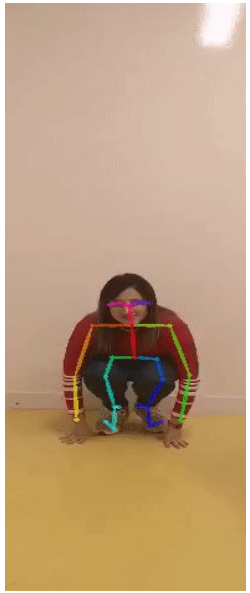
école normale supérieure paris–saclay

Humanoid Robot Imitation of Human Motion from Instructional Videos



Fatma Moalla & Carla Yagoub

Project presentation

Context

- Reconstructing human motion dynamics from real-life videos is a challenging and interesting problem.
- Used in many fields like self-driving cars, video games, clothing modelling ...

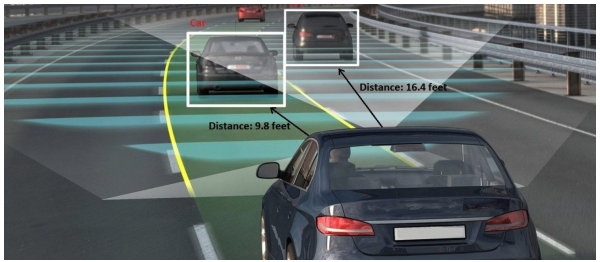


Image extracted [1]

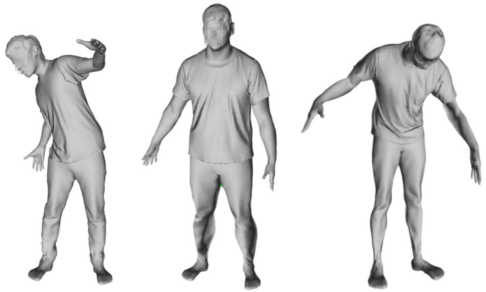


Image extracted from [2]

Objective

- Train and visualize the imitation of characters in personal videos by extracting their 3D motion. For this matter our project is divided into two steps

