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► **To cite this version:**

Christophe Lohou, Marc Bouiller, Émilie Gadea-Deschamps. Mixed Reality Experiment for Hemodialysis Treatment. SURGETICA 2019, Jun 2019, Rennes, France. hal-04342141

**HAL Id: hal-04342141**

**<https://hal.science/hal-04342141>**

Submitted on 13 Dec 2023

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## Mixed Reality Experiment for Hemodialysis Treatment

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### Medical Context and motivation



Fistula



Puncture

**Hemodialysis session:**

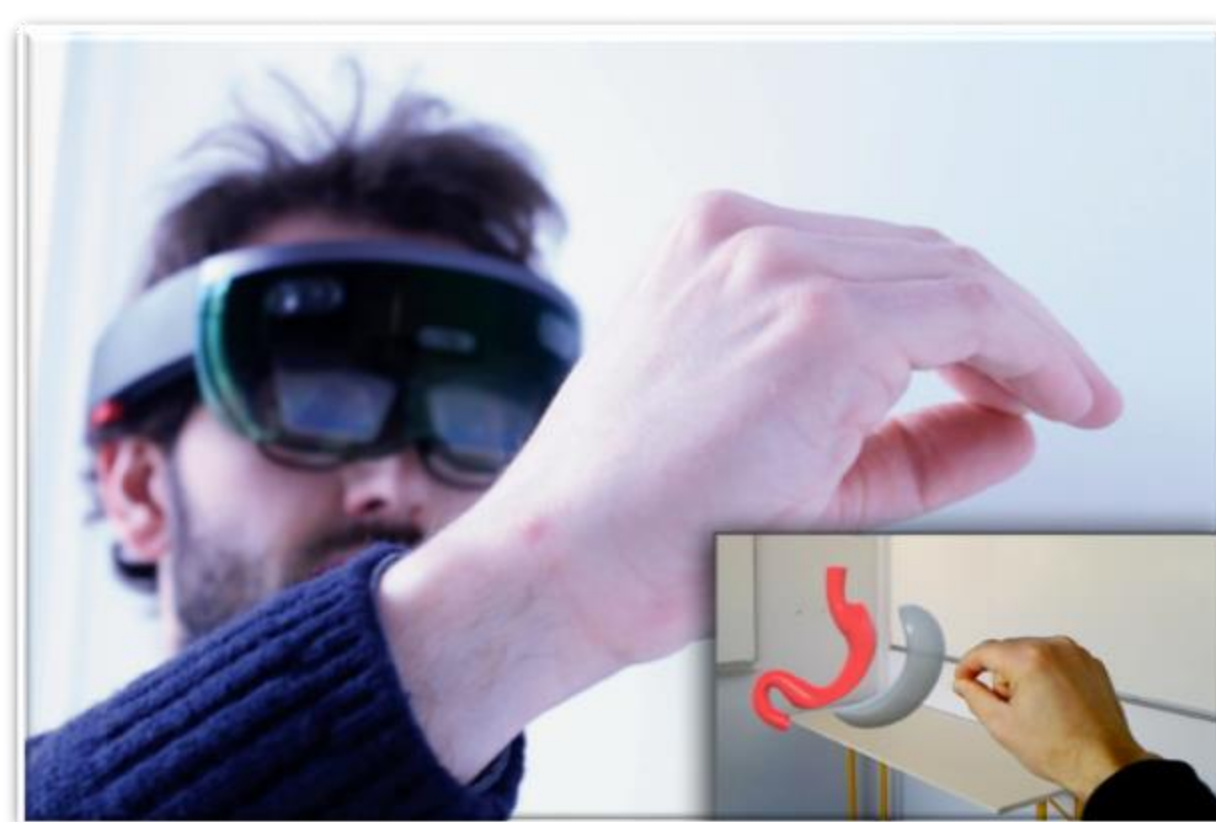
- two needles are inserted inside the fistula (dirty blood ejection and filtered blood arrival)

- to record actual needles position and orientation (**influence of the injection sites** with regard to pain/risks incurred by patients),
- to assist nurses to align needles according to the previously recorded ones.

