Analysis, Design and Practical Validation of an Augmented Reality Teaching System Based on Microsoft HoloLens 2 and Edge Computing

Aida Vidal-Balea, Oscar Blanco-Novoa, Imanol Picallo-Guembe,
Mikel Celaya-Echarri, Paula Fraga-Lamas, Peio López-Iturri,
Leyre Azpilicueta, Francisco Falcone, Tiago M. Fernández-Caramés

7th International Electronic Conference
on Sensors and Applications

15 – 30 November 2020

Motivation

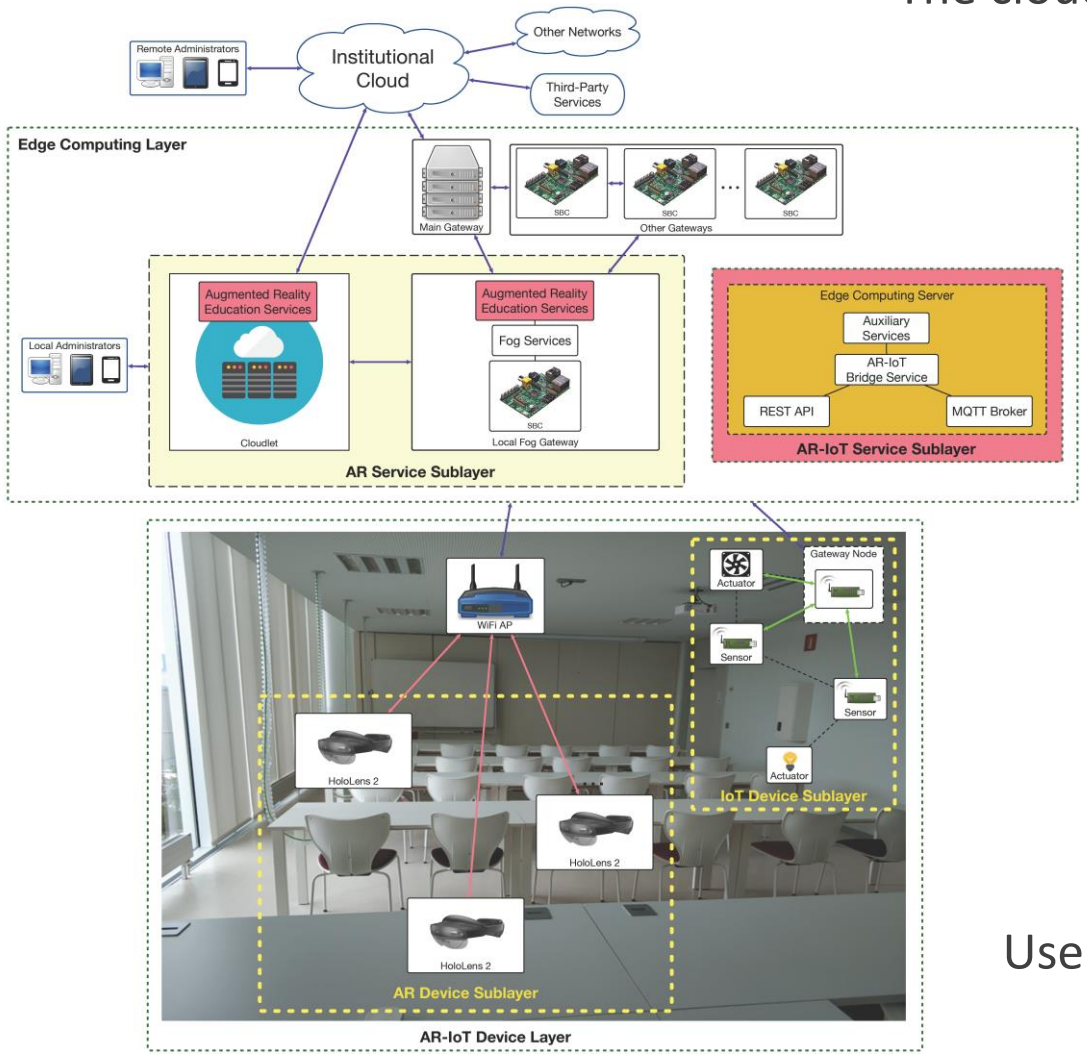
During the last years, the education sector has incorporated in classrooms the use of new technologies and computing devices, which allowed for implementing new ways for enhancing teaching and learning.

