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Biologically-Inspired
Adaptive Dynamic Walking
of the Quadruped on Irregular Terrain

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Walking is a good application
for biologically-motivated robotics.

Because

Easy evaluation of the results.

Long history of studies in biology, physiology, etc.

Comparison with a conventional robotics method based on physics.

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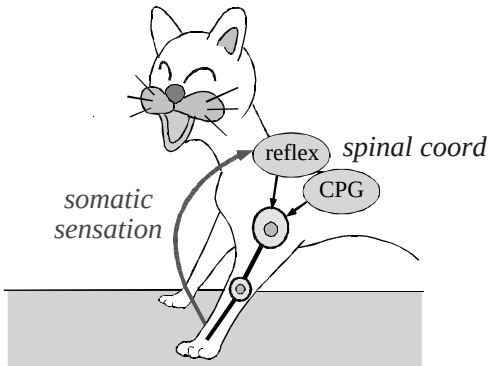
Simplified Control Mechanism in Animal



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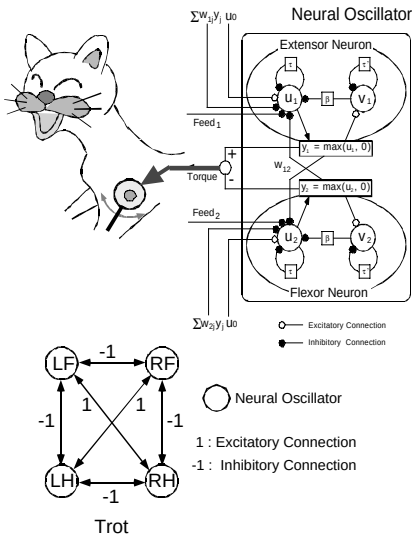
CPG



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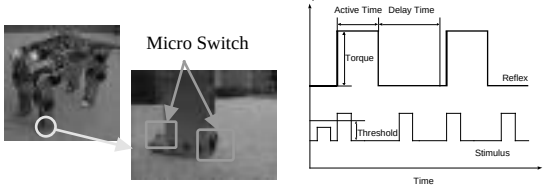
Reflex Mechanism



supporting leg → stretch reflex
swinging leg → flexor reflex

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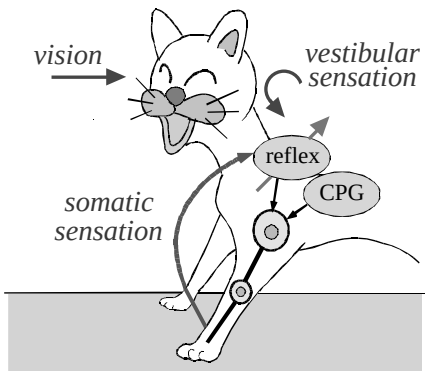
Adaptive Control Mechanism in Animal



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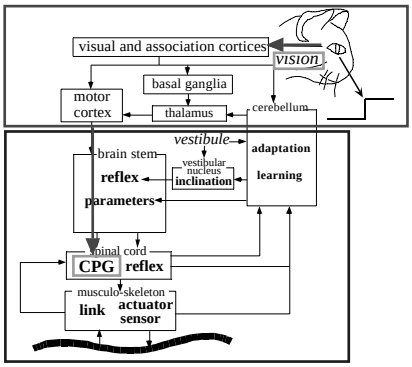
Adaptive Control Based on Vision

Drew's Model (1996)



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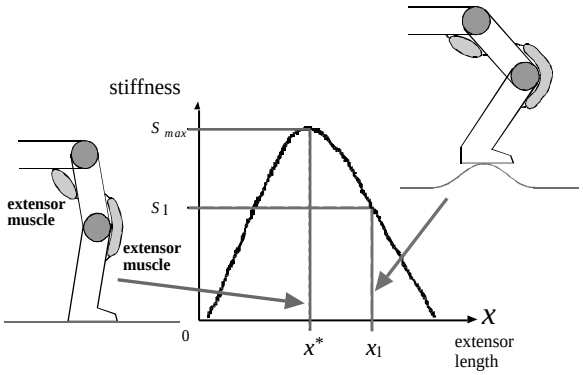
Muscle Stiffness Model



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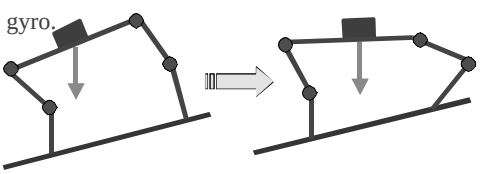
Vestibulospinal Reflex

Inclination of a body → Bend knee joints of forelegs

rate gyro.



