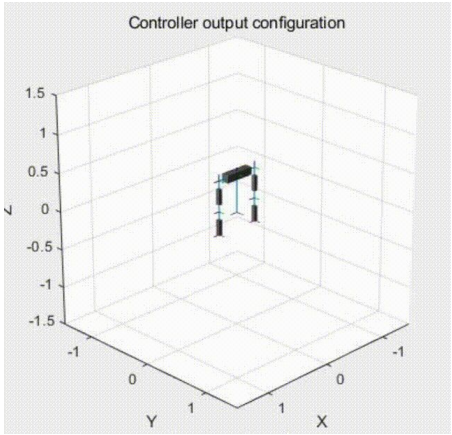
Boxing Robot: design and motion tracking



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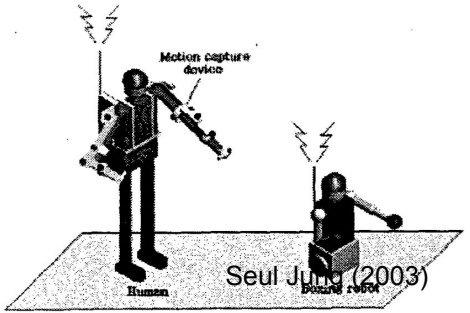
Problem Statement

Problem and Motivation:

- Design a **boxing** robot
- Using **visual input** to enhance the mobility
- Achieve **3d pose construction** based on **markless optical cameras**



Seul Jung (2003)

Challenges:

- It’s hard to reconstruct 3D motion data based on multi-camera view
- Real time processing and no lag precise PID control on the robot arm

Prior Research

- Yongbin Li et al. (2019):

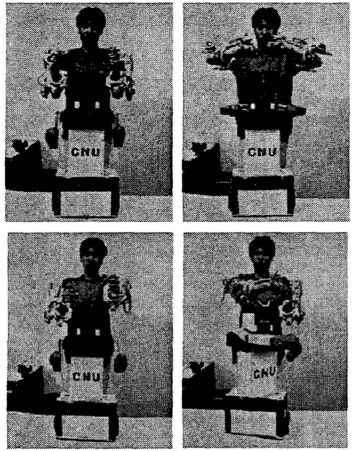
  remote control connection system **quickly**/fuzzy control

- F. Siles et al. (2018):

  optical motion capture system/**with markers/not in real time**

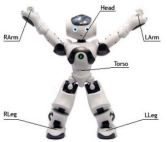
- Seul Jung (2003):

  exoskeleton type motion capturing device



Seul Jung (2003)

(a) Model of 6 chain effectors.



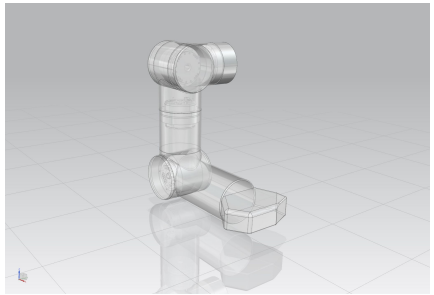
(b) Chain effectors of the NAO humanoid robot H25. Extracted from: http://doc.aldebaran.com/2-1/family/robots/bodyparts.html

F. Siles et al. (2018)

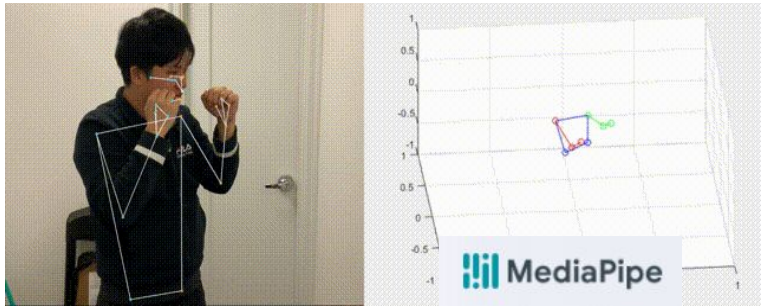
Solution Approach

Approach:

Structure design



Motion data collect and 3D reconstruction

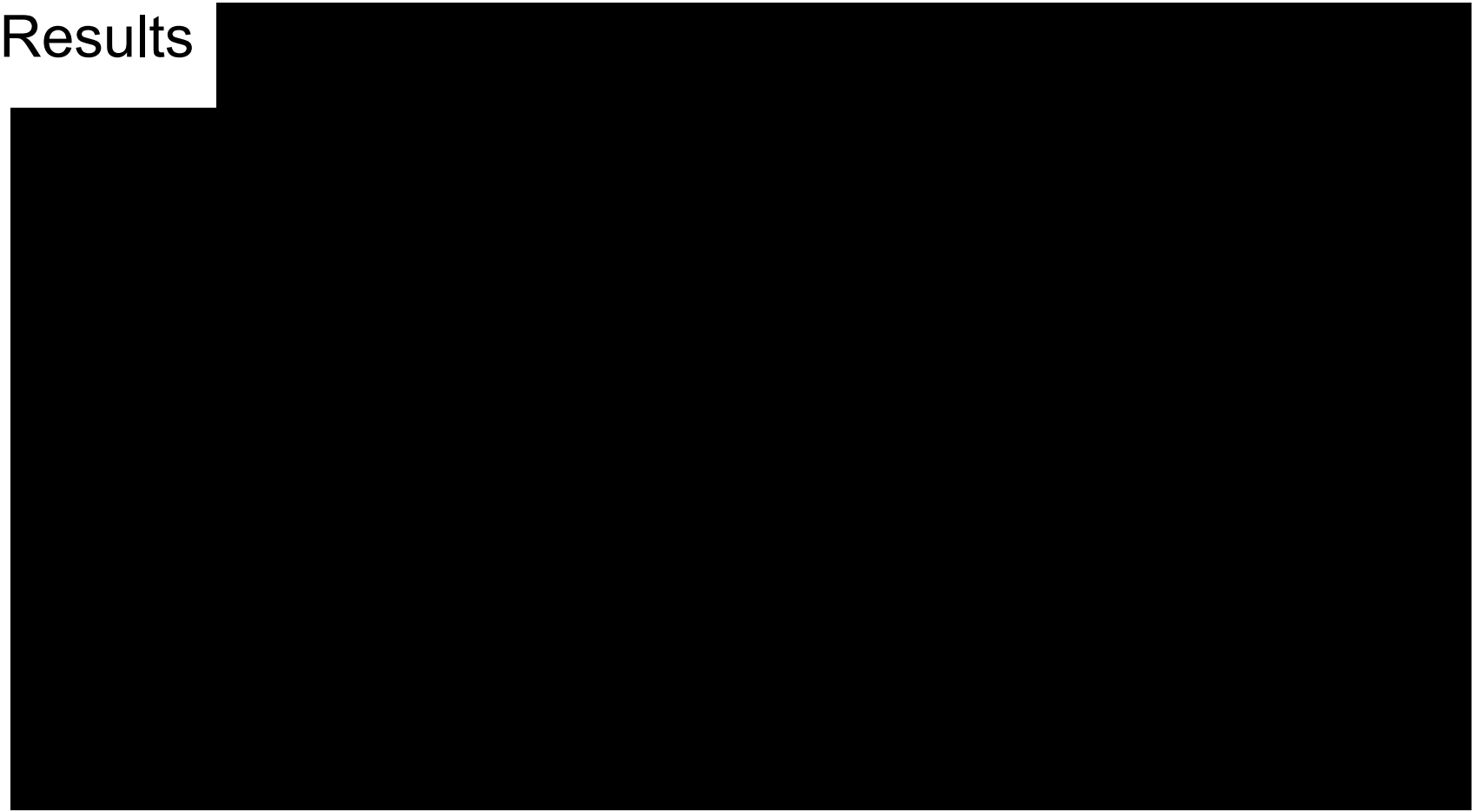


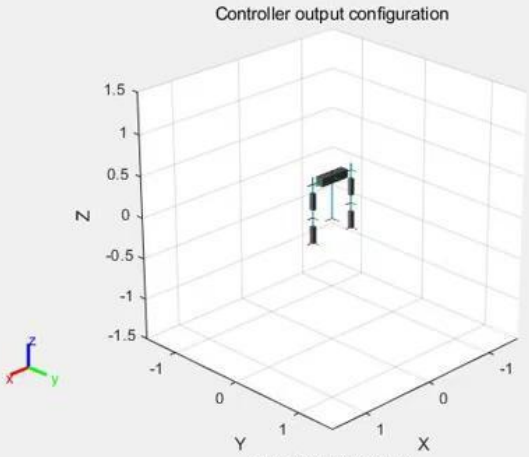
PID Controller

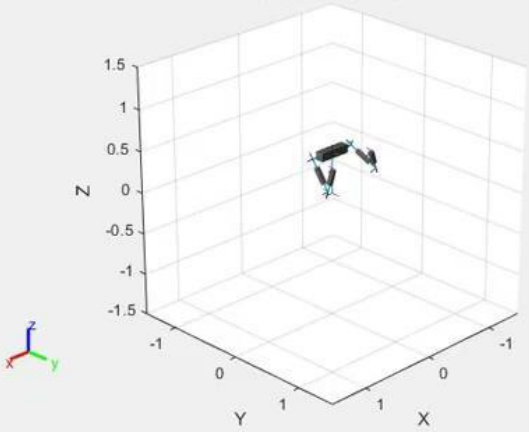
Uniqueness:

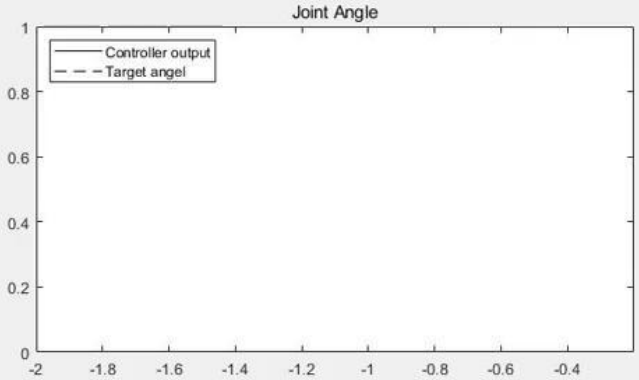
Prior Research	Our Approach
optical motion capture system or infrared camera (with markers)	multi optical cameras, markerless
Fuzzy control, etc..	deep learning for predicting landmarks position
	post-processing algorithms to reconstruct 3D data

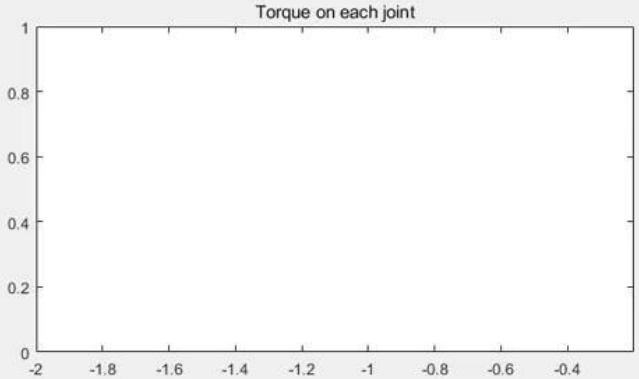
Results




Controller output configuration
Z
Y
X
1.5
1
0.5
0
-0.5
-1
-1.5


Traget configuration
Z
Y
X
1.5
1
0.5
0
-0.5
-1
-1.5

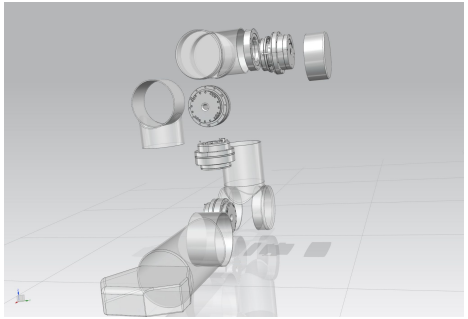

Joint Angle
Controller output
Target angel
1
0.8
0.6
0.4
0.2
0
-2
-1.8
-1.6
-1.4
-1.2
-1
-0.8
-0.6
-0.4


Torque on each joint
1
0.8
0.6
0.4
0.2
0
-2
-1.8
-1.6
-1.4
-1.2
-1
-0.8
-0.6
-0.4

Conclusion and Future Extensions

Conclusions

- Structure design and assemble of a kind of humanoid robot arm with 4 DOF
- Reconstruct 3D position of human landmarks based on multi-camera
- Tuning PID controller succeed to follow trajectory under torque limit
- Robot achieved the imitation of boxing behavior of human model



Future Extensions:

- Next Steps
  - Integrate all the modules and make the real-time edition
  - More advanced algorithms for reconstructing 3D data
  - Analyze the dynamic rationality of the mechanical structure
- Potential Related Problems
  - Delay of the motion (base on the total runtime of program)
  - Cannot achieve precise control (base on the accuracy of DL model and reconstruct algorithms)