

MPII 3D Joint Location Ground Truth Annotation Tool Readme

Introduction

This tool implements the 3D joint annotation for 2D human pose dataset MPII. Written in C++ & C#. Libraries used: OpenGL & OpenCV.

Main functionalities:

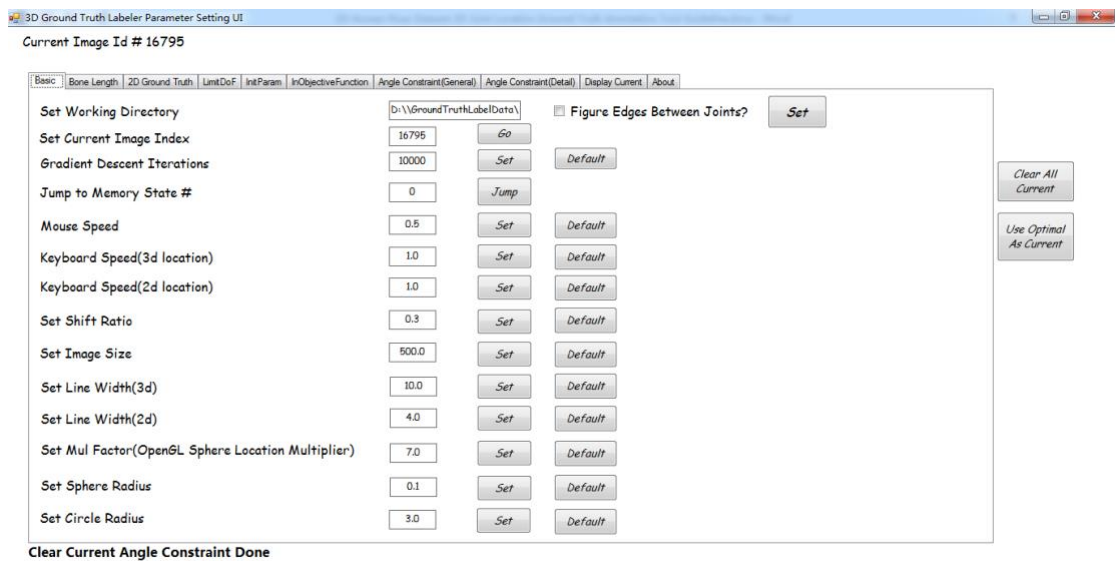
- 1) Freely translate, rotate and drag 3D coordinate via mouse and keyboard
- 2) Shift 3D coordinates of keypoints (left, right, up, down) using keyboard and mouse
- 3) Freely shift 2D keypoints annotation via keyboard and mouse
- 4) Given an option of (1) joint angle constraint (2) pose-conditioned joint angle limit (3) without any constraint. Optimize a 3D forward kinematics human model such that the 2D projection is minimum to the 2D annotation. The optimized 3D model is visualized by OpenGL. The corresponding 2D projection is shown in OpenCV windows. The visualization is real-time so that the user can observe the changes as the user shifts 2D and 3D keypoints
- 5) Change settings: bone length of all or current image; initial joint angle parameters (for FK model); constrained DoF (angle params); joint index in the objective function; objective function etc.
- 6) Auto save and permanently save result per image
- 7) Navigate to any image and load currently saved 2D and 3D annotations
- 8) Inspect current optimization result (joint angle parameters, 3D joint locations) in real
- 9) Set user-friendly preferences for OpenGL and OpenCV
- 10) Load settings for any backup. Tag supported
- 11) All saved results are text files with ".txt" suffix

Basically, the C++ OpenGL program provides a visualization interface for displaying 3D human model, where the user can interact with the system.

The C# interface sets certain things up, e.g. directories to save the optimized results etc

Main Frame

1)C#



The bottom status bar shows the current operation, like below

Set Current In Objective Function Id Done

Set Angle Constraint to Current Image Done

Finish Navigating to 5

Finish Displaying Current Optimal

Finish Replacing Current Optimal(result folder)

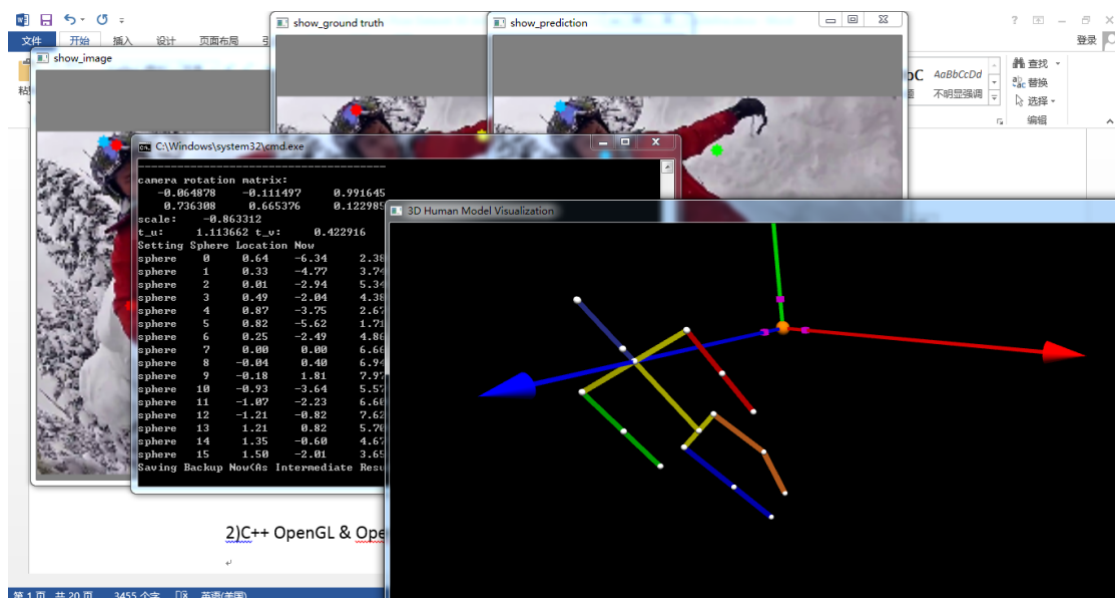
Finish Loading Angle Constraint File

Finish Loading Optimal As Base Parameter Settings

Clear Current Angle Constraint Done

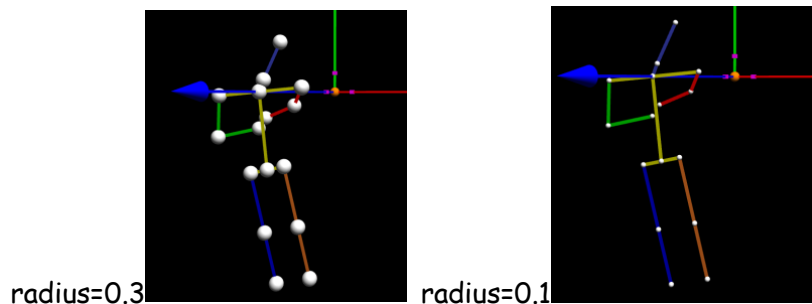
Set This Bone Length to All Images

2)C++ OpenGL & OpenCV



Basic settings

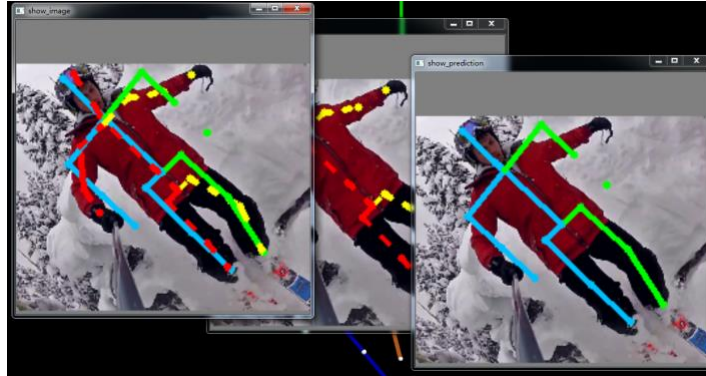
1. Set Working Directory
Root dir
2. Set Current Image Index
Click "Go" to reflect the changes in current_imageid.in.
3. Gradient Descent Iterations
The default value is 10000
4. Jump to Memory State #
With regard to each image, there are a couple of temporary states in the memory, to which the C++ program can switch. Details follow next.
5. Mouse Speed
In the OpenGL interface, left click mouse+ drag = rotate view (rotate the coordinate system). Right click + drag = translate the coordinate. Select the keypoint to be changed and then right click + drag the mouse equals updating the depth "z" value of that keypoint. The speed of mouse is set here.
6. Keyboard Speed(3d location)
Use 0-f (keypoint 0-15) to select the keypoint, \leftarrow \uparrow \rightarrow \downarrow , PageUp, PageDown to modify the keypoint coordinates as well as shift the coordinate. Speed is set here.
7. Keyboard Speed(2d location)
Shift speed when updating 2d annotations
8. Shift Ratio
Press shift to make minor changes to the keypoints
9. Image Size
Change the OpenCV window size
10. Set Mul Factor
For visualization convenience, the optimized $\{x_i, y_i, z_i\}$ is multiplied by mul_factor.
11. Set Sphere Radius



12. Set Circle Radius



13. Figure edges between joints



Basic operations

1. Make sure the file paths in FilePath.in are valid before running ThreeDGroundTruthLabeler.exe

```

1 D:\\GroundTruthLabelData
2 F:\\msraintern\\humanpose\\dataset\\mpii\\wqf\\zxydata\\train\\img
3 F:\\msraintern\\humanpose\\poseprior\\prior\\anglespread.in
4 F:\\msraintern\\humanpose\\poseprior\\prior\\sepplane.in
5 F:\\msraintern\\humanpose\\poseprior\\prior\\secondbasis.in
6 F:\\msraintern\\humanpose\\poseprior\\prior\\bbx.in
7 F:\\msraintern\\humanpose\\poseprior\\prior\\boundries.in

```

1st line: working root directory

2nd line: image directory (uniform crop size 224x224)

3rd to 7th: matlab file variables from the MatLab code of "pose-conditioned joint angle limits for 3d human pose reconstruction"

2. When the program starts, it will load images from "configuration\\current_imageid.in". If the image is already optimized, the previously saved result from "result\\param_xx.txt, pred_2d_xx.txt, pred_3d_xx.txt" will be loaded and visualized in both 2D and 3D.

