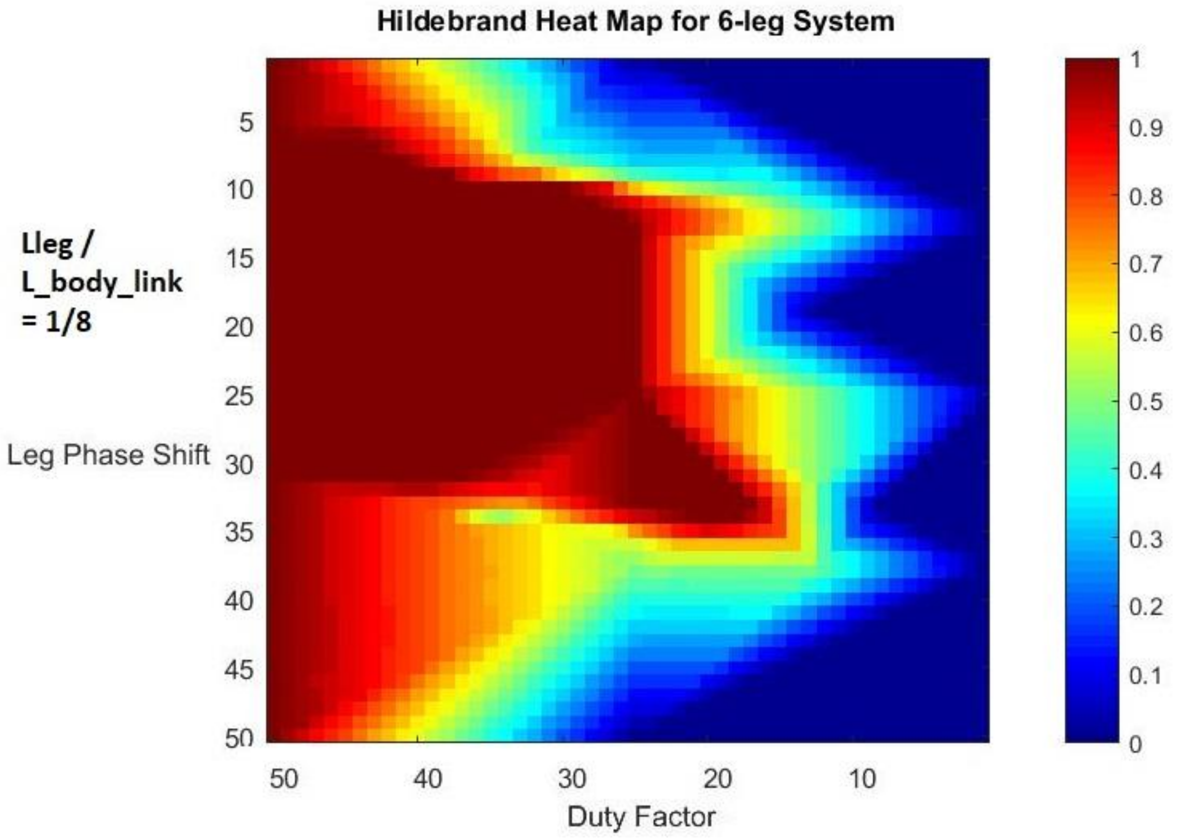
   # of stable configuration / 300

5. Repeat step 2 and 3 for duty factor = 0:100:1 and leg phase shift = 0:100:2π,
6. Repeat step 1 to 5 for Lleg/L_body_link ≈ 1/8, 1/4.



