Stop Pretending You Can’t Dance: Mimicking Human Dance Moves with the SO-101 Robot

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Introduction

- **Main Goal:** Programming the SO-101 Robot Arm to mimic human dance moves in real-time
  - SO-101 is known for executing repetitive, predetermined trajectories
  - Mapping high-dimensional human movements to lower degree-of-freedom robotic system sacrifices fluidity and variation
  - Use of pose estimation, re-framing, and inverse kinematics

Demo

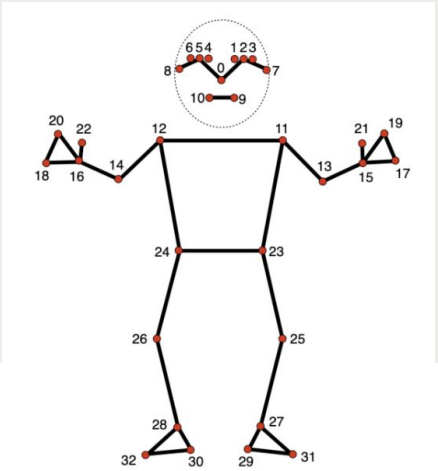
Related Works

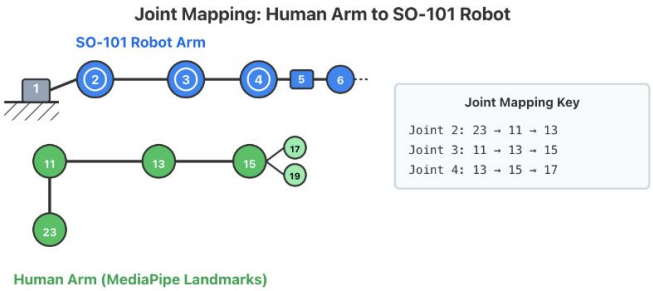
- Saviano et. al → “Multi-point mapping of dancer aesthetic movements onto a robotic arm”
  - Two main tasks: following the mobile limb and aligning robot’s center of gravity to human’s center of gravity
  - Multi-point mapping → smoother movements

- Clotet et. al → “Experiences using Mediapipe to make the arms of a humanoid robot imitate a video-recorded dancer performing a robot dance”
  - Extract 3D skeletal points from recorded footage
  - Rapid motions in video reduced tracking reliability

Q1: How do we map human joints to robot joints?

- **Theoretical approach**: focus on most involved human limb and relative positioning
- **Setup**: map left arm to 3 joints, right arm to 2 joints
- **Result:** human can control the entire robot with just a camera, no teleoperator arm needed





Q2: How can we make the robot move smoothly?

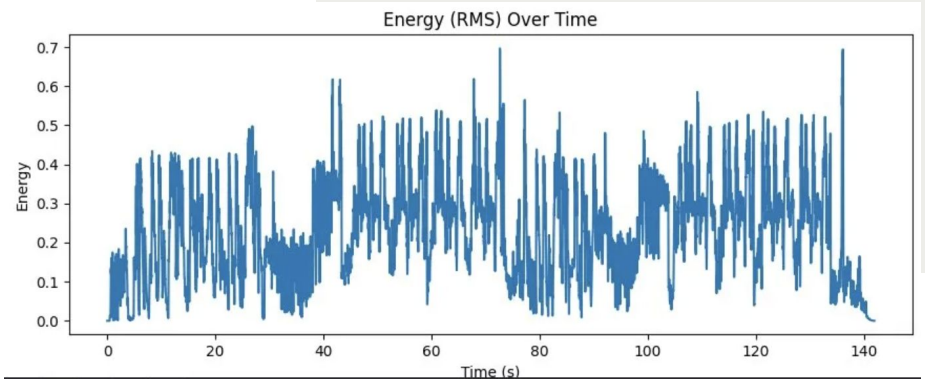
- **Setup:** adjust the maximum acceleration of the Lerobot servo bus
- **Result:** it moves more smoothly at ~20 units of acceleration

```
from src.control import fast_move_to_pose, slow_move_to_pose
from src.so101_utils import get_port_and_id
from src.utils import standardize_pose

MAX_ACCELERATION = 254
assert MAX_ACCELERATION <= 254, "MAX_ACCELERATION must be less than or equal to 254"
```

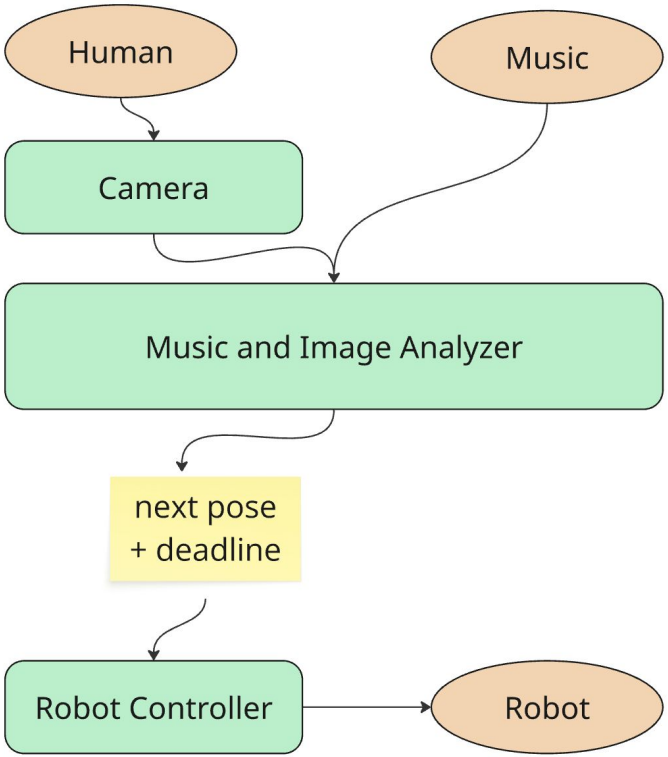
Q3: How do we make the robot move on beat?

- **Setup:** 2 parallel processes – music player and robot controller
  - Send actions at every beat with a deadline to complete
  - Takes the two inputs to execute moves on time
- **Result:** the robot dances along with the music!




```
--- ANALYSIS COMPLETE ---
Tempo (BPM): 135.99917763157896
First 10 Beats: [0.893968253968254, 1.2190476190476192, 1.5209070294784581,
07483, 4.655600907029479]
Number of Onsets: 355
```

Flow Diagram



Next Steps

- **Challenge:** lack of fluidity and limitation of motion ranges
  - Focus on increasing smoothness while maintaining same degrees of freedom
- **Metrics:** test different joint mapping algorithms to evaluate accuracy
- **Machine Learning:** train robot on different dance moves so that after music analysis is done, it can choose the moves itself

Thanks!

Questions?