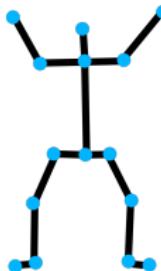


Visualization of a Human Using Kinect and XML3D

Technical Details



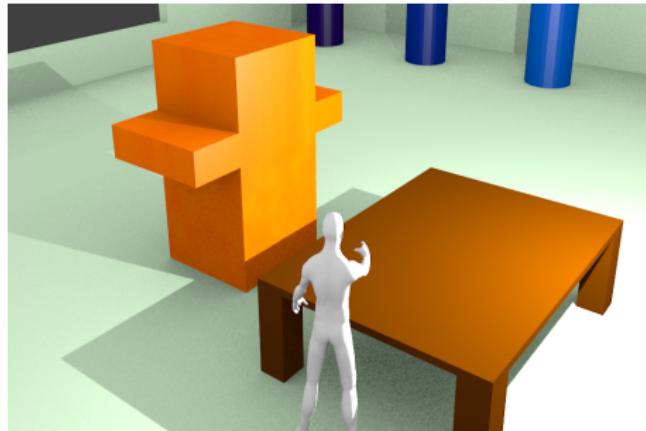
Michael Hedderich, Magdalena Kaiser, Dushyant Mehta, Guillermo Reyes
Advisers: Ingo Zinnikus, Kristian Sons

Seminar Cobots - Cooperative Robots
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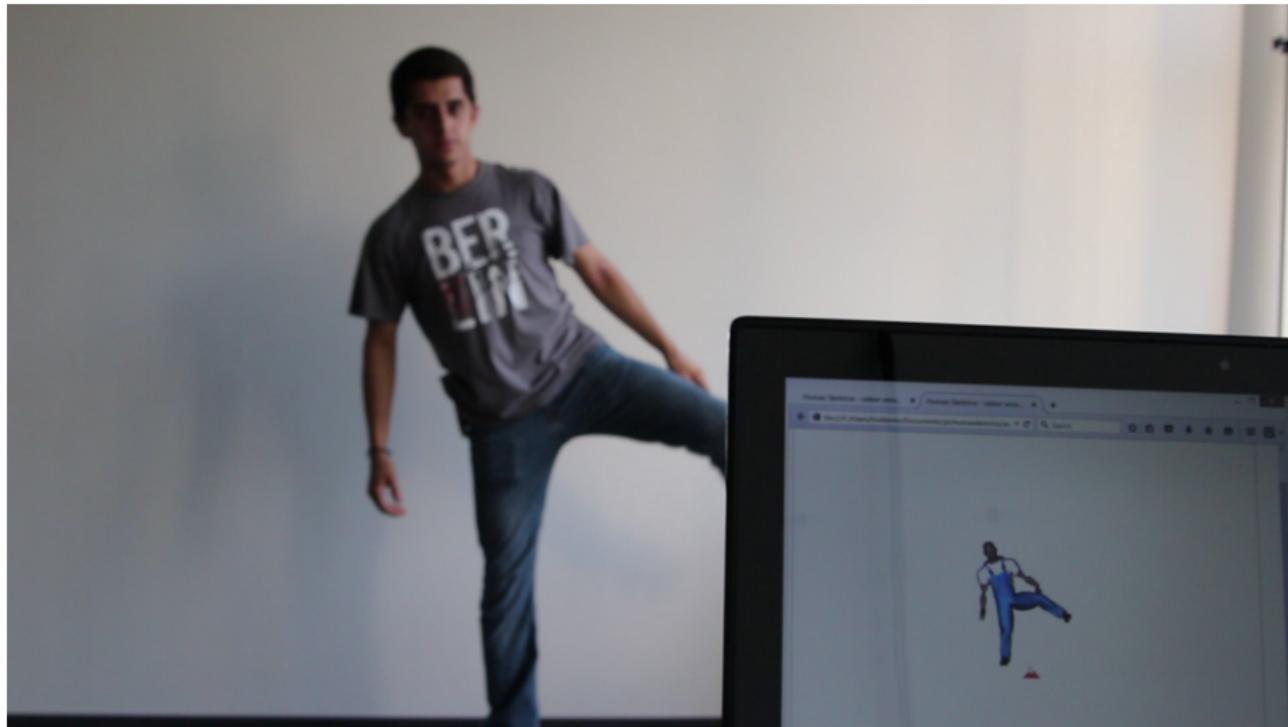
Overview