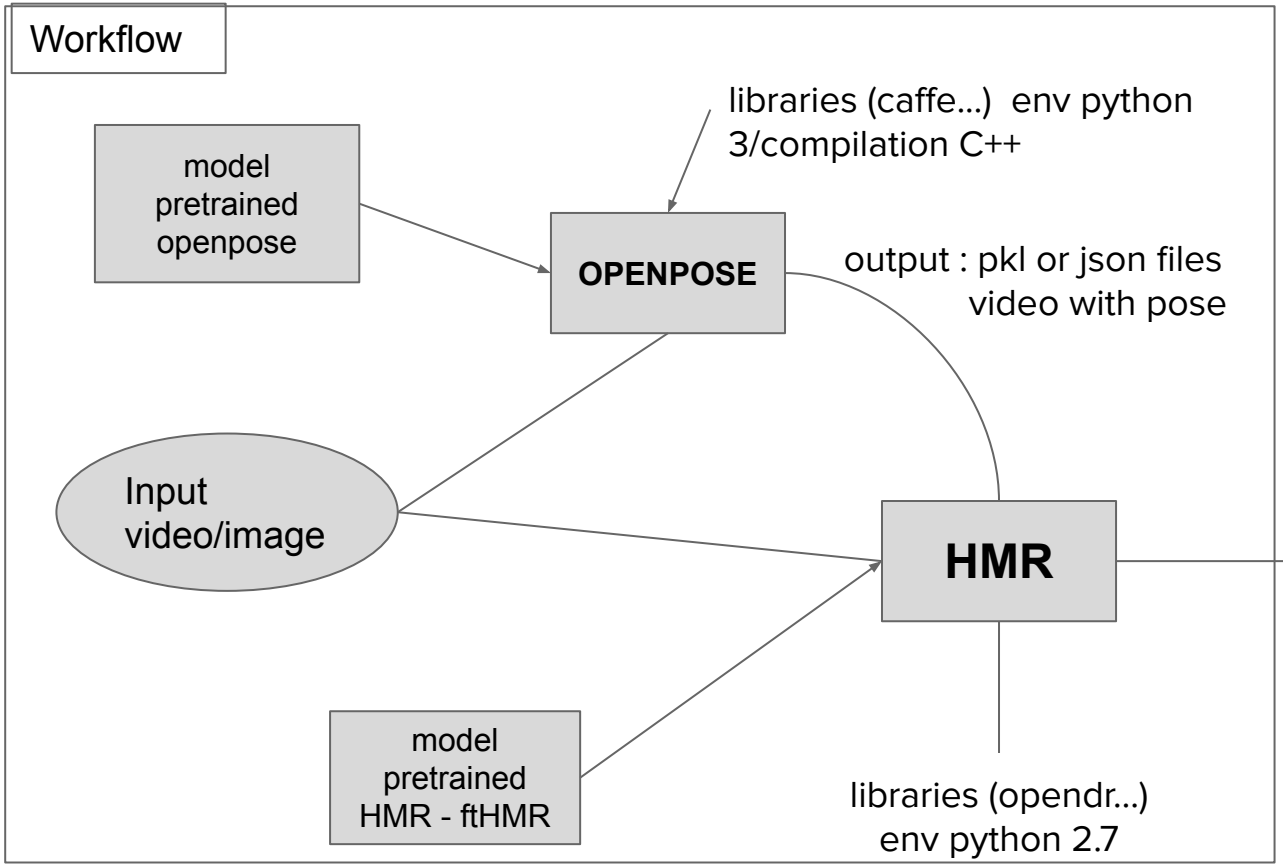
Steps

1. Executing the HMR model and trying to reproduce the 3D motions
2. Using Deep Reinforcement Learning to smooth the motions of the 3D characters

Presentation Plan

1. Introduce HMR Model
2. Testing of the HMR model on Manual Task images and the on customized videos with a fixed Camera
3. Deep Reinforcement Learning method with DeepMimic
4. Future improvements/Project challenges

HMR Model[8]



Link Openpose / HMR :

➜ pose estimation needed for better accuracy of 3D mesh
➜ cropping the image to the boxes of the pose estimation
➜ json files : dictionary of poses for each people
➜ HMR selection of people based on frequences of occurences...

HMR Model on single person videos

Openpose vs 3D mesh

➜ **Image dataset :**

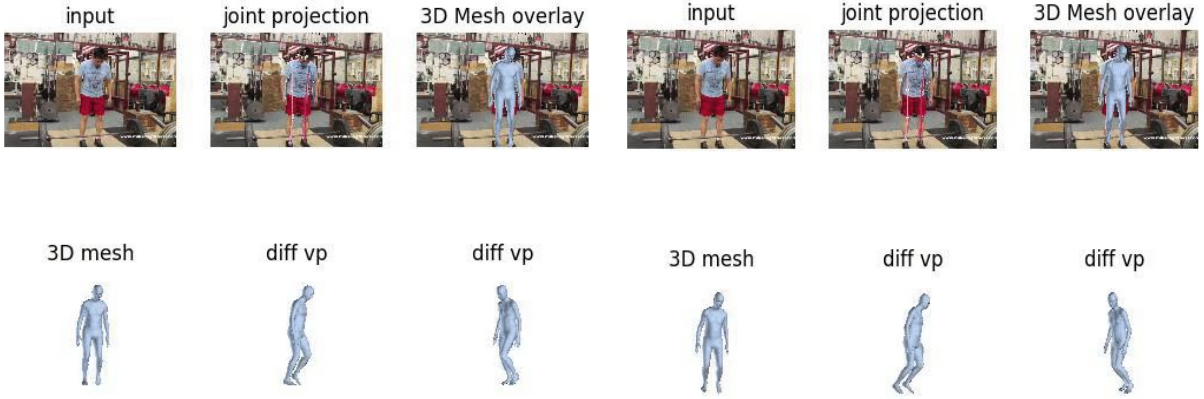
Barbell :
➜ understand the use of openpose output for HMR
➜ minor differences with and without the use of pose keypoints