One of such new technologies is Augmented Reality (AR), which enables creating experiences that mix reality and virtual elements in an attractive and visual way, thus helping teachers to foster student interest in learning certain subjects and abstract concepts in novel visual ways.

This paper proposes to harness the potential of the latest AR devices in order to enable giving AR-enabled lectures and hands-on labs.

Communications Architecture

Three-Layer Architecture.



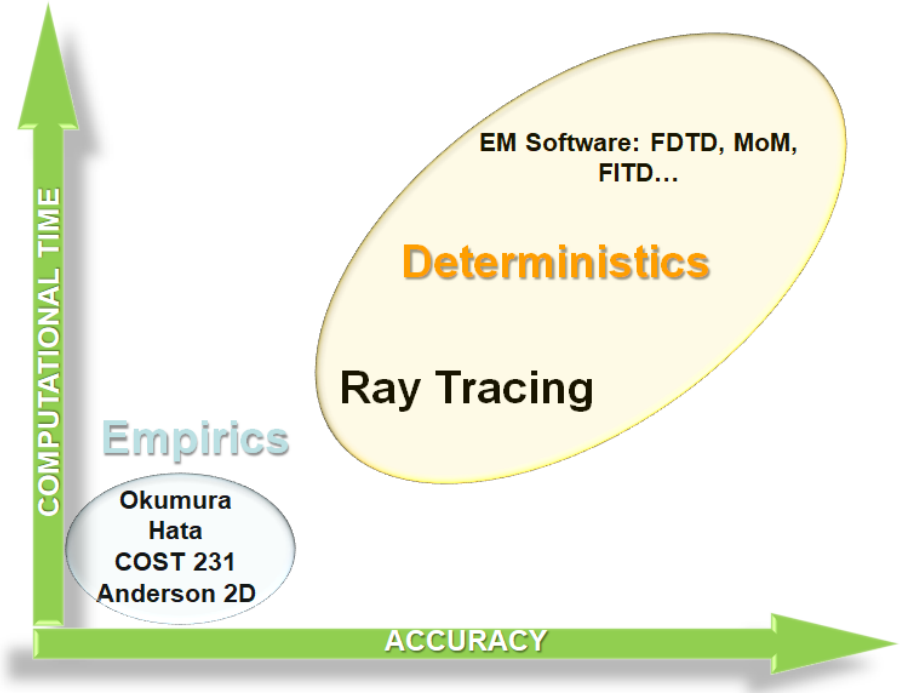
The cloud stores content and provides remote access

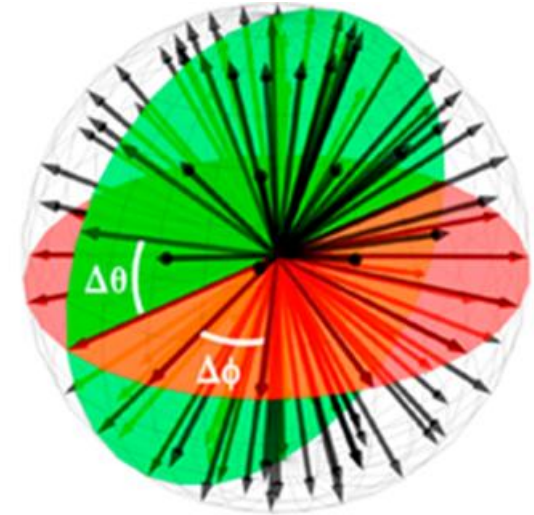
Edge computing devices deployed on the classroom provide content and collect calls from the glasses

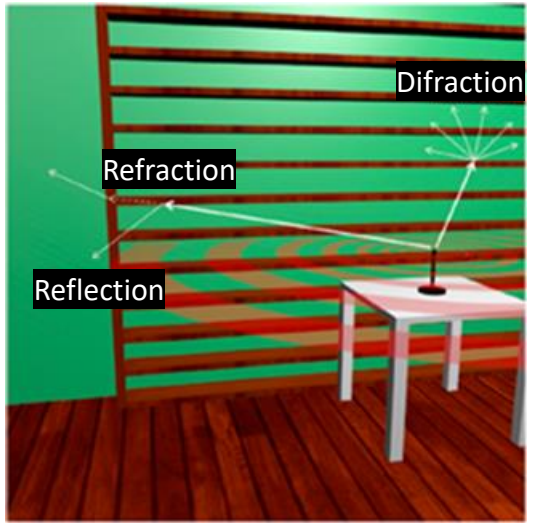
User wears Microsoft HoloLens 2 glasses

Real Practical Use Case

Analysis of wireless communication systems in complex environments using the deterministic method of 3D Ray Tracing.