- Idea
- Videos
- System Overview
- Technical Details
- Live Demo
- References and Sources

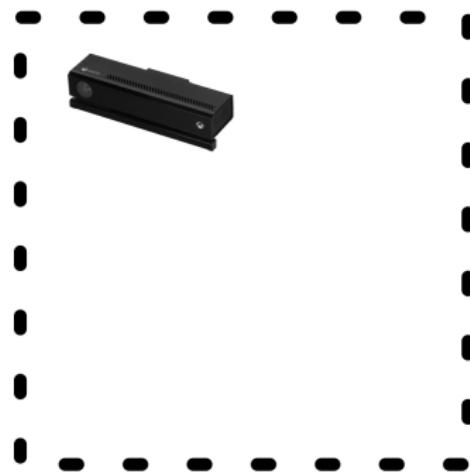
Idea



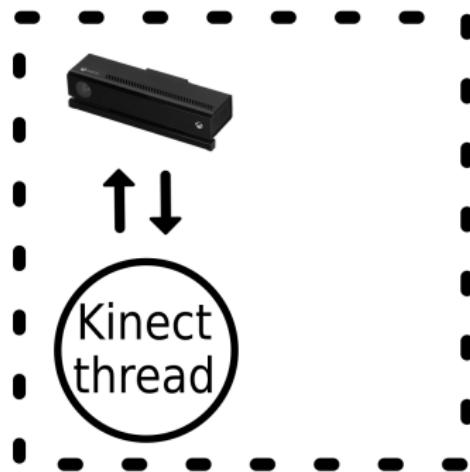
Videos



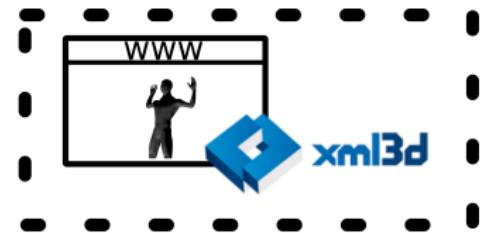
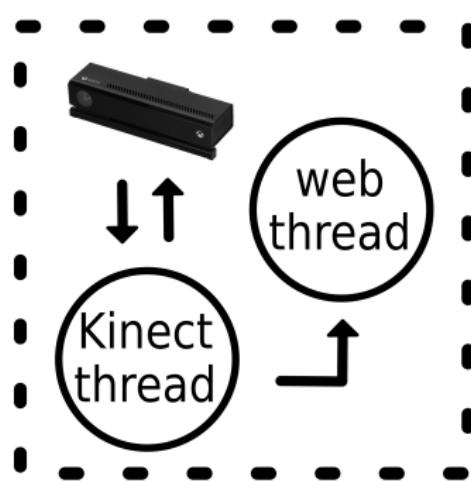
System Overview



