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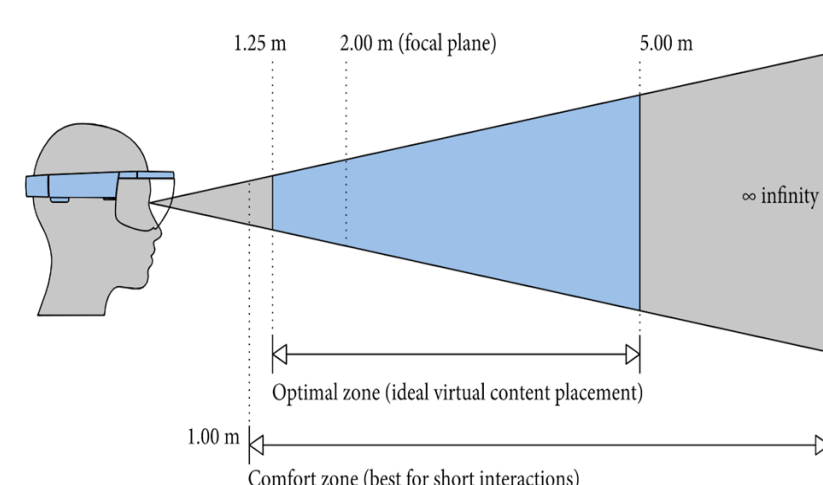
## Abstract

A new computer application that will simulate some basic nursing skills in order to train nursing students using augmented reality gear. The system will use the Microsoft HoloLens in order to display a holographic effect that the user can interact with. It will also detect how long each hologram is stared at by the user and record this information. While wearing the AR glasses, the user will perform some basic nursing skills such as giving a patient an injection. The system will use the Unity platform in order to display the renderings of the human body that will be generated from CT scans of patients. The results of this can be passed to a document that the proctor can look over in order to gauge the skill of the user.

## Introduction and Background

### Mixed-Reality

- Sometimes termed as Hybrid Reality since it technically merges the results of both real and virtual world.
- Refers to interaction with and manipulation of both physical and virtual objects at the same time in the same frame of reference using natural inputs from the user.
- Uses next-generation sensing and imaging technologies to blend the real and virtual environments where the user can immerse herself and interact seamlessly with both real and digital (virtual) elements without ever removing the headset.



**Fig 1: Optimal and Comfort zones for placing virtual content as declared by Microsoft for HoloLens mixed-reality applications.**

### Simulation

- Create software that utilizes Microsoft HoloLens to display a 3D model of a human anatomy.
- Label syringes using QR codes that generate information regarding the contents of each syringe.
- Record the time each user takes to complete various tasks within the simulation.

### Software

- Unity is the ultimate game development platform. It can be used to build high-quality 3D environments, deploy them across mobile, desktop, VR/AR, and consoles. It also has a written SDK to integrate with HoloLens.
- Interactive functions such as buttons, timing and gaze-detection are developed with C#.
- Vuforia is integrated with Unity in order to display complex 3D models.
- Blender's primary uses are making 3d models, isometric drawing, animation, behavior of 3d body, and general designing.



