POLITECNICO
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MEDICAL ROBOTICS FOR COMPUTED AIDED SURGERY

PROJECT 16:
Development of an AR tool using an Optical See-Trough Display for surgical applications

By Alice Carcone, Chiara Leoncavallo
under the supervision of
Veronica Penza (IIT)

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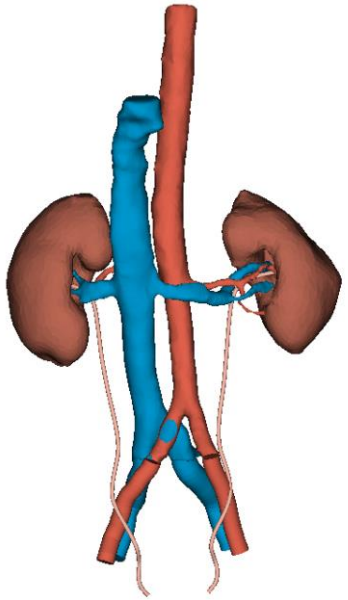
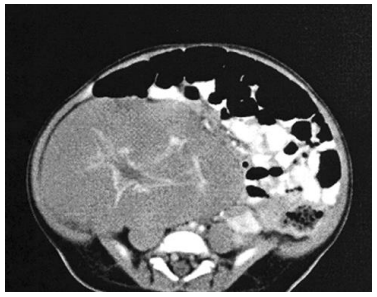
INTRODUCTION

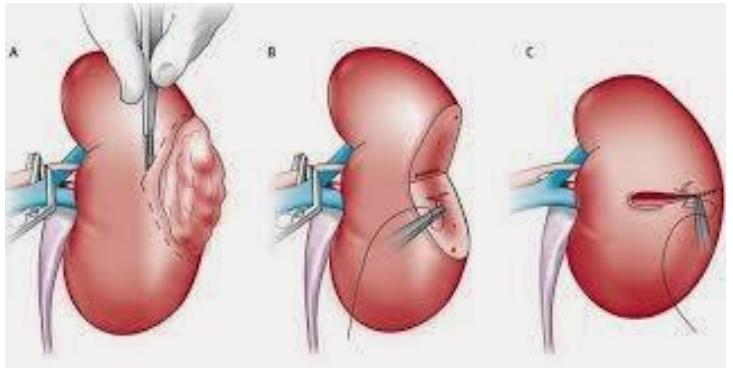
Clinical Setting: Wilms tumors are the most frequently occurring pediatric cancers of the kidney.