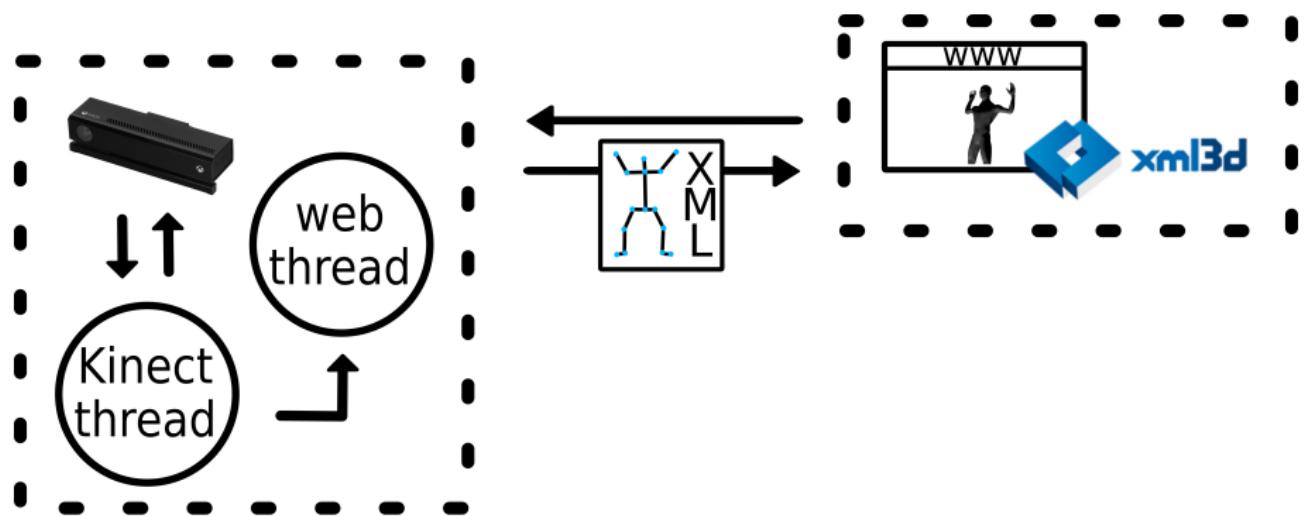
System Overview



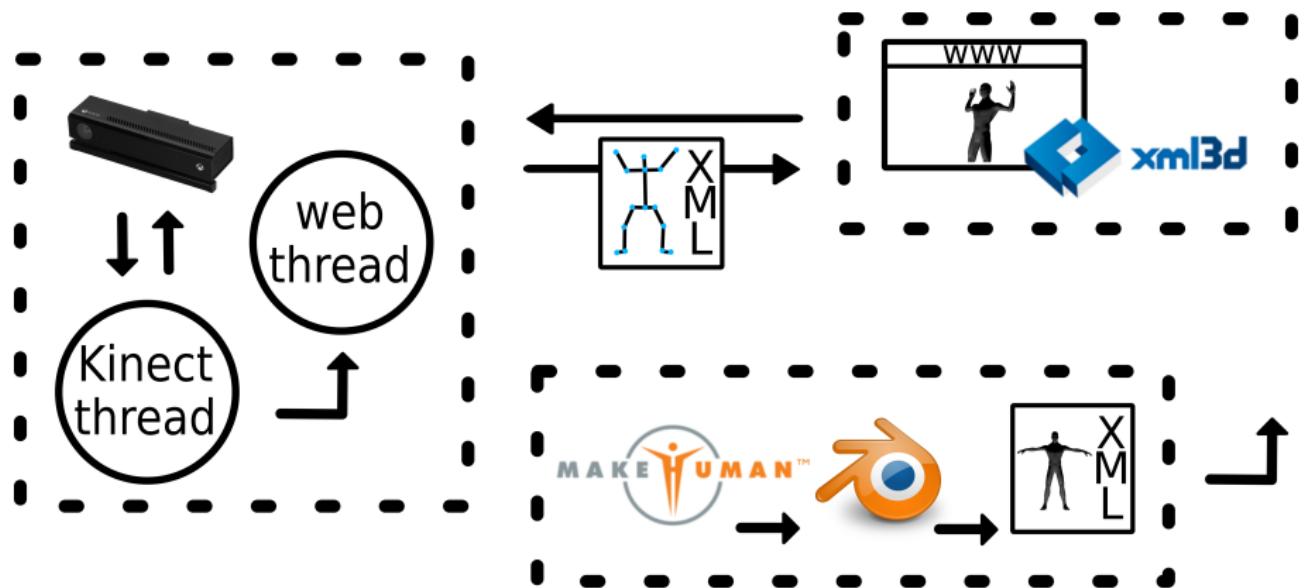
System Overview



System Overview



System Overview



Kinect



- Kinect for Windows SDK 2.0
- Track up to 6 users with 25 joints (global position and rotation)
- The end joints (head, hand tips, thumbs, feet) store no rotation (always 0)
- Limitations:
 - Noisy data
 - Occlusion
 - Can not turn around

