HOCTOPUS: An Open-Source Cross-Reality tool to Augment Live-Streaming Remote Classes

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Introduction

- Considering the field of education, features such as advanced 3D model visualization, manipulation, and physical object augmentations, are often exploited to encourage and increase learning motivation and efficacy [5,19];
- Following this, XR systems provides different opportunities for education [22]:
- In particular AR/MR technologies appear particularly interesting considering that [22]:
  - (a) it is possible to blend existing educational tools to provide new narratives in augmented environments;
  - (b) may in principle require smaller investments in 3D content creation;
  - (c) may provide a visual bridge between an object under study and its digital twin.

Related works

- Despite this, only a few works focused on studying the possible advantages and effects of AR/MR experiences to empower remote classroom teachings, and even less considered live streaming classes [3, 5, 33, 49];

- It is worth noticing that the majority of such works exploited the Microsoft Hololens 2 MR and none of the aforementioned works publicly provided their implementations in an open-source format;

- Finally, to the best of our knowledge, none adopted a Cross-Reality perspective (CR) to support interactive live-streaming remote classes [15, 34, 35].

Cross-reality in education

- However, CR could be of particular interest in such an application context, considering that **the teacher and the students have different needs and roles while participating in a live-streaming remote class**.

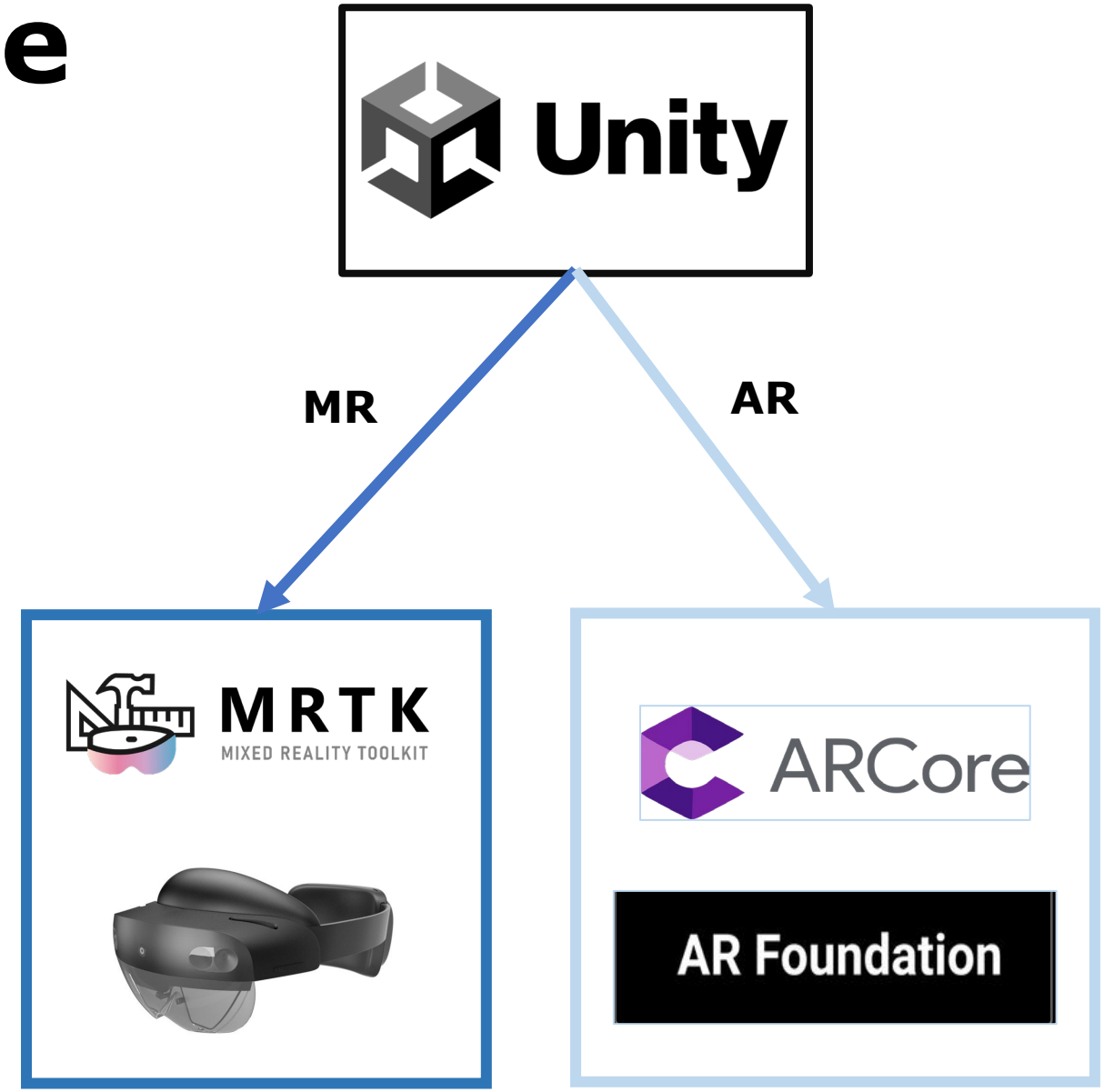
- **The teacher** should use a performing device that provides high manipulation flexibility for virtual objects while presenting the lecture material;