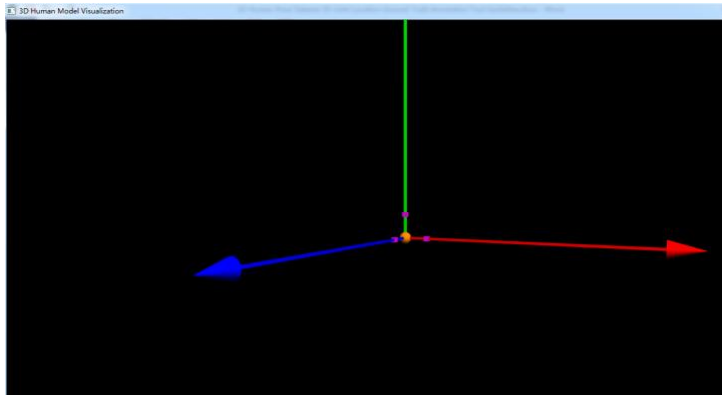
```

perspective_trans_y 0.00
perspective_scale 0.00
Current available memory num: 0
Current Image : 1613
Current Image : 1614
Current Image : 1615
Current Image : 1616
Current Image : 1617
Current Image : 1618

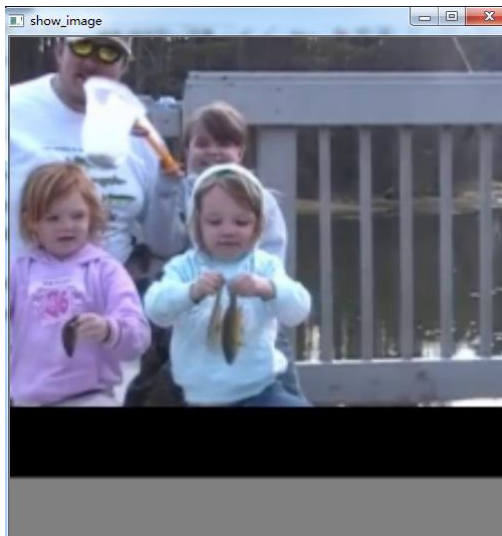
```

Terminal will show Image Index

Otherwise a blank OpenGL window pops up.



"show_image": the original image containing a human centered



3.

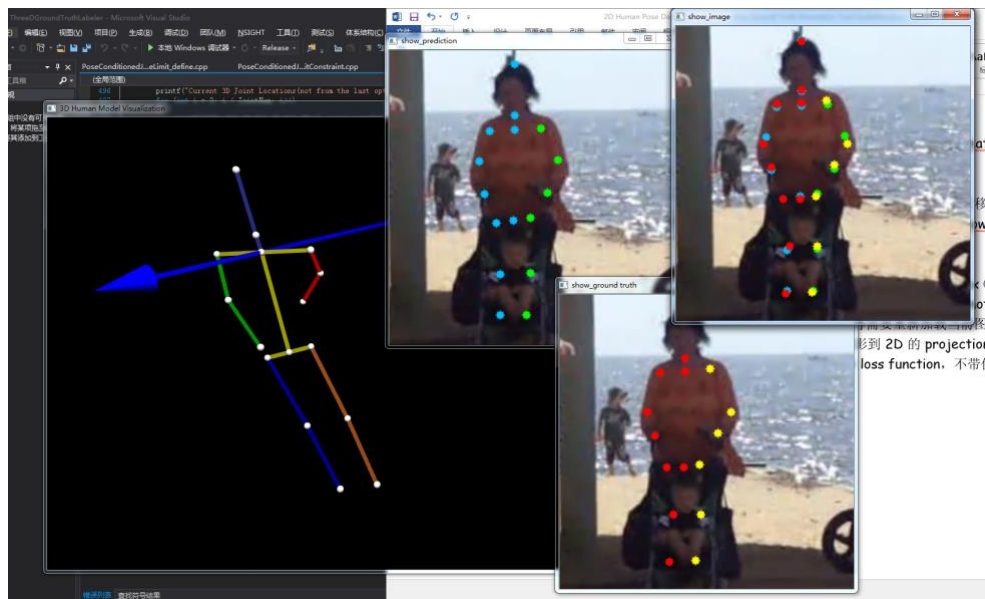
- 1) Left click and drag the mouse (keep the mouse pressed) to rotate the coordinate
- 2) Right click and drag the mouse to translate the coordinate. Move cursor to the right in order to let the coordinate shift left.
- 3) ←: the coordinate moves left, likewise for → ↑ ↓ PageUp: zoom out; PageDown: zoom in (**press Shift to make minor changes**)
- 4) Ctrl+PageUp: navigate to the last image Ctrl+PageDown: navigate to the next image

Upon loading a new image

5)l(**short for "load"**): navigate to the index in "configuration\current_imageid.in" to reflect changes made in the C# interface. E.g. current image index or any other parameters are modified (initial motion parameter, keypoints considered for the objective function, the set of degree of freedom to be constrained etc.)

6)p(**short for "projection"**): Press "p" first to get an initial Optimize using only reprojection error: the Euclidean distance between projection of optimized 3D (under the FK model optimization) and ground truth 2D. Note

no constraint is enforced at all, let alone say "joint angle limit constraint"



Windows shown: (1) 3D model("3D Human Model Visualization") (2) prediction("show_prediction"、ground truth("show_ground truth") (3) overlay prediction on ground truth ("show_image")

7)P(capital p) optimization with joint angle limit constraint (for each joint angle, there is a lower bound and a upper bound)

8)o(short for "optimize") fit the human forward kinematics model to the current 3D annotation

9)O(capital o) 3D optimization using joint angle limit

```
Current 3D Joint Locations(not from the last optimization):
right_ankle 0.459280 -0.882013 1.090532
right_knee 0.233324 -0.692988 1.033843
right_hip -0.026158 -0.461664 0.993121
left_hip 0.132869 -0.409352 0.883696
left_knee 0.370185 -0.661759 0.933416
left_ankle 0.581968 -0.861426 1.006087
pelvis 0.053355 -0.435508 0.938408
thorax 0.000000 0.000000 0.921357
upper_neck -0.000832 0.068879 0.980171
head_top -0.041588 0.315510 1.004668
right_wrist 0.134920 -0.324119 1.134303
right_elbow -0.064913 -0.195210 1.109292
right_shoulder -0.244632 -0.032967 0.910959
left_shoulder 0.244632 0.032967 0.931755
left_elbow 0.114967 -0.112889 0.775509
left_wrist -0.062904 -0.283732 0.735431

Angles:
global_trans_x 0.00
global_trans_y 0.00
global_trans_z -0.03
global_rot_x 4.29
global_rot_y -9.14
global_rot_z 6.78
right_knee_rot_x -4.57
right_hip_rot_x -27.72
right_hip_rot_y 5.04
right_hip_rot_z 23.50
left_hip_rot_x -26.61
left_hip_rot_y 0.05
left_hip_rot_z 17.77
left_knee_rot_x -6.76
upper_neck_rot_x 2.85
upper_neck_rot_y 0.04
upper_neck_rot_z 0.78
head_top_rot_x -1.63
right_elbow_rot_x 17.76
right_shoulder_rot_x -32.68
right_shoulder_rot_y 10.51
right_shoulder_rot_z 42.20
left_shoulder_rot_x 42.08
left_shoulder_rot_y 21.44
left_shoulder_rot_z -40.85
left_elbow_rot_x -29.73
hip_rot_y -24.85
hip_rot_z 7.69
perspective_rot_x 7.44
perspective_rot_y -2.13
perspective_rot_z -110.51
perspective_trans_x 1.06
perspective_trans_y 0.34
perspective_scale -0.70

Current available memory num: 0
```

10)h(short for "help")

11)m(short for "memory") save the temporary state of the current best optimized model to the memory in C++ for easy jumping.

12)j(short for "jump") jump to the state in configuration\memory_id.in

13) s(short for "save") save the best optimization for the current frame (the final state). The states saved (to files) are as follows

:

result\param_xx.txt (optimized joint angle)
result\pred_2d_xx.txt (2D projection of the optimized model)
result\pred_3d_xx.txt (3D Joint Location of the optimized model)

14) S(capital s) just as backup (not the final result)

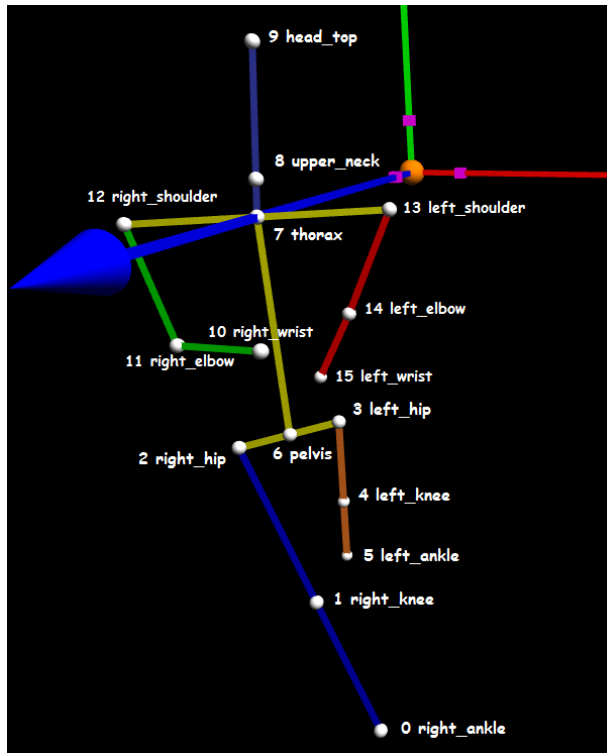
We can have multiple copies for a single frame as backup states. Say the index for the backup of the current frame is ID, saved in "configuration\saveindex.in". Upon releasing the "S" key, files are saved. The files included are:

intermediate\angleconstraint_xx_ID.in	--- joint angle limit constraint
intermediate\bonelen_xx_ID.in	--- skeletal bone length
intermediate\initparam_xx_ID.in	--- initial motion parameter
intermediate\inobj_xx_ID.in	--- joint index in energy function
intermediate\islimited_xx_ID.in	--- DoF(s) to be constrained
intermediate\interpretation_xx_ID.in	--- tags for the backup ID
intermediate\param_xx_ID.txt	--- the optimized joint angle
intermediate\pred_2d_xx_ID.txt	--- 2D projection of 3D optimization
intermediate\pred_3d_xx_ID.txt	--- 3D keypoint locations