### Hardware

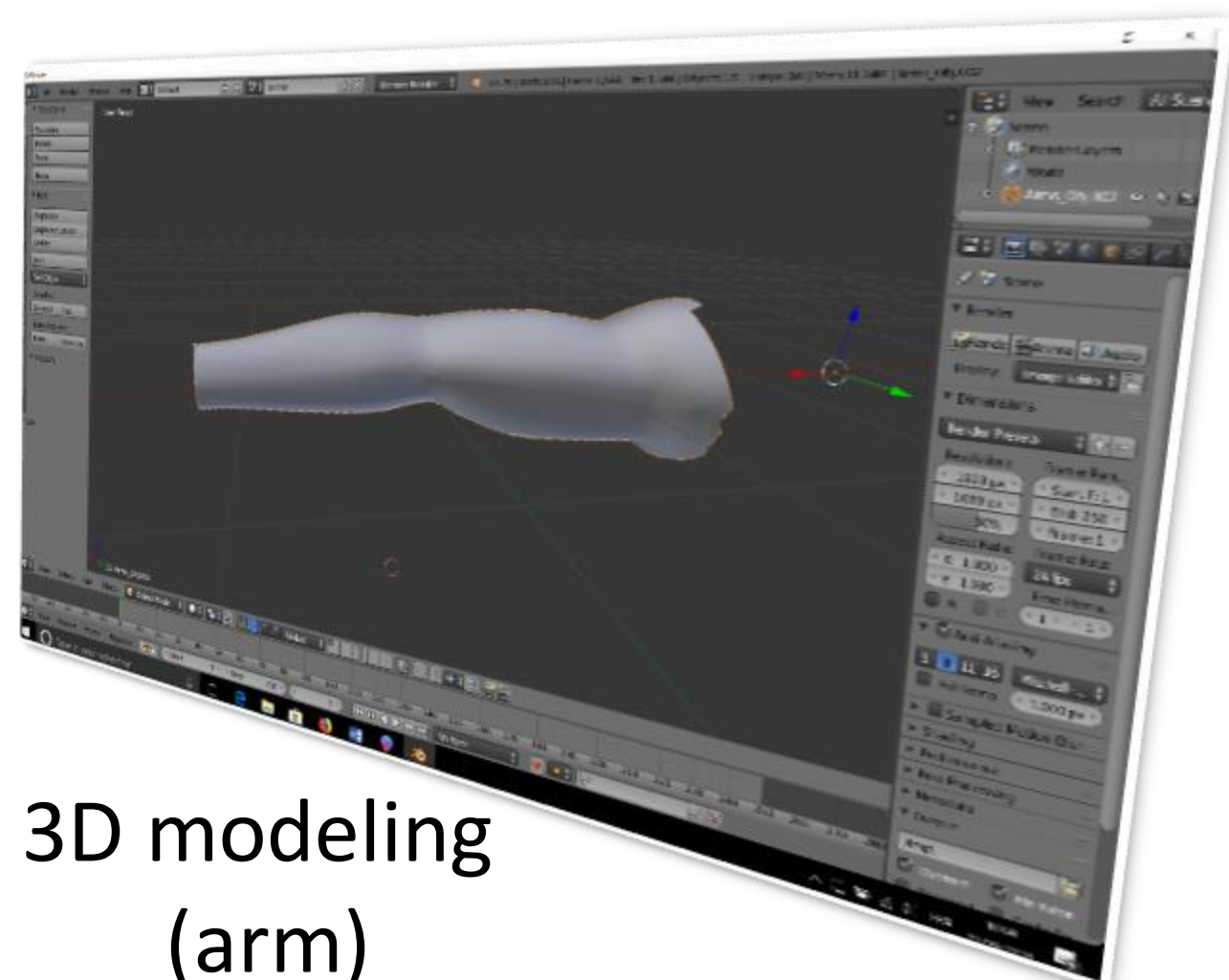
- Microsoft HoloLens Headset (v1), late 2016 in France

=> to interact with 3D virtual objects (*holograms*), **mixed reality**

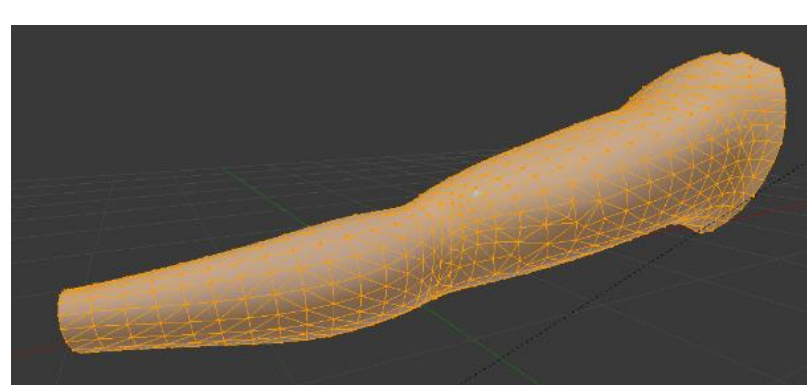


View of the user through the headset

### Digital Content Creation



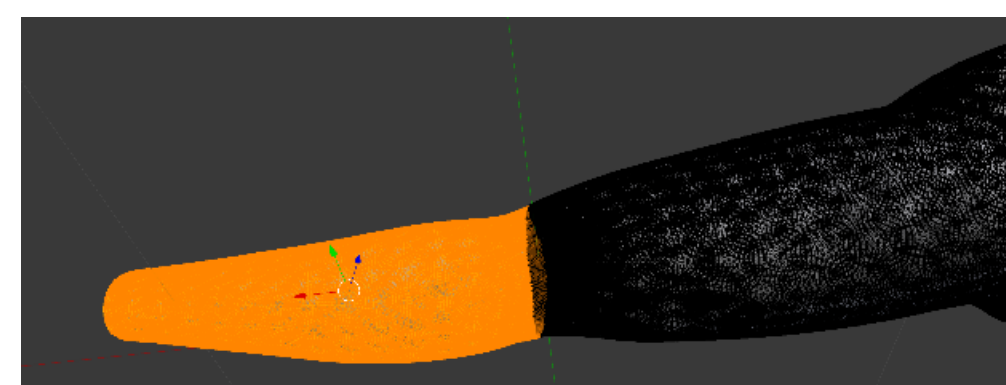
3D modeling (arm)