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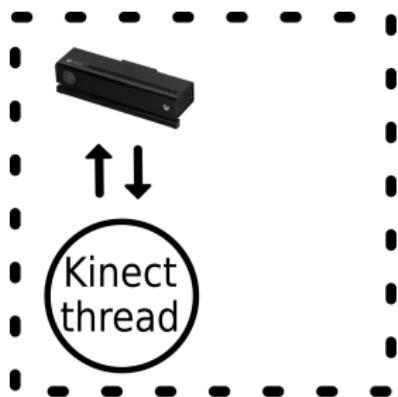
Kinect



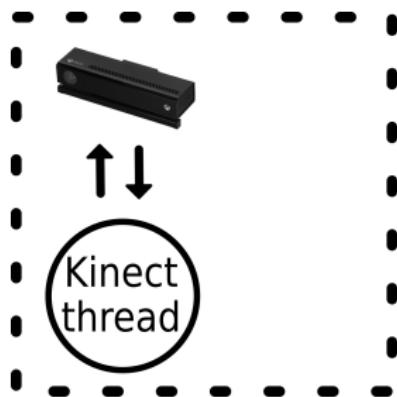
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- *Todo: Better tracking software and/or hardware*

Kinect Thread

- C++
- Background thread: reduce workload from web server
- Request latest pose from Kinect (joint position and rotation)
- Map from Kinect's joint structure to rigged bones (Blender/XML3D)
- Convert into string (XML3D format)
- Many poses not used by web thread
→ smoothing



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- *Todo: Smoothing (Joint Filtering) was implemented natively in Kinect 1.8, no longer in Kinect 2.0. Theory and libraries exist (e.g. KinectEx in C#)*

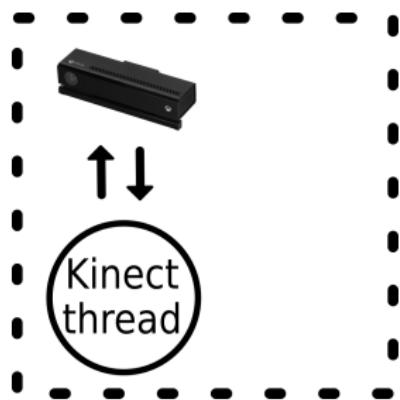
Automatic Size Detection and Scaling



Automatic Size Detection and Scaling

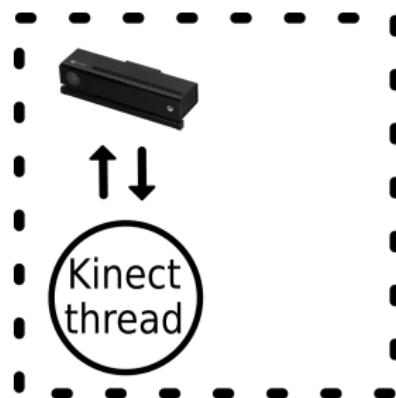


Automatic Size Detection and Scaling



- Ratio between bone lengths of Kinect and the model's rig
- Noisy data: Average of multiple bones
- People with different proportions: Scaling for lower and upper body
- Smoothing: $\text{scale} = \lambda * \text{newScale} + (1 - \lambda) * \text{oldScale}$

Automatic Size Detection and Scaling



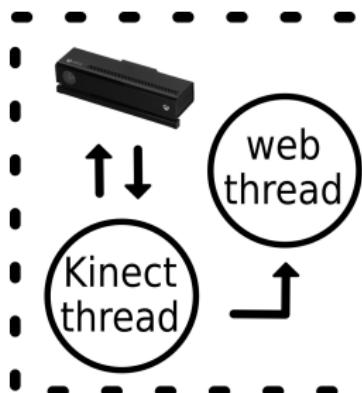
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- Smoothing: $\text{scale} = \lambda * \text{newScale} + (1 - \lambda) * \text{oldScale}$
- *Todo: Detect shape of a person (e.g. width of body parts)*