➔ **Open surgery** vs laparoscopic or robotic approach

➔ **Nephron sparing surgery** vs total resection



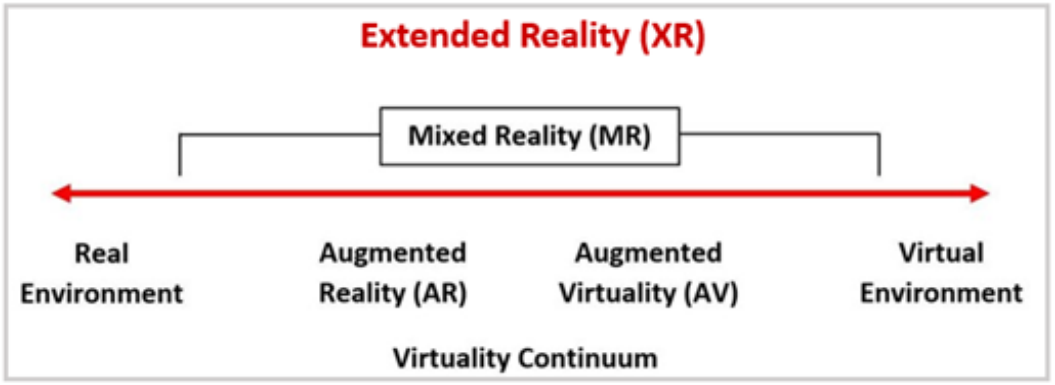


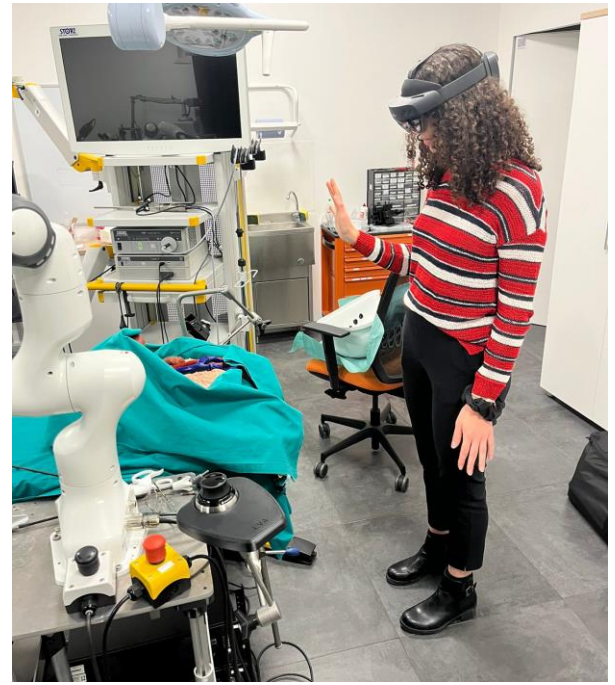


Data from MRI and CT can be reconstructed into 3D virtual models which can improve the understanding of tumor location and other relevant anatomical structures.

References: [1]-[4]

CURRENT STATE OF THE ART





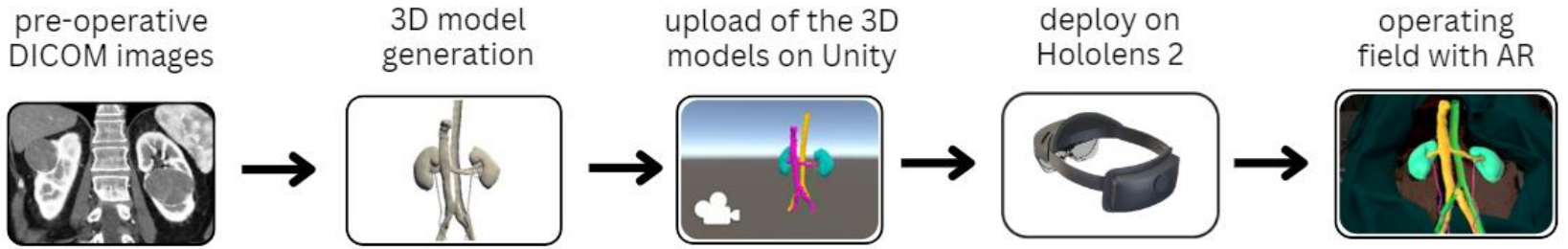
What is Augmented Reality?