**Fig 2: Mannequin used to test 3D human anatomy models**

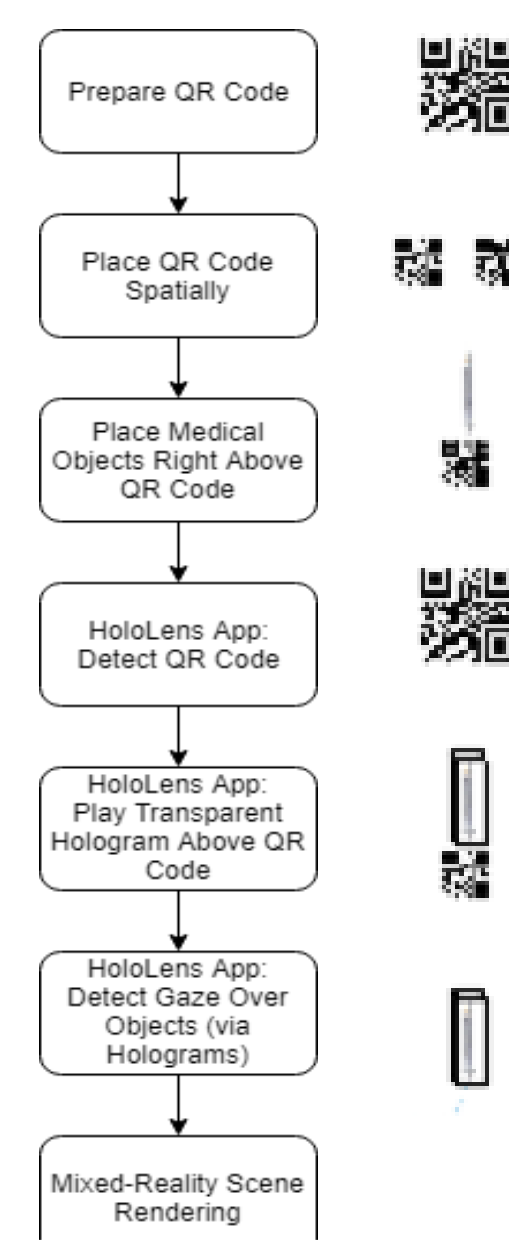
## System Design (and or Algorithm)

### Overview

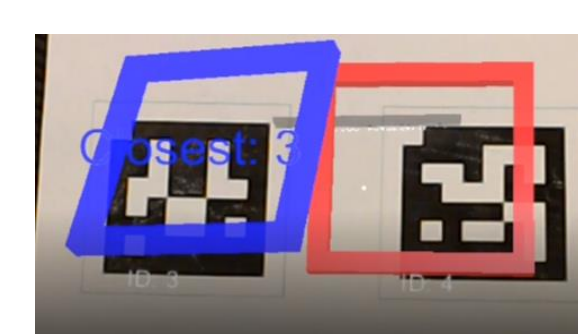
- Developed with Unity, C# and Vuforia, Blender, Microsoft Visual Studio,
- Tested on the Microsoft HoloLens

### Hologram Generation

- Generate QR codes and store them into a Vuforia image-targeting database.
- Import image-targeting database into Unity.
- Create an image target object and associate it to an image (QR code) in the database.
- Add contents you wish to display as a child of the image target.
- When the image target is detected by the HoloLens the children of the target should be displayed.