Simplified Example Pose

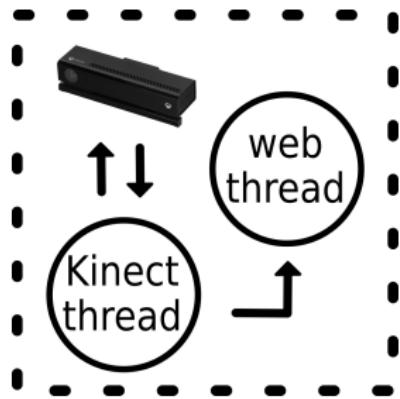
```
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  <data id="animation">

    <int id="tracking1" key="1">
      2 ...
    </int>
    <float3 id="location5" key="1">
      -0.18169 -0.0965646 2.04021 ...
    </float3>
    <float4 id="rotation_quaternion5" key="1">
      -0.0085 0.9972 0.0516 0.0525 ...
    </float4>
    <float3 id="scale5" key="1">
      0.889371 0.889371 0.889371 ...
    </float3>

  </data>
</xml3d>
```

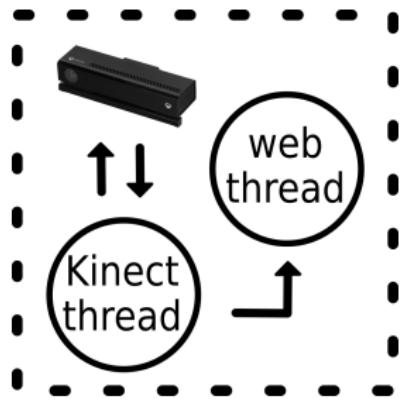


Web Thread



- C++
- Sends xml encoded pose as HTTP response
- Multiple clients in parallel with one server
- Cross-Origin-Request:
Access-Control-Allow-Origin: *

Web Thread



- C++
- Sends xml encoded pose as HTTP response
- Multiple clients in parallel with one server
- Cross-Origin-Request:
Access-Control-Allow-Origin: *
- *Todo: Replace simple web server with standard conform, more robust one (e.g. <https://github.com/eidheim/Simple-Web-Server>)*

Factory Worker Model



Model Pipeline

- Create model with clothes in MakeHuman 1.0.2
- Export to Blender (some UV mapping got wrong)
- Rig with a skeleton morphologically similar to Kinect skeleton
- Skinning: manually assign bone weights to mesh (too complex for Blender's automated tool)
- Export to XML3D
- MakeHuman exports are licensed using CC0 (public domain)



Model Pipeline



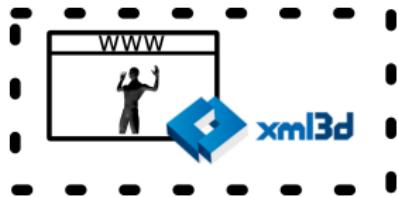
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Model Pipeline



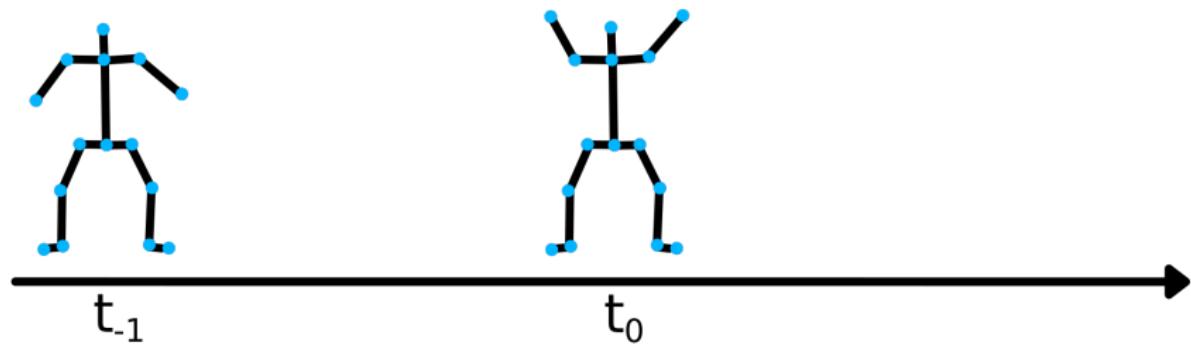
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- *Todo: Better skinning*
- *Todo: Female model*