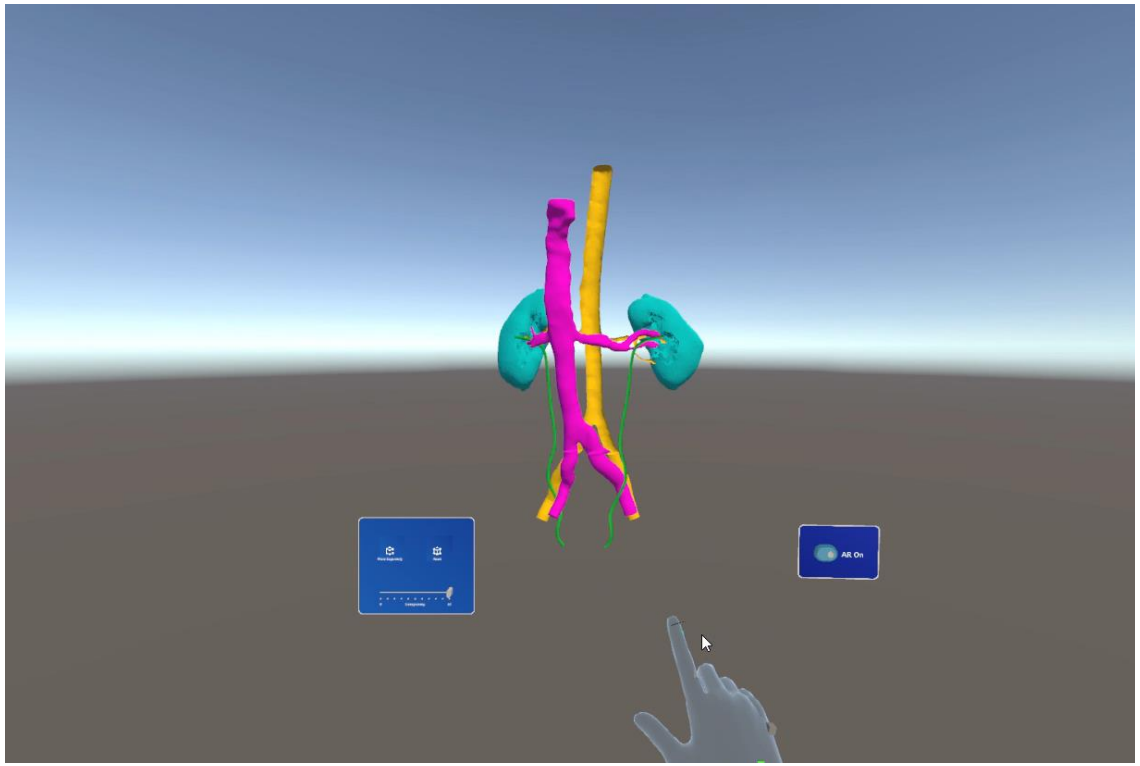
AR is a potential tool during surgical procedures since augmented informations can be overlaid on the field of view of the surgeon.

One of the most popular mixed reality headsets is the Microsoft HoloLens 2, a pair of smart glasses used in a variety of medical applications.

References: [5]-[8]