Mesh

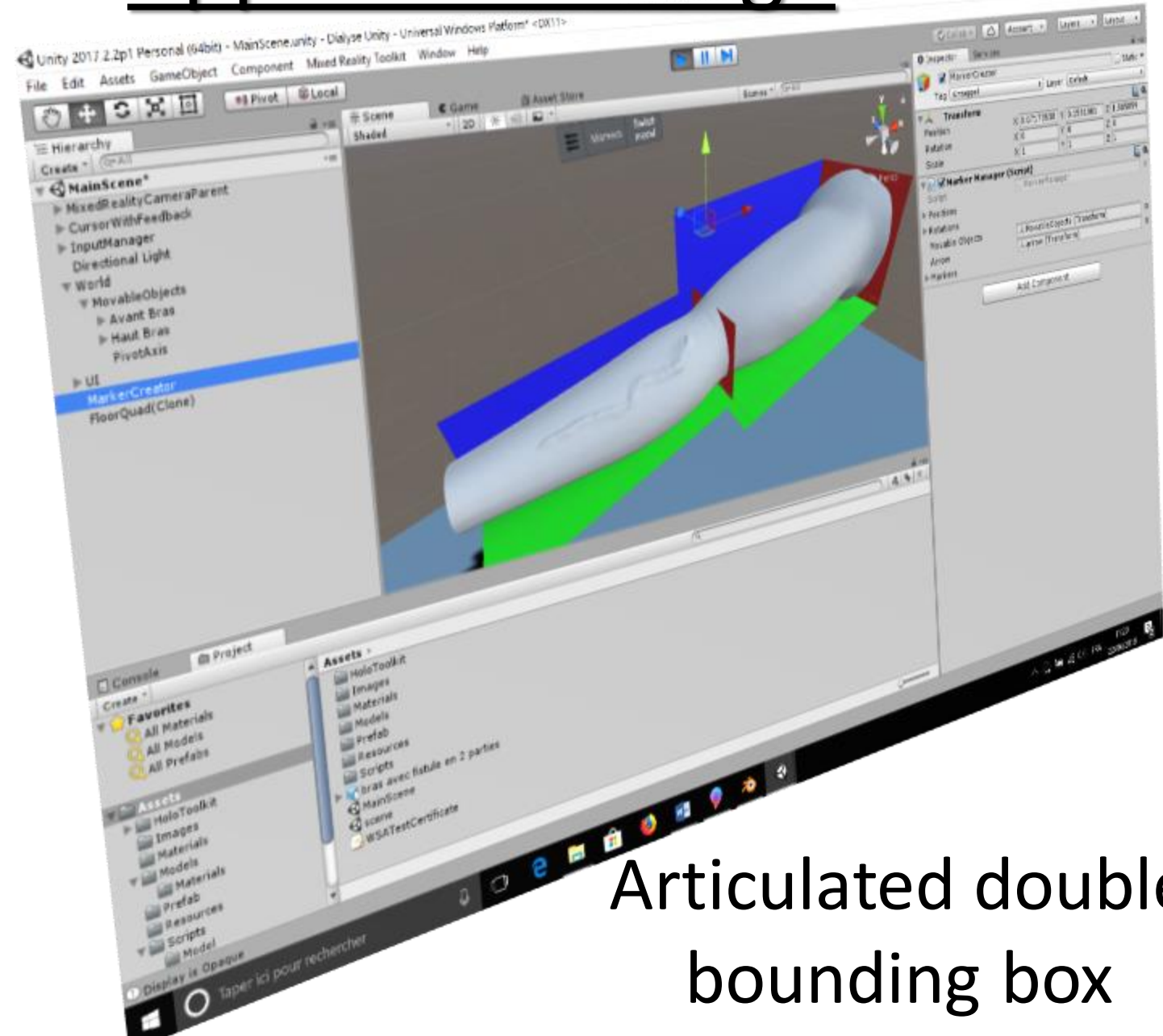


Fistula sculpting

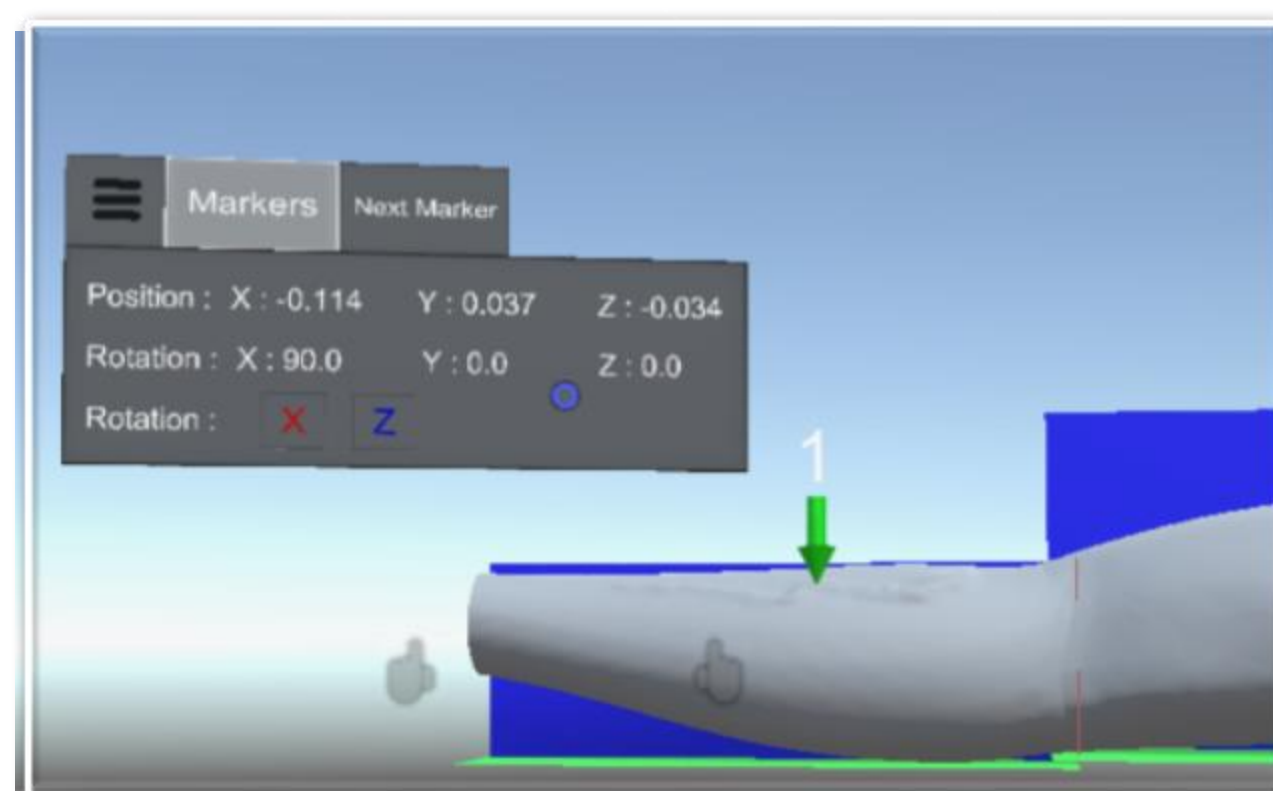


Joint (elbow)

### Application design



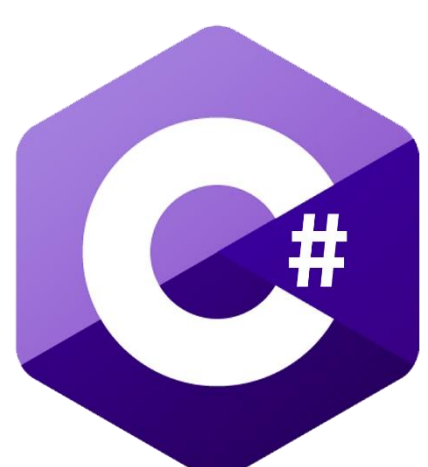
Articulated double bounding box



Needle 3D model

### Implementation

- C# language



```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;

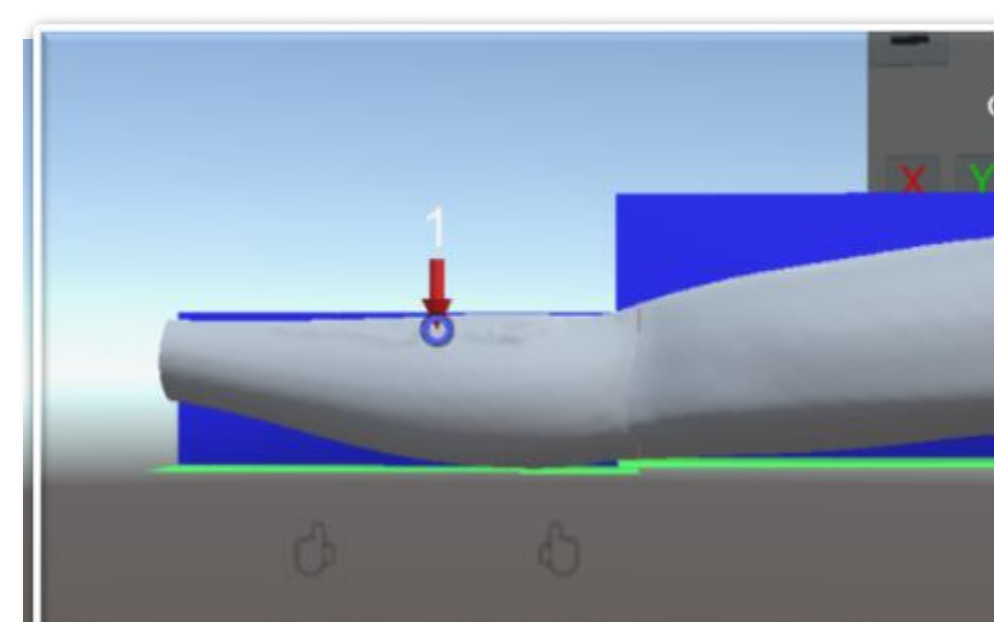
public class GeneratePlanes : MonoBehaviour
{
    private MeshFilter[] filters; //Mesh filter des enfants
    private Quaternion oldRotation; //Rotation initiale de L'objet
    private Vector3 minBound; //Point en bas à gauche de la boîte englobante
    private Vector3 maxBound; //Point en haut à droite de la boîte englobante
    private Vector3 centerBound; //Centre de la boîte englobante
    private Vector3 boundsSize; //Taille de la boîte englobante
    private static Vector3 planesOrigin; //Point à l'origine des 3 plans