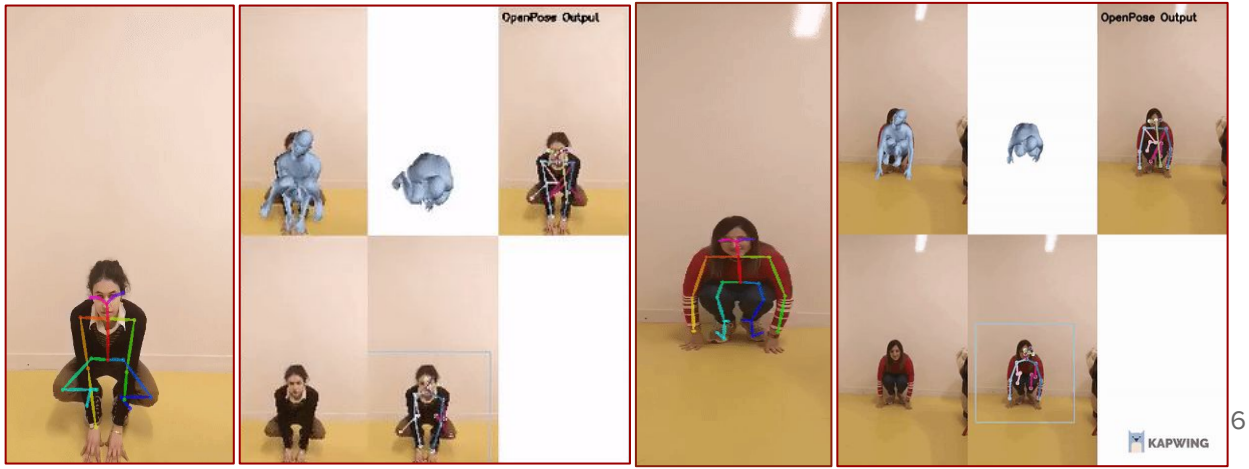
➜ **Personal videos : jump**

➜ less accurate prediction of the positions
➜ May also involve the motion of the camera

Without cropping to the Boxes

With OpenPose pose keypoints

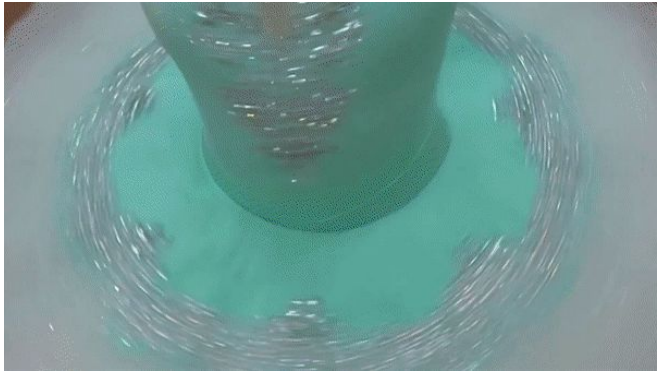




HMR Model on two person video : Dance Battle

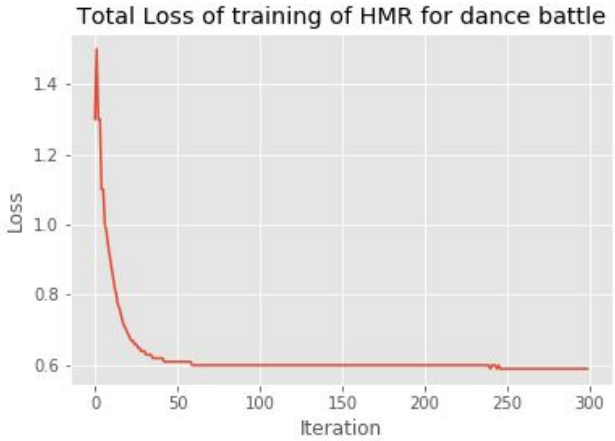
Output of openpose :

pose keypoints of both people are well computed



2D keypoints used :

HMR video output for a youtube video[7]