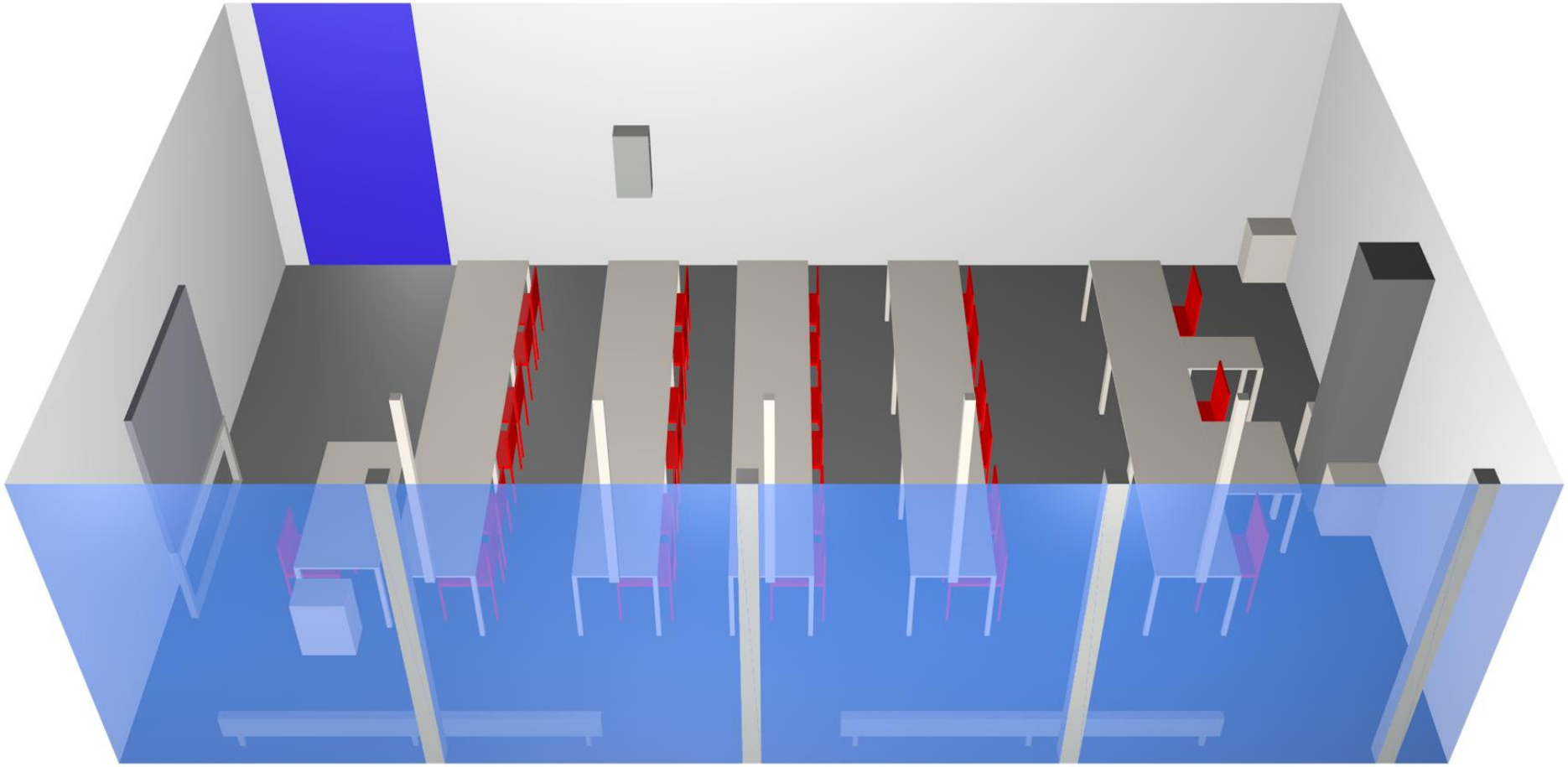






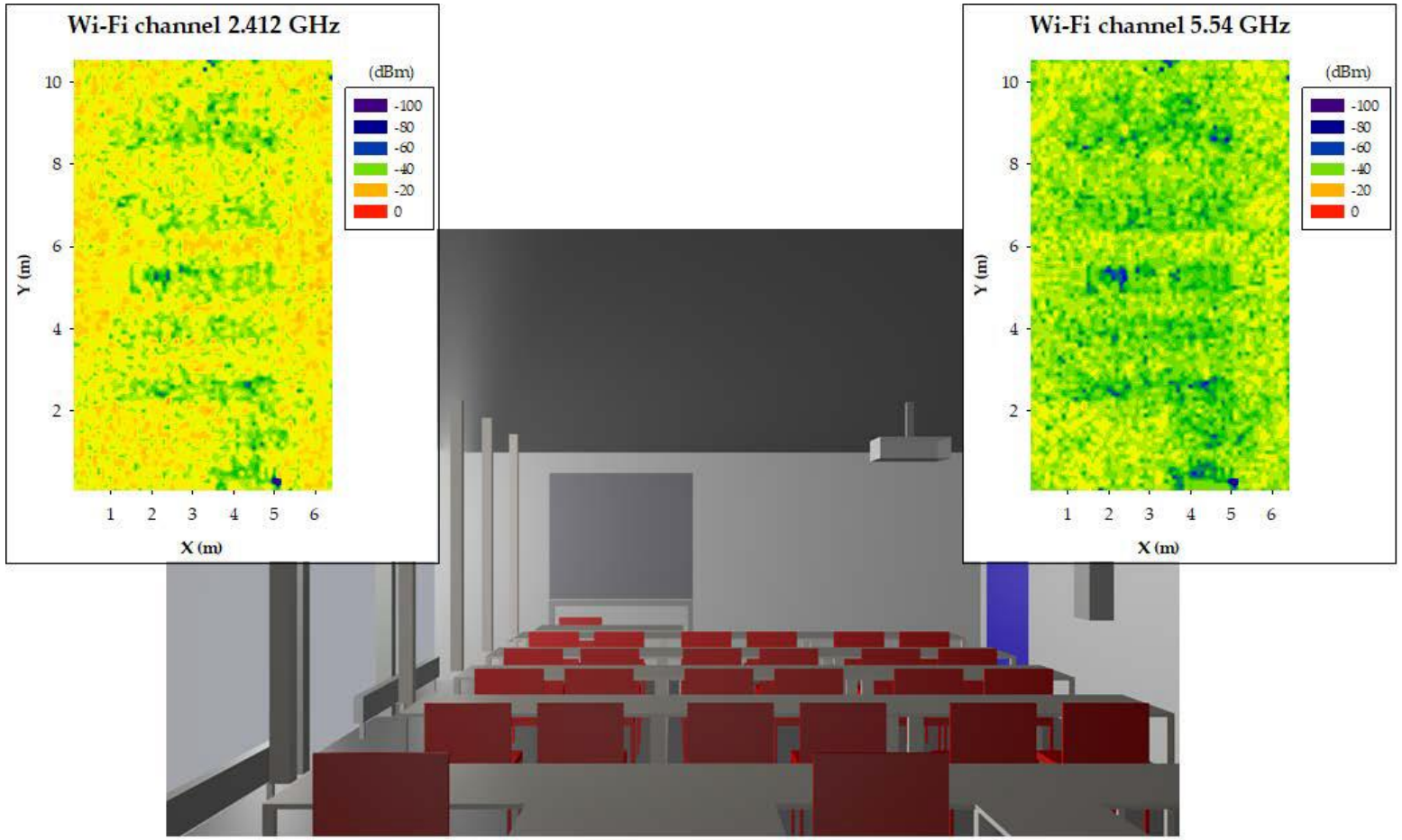
Real Practical Use Case

3D model of the classroom used in the simulation.