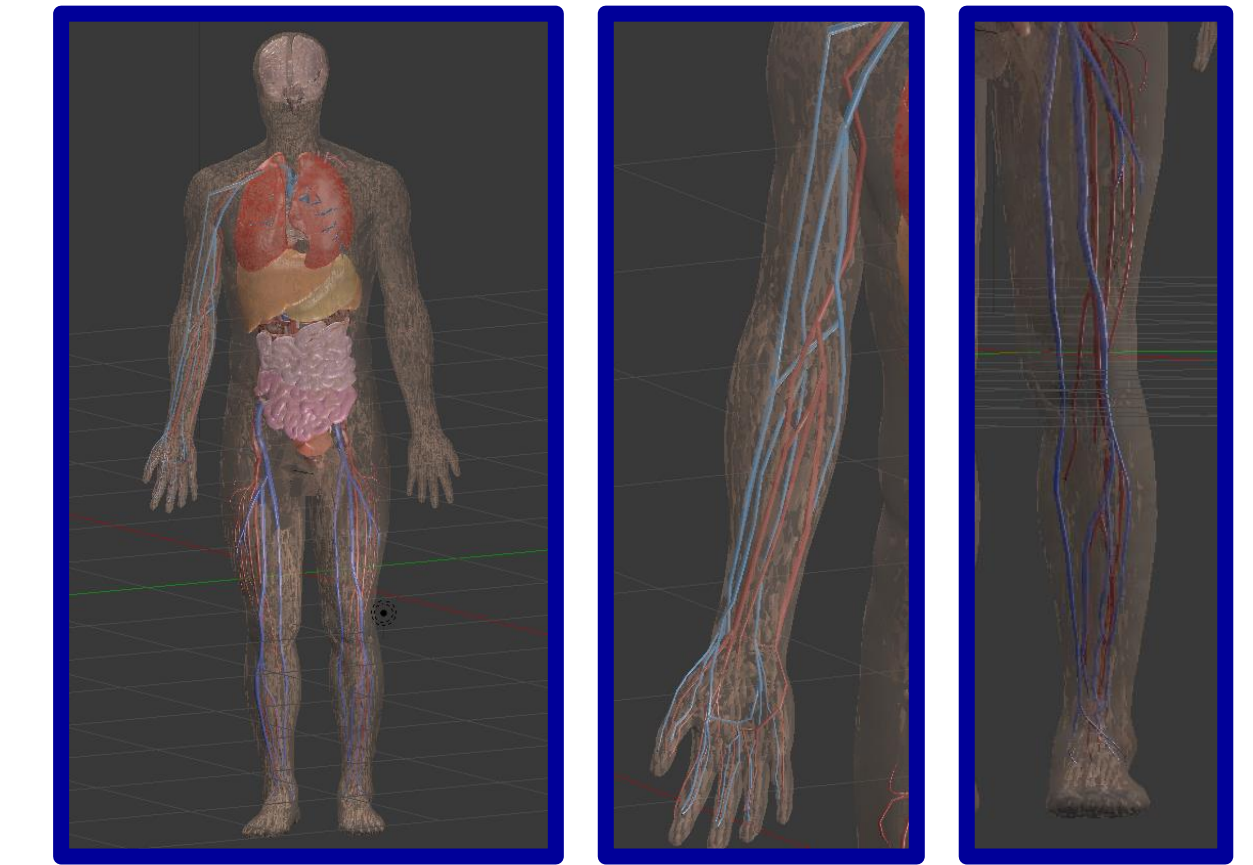
**Fig 3: Flowchart**



**Fig 4: QR code detection**

### 3D anatomy modeling

- Used 3D Slicer to generate some of the 3D bones and organs of the body using CT Scans.
- 3D models from the 3D Slicer were added to Blender for cleaning and adjusting
- Blender was also used for free-hand modeling of the veins and other parts of the anatomy.