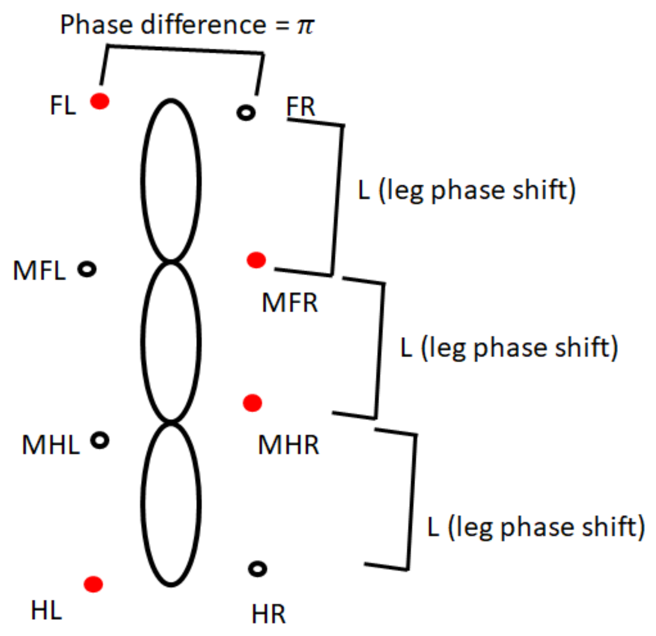


Lleg / L_body_link = 1/4



Lleg / L_body_link = 1/8

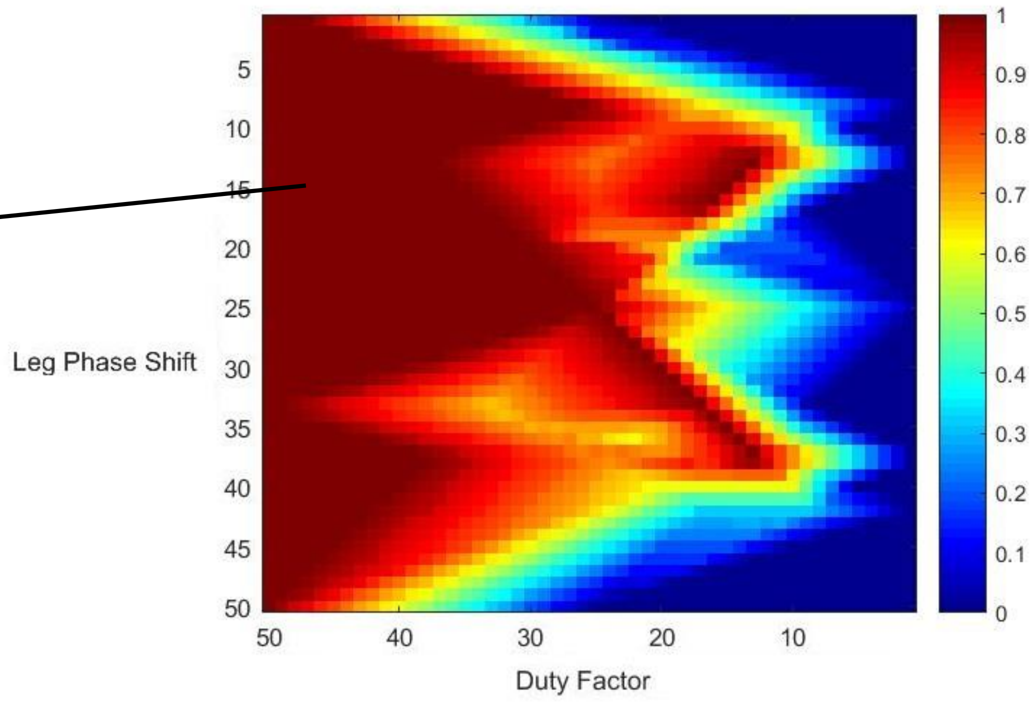
Hildebrand Gait Formula

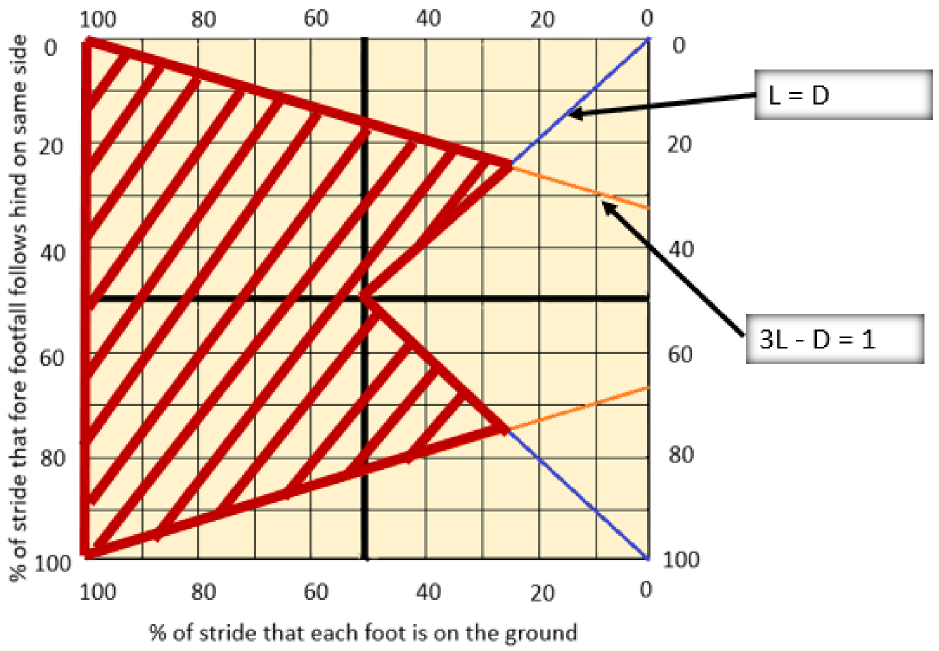


Octopod

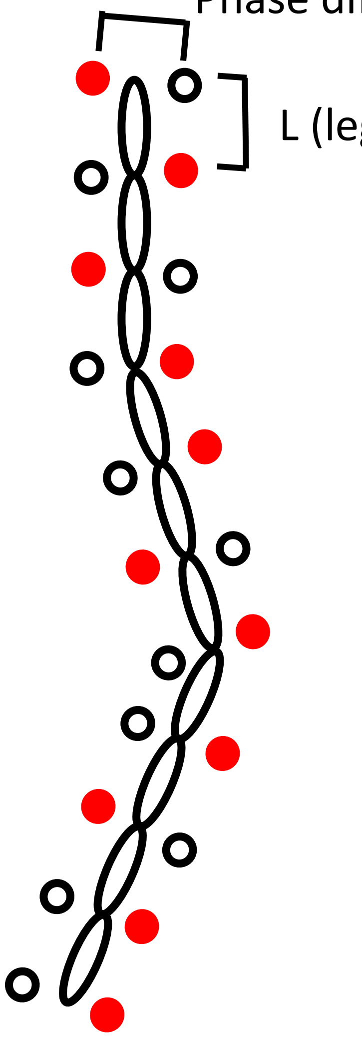
D: duty factor for each leg

More to explore:
The dark red regions with percentage = 1
What is the mathematical explanation?



