COMPUTATIONAL MECHANICS 2019
35th conference with international participation
Srní
November 4 - 6, 2019

Energy saving of bipedal walking mechanism

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1. Introduction

The analysis of passive dynamic walkers shows that walking mechanisms have different energy requirements. This logically raises the question of what mechanism is least energy efficient. From this point of view, it is clear, that the best is the wheel. On a flat surface, the center of gravity moves along a straight line, ensuring that energy is not wasted on vertical movement. Thus, the question arises as to how to minimize energy consumption of the walking bipedal mechanism, which has a periodic vertical movement. The solution could be a combination of straight-line mechanism and passive walker.

2. Straight-line mechanism

Generation of straight-line motion using linkage mechanisms has always been a common requirement in machine design practice. Although exact straight line cannot be generated using simple mechanisms though some simple mechanisms are designed such that they can produce approximate straight lines for short range of motion. These approximate straight-line mechanisms have wide applications in machine design. These mechanisms were used in classical machines such as steam engines. Perfect straight lines can also be generated using linkage mechanisms but those are relatively complex mechanisms, [3].

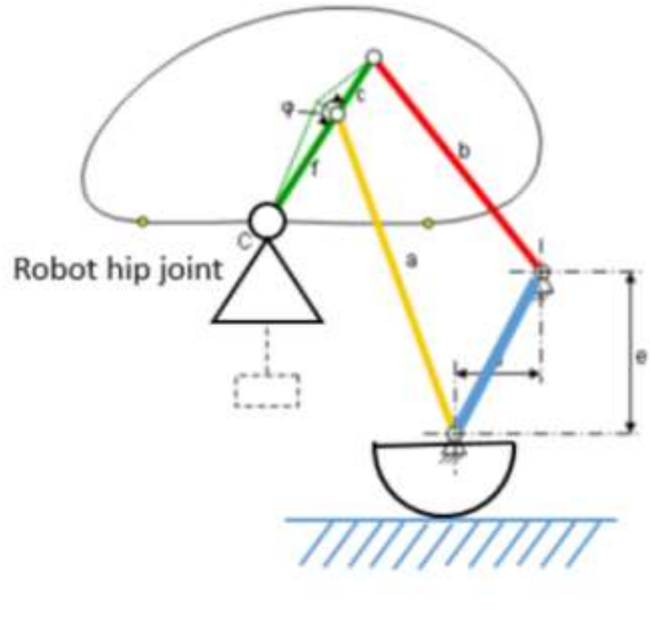

Fig. 1. Crane straight-line mechanism, [2]

3. Passive dynamic walker

Passive-dynamic walkers are simple mechanical devices, comprised of solid parts connected with joints, that can walk stably down a slope. They have no motors or controllers, although can have remarkably human-like motions. Here we present three new robots which extend passive-dynamic walking principles to walking on level ground by using an active power source. These robots use less control and less energy than other powered robots, yet walk more naturally. These results highlight the importance of the coupling between form and function in human and animal locomotion, [1].

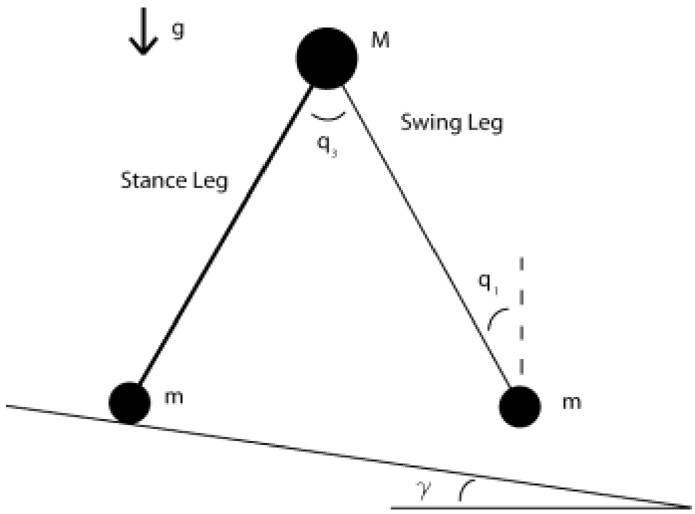

Fig. 2. Passive dynamic walker, [4]

First simulations support that these mechanisms works and that the walking consume relatively same amount of energy as human walking.

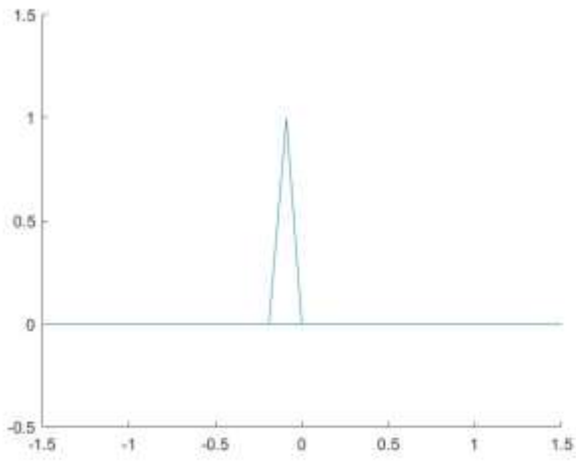

Fig. 3. Simulation of passive dynamic walker

Although these mechanisms move periodically and the hip joint, where center of mass is located, moves vertically in 2D. In 3D the movement is much more complex and involves periodical movement from side to side.

4. Combination of straight-line mechanism and passive dynamic walker

First experimental simulation suggests that it is possible to combine passive dynamic walking and straight-line mechanisms.

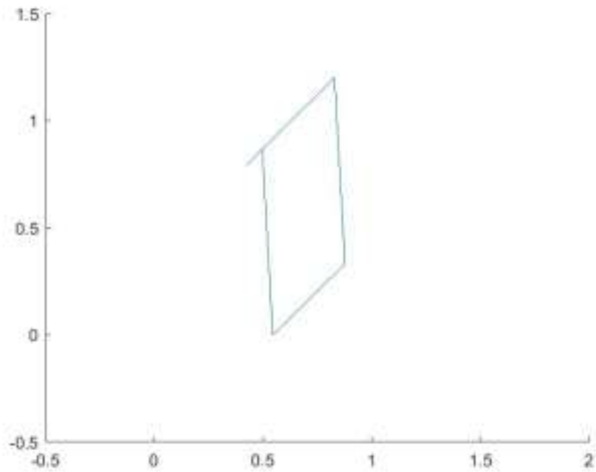

Fig. 4. Straight-line crane mechanism combination with passive dynamic walker

Although these kinds of mechanism are not passive so there have to be some kind of control system and actuation. In design of control it would be necessary to implement need of stable system but most of all low energy consumption. This approach leads to problem of optimal control of underactuated systems.

5. Conclusion

From this point of view and from observing movement of human movement is possible to say that human skeletal mechanism uses some kind of passive dynamic and straight-line mechanism that reduces movement of center of mass. And this way reduces energy consumption.

Acknowledgements

Presented work has been supported by Students Grant Competition of CTU under the project Modelling, control and design of mechanical systems 2019, No. SGS19/157/OHK2/3T/12.

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