Mixed Reality Experiment for Hemodialysis Treatment

Christophe Lohou, Marc Bouiller, Émilie Gadea-Deschamps

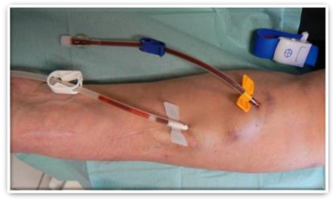
SURGETICA 2019
Computer-assisted medical interventions
June 17-18
Rennes, France

Mixed Reality Experiment for Hemodialysis Treatment

Christophe LOHOU[1],
Marc BOUILLER[2] and Emilie GADEA-DESCHAMPS[2]
[1]Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pascal, F-63000 Clermont-Ferrand France
[2]Centre Hospitalier Emile Roux, 12 boulevard Docteur Chantemesse, F-43000 Le Puy-en-Velay, France

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.

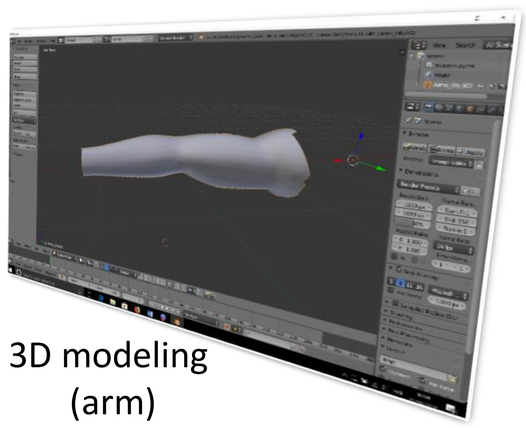
Hardware

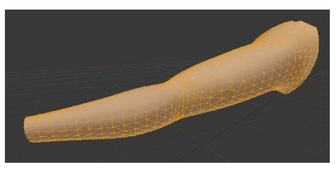
- Microsoft HoloLens Headset (v1), late 2016 in France

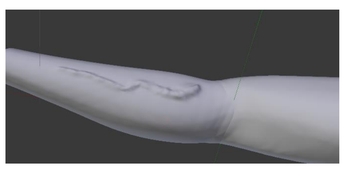
=> to interact with 3D virtual objects (*holograms*), **mixed reality**

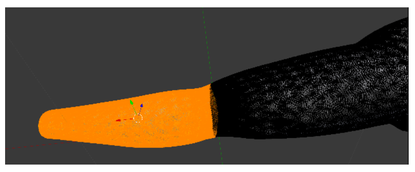

View of the user through the headset

Digital Content Creation

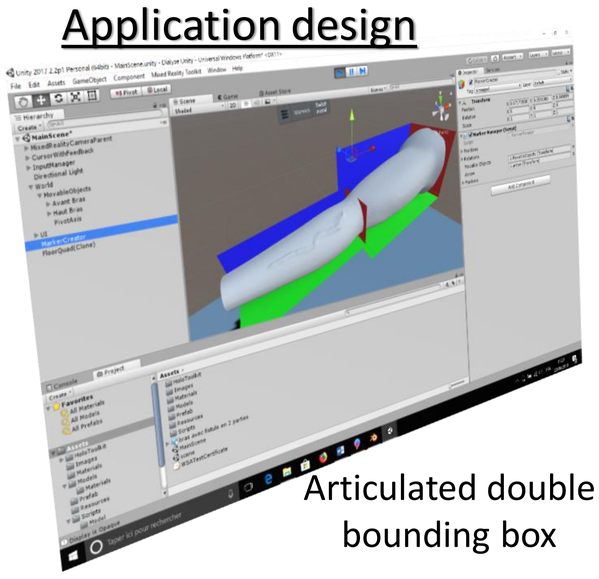

3D modeling (arm)