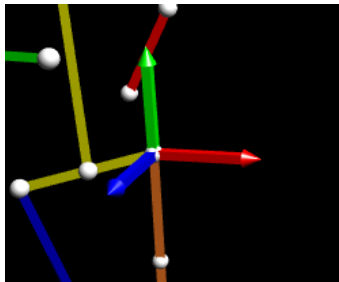
Modified annotations are saved to
intermediate\mod_xx_ID.txt
where xx is the current image id

15) C Apply joint angle limit constraint from the paper "Pose-conditioned Joint Angle Limits for 3D Human Pose Reconstruction". Output invalid bones and find the closest 3D point clouds to the current 3D keypoints while satisfying the constraint. The "o" event is triggered automatically to fit a 3D model satisfying the forward kinematics constraint.

16) The diagram below shows the index for each joint



Press the key 0-9、a-f(10-15) to select one specific keypoint and show the local coordinate of that keypoint (red, green, blue)



Use the key $\leftarrow \rightarrow \uparrow \downarrow$ 、PageUp、PageDown to adjust x, y, z values of the keypoint (PageU: keypoint is moving towards the user; PageDown: keypoint is moving away from the user), press and hold the right click key \rightarrow drag to the left == keypoint moving towards the user, press and hold the right click \rightarrow drag to the right == keypoint moving far away from the user

After manual adjusting, "o" is pressed to fit a FK model to the manual adjustment.

Always press "Esc" to return to the global view (lose focus), and deselect one specific keypoint. At which point the local coordinate system will miraculously disappear.



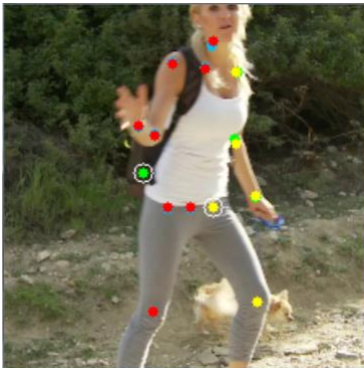
(The one besieged by a white circle is the joint currently being moved. The green solid fill shows the predicted projection (of the optimization) while the hollow white circle is the ground truth)

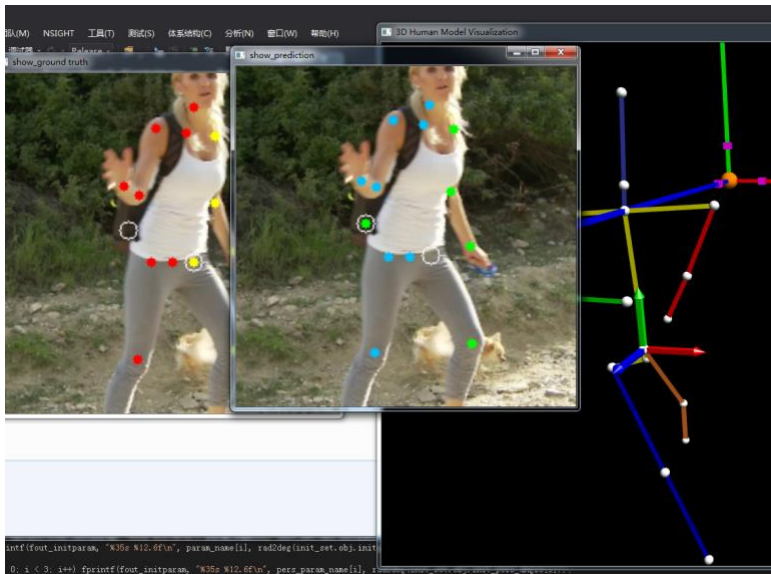
This is the window for "show_ground truth":



(Different from above, the hollow white circle corresponds to the prediction, while the solid white fill is the ground truth)

Overlay prediction on top of ground truth, we get the window "show_image":





To adjust ground truth

Alt+←/→/↑/↓ (minor changes: Shift+Alt+←→↑↓)

Color semantics:

red right part of ground truth annotation
 yellow left part of ground truth annotation
 blue right part of prediction
 green left part of prediction

Set skeletal bone length

BoneLength	
knee->ankle	0.3
hip->knee	0.35
pelvis->hip	0.1
thorax->pelvis	0.44
thorax->upper_neck	0.07
upper_neck->head_top	0.25
elbow->wrist	0.25
shoulder->elbow	0.25
thorax->shoulder	0.12

Click "load default" to load the default bone length

Load Default Bone Length

Click "set all" to apply bone length in the text box to all images, then save to the working directory\BoneLength.in

Click "set current" to only apply the length to the current image. Save path will be configuration\bonelen_xx.in (xx is the current image id)

Click "clear current" to delete bonelen_xx.in, and apply universal bone length

2D Ground Truth

To reset the initial joint annotation of the current image before optimization, simply click "Clear Modified Ground Truth". All changes reflected in (gt_2d_modified\mod_xx.txt) will be deleted, whereupon pressing "I" again will load the original ground truth rather than the modified one (the loading priority is set that gt_2d_modified > origin_data)

InitParam (initial motion parameter; joint angle parameters; DoFs)

InitParam(In Degree)

global_trans_x	0.0	head_top_rot_x	0.0
global_trans_y	0.0	right_elbow_rot_x	0.0
global_trans_z	1.0	right_shoulder_rot_x	0.0
global_rot_x	0.0	right_shoulder_rot_y	0.0
global_rot_y	0.0	right_shoulder_rot_z	0.0
global_rot_z	0.0	left_shoulder_rot_x	0.0
right_knee_rot_x	0.0	left_shoulder_rot_y	0.0
right_hip_rot_x	0.0	left_shoulder_rot_z	0.0
right_hip_rot_y	0.0	left_elbow_rot_x	0.0
right_hip_rot_z	0.0	hip_rot_y	0.0
left_hip_rot_x	0.0	hip_rot_z	0.0
left_hip_rot_y	0.0	perspective_global_rot_x	0.0
left_hip_rot_z	0.0	perspective_global_rot_y	0.0
left_knee_rot_x	0.0	perspective_global_rot_z	0.0
upper_neck_rot_x	0.0	perspective_global_trans_x	0.0
upper_neck_rot_y	0.0	perspective_global_trans_y	0.0
upper_neck_rot_z	0.0	perspective_scale	1.0

Default

Set All

Set Current

Clear Current

Read Optimized Param

Use Optimized Param

Initial DoFs are:

global_trans_x, global_trans_y, global_trans_z, perspective_global_trans_x, perspective_global_trans_y. Angle degree measure is adopted. Press Default to use default value (global_trans_z=1.0, perspective_scale=1.0, 0.0 elsewhere)

"Set Current" saves to configuration\initparam_xx.in

"Clear Current" will remove the init param for the current image:

configuration\initparam_xx.in

Read Optimized Param load best angle result for the current image from

"result\param_xx.in" to the text box.

Use Optimized Param will trigger "Read Optimized Param" and save the initial parameter for the current image to configuration\initparam_xx.in

DoFs that are constrained

Some DoFs are not learnable (tunable). Instead, initial params will be loaded.

Limit DoF

Global

<input type="checkbox"/> global_trans_x	<input type="checkbox"/> global_rot_x	<input type="checkbox"/> perspective_rot_x	<input type="checkbox"/> perspective_trans_x
<input type="checkbox"/> global_trans_y	<input type="checkbox"/> global_rot_y	<input type="checkbox"/> perspective_rot_y	<input type="checkbox"/> perspective_trans_y
<input type="checkbox"/> global_trans_z	<input type="checkbox"/> global_rot_z	<input type="checkbox"/> perspective_rot_z	<input type="checkbox"/> perspective_scale

Shoulder

<input type="checkbox"/> right_shoulder_rot_x	<input type="checkbox"/> left_shoulder_rot_x
<input type="checkbox"/> right_shoulder_rot_y	<input type="checkbox"/> left_shoulder_rot_y
<input type="checkbox"/> right_shoulder_rot_z	<input type="checkbox"/> left_shoulder_rot_z

Elbow

<input type="checkbox"/> right_elbow_rot_x	<input type="checkbox"/> left_elbow_rot_x
--	---

Hip

<input type="checkbox"/> right_hip_rot_x	<input type="checkbox"/> left_hip_rot_x
<input type="checkbox"/> right_hip_rot_y	<input type="checkbox"/> left_hip_rot_y
<input type="checkbox"/> right_hip_rot_z	<input type="checkbox"/> left_hip_rot_z

Knee

<input type="checkbox"/> right_knee_rot_x	<input type="checkbox"/> left_knee_rot_x
---	--

Neck & Head

<input type="checkbox"/> upper_neck_rot_x	<input type="checkbox"/> head_top_rot_x
<input type="checkbox"/> upper_neck_rot_y	
<input type="checkbox"/> upper_neck_rot_z	

Pelvis

<input type="checkbox"/> hip_rot_y
<input type="checkbox"/> hip_rot_z

Global

Upper_body

Lower_body

Neck & Head

Shoulder

Elbow

Pelvis

Hip

Knee

Set Current

Clear Current

Click "Global"