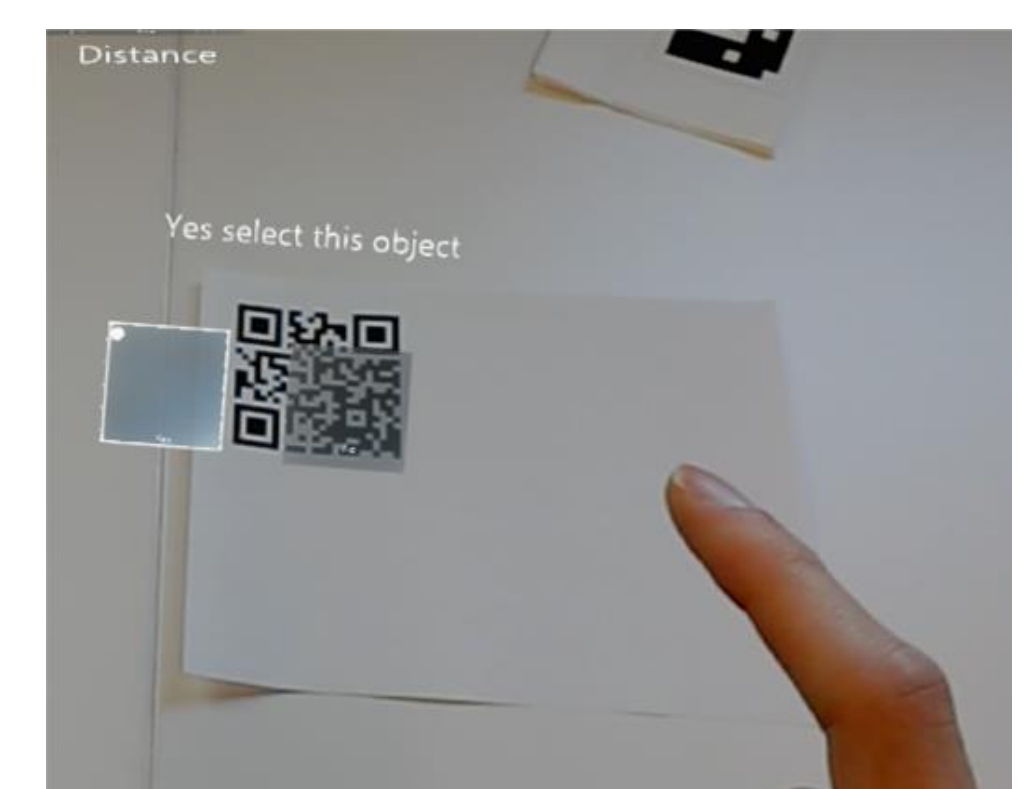


**Fig 5: 3D anatomy model**

## Experimental Results

### Overview

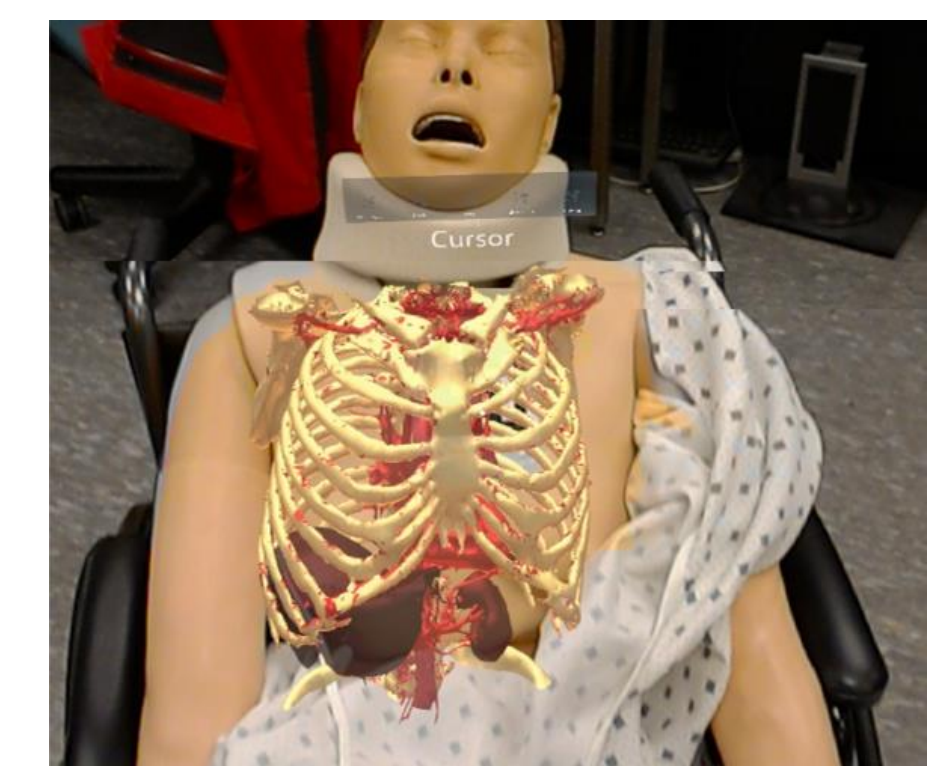
- Visible full-body 3D human anatomy model designed for mixed-reality use.
- Selection of syringes available for simulation tests.
- Time-tracking software to record the steps each user takes to complete the simulation.
- Buttons that allow the user to start/stop exams or remove the built-in cursor.