MATERIALS AND METHODS

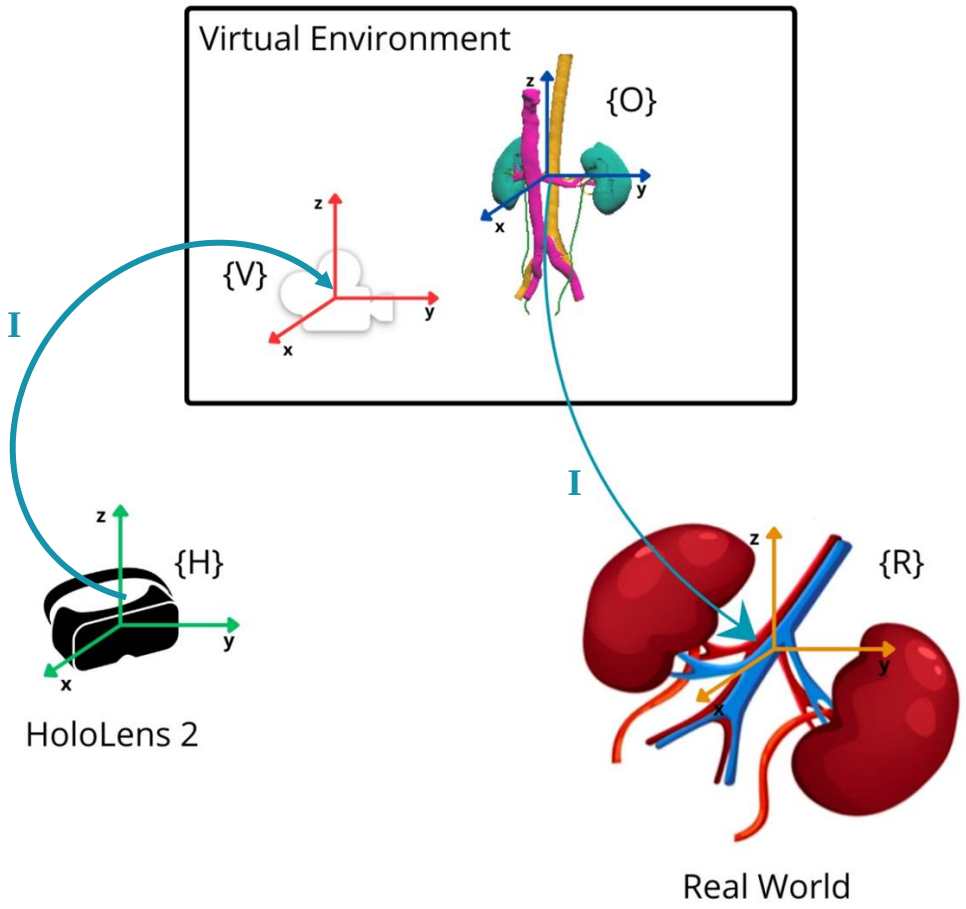




The Unity scene:

- 6 organs
- ‘AR’ button to enable augmented reality
- ‘Slider’ to change transparency
- ‘Reset’ button to reset the original position of the organs
- ‘Move separately’ button to move the organs separately

MATERIALS AND METHODS

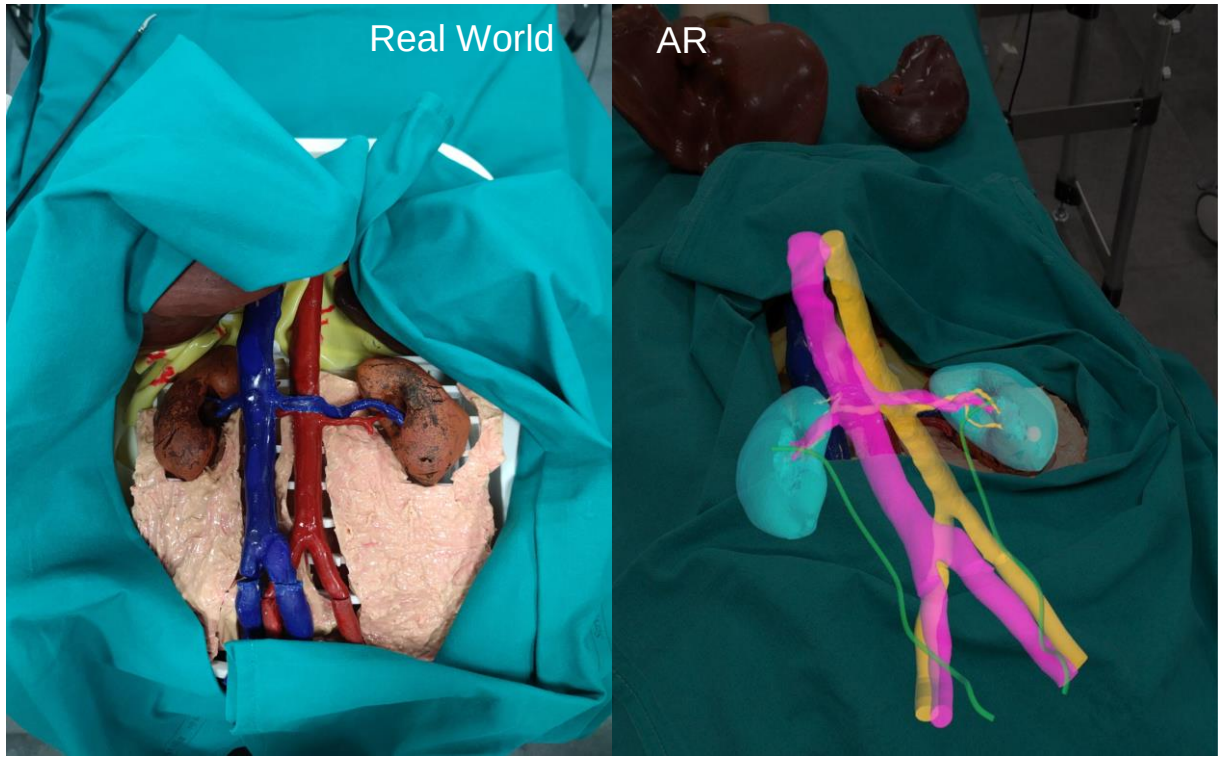


Knowing all the **reference frames** (RFs) involved in our experimental setup is essential to guarantee the alignment between reality and virtuality.