Limit DoF

Global

<input checked="" type="checkbox"/> global_trans_x	<input checked="" type="checkbox"/> global_rot_x	<input checked="" type="checkbox"/> perspective_rot_x	<input checked="" type="checkbox"/> perspective_trans_x
<input checked="" type="checkbox"/> global_trans_y	<input checked="" type="checkbox"/> global_rot_y	<input checked="" type="checkbox"/> perspective_rot_y	<input checked="" type="checkbox"/> perspective_trans_y
<input checked="" type="checkbox"/> global_trans_z	<input checked="" type="checkbox"/> global_rot_z	<input checked="" type="checkbox"/> perspective_rot_z	<input checked="" type="checkbox"/> perspective_scale

Shoulder

<input type="checkbox"/> right_shoulder_rot_x	<input type="checkbox"/> left_shoulder_rot_x
<input type="checkbox"/> right_shoulder_rot_y	<input type="checkbox"/> left_shoulder_rot_y
<input type="checkbox"/> right_shoulder_rot_z	<input type="checkbox"/> left_shoulder_rot_z

Elbow

Hip

Knee

Neck & Head

Pelvis

Global

Upper_body

Lower_body

Neck & Head

Shoulder

Elbow

Pelvis

Hip

Knee

Set Current

Clear Current

Click "Upper_body"

Click "Neck & Head Shoulder Elbow", checkboxes of related DoFs will be checked

Shoulder

<input checked="" type="checkbox"/> right_shoulder_rot_x	<input type="checkbox"/> left_shoulder_rot_x
<input type="checkbox"/> right_shoulder_rot_y	<input type="checkbox"/> left_shoulder_rot_y
<input type="checkbox"/> right_shoulder_rot_z	<input type="checkbox"/> left_shoulder_rot_z

Elbow

<input type="checkbox"/> right_elbow_rot_x	<input type="checkbox"/> left_elbow_rot_x
--	---

Hip

<input checked="" type="checkbox"/> right_hip_rot_x	<input checked="" type="checkbox"/> left_hip_rot_x
<input checked="" type="checkbox"/> right_hip_rot_y	<input checked="" type="checkbox"/> left_hip_rot_y
<input checked="" type="checkbox"/> right_hip_rot_z	<input checked="" type="checkbox"/> left_hip_rot_z

Knee

<input checked="" type="checkbox"/> right_knee_rot_x	<input checked="" type="checkbox"/> left_knee_rot_x
--	---

Neck & Head

Pelvis

Global

Upper_body

Lower_body

Neck & Head

Shoulder

Elbow

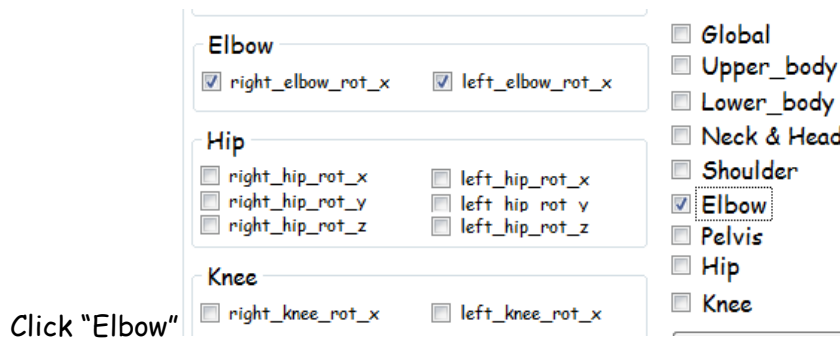
Pelvis

Hip

Knee

Set Current

Click "Lower_body"

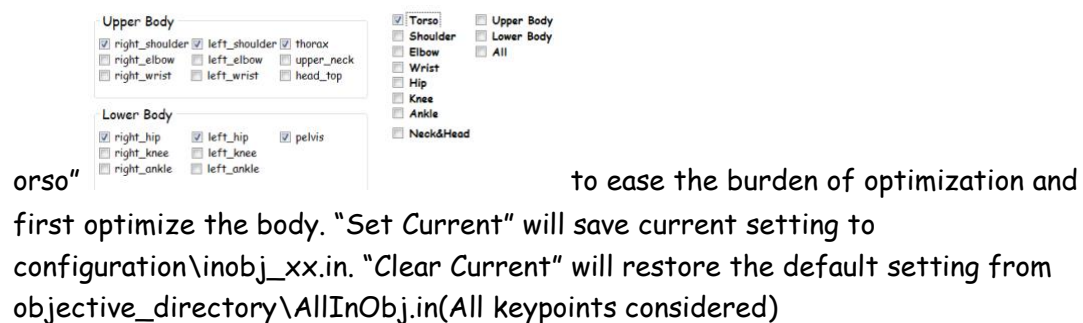


Click "Set Current" to reflect constraints to the current image, and save to "configuration\initparam_xx.in"

Click "Clear Current" to clear constraints of the current image. The default loading is working_directory\NoLimitDoF.in(no DoF constraints)

Keypoints in the objective function

To conveniently perform a hierarchical optimization, it is encouraged to select "torso"



An example of hierarchical optimization

Hierarchical:



Upper Body

☒ right_shoulder
☒ left_shoulder
☒ thorax
☐ right_elbow
☐ left_elbow
☐ upper_neck
☐ right_wrist
☐ left_wrist
☐ head_top

Lower Body

☒ right_hip
☒ left_hip
☒ pelvis
☐ right_knee
☐ left_knee
☐ right_ankle
☐ left_ankle

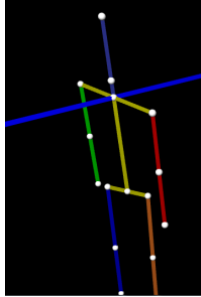
☒ Torso
☐ Shoulder
☐ Elbow
☐ Wrist
☐ Hip
☐ Knee
☐ Ankle
☐ Neck&Head

☒ Upper Body
☐ Lower Body
☐ All

Set Current

Clear Current

Set "torso" only in InObjectiveFunction.



, press "s" to save this state. Load optimized param in InitParam to the base of the next optimization (pipeline: "Read Optimized Param"→"Use Optimized Param"→"Set Current") . Next, check "Pelvis", "Global" in LimitDoF→"Set Current", check "Elbow", "Wrist" in InObjectiveFunction→"Set Current"

InitParam(In Degree)

global_trans_x	0	head_top_rot_x	0
global_trans_y	0	right_elbow_rot_x	0
global_trans_z	0.981442	right_shoulder_rot_x	0
global_rot_x	0.535939	right_shoulder_rot_y	0
global_rot_y	-9.629779	right_shoulder_rot_z	0
global_rot_z	2.563096	left_shoulder_rot_x	0
right_knee_rot_x	0	left_shoulder_rot_y	0
right_hip_rot_x	0	left_shoulder_rot_z	0
right_hip_rot_y	0	left_elbow_rot_x	0
right_hip_rot_z	0	hip_rot_y	-24.682203
left_hip_rot_x	0	hip_rot_z	-3.662802
left_hip_rot_y	0	perspective_global_rot_x	-6.733702
left_hip_rot_z	0	perspective_global_rot_y	-4.352861
left_knee_rot_x	0	perspective_global_rot_z	-129.268025
upper_neck_rot_x	0	perspective_global_trans_x	1.070525
upper_neck_rot_y	0	perspective_global_trans_y	0.357325
upper_neck_rot_z	0	perspective_scale	-0.540264

Default

Set All

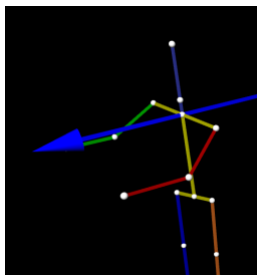
Set Current

Clear Current

Read Optimized Param

Use Optimized Param

Press "l" to reload the settings in OpenGL, then press "p" to optimize. At this point, all DoFs concerning pelvis and global are fixed, the only keypoints taken into account are "elbow" and "wrist"



Angle Constraint

Set lower bound and upper bound for some angles.

	Lower_Bound	Upper_Bound		Lower_Bound	Upper_Bound	
global_trans_x	-3600	3600	head_top_rot_x	0.0	30	<button>Default</button>
global_trans_y	-3600	3600	right_elbow_rot_x	-120	0.0	<button>Set All</button>
global_trans_z	-3600	3600	right_shoulder_rot_x	-180	30	<button>Set Current</button>
global_rot_x	-3600	3600	right_shoulder_rot_y	-90	90	<button>Clear Current</button>
global_rot_y	-3600	3600	right_shoulder_rot_z	-180	0.0	<button>Load From File</button>
global_rot_z	-3600	3600	left_shoulder_rot_x	-180	30	
right_knee_rot_x	0.0	100	left_shoulder_rot_y	-90	90	
right_hip_rot_x	-90	90	left_shoulder_rot_z	0.0	180	
right_hip_rot_y	-45	45	left_elbow_rot_x	-120	0.0	
right_hip_rot_z	-90	0.0	hip_rot_y	-90	90	
left_hip_rot_x	-90	90	hip_rot_z	-30	30	
left_hip_rot_y	-45	45	perspective_global_rot_x	-90	90	
left_hip_rot_z	0.0	90	perspective_global_rot_y	-90	90	
left_knee_rot_x	0.0	100	perspective_global_rot_z	-90	90	
upper_neck_rot_x	-60	90	perspective_global_trans_x	-10	10	
upper_neck_rot_y	-30	30	perspective_global_trans_y	-10	10	
upper_neck_rot_z	-30	30	perspective_scale	-100	100	

Click "Default" to load from working_directory\angle_constraint.in.