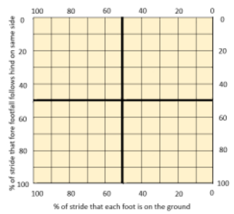


Future Work



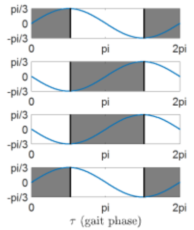
DoFs on Legs

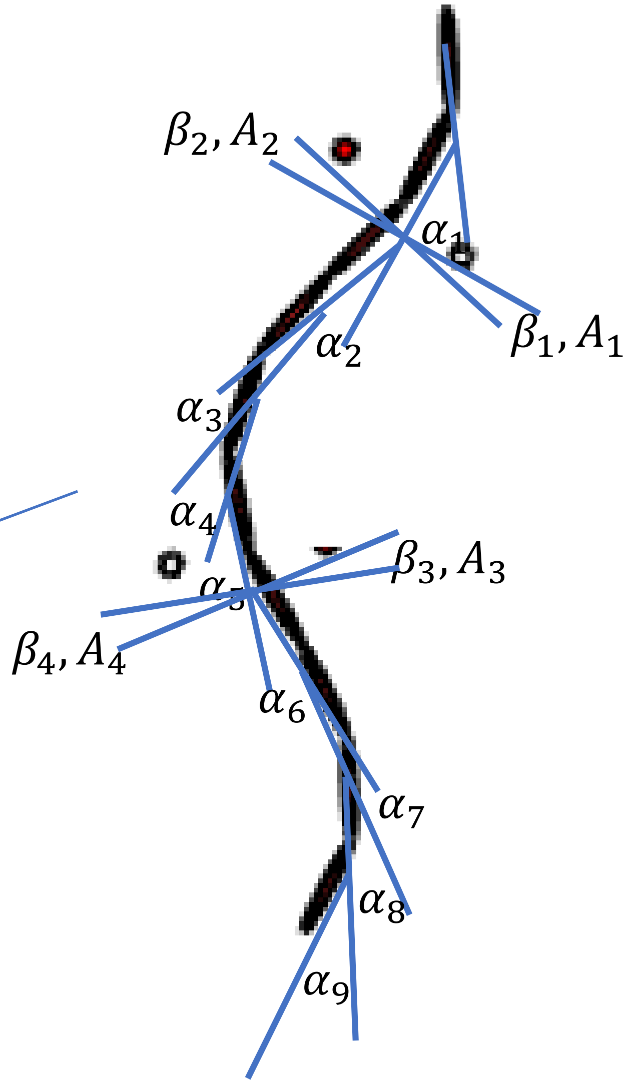
Extended Hildebrand



Coordinate Descent

Robot Experiment





DoFs in the Back

Goal:

Provide a template that is able to design locomotion gait for robots with many DoFs on legs and DoFs in the back