- ➔ I matrix between {H} and {V} thanks to Hololens 2 ‘intrinsic’ tracking
- ➔ I matrix between {O} and {R} obtained through manual registration

EVALUATION

THE EXPERIMENTAL SET-UP:



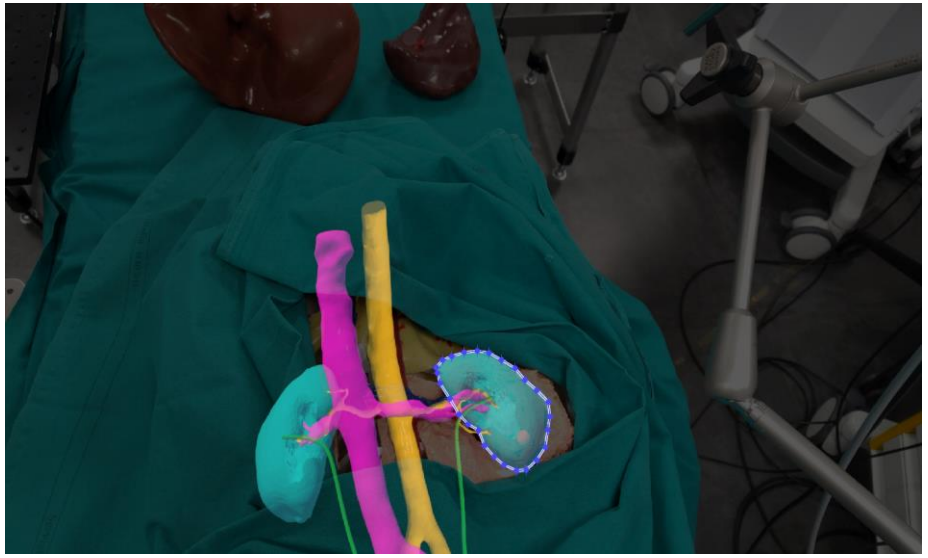
Scene was built using VS 2022 → Scene was deployed on HoloLens → Subject wears holographic lenses → Subject captures photos/videos

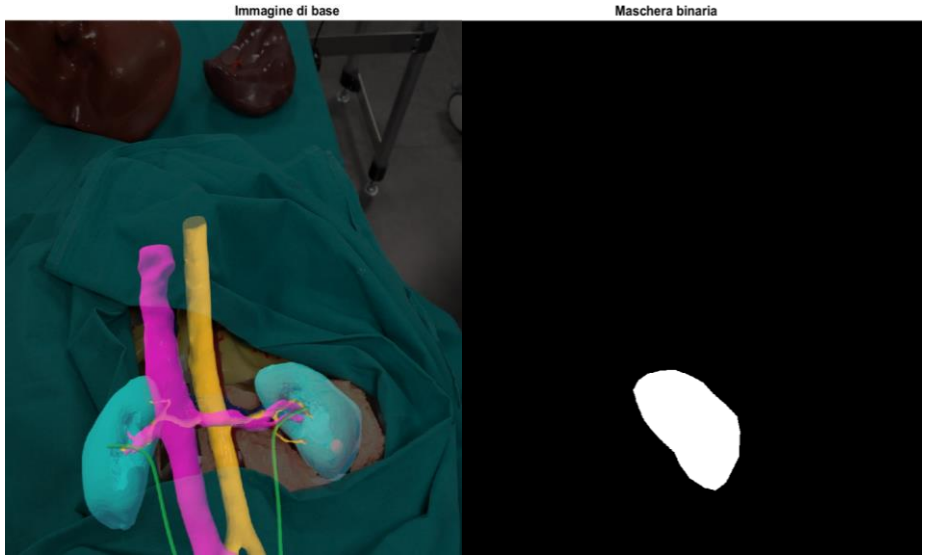
QUANTITATIVE EVALUATION

01

OPERATING ROOM

1) Perform manual registration 12 times overlapping the left virtual kidney onto the real kidney
2) Capture frames of the surgical field