"Set All" saves to working_directory \angle_constraint.in

"Set Current" saves to configuration\angleconstraint_xx.in

"Clear Current" deletes configuration\angleconstraint_xx.in

"Load From File" imports angle constraint of the current image to the text box

Elbow

Left Elbow is in ☐ Front ☒ Back ☐ Uncertain

Right Elbow is in ☐ Front ☒ Back ☐ Uncertain

Shoulder Rot X

☐ Left Between -180 and 30 Front: [-180, 0]

☐ Right Between -180 and 30 Back: [0, 90]

Default

Set to Current Image

Load From File

Knee

Left Knee is in ☐ Front ☒ Back ☐ Uncertain

Right Knee is in ☐ Front ☒ Back ☐ Uncertain

Hip Rot X

☐ Left Between -90 and 90 Front: [-90, 0]

☐ Right Between -90 and 90 Back: [0, 90]

Elbow Rot X

Left Elbow Rot X Between -120 and 0 ☐

Right Elbow Rot X Between -120 and 0 ☐

Knee Rot X

Left Knee Rot X Between 0 and 100 ☐

Right Knee Rot X Between 0 and 100 ☐

It's easily observed from the image that Elbow, Knee are in the front/at the back of body. Ambiguity from projecting 3D to 2D arises, in large part from the nebulous front/back orientation of elbow and knee.

One way to get around this is by assigning front/back relationship between nearby

Elbow

Left Elbow is in ☒ Front ☐ Back ☐ Uncertain

Right Elbow is in ☒ Front ☐ Back ☐ Uncertain

Knee

Left Knee is in ☒ Front ☐ Back ☐ Uncertain

Right Knee is in ☒ Front ☐ Back ☐ Uncertain

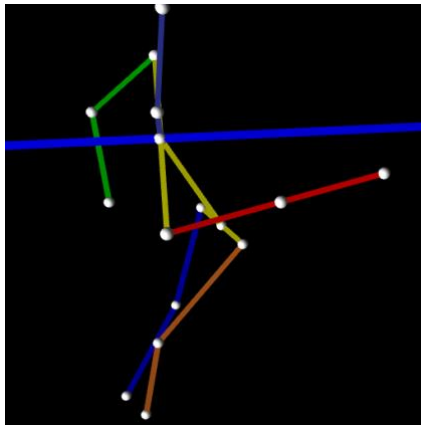
keypoints to restrain joint angles. Another complicated method is to concretely set the angles, e.g. the rotation angle of shoulder along axis X i.e. shoulder_rot_x, [-180,0]: elbow in front of the body. [0,30]: elbow at the back of the body. hip_rot_x[-90,0]: knee in the front, [0,90]: knee at the back

Other than that, set Elbow Rot X and Knee Rot X can effectively change the movable range of Wrist and Ankle.

Angle Constraint 1(id: 1639)



, press "p" (only 2d projection loss)



the left arm is facing back, which is contradictory to the image evidence. Plus, the body is twisting dramatically.

Elbow

Left Elbow is in ☒ Front ☐ Back ☐ Uncertain

Right Elbow is in ☒ Front ☐ Back ☐ Uncertain

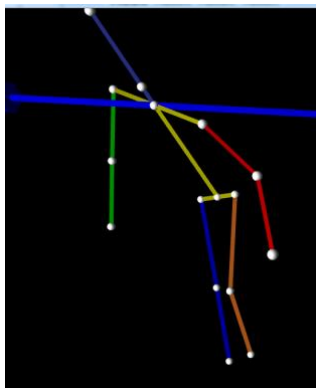
Knee

Left Knee is in ☒ Front ☐ Back ☐ Uncertain

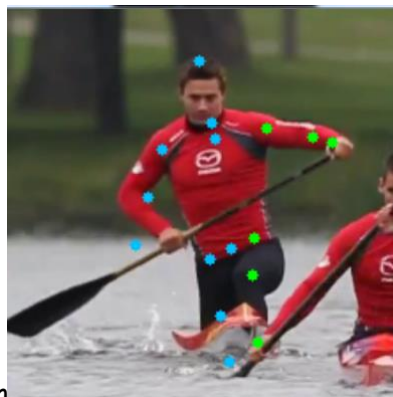
Right Knee is in ☒ Front ☐ Back ☐ Uncertain

By setting elbow and knee forward, the optimization with joint angle limit constraint, the result follows:

along with "P" :



2D prediction



At this time we find a mismatch between pred and gt for the joint right_elbow and right_wrist. We see right_elbow is bending significantly. The following figure sets

the angle range to [-120, -70], which is more reasonable.

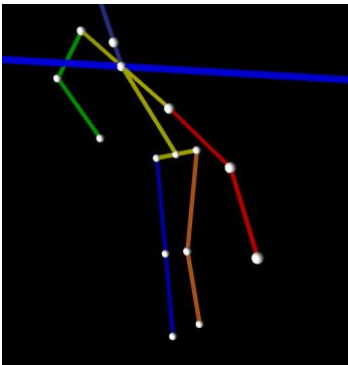
Elbow Rot X

Left Elbow Rot X Between and ☐

Right Elbow Rot X Between and ☒

(Check means apply

this constraint)



. However, the shoulder and hip still are not acceptable.

Then we set hip_rot_y, hip_rot_z to [-10,10].

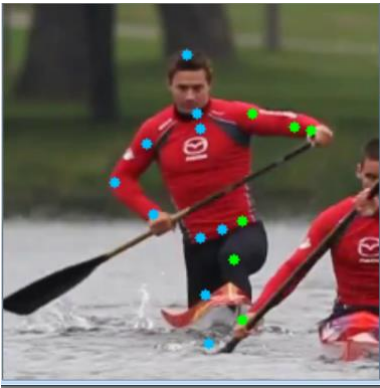
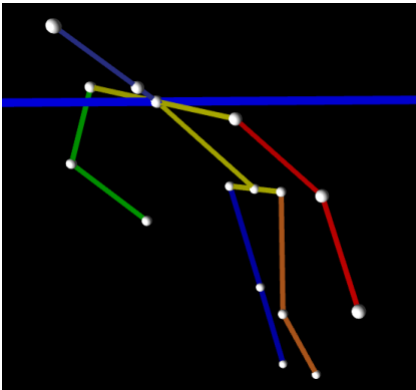
Load From File in Angle Constraint(General)

hip_rot_y	<input type="text" value="-5"/>	<input type="text" value="5"/>
hip_rot_z	<input type="text" value="-5"/>	<input type="text" value="5"/>
nonselective global rot x	<input type="text" value="0"/>	<input type="text" value="0"/>

→ "Set

Current"

Reload in C++ by "I" -> "P" to re-optimize



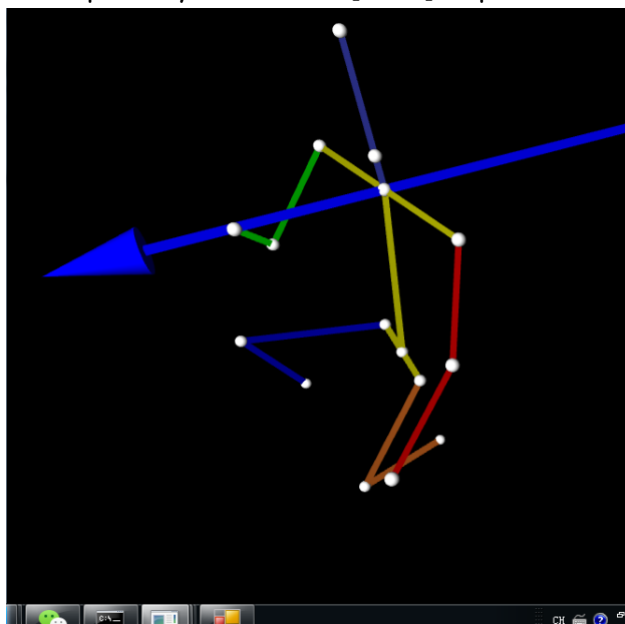
. Now we are

done.

Angle Constraint 2 (1670)



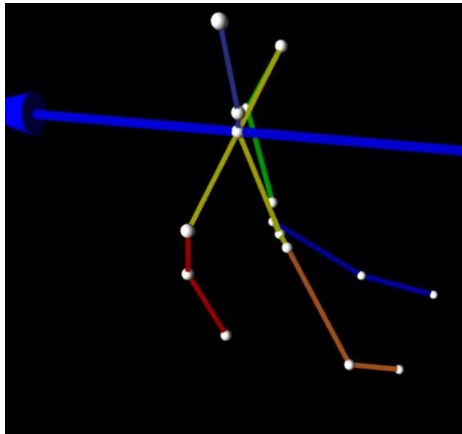
Set right hip rot x to be at least -60 degree
 Set hip_rot_y in between [-5, 5] to prevent from over-bending



Angle Constraint 3(16712)

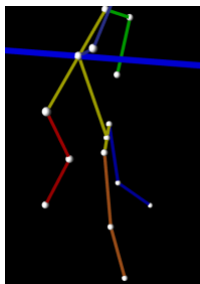


optimize w/o constraint

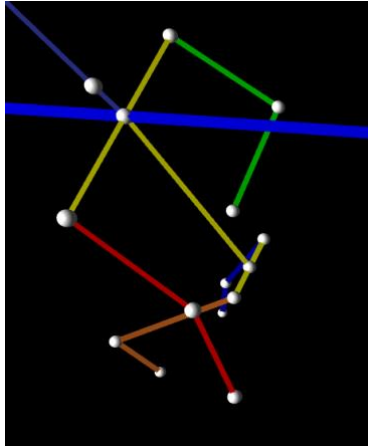


Elbow Left Elbow is in <input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain Right Elbow is in <input type="radio"/> Front <input checked="" type="radio"/> Back <input type="radio"/> Uncertain		Shoulder Rot X <input type="checkbox"/> Left Between -180 and 0 Front: [-180, 0] <input type="checkbox"/> Right Between -180 and 0 Back: [0, 90]	
Knee Left Knee is in <input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain Right Knee is in <input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain		Hip Rot X <input type="checkbox"/> Left Between -90 and -20 Front: [-90, 0] <input type="checkbox"/> Right Between -90 and 0 Back: [0, 90]	
Elbow Rot X Left Elbow Rot X Between -120 and -40 Right Elbow Rot X Between -120 and -40			
Knee Rot X			