    private void Awake()
    {
        filters = GetComponentsInChildren<MeshFilter>();
        oldRotation = transform.parent.rotation;
        transform.parent.rotation = Quaternion.identity;
        maxBound = filters[0].mesh.bounds.max;
        minBound = filters[0].mesh.bounds.min;
        for (int i = 1; i < filters.Length; i++)
        {
            if (filters[i].mesh.bounds.max.x > maxBound.x)
                maxBound.x = filters[i].mesh.bounds.max.x;
            if (filters[i].mesh.bounds.max.y > maxBound.y)
                maxBound.y = filters[i].mesh.bounds.max.y;
            if (filters[i].mesh.bounds.max.z > maxBound.z)
                maxBound.z = filters[i].mesh.bounds.max.z;
            if (filters[i].mesh.bounds.min.x < minBound.x)
                minBound.x = filters[i].mesh.bounds.min.x;
        }
    }
}

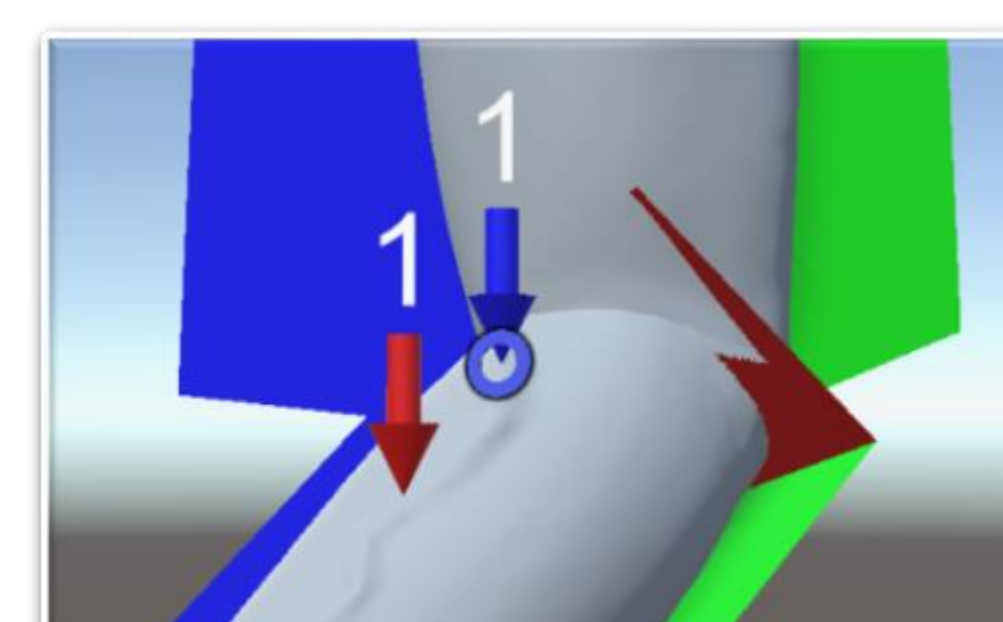
```