Client

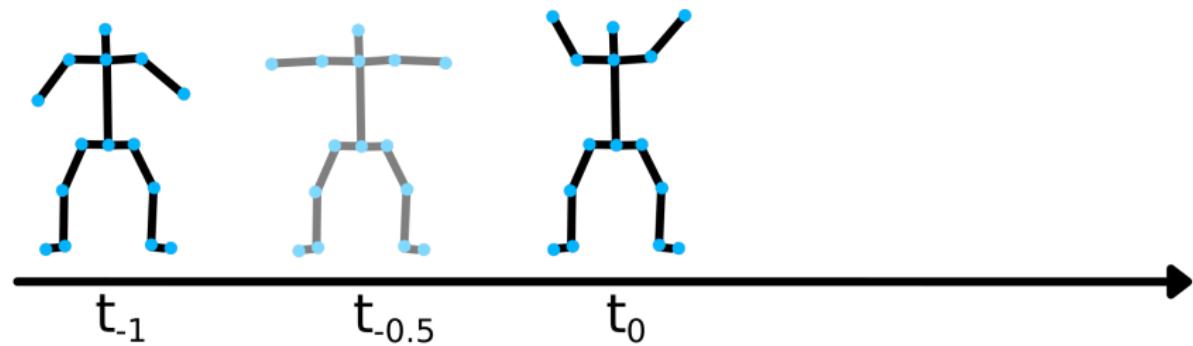


- HTML + XML3D + Xflow + JavaScript
- 6 instantiations of human mesh
- Poses via AJAX from server added to DOM with (correct) keyframe
- Hide non visible instantiations
- Transform visible instantiations based on poses