Real Practical Use Case

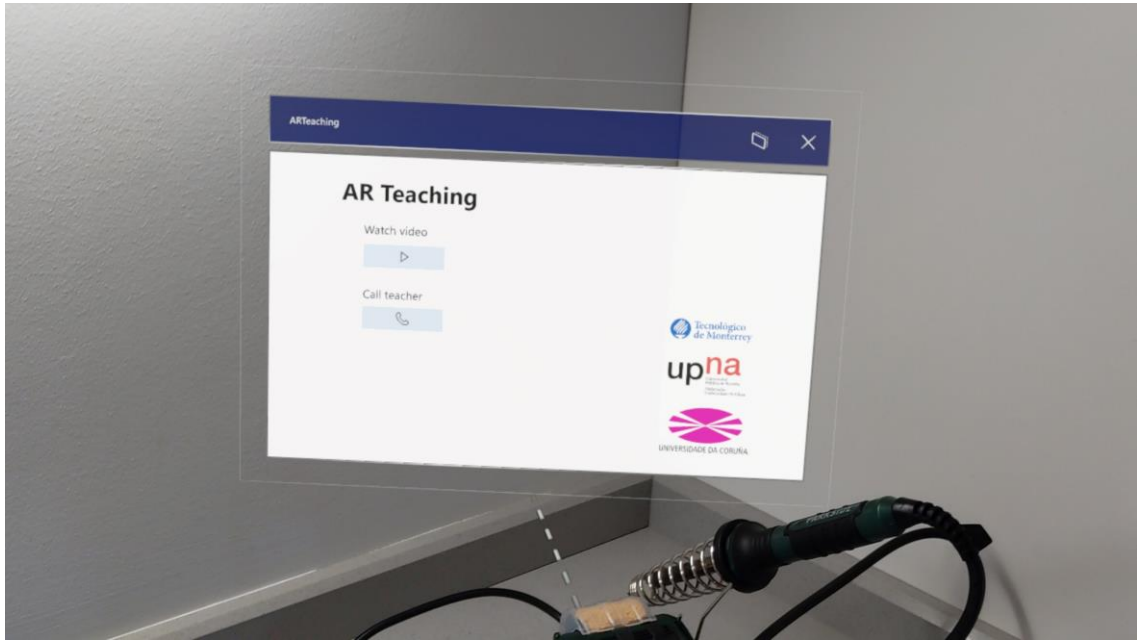
Simulation results by means of an in-house developed 3D Ray Launching algorithm for both HoloLens 2 Wi-Fi 2.4 GHz and 5 GHz operating frequency bands.