Contact: christophe.lohou@uca.fr

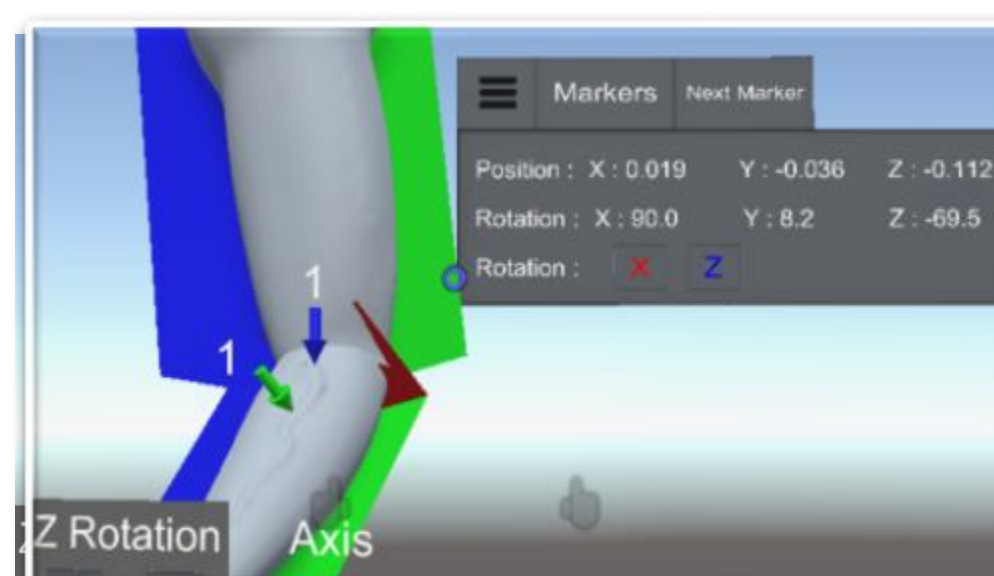
### Needles placement (simulation inside Unity)