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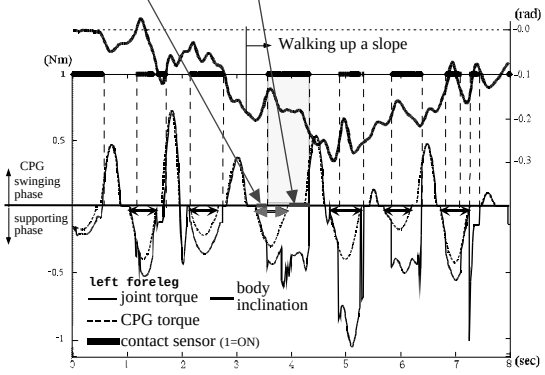
Success, but slipping and stamping



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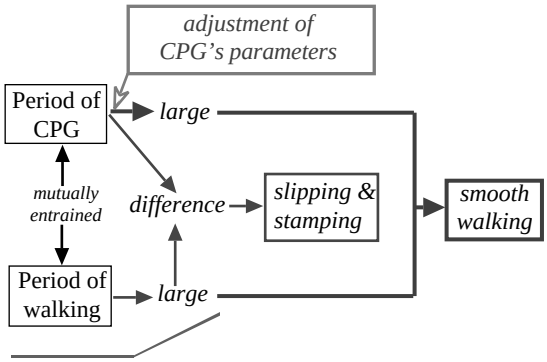
Adjustment of CPG's Parameters by Cerebellum



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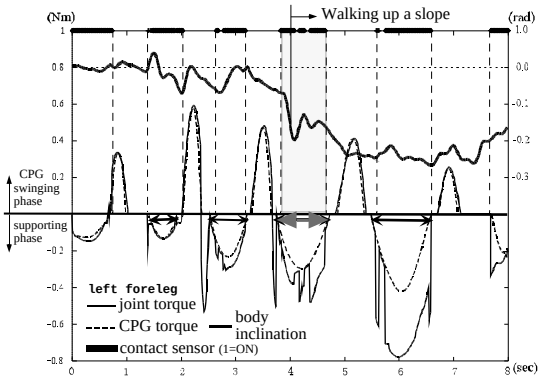
Walking up a slope much smoothly



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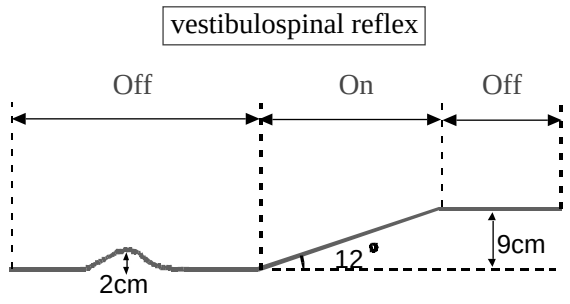
Coordination of Reflexes by Cerebellum



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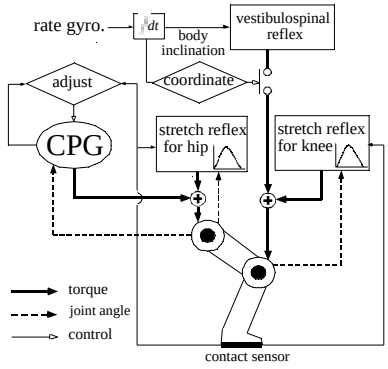
Actual Control Diagram of a Leg



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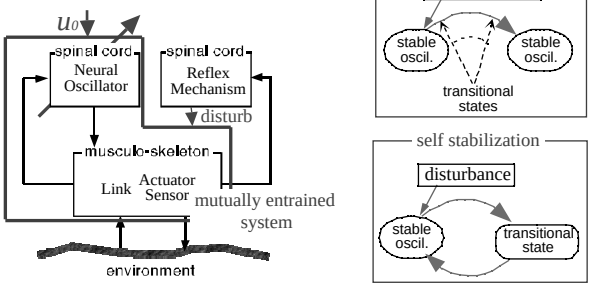
Advantages of Biologically-inspired Control #1

CPG as a Lower Controller



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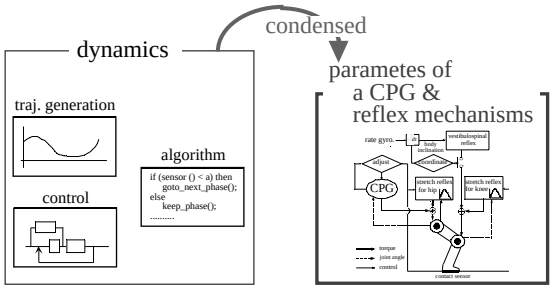
Advantages of Biologically-inspired Control #2

Parameterization



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Legged Locomotion Studies in Robotics

various aspects

to develop a practical walking machine

to clarify a real nature of legged locomotion by

analysis of passive dynamic walking and hopping

realization of dynamic walking and running by simplified control

in view of dynamic adaptation to irregular terrain

→ realization of adaptive dynamic walking by simplified control

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Summary

In addition to CPG and stretch & flexor reflex, we proposed following adaptive control:

muscle stiffness model

vestibulospinal reflex

parameters adjustment of CPG

& reflexes coordination

motion switching based on vision