DIY Augmented Reality Head-Mounted Display

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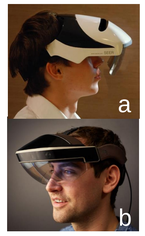
Motivation

Head-mounted displays have been heralded as the next generation in wearables. With the excitement surrounding such technologies as Oculus Rift, Microsoft Hololens and Google Glass in the recent past many developers are starting to work in Augmented Reality (AR) and Virtual Reality (VR). One challenge in developing new applications and software for these platforms is the cost of the devices needed to generate the AR or VR experience. On the VR side, Google Cardboard has provided a low-cost, open source platform that can be easily obtained and modified. On the AR side however, there isn't a good parallel yet. Our goal is to design an AR platform that can be made without any special equipment and with easily obtainable, low cost materials.

Related Work

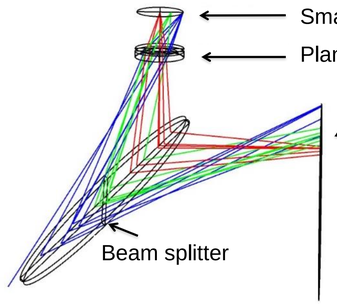
In the past, AR systems generally had complicated optics and sophisticated illumination systems. Many of the more recent systems are aiming to develop simpler, cheaper systems for consumer electronics applications. Two systems with designs similar to the ones examined here are shown at the right.

a) Seer: Phone illumination, single curved optic, untethered, $120
b) Meta 2: Projector illumination, single optic, tethered, $950

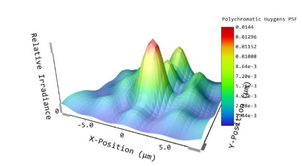


Optical Design

Lens and beam splitter



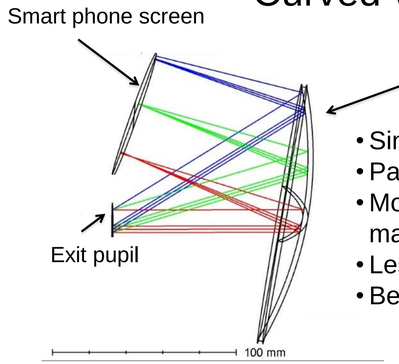
- Two optical components: lens and beam splitter
- Interchangeable parts and adjustable angles allow for dynamic design



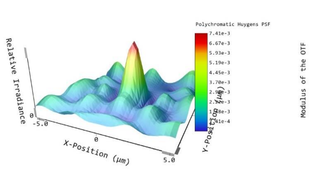
Point spread function

Modulation transfer function decent, but sub-optimal (slightly blurry at some frequencies)

Curved visor



- Single optical component
- Parabolic or spherical curvature
- More robust design for mass-manufacturing and use
- Less expensive
- Better image quality



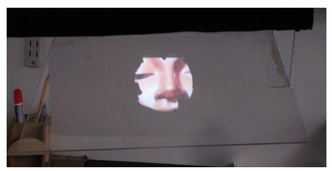
Point spread function

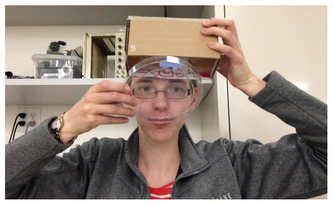
Modulation transfer function behaves nicely (image sharp for all frequencies)

Demonstration 1:

Phone holder, condensing lens and flat beam splitter

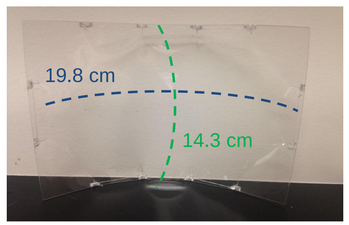
- Phone-lens distance = 3.5 cm
- Beam splitter angle = 50°
- Field of View ≈ 28°
- Total cost ≈ $40
- Beam splitter made from 0.06" acrylic sheet
- Plano-convex lens with f/0.78

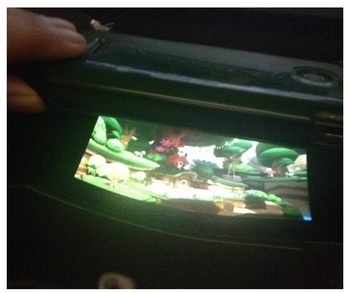




Demonstration 2:

Phone holder and curved optical component





- Curved optical surface formed from flat 0.02" acrylic sheet
- Spherical curvature
- Radius of curvature = 20 cm
- Field of View ≈ 36°
- Total cost ≈ $4

Demonstration 3:

Phone holder and curved optical component

- Separated eye views support stereo cues
- Curved optical surface created freehand from 0.02" acrylic sheet
- Modified Google Cardboard
- Field of View ≈ 26°
- Total cost ≈ $4