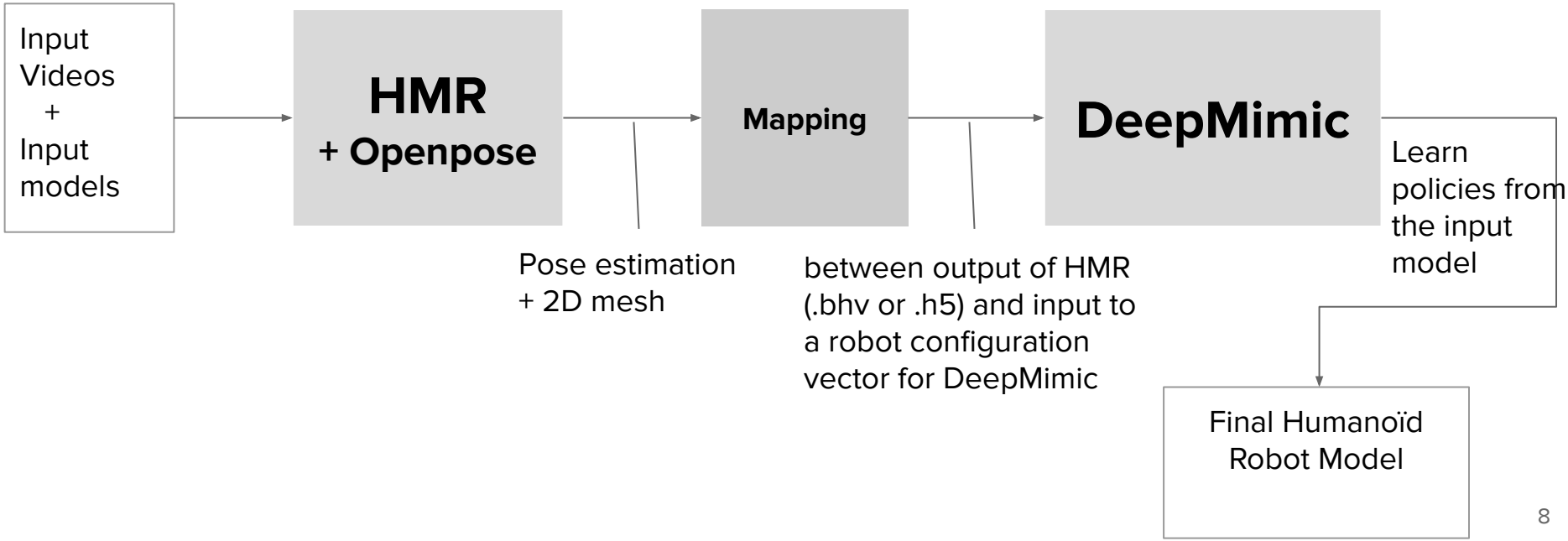
Output of HMR :

➔ 300 iterations for 545 s of computation

➔ Convergence assessed by the total loss function

➔ HMR not suited for multiple persons

Reinforcement Learning pipeline



Policy training process in DeepMimic Environment

- In this environment, the agent maximizes The expected return :

$$J(\theta) = \mathbb{E}_{\tau \sim p_\theta(\tau)} \left[\sum_{t=0}^{T} \gamma^t r_t \right]$$

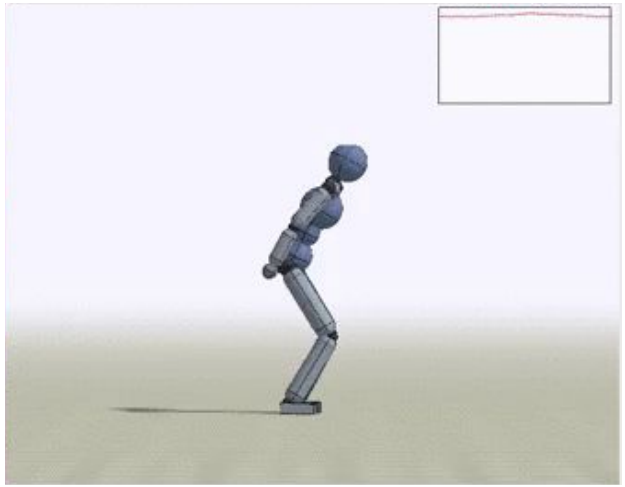
- At each step t the reward : $r_t = \omega^I r_t^I + \omega^G r_t^G$.

