# EE267 Project Proposal


Sam Girvin
MS, Electrical Engineering
Stanford University
sgirvin@stanford.edu

Olivier Jin
MS, Electrical Engineering
Stanford University
ojin@stanford.edu

Anna Zeng
BS, Computer Science
Stanford University
annazeng@stanford.edu


## I. Problem Statement

Augmented reality (AR) is one of the fastest-growing areas in modern technology. Compared to traditional virtual reality (VR) displays, AR carries the added benefit of incorporating virtual elements into a real-world setting. However, one barrier to successful AR integration is input latency. Too high of an input latency results in motion sickness and an ultimate loss of immersion for the user.

One way to reduce this latency is to use an approach called 'pass-through AR'. Pass-through AR adds digital elements into the user's field of view, to create the visual illusion of incorporating these elements into the physical world. This technique can be done by covering one of the user's eyes with a monocular display. The user's brain will still be able to perform binocular fusion using the camera and the user's uncovered eye. However, the viewer can also experience additional information from the screen overlaid on the real world in front of them. This overlay effect is referred to as 'binocular rivalry'.

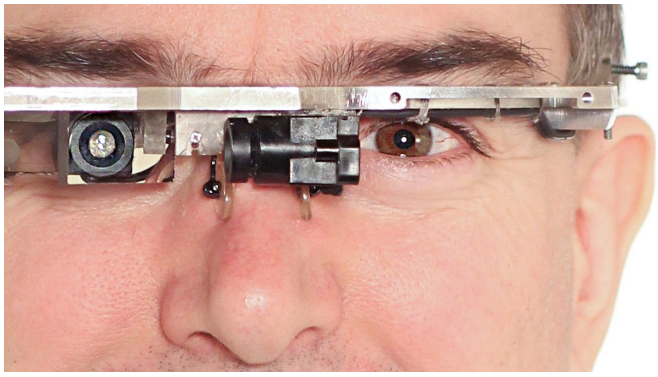

*Figure 1. An example of a monocular display*[1]

## II. Previous Work

The use of monocular displays is not a new concept. As far back as 2003, displays such as Microvision's Nomad product line were already relying on monocular displays to relay virtual information to the user.[2] However, the issues with monocular displays have been well-documented in previous papers. For example, Eli Peli noted that the displayed images appeared to move even without user head motion, due to small eye movements caused by the vestibulo-ocular reflex[3].

## III. Technical Approach

We will attempt to build a monocular AR display using a Google Cardboard, the VRduino motion sensors, a depth camera, a small OLED screen, and some tinted glass. The Google Cardboard, OLED screen, and tinted create the structure of the monocular AR display, while the depth camera and VRduino motion sensors capture information from the surrounding environment, which will allow the displayed information to seem fixed in world space and experience occlusions.

As a proof of concept, we built a mechanical prototype to demonstrate binocular fusion with a “display” covering one eye and a neutral density filter over the other eye. The “display” in the prototype is a Voigtlander Kontur viewfinder, which consists of a lens and a black piece of plastic with clear markings. The clear markings (“1m”) show up as a white text on a black field. Because the black field has no spatial frequency information, it is suppressed during binocular fusion, but the white text remains[4].

*Figure 2. The rough mechanical prototype*

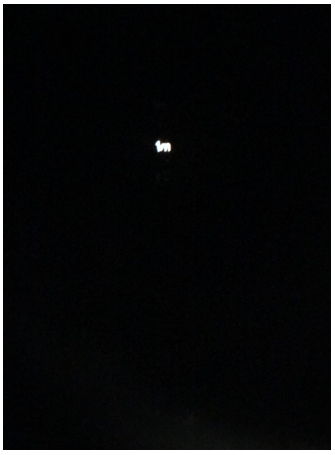

*Figure 3. Left eye view*

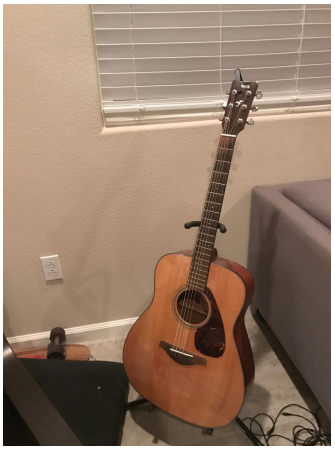

*Figure 4. Right eye view*

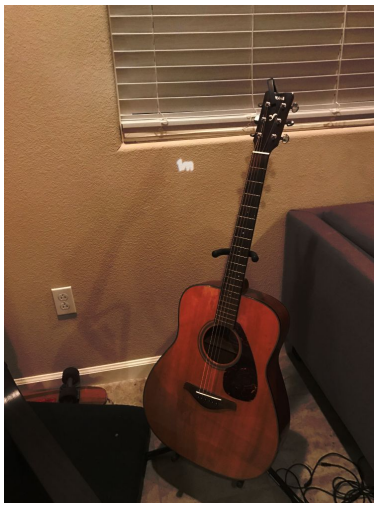

*Figure 5. Resulting image, after binocular fusion (simulation of the experienced effect)*

## IV. Timeline

| Date | Milestone | Status |
|---|---|---|
| Wednesday 5/24 | Received feedback from Prof Wetzstein, finalized idea | **DONE** |
| Friday 5/26 | Gathered hardware components from Keenan | **DONE** |
| Saturday 5/27 | Proposal deadline | **DONE** |
| Wednesday 5/31 | All parts hooked up and running; blank screen test | **IN PROGRESS** |
| Friday 6/2 | Camera connected and running; basic binocular vision | - |
| Tuesday 6/6 | Displaying virtual elements; basic binocular rivalry | - |
| Thursday 6/8 | Binocular rivalry finalized | - |
| Friday 6/9 | Poster session | - |
| Monday 6/12 | Report deadline | - |

## V. Citations


1. *https://upload.wikimedia.org/wikipedia/commons/3/3e/SteveMann_with_Generation-4_Glass_1999.jpg*
2. *Sarko, Thomas. "Microvision's Nomad Augmented Vision System: The How and the Why." SID Pacific Northwest Chapter Meeting (2003): n. pag. Web.*
3. *Peli, E. Visual issues in the use of a head-mounted monocular display. Opt. Eng. 0001;29(8):883-892.*
4. *Fahle, M. Binocular rivalry: suppression depends on orientation and spatial frequency. Vision Res. Vol 27 No. 22, 1982.*