Optimize with constraint



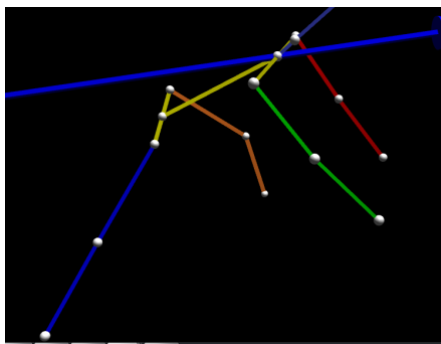
Result: The left leg is incorrect. We now constrain left hip rot x to fall in the range $[-90, -20]$

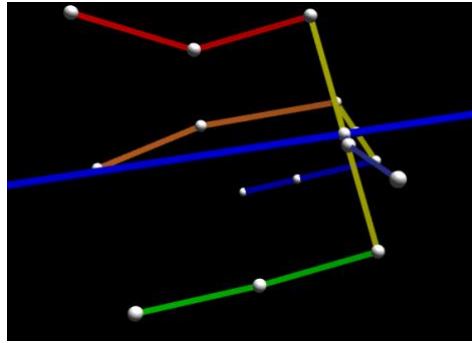


Angle Constraint 4(16784)



Enforce constraints





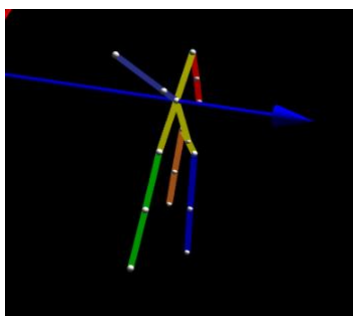
W/o constraints:

Angle Constraint 5(16791)

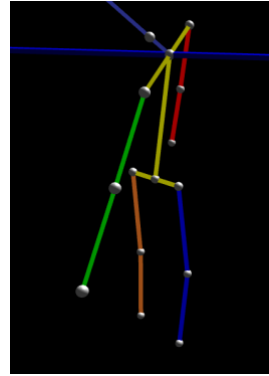


Elbow		Shoulder Rot X	
Left Elbow is in	<input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain	<input type="checkbox"/> Left Between <input type="text" value="-180"/> and <input type="text" value="30"/> Front: [-180, 0]	
Right Elbow is in	<input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain	<input type="checkbox"/> Right Between <input type="text" value="-180"/> and <input type="text" value="30"/> Back: [0, 30]	
Knee		Hip Rot X	
Left Knee is in	<input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain	<input type="checkbox"/> Left Between <input type="text" value="-90"/> and <input type="text" value="90"/> Front: [-90, 0]	
Right Knee is in	<input checked="" type="radio"/> Front <input type="radio"/> Back <input type="radio"/> Uncertain	<input type="checkbox"/> Right Between <input type="text" value="-90"/> and <input type="text" value="90"/> Back: [0, 90]	

Naive Constraint:

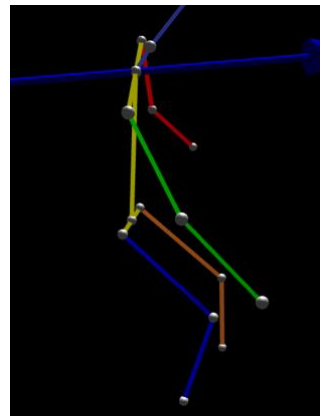


Considering the bending of left knee and right knee is



considerably large, we set it to be roughly $[30, 50]$

Then we



adjust hip_rot_y and hip_rot_z to be in $[-10, 10]$

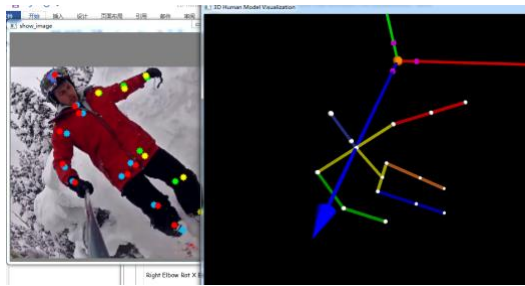


The projection almost match.

Pose-Conditioned Joint Angle Limit Constraint

The original MatLab code is rewritten in C++.

When all bones are legal>

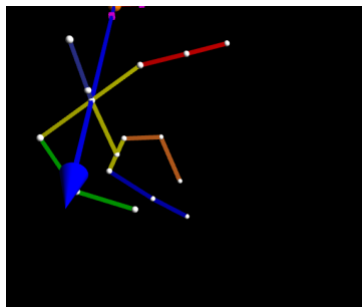


press "C",

The prompt says

```
All bones are valid!
```

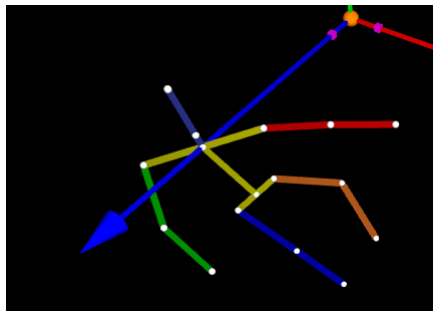
Otherwise for example manually adjust left_knee as follows



then press "C"

The program will replace the current joint with the closest joint satisfying the constraint in the paper "pose-conditioned joint angle limits for 3d human pose reconstruction". A prompt will say

```
right_elbow    --->  right_wrist    is invalid!
left_knee      --->  left_ankle     is invalid!
Replacing it with the closest valid points under the pose-conditioned joint angle limit constraint now!Current Iteration    1 last error:  0.16741991 error
for CT      0.07401630 current constraint    6.950000
```



Display settings and backups for the current image

For each image, we can save multiple copies (by pressing "S") to represent results under different settings.

The available backup index is:

Available Backups

Index	Interpretation
1	
5	
30	

Click index in the listbox will navigate the that specific backup (checkpoint).
And show the corresponding bone length etc.

Available Backups

Index	Interpretation
1	
2	
5	
10	
11	

Replace Current

Display Optimal

Delete Selected

Save as Index 2

Tags (notes) will also be shown for easy future reference. Modifications in the textbox will sync to files and the listbox (column Interpretation) in real time.

Available Backups

Index	Interpretation
1	
2	fsddfsdfsdf
5	
10	
11	

Replace Current

Display Optimal

Delete Selected

Save as Index 2

fsddfsdfsdf

BoneLength	
knee->ankle	0.30
hip->knee	0.35
pelvis->hip	0.10
thorax->pelvis	0.44
thorax->upper_neck	0.07
upper_neck->head_top	0.25
elbow->wrist	0.25
shoulder->elbow	0.29
thorax->shoulder	0.12

Orig(Ground Truth)	Mod(Pred Ground Truth)	Prediction
right_ankle 361.0436485959595 187.512472132296	right_ankle 361.0436485959595 187.512472132296	right_ankle 197.568512 170.136132
right_knee 144.860490959595 168.60873132296	right_knee 144.860490959595 168.60873132296	right_knee 136.895483 188.493636
right_hip 154.87034059595 138.347768132296	right_hip 154.87034059595 138.347768132296	right_hip 129.627168 163.305568
left_hip 131.568733959595 120.087044132296	left_hip 131.568733959595 120.087044132296	left_hip 127.754592 78.7304
left_knee 369.65220959595 141.21708132296	left_knee 369.65220959595 141.21708132296	left_knee 654.366844 36.244592
left_ankle 186.40861039595 175.20912132296	left_ankle 186.40861039595 175.20912132296	left_ankle 393.36672 131.47836
pelvis 123.21792959595 129.217928132296	pelvis 123.21792959595 129.217928132296	pelvis 99.38144 58.29936
thorax 66.870725059595 77.565814132296	thorax 66.870725059595 77.565814132296	thorax 52.645088 48.184416
upper_neck 62.773277959595 71.209592132296	upper_neck 62.773277959595 71.209592132296	upper_neck 62.043072 70.134624
head_top 42.536327959595 39.295794132296	head_top 42.536327959595 39.295794132296	head_top 42.639296 39.77312
right_wrist 62.436127959595 145.912492132296	right_wrist 62.436127959595 145.912492132296	right_wrist 63.129148 147.036288
right_elbow 50.436293959595 128.173912132296	right_elbow 50.436293959595 128.173912132296	right_elbow 49.456064 124.932392
right_shoulder 47.827889959595 96.348216132296	right_shoulder 47.827889959595 96.348216132296	right_shoulder 48.364288 98.117376
left_shoulder 85.65125959595 56.522680132296	left_shoulder 85.65125959595 56.522680132296	left_shoulder 86.675456 55.091248
left_elbow 132.00477959595 63.264946132296	left_elbow 132.00477959595 63.264946132296	left_elbow 130.399216 63.500216
left_wrist 133.130821959595 41.305168132296	left_wrist 133.130821959595 41.305168132296	left_wrist 134.403056 41.300096

(coordinates within

224*224)

3D			
right_ankle	0.322301	-0.938858	0.658663
right_knee	0.163507	-0.705364	0.755412
right_hip	-0.002419	-0.424674	0.882617
left_hip	0.052057	-0.367326	0.698923
left_knee	0.196950	-0.541729	0.432297
left_ankle	0.386290	-0.772530	0.463624
pelvis	0.024819	-0.396000	0.790770
thorax	0.000000	0.000000	0.000950
upper_neck	-0.003341	0.060360	0.996540
head_top	-0.015272	0.311589	1.052219
right_wrist	0.068007	-0.448321	1.184079
right_elbow	-0.072624	-0.275371	1.205574
right_shoulder	-0.195765	-0.077112	1.115967
left_shoulder	0.195765	0.077112	0.845932
left_elbow	0.370862	0.042741	0.670833
left_wrist	0.555153	0.003431	0.506541