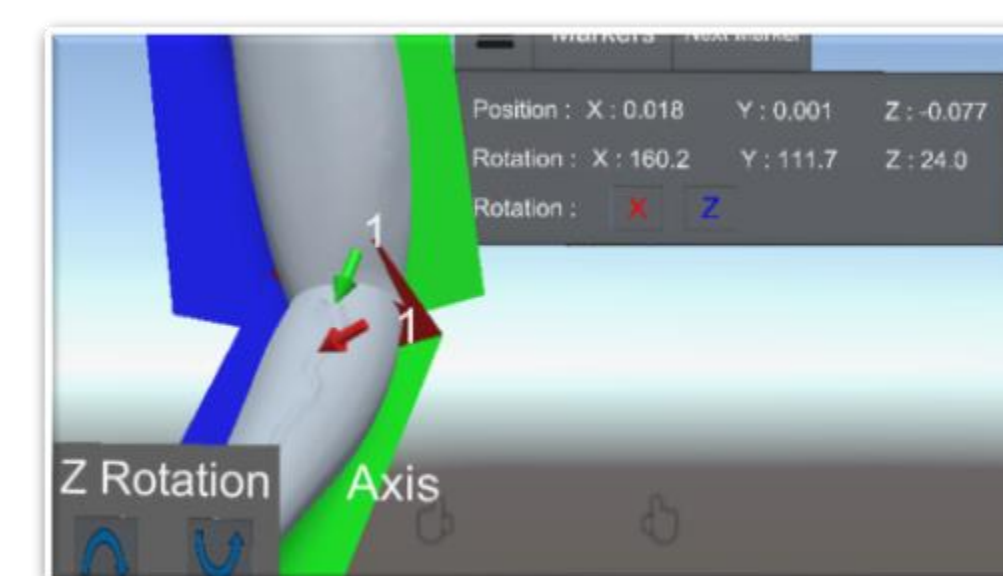
First needle position



Second needle position

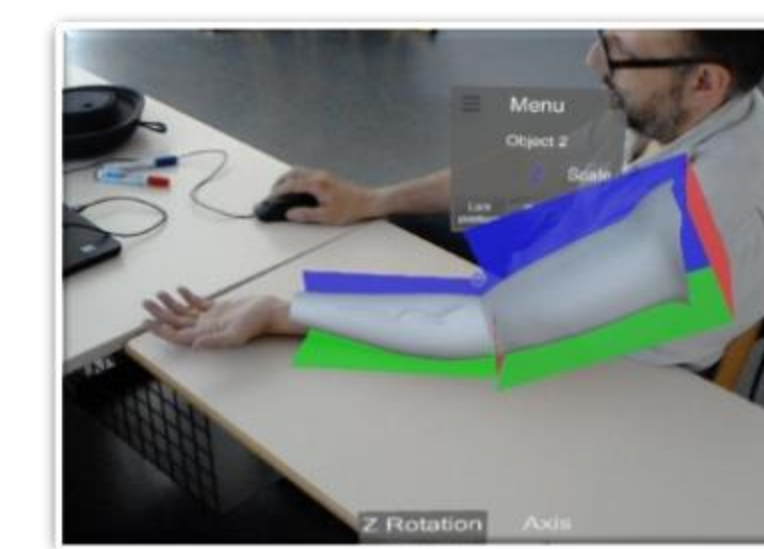
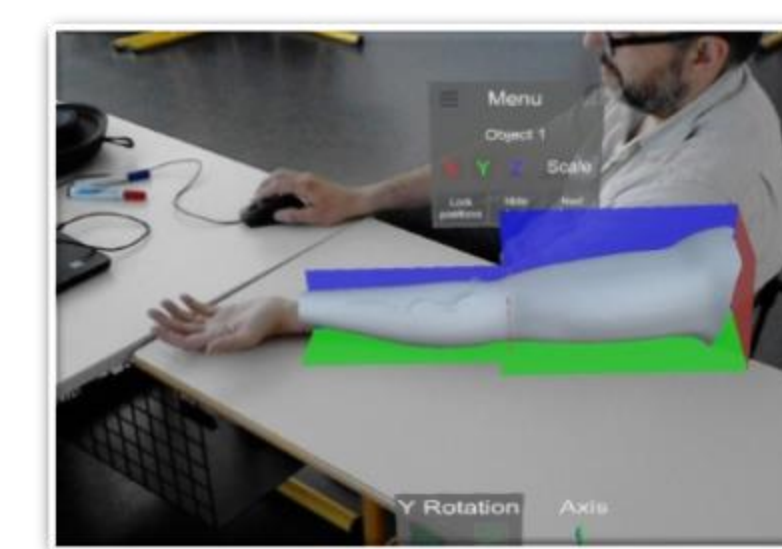
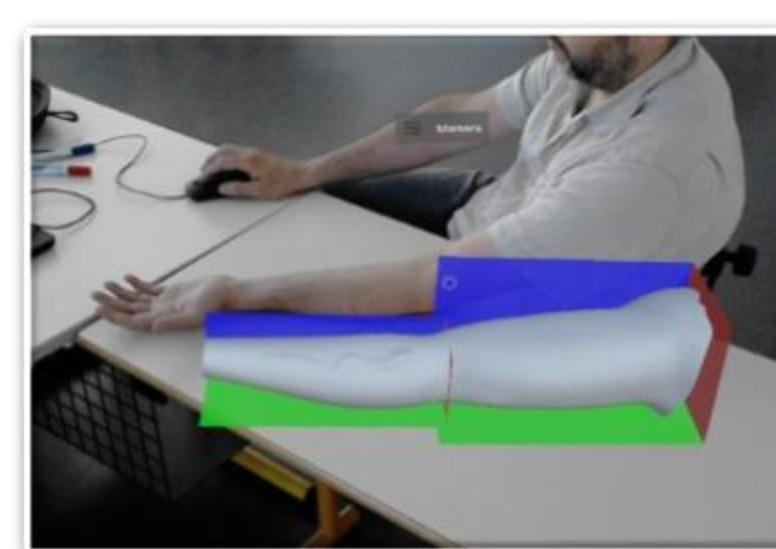