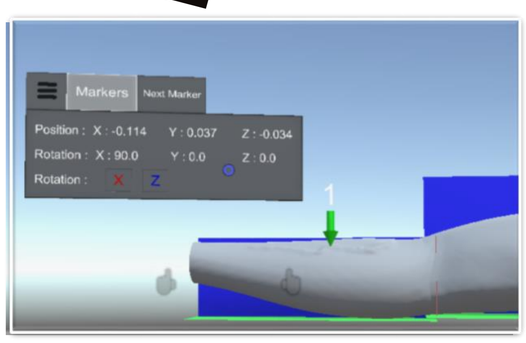

Mesh


Fistula sculpting


Joint (elbow)

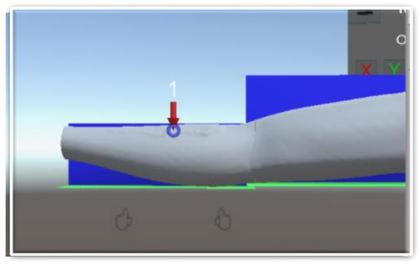
Application design


Articulated double bounding box

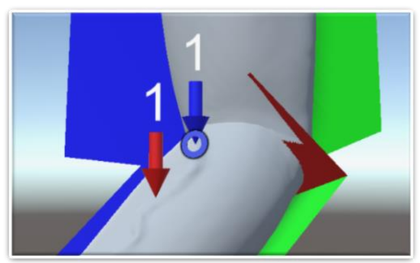


Needle 3D model

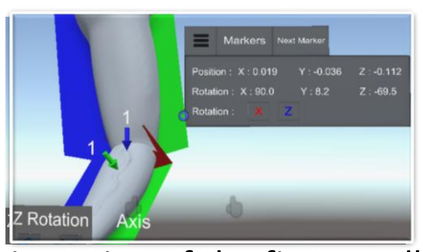
Needles placement (simulation inside Unity)



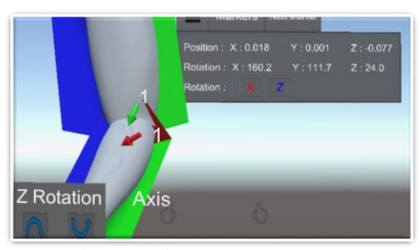
First needle position



Second needle position

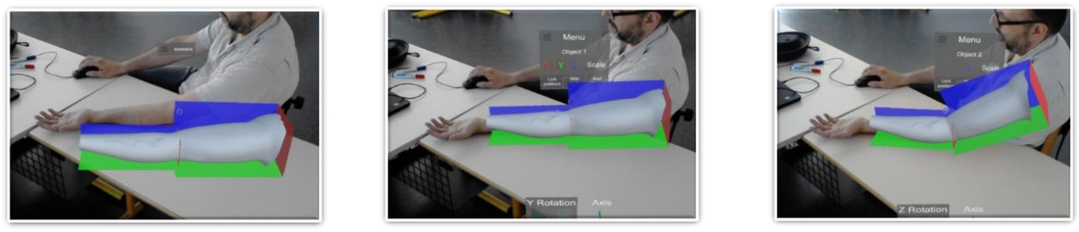


Orientation of the first needle

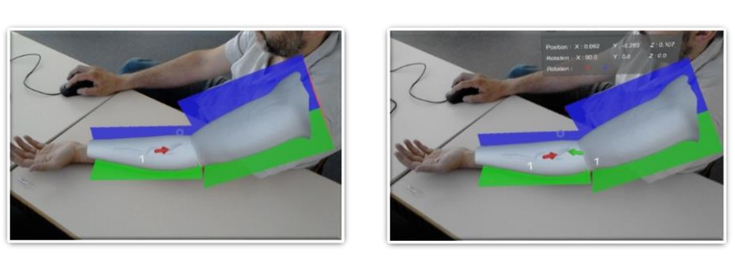


Orientation of the second needle

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.

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 boite englobante
    private Vector3 maxBound;//Point en haut à gauche de la boite englobante
    private Vector3 centerBound;//Centre de la boite englobante
    private Vector3 boundSize;//Taille de la boite 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

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