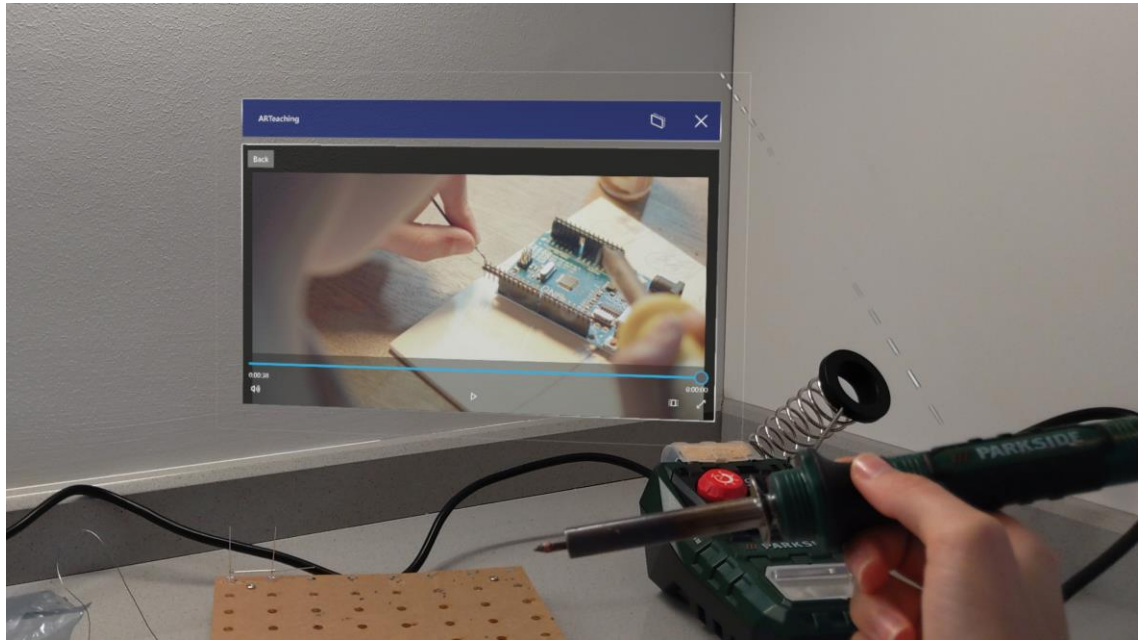


Microsoft HoloLens 2 smart glasses

HoloLens 2 teaching application

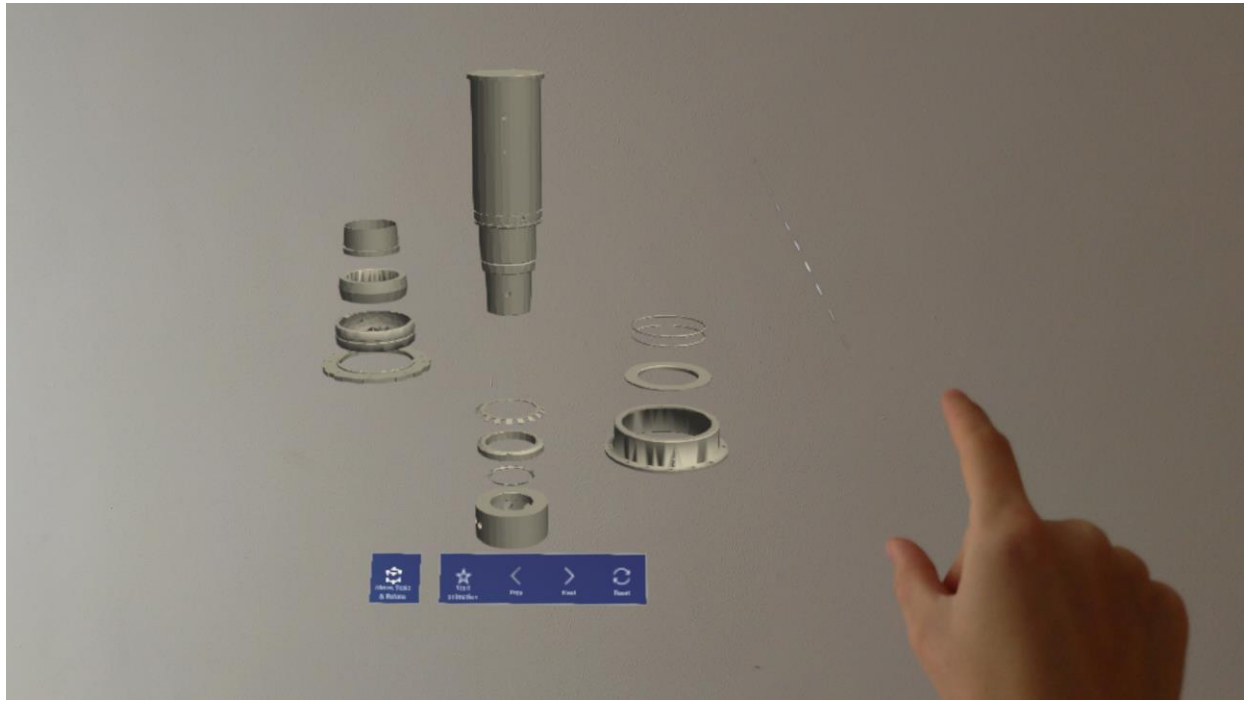
AR application that provides educational video watching and remote teaching guidance to solve questions and illustrate the process.





HoloLens 2 teaching application

The AR application also provides guidance through step-by-step multimedia content that includes the visualization of animations and 3D models, which can be moved, rotated and scaled.



Conclusions

This paper presented an AR teaching system based on Microsoft HoloLens 2:

- System architecture based on edge computing devices, achieving:
  - Low-latency services.
  - Interaction between IoT and RA devices.
- Preliminary Wi-Fi radio channel measurements and simulations obtained through an in-house developed 3D-RL simulator:
  - Avoid potential QoS limitations when the AR system used by a high number of students.

Authors: Aida Vidal-Balea
Oscar Blanco-Novoa
Imanol Picallo-Guembe
Mikel Celaya-Echarri
Paula Fraga-Lamas
Peio López-Iturri
Leyre Azpilicueta
Francisco Falcone
Tiago M. Fernández-Caramés