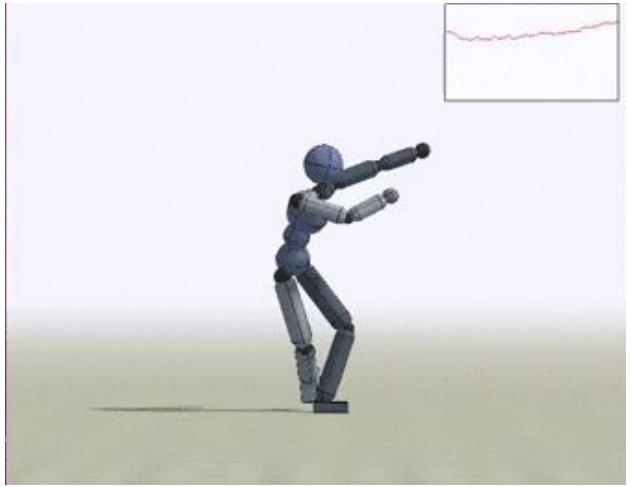
  ➜ The First term is weighted “imitation” and the second is the weighted “task objective”

- Use of Proximal Policy Approximation to train the policy

Pretrained models on manual tasks videos

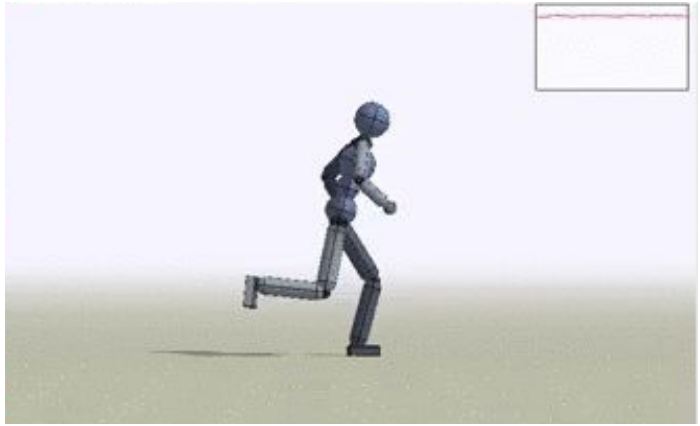
- Running pre-trained models without any motion





Jump **&** **Dance**

- Running pre-trained models on a random motion: **pose=Run , motion= Get_up_face_down** ➜ **Failure**



- Running pre-trained models on a random motion: **pose=Run , motion= Run**

➜ **Success**

➜ Unfortunately, we couldn't train a policy using Deepmimic, due to technical problems with mpi_run.py that we didn't manage to solve.

Project difficulties and Future improvements

Future improvements

- Solve technical issues related to mpi_run.py
- Add mapping for input models and train the different policies
- Add smoothness by applying smoothness loss on Motion reconstruction

Project Difficulties :

- The code proposed presents different versions of the same package that might be incompatible with other packages used : we should run 3 repository with more than 2 versions of python and 2 version of tensorflow
- Difficulty in installing some packages on our computer architecture (MacOs and Ubuntu 18) ➜ Using ***VirtualBox, virtual ubuntu 14.06*** and Google Colab

References

[1] DeepWrinkles: Accurate and Realistic Clothing Modeling

[2] Short course on Deep Learning and Computer Vision for Autonomous Systems

[3] xbpeng/DeepMimic: Motion imitation with deep reinforcement learning.

[4] zhaolongkzz/DeepMimic_configuration: Motion imitation with deep reinforcement learning.

[5] akanazawa/motion_reconstruction: Motion Reconstruction Code and Data for Skills from Videos (SFV)

[6] akanazawa/hmr: Project page for End-to-end Recovery of Human Shape and Pose

[7] Ballet vs hip hop! video (2018), https://www.youtube.com/watch?v=OYZunaWxOY4

[8] Kanazawa, A., Black, M.J., Jacobs, D.W., Malik, J.: End-to-end recovery of human shape and pose. CoRR abs/1712.06584 (2017), http://arxiv.org/abs/1712.06584

[9] Peng, X.B., Abbeel, P., Levine, S., van de Panne, M.: Deepmimic: Example-guided deep reinforcement learning of physics-based character skills. https://doi.org/10.1145/3197517.3201311, http://doi.acm.org/10.1145/3197517.3201311

Thank you for your attention

input

joint projection

3D Mesh overlay

3D mesh

diff vp

diff vp