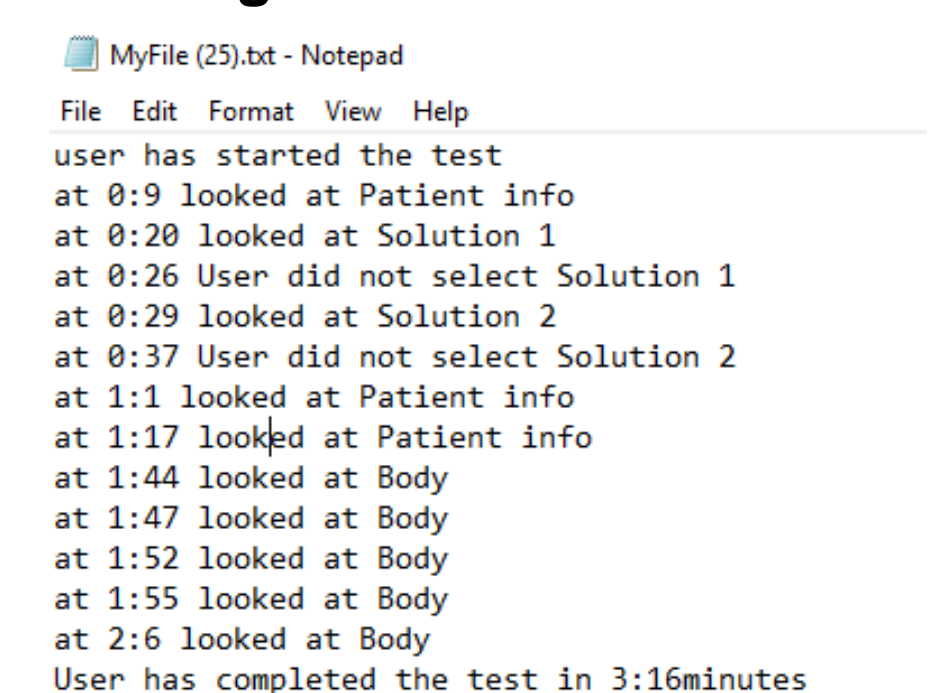
**Fig 6: User selecting which object to use in the simulation**

### Nursing Simulation Step-By-Step Guide

- 1) User puts on the HoloLens device and starts the application.
- 2) A menu displays where the user has the option to start a medical exam.
- 3) Once the exam is started, the software records every action the user commits.
- 4) Various 3D objects can be interacted with throughout the simulation, such as:
  - ❖ A chart displaying the patient's information.
  - ❖ Multiple syringes (the contents of each syringe can be modified in the code to contain different medical solutions).
  - ❖ A 3D human anatomy model that can be "injected" with whatever syringe the user has selected.
  - ❖ A button that allows the user to get rid of the HoloLens built-in cursor.
- 1) Once the user thinks they have accomplished the medical tasks they were asked to do, they can stop the exam.
- 2) After the exam has ended, the results are exported and can be viewed to determine whether the user completed the exam correctly within the desired amount of time.



**Fig 7: Human anatomy as seen through Microsoft HoloLens**



**Fig 8: Example output-file that tracks what the user is doing at a given time**

## Conclusion and Future Recommendations

### Conclusion

- The team learned how to develop a working application for Microsoft HoloLens.
- The software can be modified to accommodate for different nursing practices and used to train nursing students.
- The team met all of the objectives, but there's still a lot of room for future updates.

### Recommendations

- Learning the tools for the project (Ex: Unity) and creating simple projects first before jumping in and trying to develop a complex application would have saved some time for the developers.
- The experiment would benefit greatly if additional functions were available for use (such as selecting different medical devices other than syringes).
- The knowledge acquired during this project will allow the developers to create future mixed-reality applications for Microsoft HoloLens.