02

MATLAB

1) Manually segment real and virtual kidneys
2) Obtain the corresponding binary masks
3) Compute Intersection Over Union

$$IoU = \frac{A \cap B}{A \cup B}$$

RESULTS

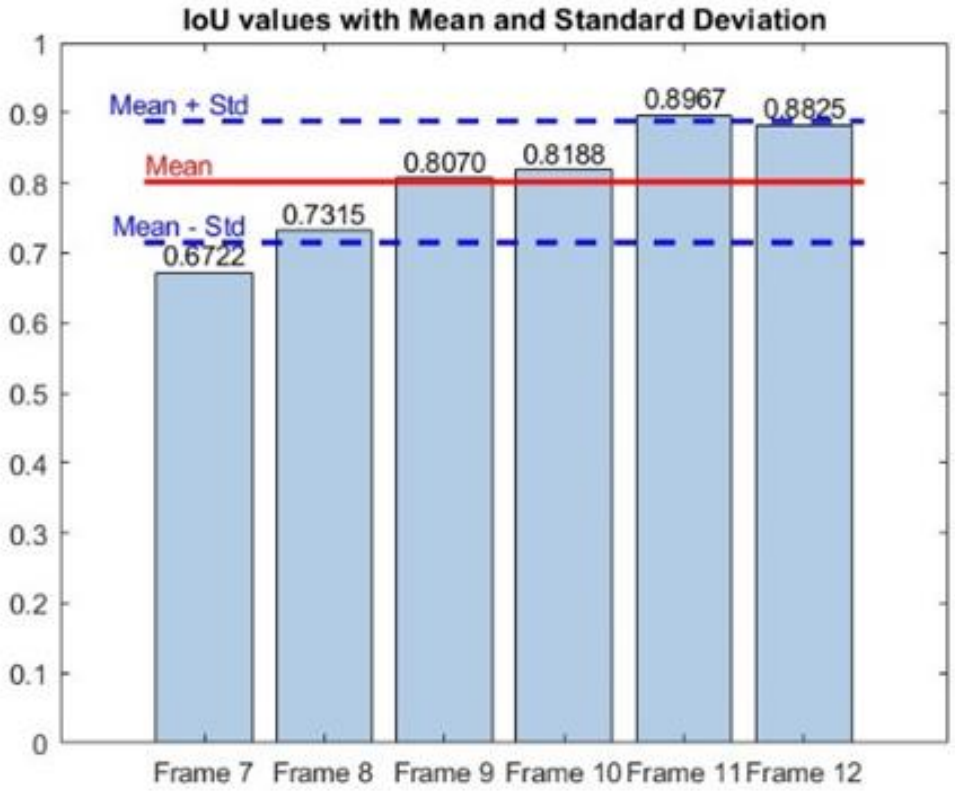
IOU

Mean: 0.83563
Std: 0.075499

REGISTRATION TIME

Mean: 35.745 s
Std: 37.9693 s

- High overlap between real and virtual models
- Correlation between time and accuracy
- Accuracy increases with practice



CONCLUSIONS & FUTURE DIRECTIONS

01 **Scene details**

Improve the illumination and the choice of materials for a better rendering of the virtual organs.

02 **From manual to automated registration procedure**

Voice commands, computer vision strategies, deep learning algorithms

03 **Implement a ROS package** ROS

Real-time data streaming between HoloLens 2 and other applications/devices in the operating scene

04 **Deploy the Unity scene**

Deploy to other see-through devices

References: [9], [10]

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