- **The students** could use a lightweight and affordable device that supports a simpler manipulation and interaction system (asking questions while interacting with objects, as an example);

- Following such a perspective, we here introduce an open-source synchronous CR platform, comprising AR and MR, to support live remote educational classes, named “HOlolens remote Class Teaching with peer-tO-Peer objects Unity Synchronization” (**HOCTOPUS**).

System architecture

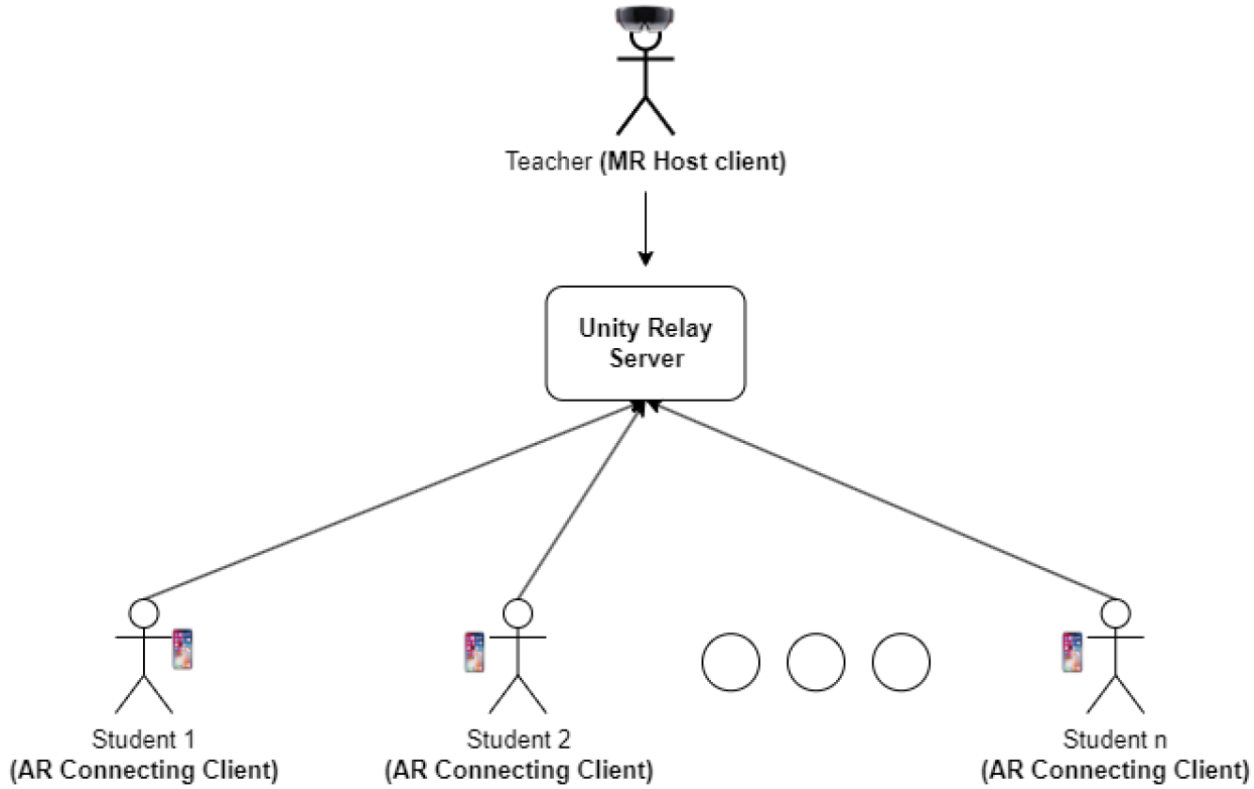
- HOCTOPUS was entirely developed with Unity (2021.3.x);
- The Mixed Reality Toolkit (MRTK) to develop the teacher MR experience in the Hololens 2;
- The AR Foundation and the Google ARCore frameworks to implement the student's mobile AR interface;
- This cross-reality setting was thought as a trade-off between the cost of the device that different users could use and spatial computing/interaction flexibility.