Limit DoF

Global

☐ global_trans_x ☐ global_rot_x ☐ perspective_rot_x ☐ perspective_trans_x

☐ global_trans_y ☐ global_rot_y ☐ perspective_rot_y ☐ perspective_trans_y

☐ global_trans_z ☐ global_rot_z ☐ perspective_rot_z ☐ perspective_trans_z

Shoulder

☒ right_shoulder_rot_x ☒ left_shoulder_rot_x ☐ hip_rot_y

☒ right_shoulder_rot_y ☒ left_shoulder_rot_y ☐ hip_rot_x

☒ right_shoulder_rot_z ☒ left_shoulder_rot_z

Elbow

☒ right_elbow_rot_x ☒ left_elbow_rot_x

Hip

☒ right_hip_rot_x ☐ left_hip_rot_x

☒ right_hip_rot_y ☐ left_hip_rot_y

☒ right_hip_rot_z ☐ left_hip_rot_z

Knee

☐ right_knee_rot_x ☐ left_knee_rot_x

Pelvis

☐ hip_rot_y ☐ hip_rot_x

Neck & Head

☒ upper_neck_rot_x ☒ head_top_rot_x

☒ upper_neck_rot_y ☐ upper_neck_rot_z

InitParam(In Degree)			
global_trans_x	0.000000	head_top_rot_x	0.000000
global_trans_y	0.000000	right_elbow_rot_x	0.000000
global_trans_z	0.955123	right_shoulder_rot_x	0.000000
global_rot_x	36.776612	right_shoulder_rot_y	0.000000
global_rot_y	-42.726299	right_shoulder_rot_z	0.000000
global_rot_z	5.856471	left_shoulder_rot_x	0.000000
right_knee_rot_x	-0.174068	left_shoulder_rot_y	0.000000
right_hip_rot_x	0.735118	left_shoulder_rot_z	0.000000
right_hip_rot_y	1.045557	left_elbow_rot_x	0.000000
right_hip_rot_z	0.174766	hip_rot_y	-11.404482
left_hip_rot_x	0.703561	hip_rot_z	-0.931805
left_hip_rot_y	-36.899518	perspective_global_rot_x	5.072800
left_hip_rot_z	1.819413	perspective_global_rot_y	49.136901
left_knee_rot_x	20.653972	perspective_global_rot_z	-90.001087
upper_neck_rot_x	0.000000	perspective_global_trans_x	1.068860
upper_neck_rot_y	0.000000	perspective_global_trans_y	0.395519
upper_neck_rot_z	0.000000	perspective_scale	-0.808090

Param(In Degree)			
global_trans_x	0.000000	head_top_rot_x	0.000000
global_trans_y	0.000000	right_elbow_rot_x	0.000000
global_trans_z	-0.003953	right_shoulder_rot_x	0.000000
global_rot_x	-1.022969	right_shoulder_rot_y	0.000000
global_rot_y	0.150315	right_shoulder_rot_z	0.000000
global_rot_z	-0.137445	left_shoulder_rot_x	0.000000
right_knee_rot_x	-0.703927	left_shoulder_rot_y	0.000000
right_hip_rot_x	0.523074	left_shoulder_rot_z	0.000000
right_hip_rot_y	3.609626	left_shoulder_rot_x	0.000000
right_hip_rot_z	0.429112	hip_rot_y	-11.536781
left_hip_rot_x	0.872882	hip_rot_z	6.753903
left_hip_rot_y	-44.366180	perspective_global_rot_x	9.512680
left_hip_rot_z	2.844707	perspective_global_rot_y	47.572750
left_knee_rot_x	-0.038374	perspective_global_rot_z	-86.692131
upper_neck_rot_x	0.000000	perspective_global_trans_x	1.113662
upper_neck_rot_y	0.000000	perspective_global_trans_y	0.422516
upper_neck_rot_z	0.000000	perspective_scale	-0.863312

InObjectiveFunction

Upper Body

☐ right_shoulder ☐ left_shoulder ☐ thorax

☒ right_elbow ☒ left_elbow ☒ upper_neck

☐ right_wrist ☐ left_wrist ☒ head_top

Lower Body

☐ right_hip ☐ left_hip ☐ pelvis

☒ right_knee ☒ left_knee

☒ right_ankle ☒ left_ankle

AngleConstraint

	Lower_Bound	Upper_Bound		Lower_Bound	Upper_Bound
global_trans_x	-3600.000000	3600.000000	head_top_rot_x	0.000000	30.000000
global_trans_y	-3600.000000	3600.000000	right_elbow_rot_x	-120.000000	0.000000
global_trans_z	-3600.000000	3600.000000	right_shoulder_rot_x	-180.000000	0.000000
global_rot_x	-3600.000000	3600.000000	right_shoulder_rot_y	-90.000000	90.000000
global_rot_y	-3600.000000	3600.000000	right_shoulder_rot_z	-180.000000	0.000000
global_rot_z	-3600.000000	3600.000000	left_shoulder_rot_x	-180.000000	0.000000
right_knee_rot_x	0.000000	100.000000	left_shoulder_rot_y	-90.000000	90.000000
right_hip_rot_x	-90.000000	0.000000	left_shoulder_rot_z	0.000000	180.000000
right_hip_rot_y	-45.000000	45.000000	left_elbow_rot_x	-120.000000	0.000000
right_hip_rot_z	-90.000000	0.000000	hip_rot_y	-90.000000	90.000000
left_hip_rot_x	-90.000000	0.000000	hip_rot_z	-30.000000	30.000000
left_hip_rot_y	-45.000000	45.000000	perspective_global_rot_x	-90.000000	90.000000
left_hip_rot_z	0.000000	90.000000	perspective_global_rot_y	-90.000000	90.000000
left_knee_rot_x	0.000000	100.000000	perspective_global_rot_z	-90.000000	90.000000
upper_neck_rot_x	-60.000000	90.000000	perspective_global_trans_x	-10.000000	10.000000
upper_neck_rot_y	-30.000000	30.000000	perspective_global_trans_y	-10.000000	10.000000
upper_neck_rot_z	-30.000000	30.000000	perspective_scale	-100.000000	100.000000

Basic | Bone Length | 3D Ground State | LimitDoF | InitParam | InObjectiveFunction | AngleConstraintGeneral | AngleConstraintDetail | Restore Current | About

Navigation | Bone Length | 3D Locations | LimitDoF | InitParam | Param | InObjectiveFunction | AngleConstraint

Upper Body

☒ right_shoulder ☒ left_shoulder ☐ thorax

☒ right_elbow ☐ left_elbow ☐ upper_neck

☒ right_wrist ☐ left_wrist ☐ head_top

Lower Body

☒ right_hip ☐ left_hip ☐ pelvis

☒ right_knee ☐ left_knee

☒ right_ankle ☐ left_ankle

Finish Navigating to 10

Click "Delete Selected" to delete the current selected backup.

Click "Display Optimal" to read optimal param, 2D, 3D from working_directory\result\

Click "Replace Current" to save selected backup (state) under the "result\"

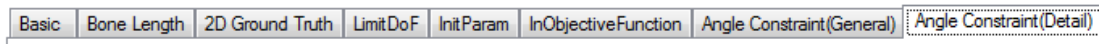
folder

Clear All Current

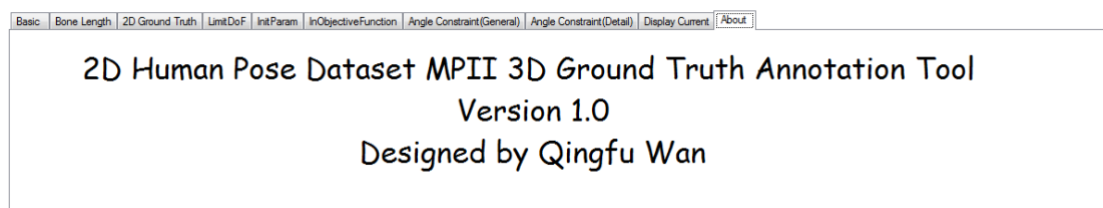
Restore to factory settings.

Use Optimal As Current

To use the settings (bone length; initparam) related to the optimal result ("result\\") of the current image, click "Use Optimal As Current". The current settings will automatically be loaded to the textboxes under different tabs.



Version



Code structure

1. C++

1) include

Name	Line of Code	Function
basic.h	110	Declarations of basic variables and functions
HumanModel_define.h	40	Declarations of the human model
HumanModel.h	80	Declarations of the forward kinematics layer(human model layer)
InitConfiguration.h	28	Declarations of the initial setting

		module(bone length, initparam etc.)
WeakPerspective.h	17	Declarations of the weak perspective projection layer
JointLocationLoss_2d.h	15	Declarations of the 2d joint location loss layer
JointLocationLoss_3d.h	15	Declarations of the 3d joint location loss layer
AngleConstraintLoss.h	17	Declarations of the angle constraint loss layer
ProjectionParamLoss.h	17	Declarations of the projection parameter loss layer
GradientDescent_2d.h	36	Declarations of the gradient descent module(2d joint location loss)
GradientDescent_3d.h	32	Declarations of the gradient descent module(3d joint location loss)
DisplayJointOnImage.h	120	Declarations of the module of displaying joint on image
ModelOptimization.h	20	Declarations of the human model optimization module(2d & 3d optimization)
PoseConditionedJointAngleLimit_define.h	126	Declarations of some arrays and functions used in the PCJAL paper
PoseConditionedJointAngleLimitConstraint.h	14	Declarations of the PCJAL constraint functions
global2local.h	4	Declarations of the

		conversion from global coordinate to local coordinate
local2global.h	4	Declarations of the conversion from local coordinate to global coordinate
All	680	

