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Walking Gait: For a Humanoid Robot

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Intruduction

The human walking gate is a cyclical motion. There are two phases: 1) double - both feet on the ground, and 2) single - only one foot on the ground, support phase.

This initial research presents the implementation of simple static walking gait for a humanoid robot in the sagittal plane, Figure 1, using the parameters in Figure 2. Solving this problem was implemented in two different approaches, Central Pattern Generators and Parameterized Motions.

Central Pattern Generators

In [1] authors defined Central pattern generators (CPGs) as neural circuits that produce the patterns of neural activity that underlie rhythmic motor behaviors such as walking, swimming, and feeding. As the name implies, these patterns are generated centrally, without the need for sensory feedback or other patterned input. Thus, many experimental CPG preparations can produce rhythmic neural activity even when isolated from the animal, facilitating access to the neurons. Figure 3 walking robot example.

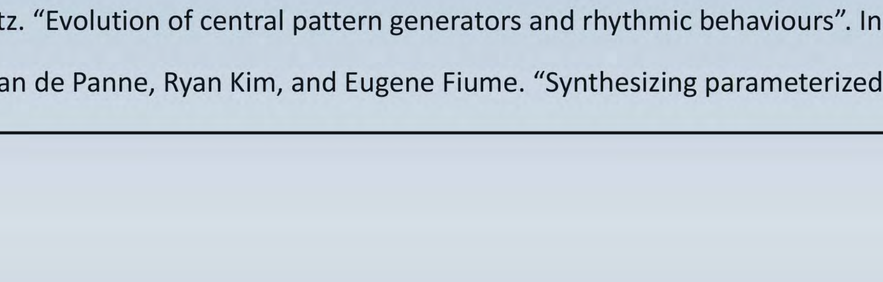

Figure 4: Parameterized Motions

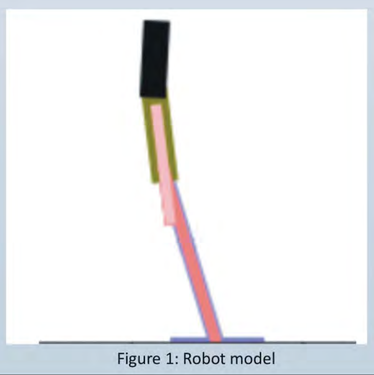

Figure 1: Robot model

Link Name	Link Length (mm)	Link Mass (kg)
Head	60.00	0.3
Torso	80.00	1.0
Upper Arm (Left/Right)	85.00	0.6
Lower Arm and Hand (Left/Right)	130.00	0.7
Thigh (Left/Right)	92.00	0.6
Calf (Left/Right)	120.00	0.5
Foot (Left/Right)	110.00	0.3
Maximum angular velocity	30 revolutions per minute	

Figure 2: Parameters

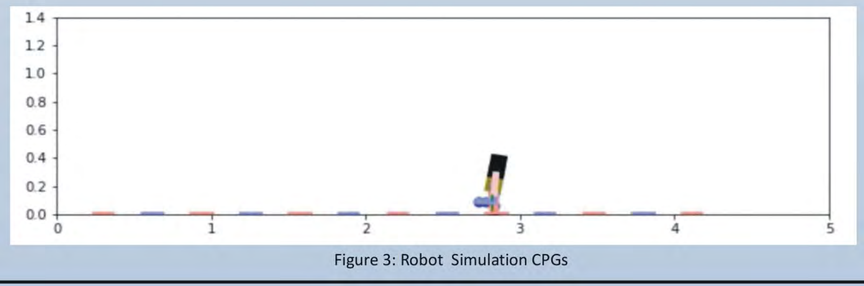

Figure 3: Robot Simulation CPGs

Parameterized Motions

Regarding [2], many of the most exciting objects to animate, such as humans, animals, and robots, are capable of controlling their motion using muscles or actuators. While realistic movement can be obtained for these active systems by applying the Newtonian laws of physics, this also requires solving an associated control problem. Informally stated control problems for animation such as ”jump from A to B, then walk to the left” could be posed in various ways. Figure 4 walking robot example.

Conclusion

At the end of this preliminary research, it is possible to come with some conclusions:

- CPGs are computationally more lighters. Additionally, it seems to be easier to be implemented;
- Parametrized Motions have higher computational costs compared to CPGs, and it is necessary to give the target to reach. Besides that, it is required to calculate the Jacobian matrices for each target set on the simulation, which can take more costs and time to get the goal. However, this approach can be more diverse and set different positions and modes for the robot walk.

Next Steps:

- Apply the measurement for the real robot humanoid;
- Create a simulation to run in a simulator these walking gate approaches; and
- Run in the physical robot.

References

[1] Paul S Katz. “Evolution of central pattern generators and rhythmic behaviours”. In: Philosophical Transactions of the Royal Society B: Biological Sciences 371.1685 (2016), p. 20150057.

[2] Michiel van de Panne, Ryan Kim, and Eugene Fiume. “Synthesizing parameterized motions”. In: Fifth Eurographics Workshop on Animation and Simulation, at Oslo. Citeseer. 1994.