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|--------------------------------|-----------------------------------------------------------|
| Topic Areas:                   | Legged Robots, Sensors, Control, Mechanical Design        |
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| Responsible Professor:         | Prof. C. David Remy                                       |
| Prerequisites/Prior Knowledge: | CAD, Experience with motors, sensors and microcontrollers |

Passive Dynamic Walkers (PDWs) exploit the natural dynamics of their legs and body to walk downhill without motors or active actuation. A first PDW prototype was recently built in our lab (Fig. 1 [1]). It is attached to a planarizer (a sliding and rotating arm) that constrains its motion to the sagittal plane, thereby simplifying the walker's mechanical design. An inclined treadmill provides a continuously moving slope, allowing the walker to potentially walk downhill indefinitely.

The prototype can already take several steps but eventually drifts off the treadmill and falls. Currently, the treadmill operates in open loop, meaning that its speed does not adapt to the walker's position.

In this project, you will equip the treadmill and planarizer with sensors to measure belt speed and walker position, then develop a control system to keep the walker centered by adjusting treadmill speed.

Besides implementing the control system, several mechanical improvements are needed: the maximum treadmill speed must be increased, the walker must be protected from damage during falls, and friction in the planarizer must be further reduced.

Your tasks include:

- Select and integrate sensors to measure treadmill belt speed and PDW position.
- Modify the treadmill gear ratio to increase the maximum belt speed.
- Develop and implement a feedback control system to keep the walker centered on the treadmill.
- Design and implement a safety mechanism to protect the walker during falls.
- Improve the planarizer to further reduce friction in its guides and bearings.

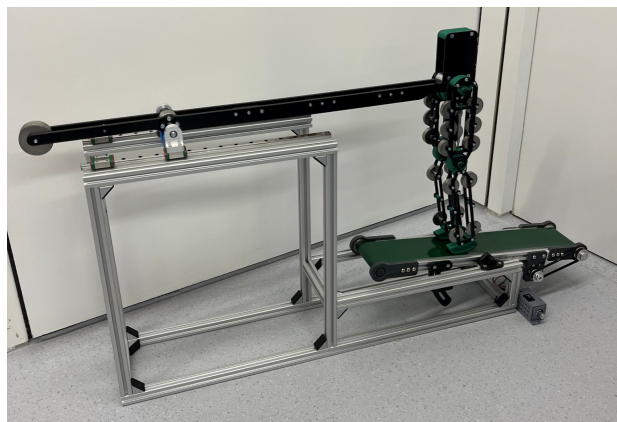


Figure 1: First prototype with treadmill and planarizer (Fig. 4.4 in [1]).

[1] *Designoptimierung eines passiv-dynamischen Laufroboters*. Bachelor's thesis, University of Stuttgart, 2026.  
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