Wide Field-Of-View Virtual Reality Display using Fresnel Lens

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Fig. 1. Left: World's widest FOV (343° diagonal). Right: Fresnel lenses curved around safety glasses (FOV: 293° diagonal)

1 ELEVATOR PITCH

We will assemble a prototype curved wide-FOV display that contains peripheral information. We will use single or stacked curved rectangular Fresnel lens on each eye, combined to achieve a FOV $> (200^\circ \times 100^\circ)$. A printed curved image will be used and distortion corrections will be applied accordingly. We will use multiple flat displays. Some contraption will be made for holding 2 or 3 5.5 inch displays. The first stretch goal is to make it an actual HMD and do pose tracking. We will reuse the in-class IMU for 6-DOF tracking. Alternatively, this can be achieved by using multiple VR supported mobile phone. The second stretch goal is to do basic user studies on wide FOV and different lens design.

2 EXTENDED OVERVIEW

We do not need good image quality in the peripheral areas, thus we can choose to neglect the curvature on the glass or display. The device can either be: one part, HMD; or two parts, lenses on glasses and fixed displays; or one part, fixed lens and display.

2.1 Technical Challenges

This project involves addressing the following key technical challenges.

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- Designing the device, including lens and stands for displays. We can grab existing materials as well as 3D print parts if necessary. We will neither use the class headset nor commercial headsets.
- Calculate distortion correction. We need to derive different corrections for flat displays since they may form angles. We will also explore different peripheral corrections for best immersion. According to previous research on sparse light peripheral rendering [TODO cite here, I guess], we will consider using no corrections, only blur and blend.
- We will implement multi-target rendering in either Unity3D or WebGL. Performance will become important if we're rendering on a laptop with 2 or 3 displays. At this stage, we will use multiple cameras on different rendering targets. The off-axis frustum on peripheral cameras need to be calculated separately.

2.2 Key Risks and Mitigations

We identify the following key risks and potential implementation alternatives.

- Hard to find cheap lens with $f < 200mm$ as most of them has a $f > 300mm$. There's also no guarantee on shipping and quality. We have to order parts as soon as we can.
- None of the team members have a good hardware background, only have knowledge on modeling and 3D printing. We may need advice on designing the HMD.

3 HARDWARE AND SOFTWARE

This project requires the following hardware.

- [Requested] Fresnel Lens. Specifications for Reference : (90mm x 80mm, f=50mm(100mm if stack 2)).
- [Requested] Displays, cables and boards. Preferred 2 extra display kits, at least 1 required.
- [Requested] 3D-printing: materials and access. We can use one in the maker space, but we need to check policies.

4 TEAM RESPONSIBILITIES

This is a 2-person project, with the primary responsibilities being divided as follows.

- **Andrew**: Responsible for: (1) Work on distortion correction. (2) Design display parts
- **Daoyi**: Responsible for: (1) Implement software that handles rendering parts. (2) Design glass parts and 3D-print

5 DEVELOPMENT PLAN

We aim to complete this project over three weeks, with the following major milestones.

- **Date 3**: Prototyping Fresnel Lens on a safety glass or other frame. Testing on curved paper, as well as flat papers. We will use this information to design our device.
- **Date 5**: Finish the design, as well as functions that take care of distortion.
- **Date 7**: Test distortion on displays and find the best scheme. 3D printed frame should also be completed.
- **Date 10**: Finish rendering parts, put everything together.
- **Date 16**: Write report. While doing so, try to improve user experience.

REFERENCES

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