CSE 493V
VR Systems

Holographic Whiteboard

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Problem and Motivation

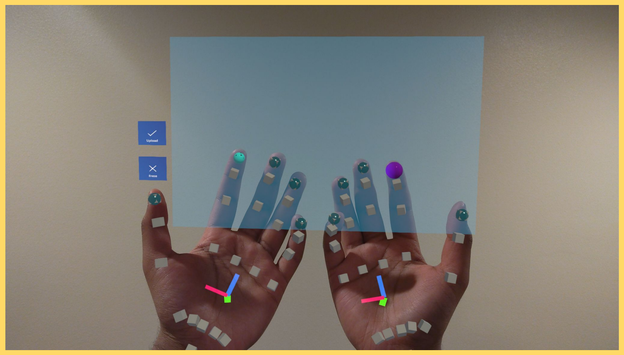
- We wanted to make math calculations on devices feel more natural and interactive as it is writing on a whiteboard or a paper while allowing users to access powerful computational software
- Some mathematical terms are hard to type out but easy to draw such as matrices
- Current technology such as white board markers always run out of ink and are very restrictive. We wanted to have the ability to draw on any surface
- There already exist applications that utilize AR technology to show graphs and mobile applications that read mathematical handwriting. However these solutions are disconnected from each other and do not exist on AR devices like the Hololens
- We also wanted to replicate AR interaction through lighting demonstrated in an article by Oscar Salandin and Microsoft Mixed Reality Studios as shown in the image below

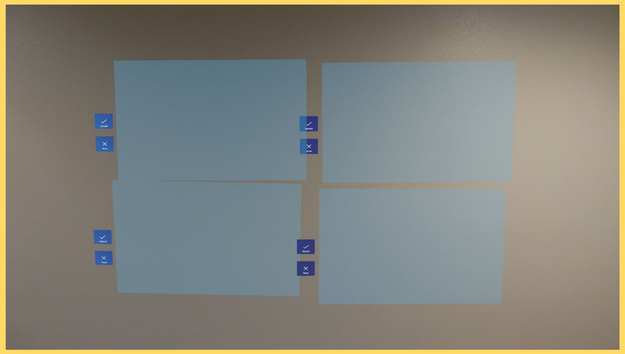
Approach

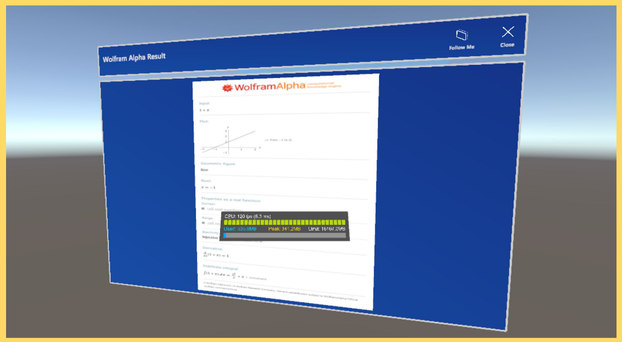
- We decided to create an application using existing AR technology in the Microsoft HoloLens 2
- The application allows users to create, rotate, translate and manage virtual drawing boards that they can view and interact with in their own environment
- The boards not only allow user drawings but can parse text and perform calculations and draw graphs using AI technology

References

- Salandin, O. 2021. Touching holograms. Medium. https://medium.com/microsoft-design/blankstory-e286ac1fb11a.
- Ron Avitzur, 2022. Graphing Calculator AR. Apple. https://apps.apple.com/us/app/graphing-calculator-ar/id1135478998







Method

- We created a HoloLens 2 application using Unity and Microsoft's Mixed Reality toolkit (MRTK)
- We used Unity and MRTK to allow users to interact with the virtual boards utilizing both Unity's physics engine and spatial rendering technology
- We used Azure Cognitive Service to perform Optical Character Recognition (OCR) to parse mathematical expressions into texts
- Using C# web services, we also made HTTP request to WolframAlpha API to perform the calculations made on the virtual boards. This also allows us to display other information such as graphs and data.
- To replicate the lighting featured in Oscar Salandin's article we attached point lights to each finger that only illuminated the boards on collision such as when drawing on a board
- We made heavy use of Unity services to bring together each of these components

Result

- We manage to incorporate all services mentioned above to create a working calculator running on HoloLens 2 with minimal latency for network calls
- Voice commands to create a board (say "Holo Create") are detected well

Limitations

- The glowing effect that we wish to accomplish is not that apparent to the user
- Due to the limitation of the Azure OCR service, the application couldn't recognize any 2D algebra (e.g. matrices) and multiline calculations yet.
- Hand interactions are prone to latency issues

Further Improvements

- We might consider using Math-specialized OCR technology such as MathPix (there is currently no free trial available)
- We can use the new MRTK version 3 which provides updated UI and interactions compared to the MRTK version 2 we are using now
- We can also implement Microsoft's new Scene Understanding package which has better sensing location and allows better virtual and physical interaction, though it takes more time to render