- The synchronicity of the system was implemented with Relay servers (RS) provided by Unity.

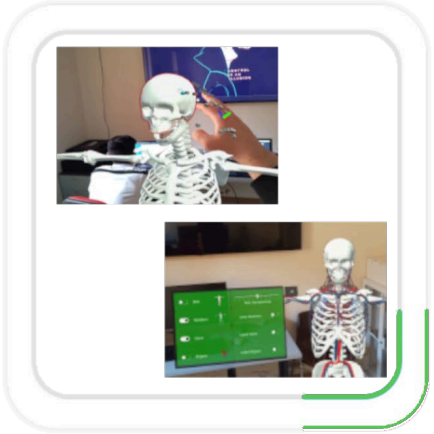
- Relay servers are employed in multiplayer XR experiences that mimic a client-server schema: one application acts as a “server” and all the others as the “connecting clients”.

- This perfectly matches our XR Remote Class Education use case: the server role is covered by the **MR teacher application**, while the **AR students correspond to the connecting clients**.



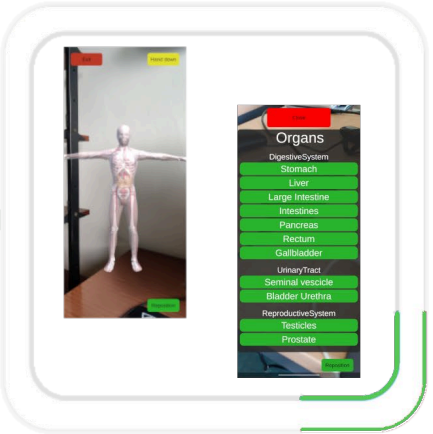
HOCTOPUS: an open-source cross-reality system for education

