Learning and Transfer of movement gaits using reinforcement learning

Prof. M. Strand, Informatik
RaHM-Lab (DHBW Karlsruhe)

DHBW TRANSFER CONGRESS

Beschreibung

In this proposal, a four-legged robot is trained to walk in the real world, without any manual engineering or programmed movement sequences. The goal is to enable robots to learn to walk on their own using reinforcement learning algorithms. Since each leg has three joints and the robot has four legs in total, this is a very sophisticated behavior to learn, so doing the training process in the real world would not be feasible. To accelerate the learning progress, an accurate simulated environment is used in which the robot can safely be trained using state-of-the-art learning algorithms, such as soft-actor critic and proximal policy optimization. The learnt behavior has then successfully been transferred to the real robot, with the real robot mirroring the behavior of the robot in the simulation. This resulted in the real robot moving forward [1].

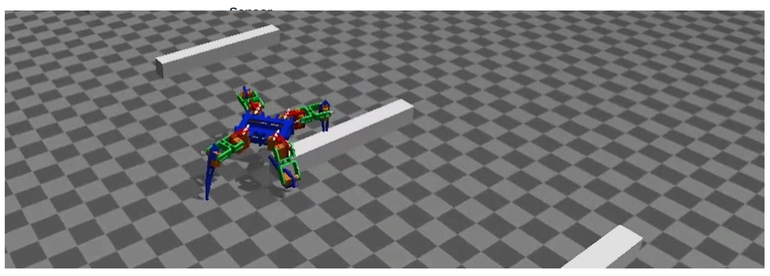
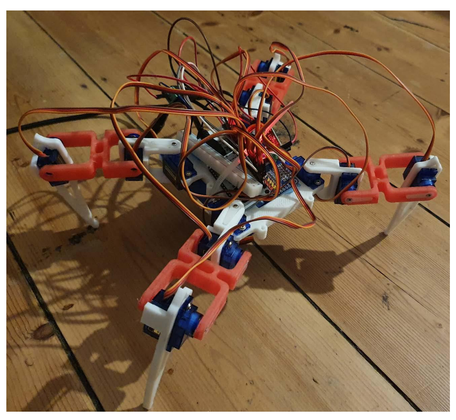


Fig1: Simulation Environment and legged Robot in real



By using the software Unity3D with ml-agents toolkit, the robot will first learn how to move inside a safe environment, where no physical parts of the robot can be damaged, and the learning process can be greatly accelerated by utilizing the parallelization features of the simulation. This allows training multiple simulated robots at the same time, and combining the experiences collected by each robot. The experiences will be used to optimize the movement based on a reward function, which depends on the distance the robot moved forward within a fixed timestep. Once the robot is trained inside the simulation, we will transfer the learned behavior to the robot in the real world, and measure the performance there, to see if there has been a significant loss of performance when transferring between the simulation and the real world.
To train the robot, both, the soft-actor critic and the proximal policy algorithm will be used, with the more successful one being then transferred outside the simulation.
Since the training process does not require any prior knowledge of the gait or the robot's dynamics, it can in principle be applied to any robotic system without explicit system identification or manual engineering.

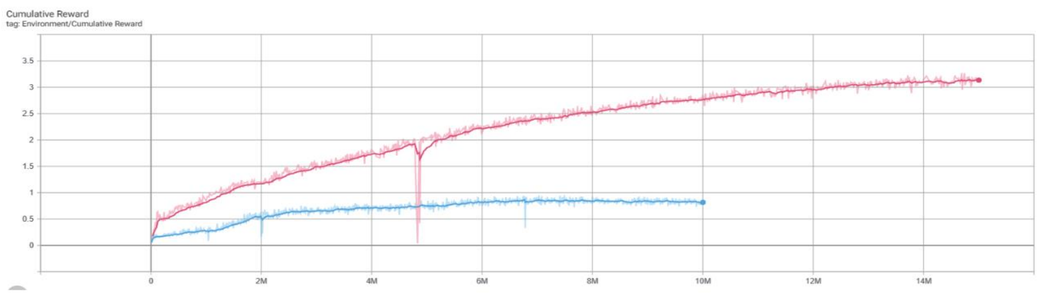


Fig 2: Comparison of achieved results using PPO (red) and SAC (blue)

Ergebnisse

The system coul be verified in the simulation environment where the robot learned to walk autonomously. The tranfer to the real world scenario failed due to simplifications made in the simulation environment. It could be shown, that different kinematics can be learned without prior knowledge

Ausblick

A physics simulation Mujoco will further be used to align the simulated world with the real world in order to suceed in the transfer of the robot motion to real world. Furthermore more sophisticated tasks like avoiding obstacles, goal directed motion will be adressed.

Kooperative Partner

Developed in study thesis

Quellen:

» [1] Waidner, David; Strand, Marcus (2021) : Learning and Transfer of movement gaits using reinforcement learning In: Proceedings of the 24rd International Conference on Climbing and Walking Robots and the support Technologies for Mobile Machines (CLAWAR 2021): Takarazuka, Japan: 30 Aug - 1 Sep 2021. CLAWAR Association, Kwansei Gakuin University (KGU), Takarazuka, Japan: Springer (AISC Springer Series)

Kontakt

Duale Hochschule Baden-Württemberg

Marcus Strand
Erzbergerstraße 121, 76133 Karlsruhe
marcus.strand@dhbw-karlsruhe.de