LABORATORY FOR Computational Sensing + Robotics

Technische Universität München + Johns Hopkins Whiting School of Engineering

Use of HMD's Built-in Environmental Cameras for Out-of-sight Object Awareness

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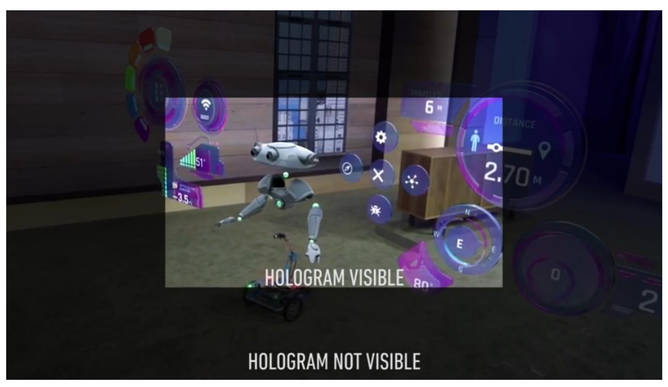
Introduction

Problem: Limited Field of View

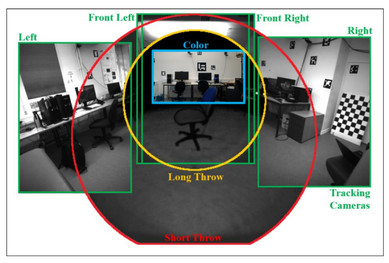
Microsoft Hololens 1 has a limited 43°horizontal FoV. When focusing on the augmented content, users can easily ignore the obstacles around. Important objects may be outside the user's field-of-view.



https://www.reddit.com/r/HoloLens/comments/5h1byx/why_does_hololens_have_a_small_field_of_view_will/

Goals:

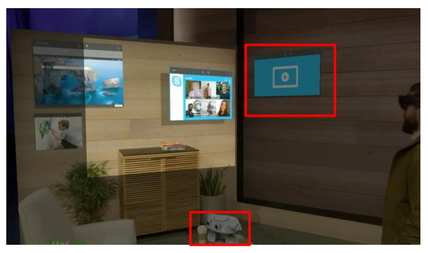
Environmental Sensors



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7070293/

1. Expand HMD user's field-of-view (FoV) by utilizing the environmental sensors.

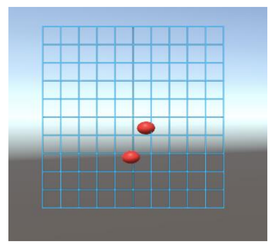
Detection and Tracking System



https://www.wired.com/2015/05/microsoft-hololens-narrower-than-you-think/

2. Develop a detection and tracking system to objects of interest that are out of user's sight.

User Interface



3.Design an intuitive and informative HMD UI that can precisely indicate the location of out-of-sight objects.

Method

Research Mode

https://www.microsoft.com/en-us/research/blog/microsoft-hololens-facilitates-computer-vision-research-by-providing-access-to-raw-image-sensor-streams-with-research-mode/

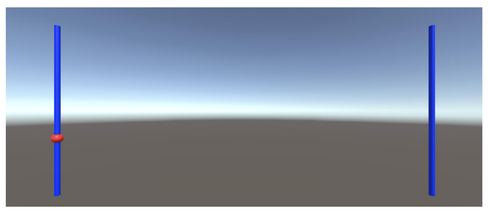
- Our main focus is to access the far left (LEFT_LEFT) and far right (RIGHT_RIGHT) environmental grayscale cameras.
- ResearchModeApi would enable us get the byte array of images taken by those cameras.
- Images from cameras are saved in alpha8 texture format for later rendering and calibration.

ArUco Markers

https://docs.opencv.org/4.x/d5/dae/tutorial_aruco_detection.html

- ArUco markers were used for tracking objects.
- By using ArUco markers, 3D pose can be obtained from mono image.
- ArUco libraries were converted for unity use.

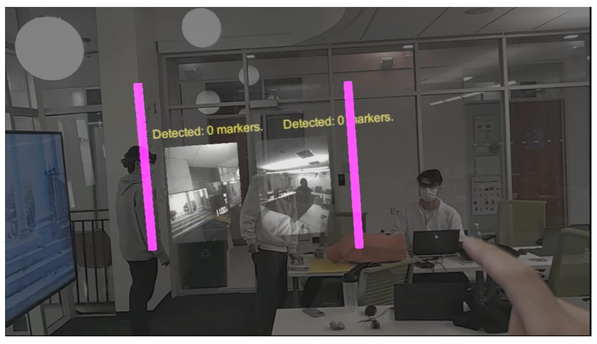
Slidebar UI

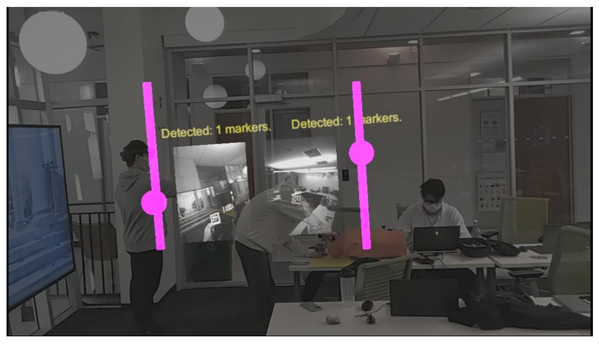


- Intuitive UI using sliding bars to represent the y position of the tracked objects
- The left bar is for the left camera and the right is for the right camera
- Each tracked object is represented by a circle on the bar.
- As the tracked object moves, the circle counterpart will ”slide” on the bar to the new y-position.

Results

- The following images are results generated by our demo.
- It supports single marker detection and multiple markers detection.
- Please try the demo in Hololens 2 for more interactive feedback.





Conclusions

Our thoughts

- This project demonstrates the feasibility of using side cameras to track ArUco markers
- Research mode must be used in order to access information from all side cameras
- A good user interface gives users better awareness of out-of-sight objects

Future Steps:

- Support more object detection beyond ArUco markers.
- Further calibration to obtain the object position in world frame.
- More intuitive implementation of a minimap UI to display the tracked objects 2D location
- Transparent grid map to minimize blockage of the FoV

Acknowledgements

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