Orientation of the first needle



Orientation of the second needle

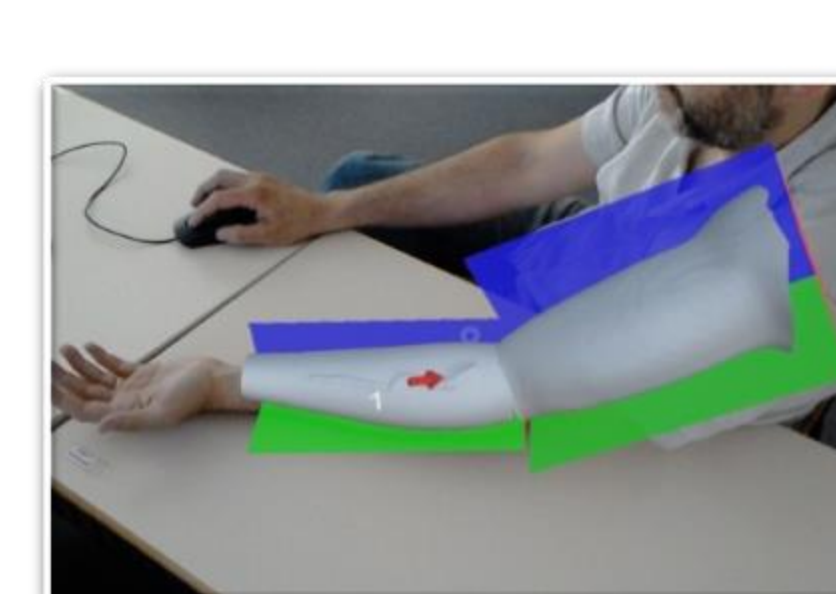
### RESULTS: Interactive registration (to record actual needles)