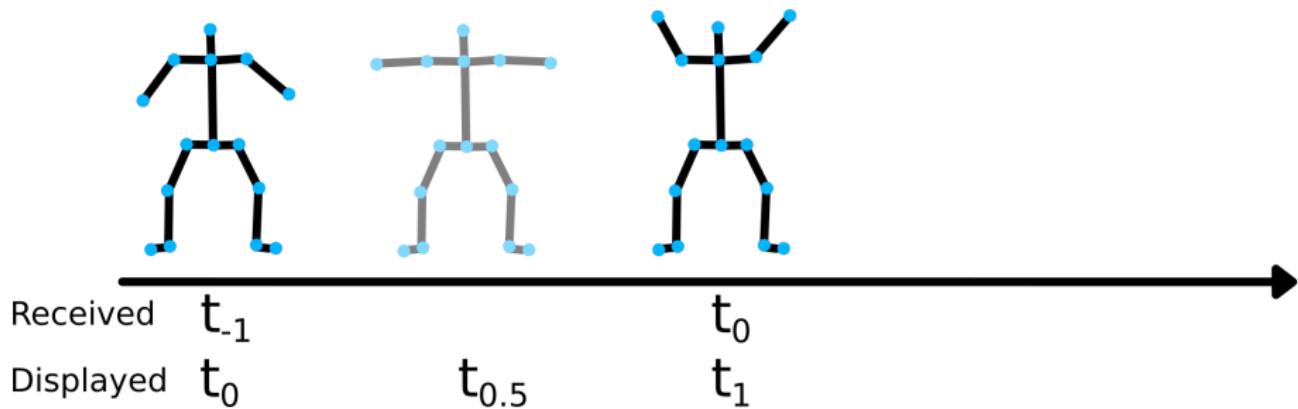
Interpolation and Requests



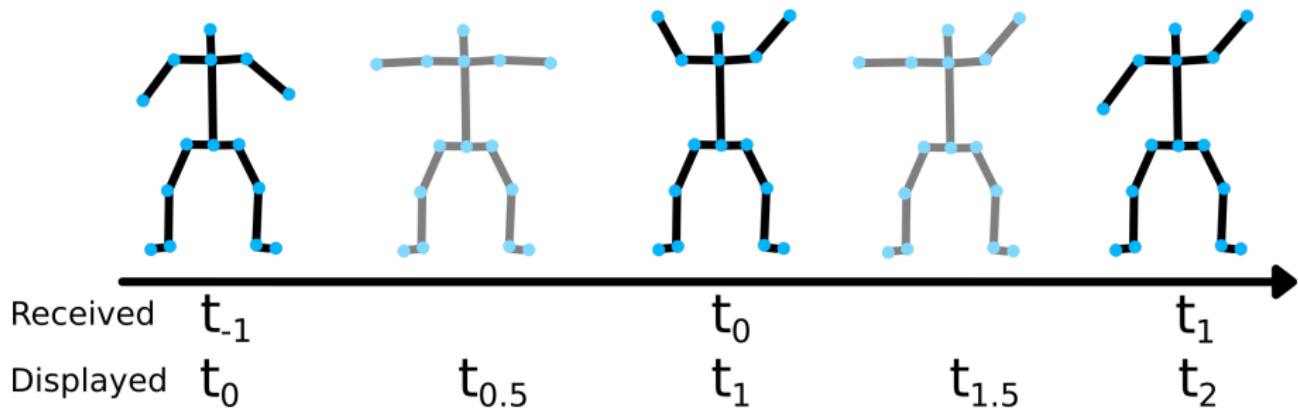
Interpolation and Requests



Interpolation and Requests



Interpolation and Requests



Skeleton Transformation With Kinect Data



Using local transformations
(original code from Blender exporter)