2) source

Name	Line of Code	Function
basic.cpp	311	Basic functions
HumanModel.cpp	204	The forward kinematics layer(human model layer)
InitConfiguration.cpp	71	The initial setting module(bone length, initparam etc.)
WeakPerspective.cpp	79	The weak perspective projection layer
JointLocationLoss_2d.cpp	38	The 2d joint location loss layer
JointLocationLoss_3d.cpp	38	The 3d joint location loss layer
AngleConstraintLoss.cpp	26	The angle constraint loss layer
ProjectionParamLoss.cpp	42	The projection parameter loss layer
GradientDescent_2d.cpp	201	The gradient descent module(2d joint location loss)
GradientDescent_3d.cpp	178	The gradient descent module(3d joint location loss)
DisplayJointOnImage.cpp	120	The module of displaying joint on image
ModelOptimization.h	101	The human model optimization

		module(2d & 3d optimization)
PoseConditionedJointAngleLimit_define.cpp	98	Some arrays and functions used in the PCJAL paper(e.g. get normal spherical to Cartesian)
PoseConditionedJointAngleLimitConstraint.cpp	337	The PCJAL constraint functions
global2local.cpp	44	The conversion from global coordinate to local coordinate
local2global.cpp	43	The conversion from local coordinate to global coordinate
ogl.cpp	981	OpenGL functions(keyboard & mouse functions & set sphere locations ...)
ThreeDGroundTruthLabeler.cpp	732	Main Function
All	3644	

2. C#

Name	Line of Code	Function
frmmain.cs	2092	Main file

3. All

C++ 1)include 680
 2)src 3644
 C# 2092
 Total 6416

Folder description

- Working root directory
 folder configuration、gt_2d_modified、intermediate、origin_data、result
 file AllInObj.in inobjectivefunction
 BoneLength.in: default bone length

InitParam.in: initial parameter
 NoLimitDoF.in: initial constrained DoF index
 angle_constraint.in: default angle constraint

2. configuration

current_imageid.in
 descent_iterations.in
 memory_id.in the memory id to jump to
 mouse_speed.in
 keyboard_speed_3d.in the speed to adjust 3d using keyboard 一个数字, 表示键盘调整关节 3d 坐标速度
 keyboard_speed_2d.in the keyboard speed to adjust 2d
 shift_ratio.in the ratio of shift (minor changes) to normal
 tshow_image_size.in
 line_width_3d.in line (edge) width connecting 3d spheres
 line_width_2d.in line width connecting 2d keypoints
 mul_factor.in
 sphere_radius.in
 circle_radius.in
 fig_edges.in whether to connect keypoints by edges (lines)
 saveindex.in the index to the next memory state backup
 islimited_xx.in(xx is imageid) the Boolean values of each DoF (constrain or

not)

```

1      global_trans_x 1
2      global_trans_y 1
3      global_trans_z 1
4      global_rot_x 1
5      global_rot_y 1
6      global_rot_z 1
7      right_knee_rot_x 0
8      right_knee_rot_y 0
9      right_knee_rot_z 0
10     right_hip_rot_x 0
11     right_hip_rot_y 0
12     right_hip_rot_z 0
13     left_knee_rot_x 0
14     left_knee_rot_y 0
15     left_knee_rot_z 0
16     upper_back_rot_x 0
17     upper_back_rot_y 0
18     upper_back_rot_z 0
19     head_top_rot_x 0
20     right_elbow_rot_x 0
21     right_elbow_rot_y 0
22     right_elbow_rot_z 0
23     left_elbow_rot_x 0
24     left_elbow_rot_y 0
25     left_elbow_rot_z 0
26     left_hip_rot_x 0
27     left_hip_rot_y 1
28     left_hip_rot_z 1
29     perspective_rot_x 1
30     perspective_rot_y 1
31     perspective_rot_z 1
32     perspective_trans_x 1
33     perspective_trans_y 1
34     perspective_trans_z 1
35     perspective_scale 1

```

initparam_xx.in

```
global_trans_x 0
global_trans_y 0
global_trans_z 0.967388
global_rot_x 5.092886
global_rot_y -8.461318
global_rot_z -7.833615
right_knee_rot_x 0
right_knee_rot_y 0
right_knee_rot_z 0
right_hip_rot_x 0
right_hip_rot_y 0
right_hip_rot_z 0
left_hip_rot_x 0
left_hip_rot_y 0
left_hip_rot_z 0
left_knee_rot_x 0
left_knee_rot_y 0
left_knee_rot_z 0
upper_neck_rot_x 0
upper_neck_rot_y 0
upper_neck_rot_z 0
head_top_rot_x 0
head_top_rot_y 0
head_top_rot_z 0
right_elbow_rot_x 0
right_elbow_rot_y 0
right_elbow_rot_z 0
right_shoulder_rot_x 0
right_shoulder_rot_y 0
right_shoulder_rot_z 0
left_shoulder_rot_x 0
left_shoulder_rot_y 0
left_shoulder_rot_z 0
left_elbow_rot_x 0
left_elbow_rot_y 0
left_elbow_rot_z 0
hip_rot_x -2.010857
hip_rot_y 3.97685
hip_rot_z 0
perspective_rot_x -96.651923
perspective_rot_y 6.10769
perspective_rot_z -81.447270
perspective_trans_x 0.591998
perspective_trans_y 1.010093
perspective_trans_z 0.691703
```

inobj_xx.in

```
1 right_knee 0
2 right_knee 0
3 right_hip 0
4 left_hip 0
5 left_knee 0
6 pelvis 0
7 thorax 0
8 upper_neck 0
9 head_top 0
10 right_wrist 0
11 right_elbow 0
12 right_shoulder 0
13 left_shoulder 0
14 left_elbow 0
15 left_wrist 0
16 left_wrist 0
17
```

angleconstraint_xx.in

1	global_trans_x	-3600	3600
2	global_trans_y	-3600	3600
3	global_trans_z	-3600	3600
4	global_rot_x	-3600	3600
5	global_rot_y	-3600	3600
6	global_rot_z	-3600	3600
7	right_knee_rot_x	0	100
8	right_hip_rot_x	-90	0
9	right_hip_rot_y	-45	45
10	right_hip_rot_z	-90	0
11	left_hip_rot_x	-90	0
12	left_hip_rot_y	-45	45
13	left_hip_rot_z	0	90
14	left_knee_rot_x	0	100
15	upper_neck_rot_x	-60	90
16	upper_neck_rot_y	-30	30
17	upper_neck_rot_z	-30	30
18	head_top_rot_x	0	30
19	right_elbow_rot_x	-120	0
20	right_shoulder_rot_x	-180	0
21	right_shoulder_rot_y	-90	90
22	right_shoulder_rot_z	-180	0
23	left_shoulder_rot_x	-180	0
24	left_shoulder_rot_y	-90	90
25	left_shoulder_rot_z	0	180
26	left_elbow_rot_x	-120	-70
27	hip_rot_y	-90	90
28	hip_rot_z	-30	30
29	perspective_rot_x	-90	90
30	perspective_rot_y	-90	90
31	perspective_rot_z	-90	90
32	perspective_trans_x	-10	10
33	perspective_trans_y	-10	10
34	perspective_trans_z	-10	10

bonelen_xx.in

1	bone_knee_connect_ankle	0.3
2	bone_hip_connect_knee	0.35
3	bone_pelvis_connect_hip	0.1
4	bone_thorax_connect_pelvis	0.44
5	bone_thorax_connect_upper_neck	0.07
6	bone_upper_neck_connect_head_top	0.25
7	bone_elbow_connect_wrist	0.25
8	bone_shoulder_connect_elbow	0.25
9	bone_thorax_connect_shoulder	0.25
10		

3. gt_2d_modified

mod_xx.txt

the modified 2d ground truth annotation

1	right_ankle	1.149443	0.659433
2	right_knee	1.077239	0.603254
3	right_hip	0.943312	0.469162
4	left_hip	1.037845	0.396641
5	left_knee	1.187874	0.467579
6	left_ankle	1.263572	0.632368
7	pelvis	0.980578	0.427402
8	thorax	0.729028	0.196814
9	upper_neck	0.710726	0.168438
10	head_top	0.620391	0.028376
11	right_wrist	0.709231	0.501935
12	right_elbow	0.655660	0.422743
13	right_shoulder	0.644014	0.280664
14	left_shoulder	0.812878	0.111800
15	left_elbow	0.930501	0.090837
16	left_wrist	1.024832	0.034937
17			

4. intermediate
 - angleconstraint_xx_ID.in
 - bonelen_xx_ID.in
 - initparam_xx_ID.in
 - inobj_xx_ID.in
 - islimited_xx_ID.in
 - interpretation_xx_ID.in notes on the backup ID
 - param_xx_ID.txt the optimized joint angle 优化的角度
 - pred_2d_xx_ID.txt the 2D projection of optimized 3D
 - pred_3d_xx_ID.txt the optimized 3D
5. origin_data

1	image_id	635.00
2	person_id	0.00
3	crop_size	813.24
4	bbx_x1	604.38
5	bbx_y1	156.38
6	bbx_x2	1417.62
7	bbx_y2	969.62
8	head_x1	872.00
9	head_y1	311.00
10	head_x2	983.00
11	head_y2	439.00
12	image_width	1920.00
13	image_height	1080.00
14		

config_xx.txt

1	right_ankle	2.039879	1.283662
2	right_knee	2.109782	1.042181
3	right_hip	2.188157	0.828238
4	left_hip	2.255941	0.824001
5	left_knee	2.323725	1.052773
6	left_ankle	2.399982	1.292135
7	pelvis	2.222049	0.826119
8	thorax	2.222049	0.586757
9	upper_neck	2.212578	0.550833
10	head_top	2.170091	0.389672
11	right_wrist	2.243232	0.857893
12	right_elbow	2.209340	0.726561
13	right_shoulder	2.198748	0.588875
14	left_shoulder	2.243232	0.582520
15	left_elbow	2.175447	0.732916
16	left_wrist	2.073771	0.834592
17			

gt_2d_xx.txt

1	right_ankle	0
2	right_knee	0
3	right_hip	1
4	left_hip	1
5	left_knee	0
6	left_ankle	0
7	pelvis	1
8	thorax	1
9	upper_neck	1
10	head_top	1
11	right_wrist	1
12	right_elbow	1
13	right_shoulder	1
14	left_shoulder	1
15	left_elbow	1
16	left_wrist	1
17		

vis_xx.txt

visibility of each keypoint

6. result

param_xx.txt optimized joint angle

pred_2d_xx.txt projection (2D) of optimized 3D coordinate

pred_3d_xx.txt optimized 3D coordinates

7. images

Human images of size 224x224, cropped from the original image. (Human-centered)