Gait generation for the Unitree Go2

Motion data acquisition,
Training controllers in simulation
Transfer to physical hardware

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Please note

- These slides are not intended as a standalone presentation, but as collection of notes and ideas
- Instead they are intended for a second online call to discuss an approach I would take for enabling a low-cost robot dog like the Unitree Go2 Air to learn custom locomotion patterns without the full „AI mode“ capabilities of the Pro/EDU versions

Observations (1)

- Ample selection of projects for quadruped gait generation available (see gait_generation.md)
- Solutions for deep learning-based gait generation generally require reference motion sequences for training controllers

→ Availability of training data is more of a problem than finding suitable DL models for gait generation

Observations (2)

- None of the solutions for gait generation are specifically tailored for the Unitree Go2
- Some projects do however support older quadruped robots from Unitree
- One project (GenLoco) specifically supports training generalized gait controllers for multiple robot platforms

→Use more than one project to target the Go2 as platform

→E. g.: Motion Imitation → GenLoco/Walk these Ways

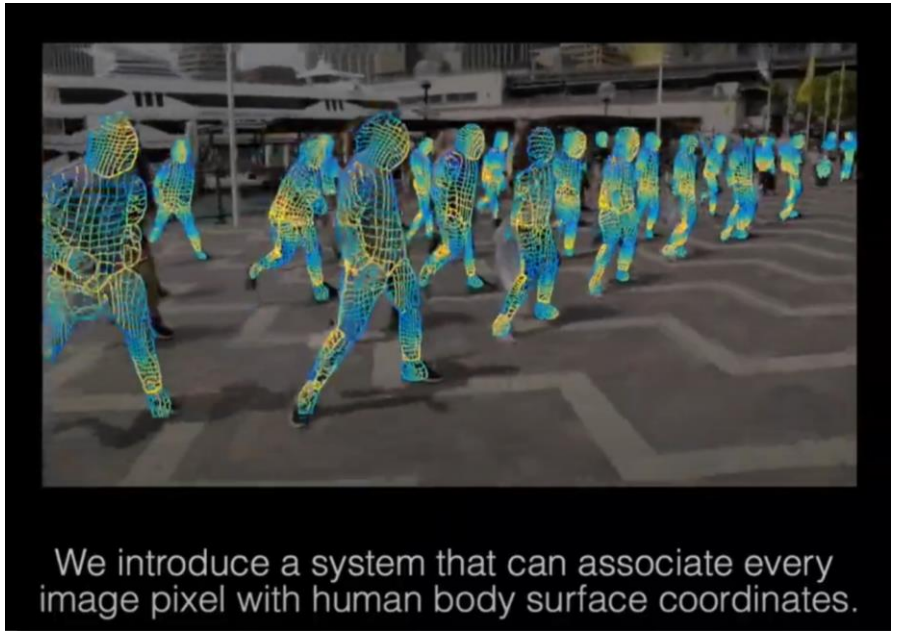
Where to source motion capture data from

- **Hardware**:
  Use a Go2 EDU (with „AI mode enabled“) to record low-level motor commands/joint angles as ground truth
- **Computer vision**:
  Extract motion sequences from online videos
- **Character animations/game assets**:
  Use animations from game assets for quadruped animals
- **Conduct own motion capturing for animals**:
  E. g. collaborate with a local animal shelter

MoCap-able DL models for quadrupeds

- Detectron 2 is capable of pose estimation for animals, in 2D and 3D: See https://github.com/facebookresearch/detectron2/blob/main/projects/DensePose/doc/DENSEPOSE_CSE.md
- Custom YOLO models (2D only): e. g., https://learnopencv.com/animal-pose-estimation/
- 2D to 3D:
  - Record own video sequences with a depth cam
  - Use monocular depth estimation (MiDaS, DepthAnything) to do depth estimation on 2D video data

DensePose with Detectron 2



- Pixel to surface coofdinate mapping also works for animals, not just humans.
- Combine with keypoint detection in 2D + monocular depth estimation: 3D motion capturing from video sequences

Open points

- Test gait generation with obstacles in environment ➔ Walk these Ways project
- Test transitioning between different gaits ➔AI4Animation project
- Address technical details: Using multiple GPUs + multiprocessing/MPI for training
- Narrow down selection for most promising candidate projects for gait generation
- Add support for new(er) CUDA versions/GPU generations, port projects to newer versions of Tensorflow/PyTorch