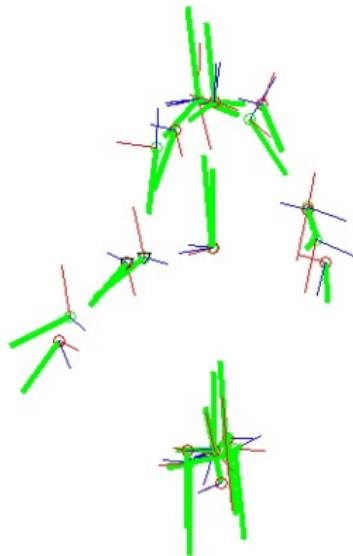
First version retargeting

Using global transformations



Final retargeting

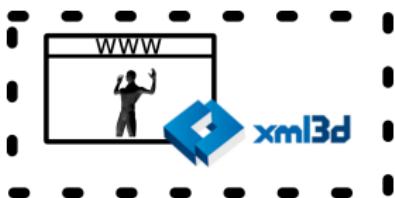
Retargeting Pipeline



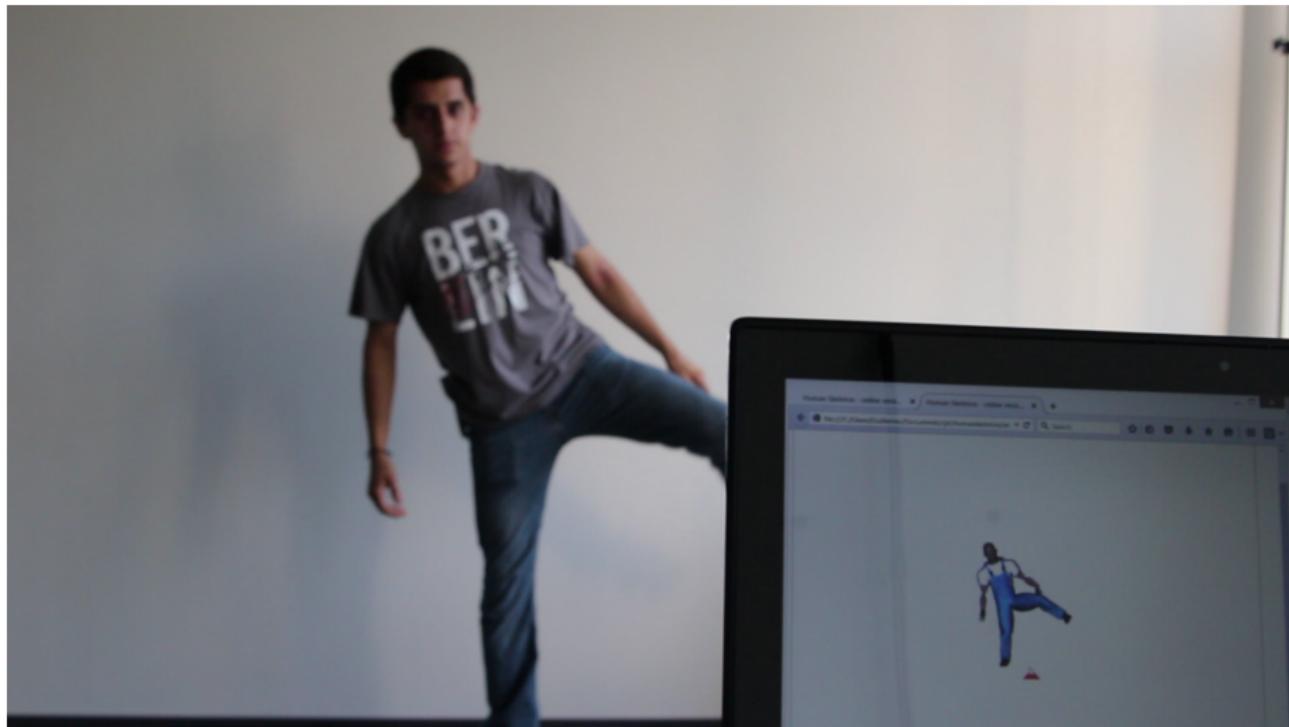
- Armatures similar to simplify retargeting
- Offline (Matlab):
 - Get same (A-)pose in Kinect and Blender/XML3D
 - Align the two poses with single transformation (best fit)
 - Align poses with per bone transformations to correct bone roll-angles
- Online (Xflow):
Apply transformation matrices on Kinect pose

Client: Minor Aspects

- Time between interpolation and requests depending on hardware (can be changed on website)
- Sometimes a pose request contains no poses (Kinect tracking error?)
→ Flickering → Only hide all when not visible for several requests
- Old, unused poses have to be deleted to avoid browser crash
- Kinect's person id only constant while person in view



Live Demo



References

- K. Sons, F. Klein, D. Rubinstein, S. Byelozorov, P. Slusallek
XML3D: Interactive 3D Graphics for the Web (2010)
- F. Klein, K. Sons, S. John, D. Rubinstein, S. Byelozorov, P. Slusallek
Xflow – Declarative Data Processing for the Web (2012)
- <https://github.com/xml3d/xml3d.js/wiki/The-Basics-of-XML3D>
- <https://github.com/xml3d/xml3d.js/wiki/Animating-Models-with-Xflow>
- <https://msdn.microsoft.com/en-us/en-en/library/dn799271.aspx>
- <https://www.makehuman.org>
- <https://www.blender.org>

All accessed 28.08.2015

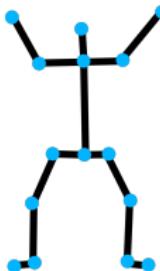
Image Sources

- https://upload.wikimedia.org/wikipedia/commons/0/0f/AEMC_Summit_%2811343420013%29.jpg (public domain)
- <https://upload.wikimedia.org/wikipedia/commons/f/f6/Xbox-One-Kinect.jpg> (public domain)
- <https://tf3dm.com/3d-model/base-mesh-ready-to-be-rigged-15483.html> (non-commercial use)
- <https://xml3d.org/wp-content/ata-images/logo.png>
- <https://download.blender.org/institute/BlenderDesktopLogo.png>
- <https://www.makehuman.org/images/logo.png>

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