TEACHER MR DEVICE APP

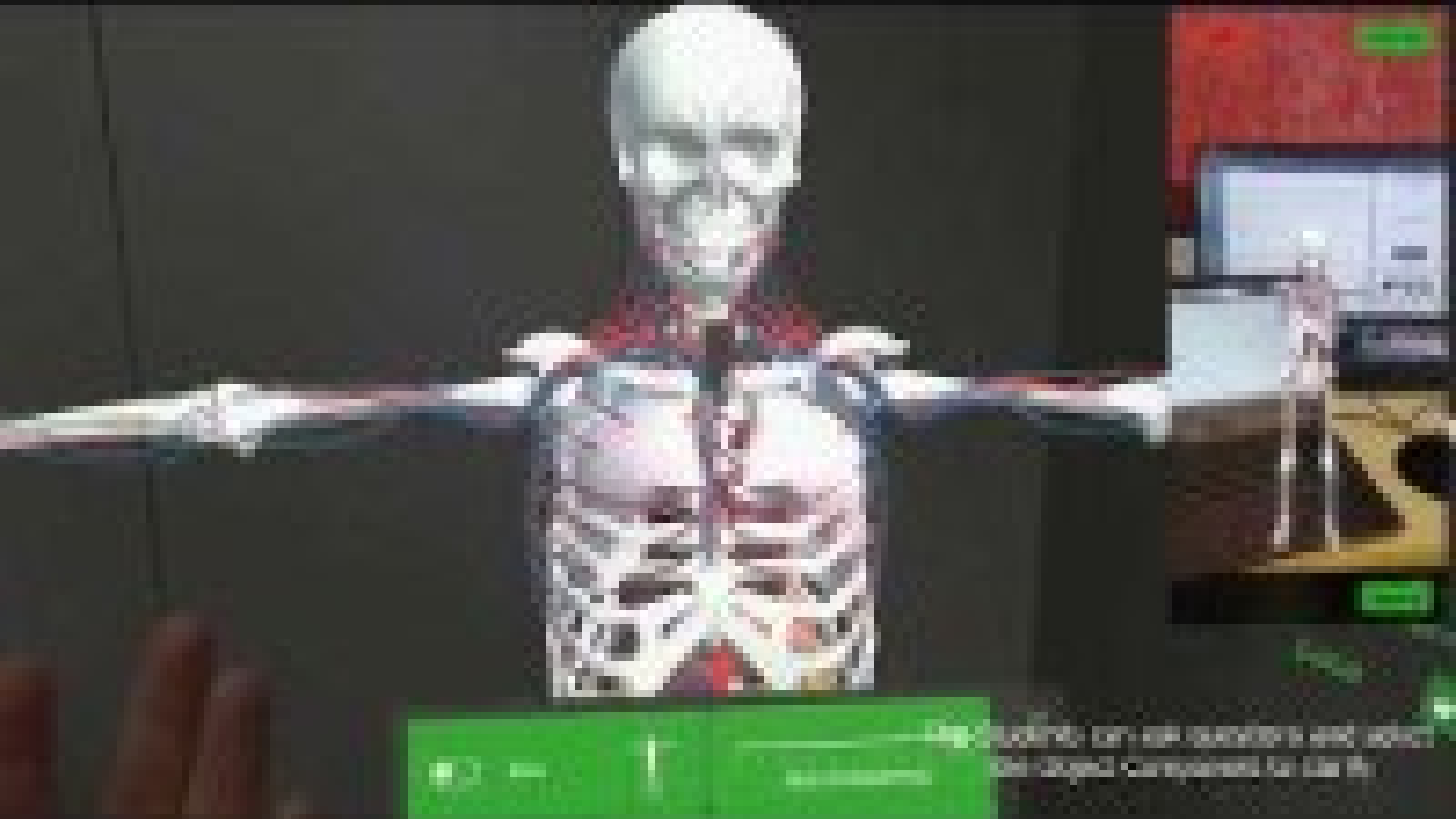


HOCTOPUS

STUDENT AR MOBILE APP



https://github.com/VARLAB-Unibo/HOCTOPUS



Conclusions

- We introduced HOCTOPUS, a CR platform that exploits both MR and AR aiming to enhance live remote classroom experiences;
- In particular, the MR application, developed for the Hololens 2, lets a teacher host a livestream remote class, mirroring her/his activities to all the connected students;
- The AR application, developed for mobile devices, provides a more accessible and easy-to-use system to follow the class while letting the students make questions.
- However, among other limitations, our system does not include a method for teachers and students to annotate the considered 3D objects with multimedia information (e.g., texts, audio, images);
- In future works, we plan to integrate this feature and carry out an experimental user study, with both teachers and students, to validate the proposed tool.

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*** References follow the paper indexing**

HOCTOPUS

Thank you for your attention!

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