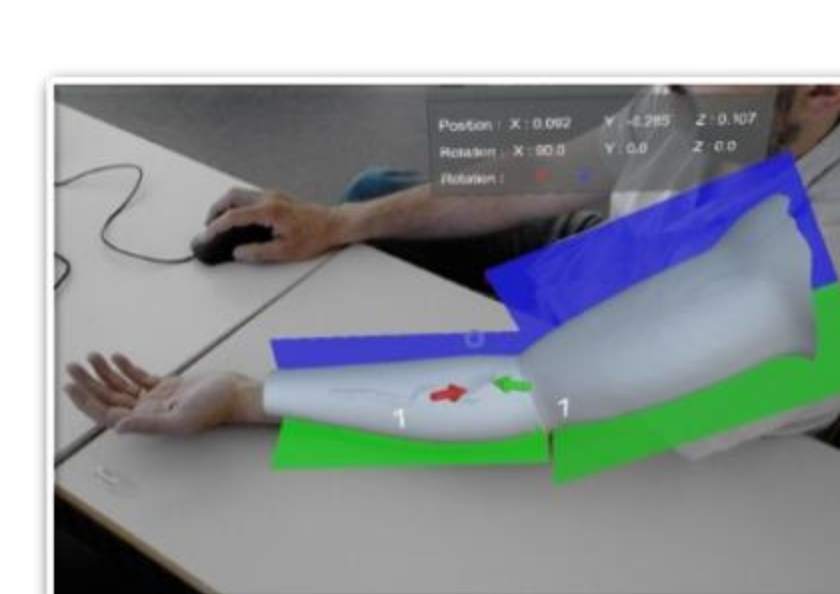
Bounding box placement and orientation



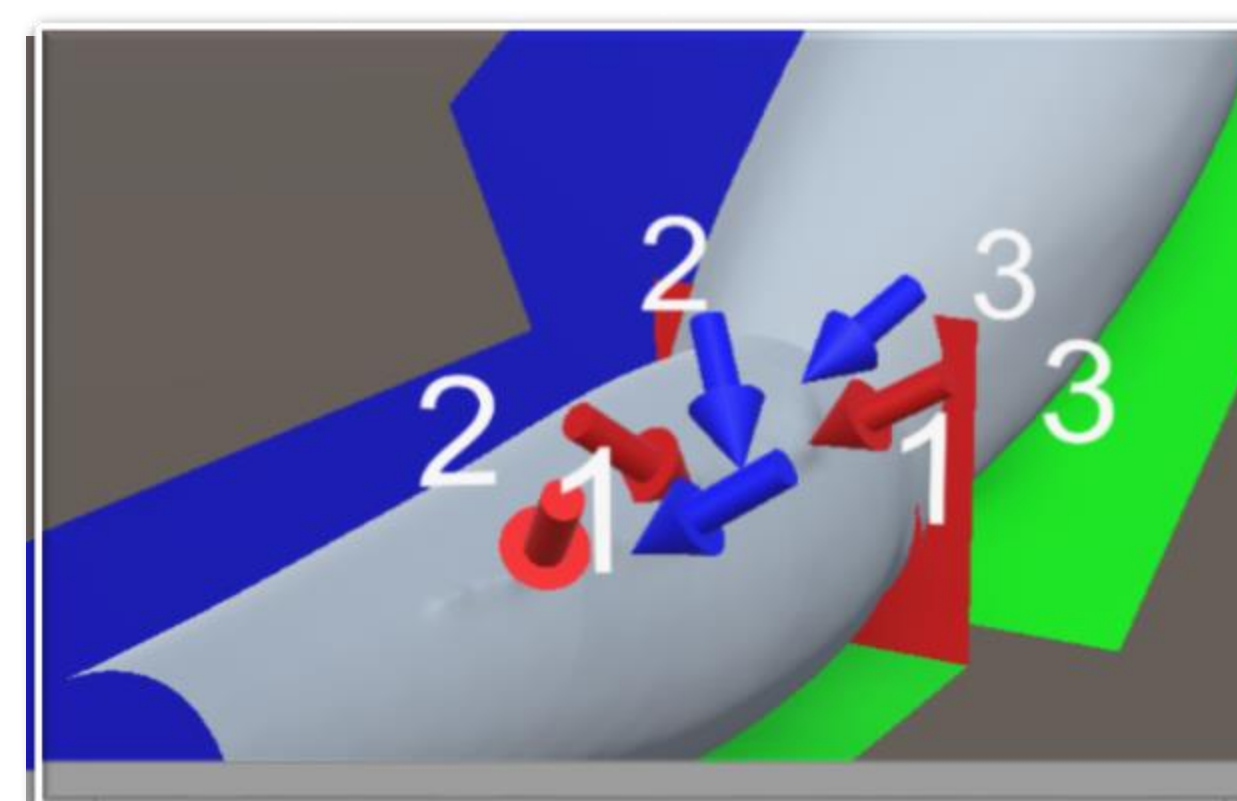
Another view



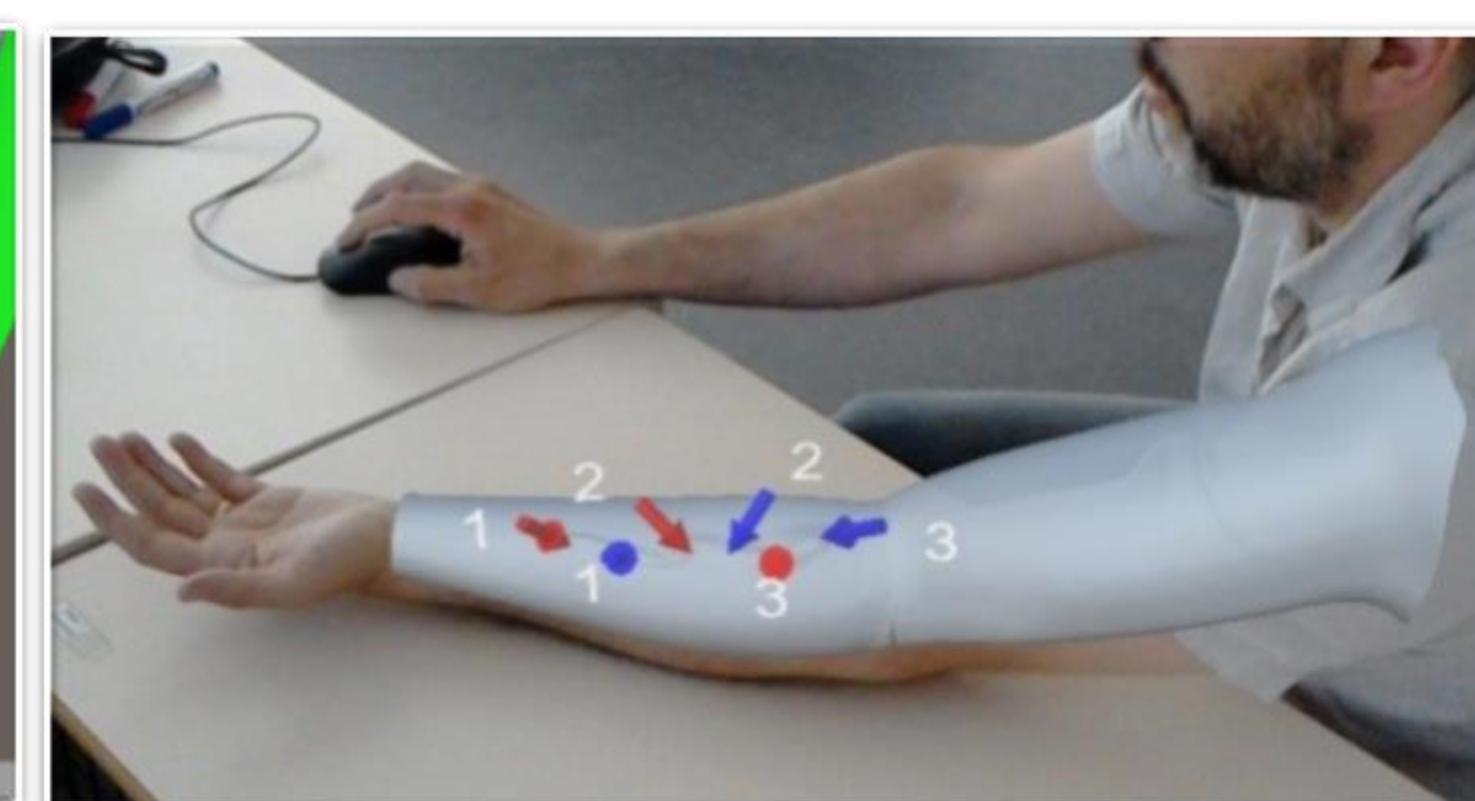
Recording of the virtual needles (simulation)



### RESULTS: Interactive registration (to show previously recorded needles)



With three previous sets of needles



### Future works

- 3d CT-scan of the actual pair (arm+fistula) of patients,
- marker-based registration.

### Acknowledgments

- Arthur Jacquin, student (DUT Informatique), IUT Le Puy-en-Velay
- Funding PEPS CNRS INSIS, « Sciences de l'Ingénierie pour la Santé pour accompagner des projets translationnels », 2017

