Macular Team

Product Requirements Document

Team members:

Huiqing Zhu
Michelle Relin
Haotian Jiang

Customer: Dr. Donald Grover

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Revision Level	Date
D	Dec. 10, 2015

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Authentication Block

Revision History

Rev	Description	Date	Authorization
A	Initial PRD after first meeting with customer	10/30/2015	
B	Revision of the first PRD	11/13/2015	
C	Revision of the new method for AMG after the first meeting with faculty advisor	11/30/2015	
D	Correction things from last PRD review Adding components and budget. Update Spring semester schedule.	12/20/2015	

Contents

The glasses are a designed only to be used by patients with age-related macular degeneration or people who want to saw magnify images in front of their eyes. As such its design inputs were derived from our interactions with our faculty advisor Geunyoung Yoon, retina specialist Dr. Mina Chung, and our customer Dr. Donald Grover.

1.1 Team Member Responsibilities

1.2

Huiqing Zhu is the team coordinator, and she is responsible for the document handling. Michelle Relin is the customer liason, and she is responsible for the communication with the customer and advisors. Haotian Jiang is scribe, and he is responsible for taking notes after each meeting. As a team, we all responsible for the optical design of the device, mechanical design to put components together, and test our device at the end.

1.2 Product Vision

Our goal is to create a device that enables people to see better who have limited vision. Essentially, we are looking to magnify the images and decrease the effect of the black spot in the images.

1.3 Background

Age-related degeneration (AMD) is gradual, progressive, painless deterioration of the macula, the small sensitive area in the center of retina provides clear central vision. It is an eye disease that slowly destroys the macula, the central part of the retina. This eliminates a large part of your central vision and causes those who are affected by this to be handicapped. It won't cause you to be completely blind, because you still have your peripheral vision but it inhibits day-to-day activities. This disease is the leading cause of vision loss for people who are 60 and older in the United States. The "blind spot" AKA the area you cannot see does get larger over time as the disease becomes more severe. The area you cannot see does increase and moves farther outward toward the peripheral. Most times, it will never cause complete blindness though.

1.4 Problems

Wet Macular Degeneration

In Wet, the choroid (a part of the eye containing blood vessels that nourish the retina) begins to sprout abnormal new blood vessels that develop into a cluster under the macula. The abnormal blood vessels tend to break and leak fluid under macula, casing it to life up and pull away from its base. This damages the fragile photoreceptor cells (sense and receive light), resulting in a rapid and severe loss of central vision.

Dry Macular Degeneration

It affects approximately 80-90% of individuals with AMD. The cause is unknown, it tends to progress more slowly than wet type. Small white or yellowish deposits form on the retina causing it to degenerate over time. Typically, when drusen first form, they do not cause vision loss. However, they are a risk factor for progressing to vision loss.

People with central vision loss must use peripheral vision for visual tasks. However, the performance for almost all spatial tasks is worse in the normal periphery than in the normal fovea.

1.5 Goals and Objectives

We need to figure out how to magnify the images taken by the camera and to make the magnification adjustable for all stages of the disease and to fit all individual cases of AMD.

2.1 Users

People have limited visions. Especially, people with central vision loss due to the age-related degeneration. We are targeting for people with version measurement from 20100 to 20200. [Appendix 1]

People who want to see magnify images; for example, the military people who want to targeting objects in front of them.

2.2 Environment

As a wearable instrument, it needs to operate in the following environment:

Temperature
0 – 35 °C

Note the environment factors have not been tested

During normal operation, the maintenance such as cleaning the glass surface is required nearly every day. A microfiber optical cleaning cloth and glasses lens cleaning spray may needed for clean up.

A case is needed to store the spectacle lens when it's not in use.
It will operate with replaceable batteries.

2.3 Regulatory Issues

- Might not be classified as exempted Class 1 medical devices
- Security. This device can take a photograph of a classified document with the tap of a finger.

2.4 Fitness for use

The product will be a glasses that has

- Camera
- Display
- Beam splitter to redirect light from display to the eyes.
- The virtual image will be displayed in front of the eyes
- The system be attached to the frame of a pair of glasses
- The system be battery powered

- The system will enlarge the camera images by around 5 fives bigger.
- The system will have a bigger field of view compare to Google glass, which covers the full retina of your right eyes.

It is desirable that the product has

- The camera has zoom (accounts for different MD situations)

2.5 System Block Diagram

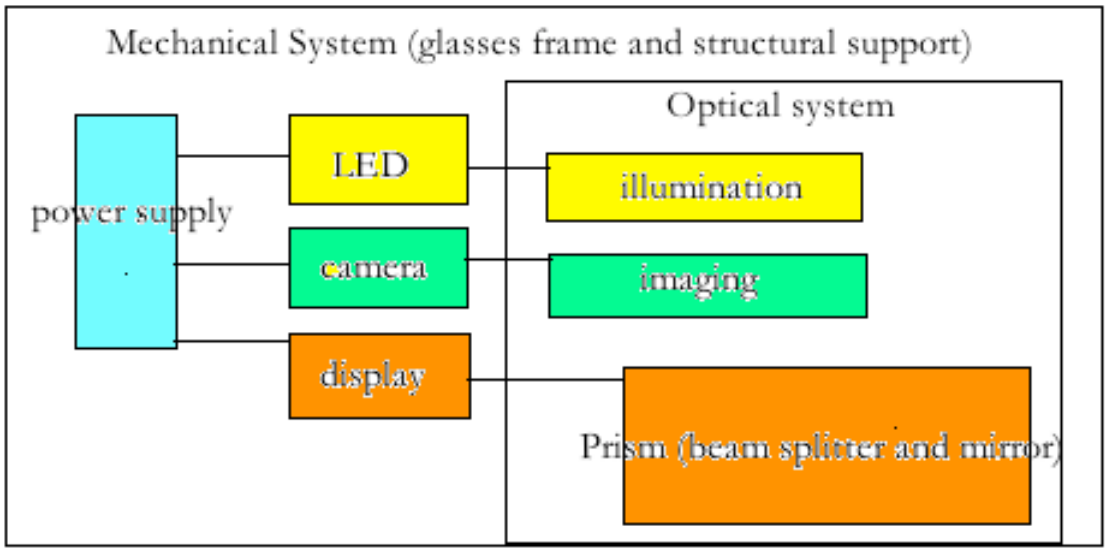


Figure 1: Block diagram of deliverable mechanical and optical system. Refer appendix for details of the optics schematic of the polarized beam splitters and prism.

2.6 Sketch of Design

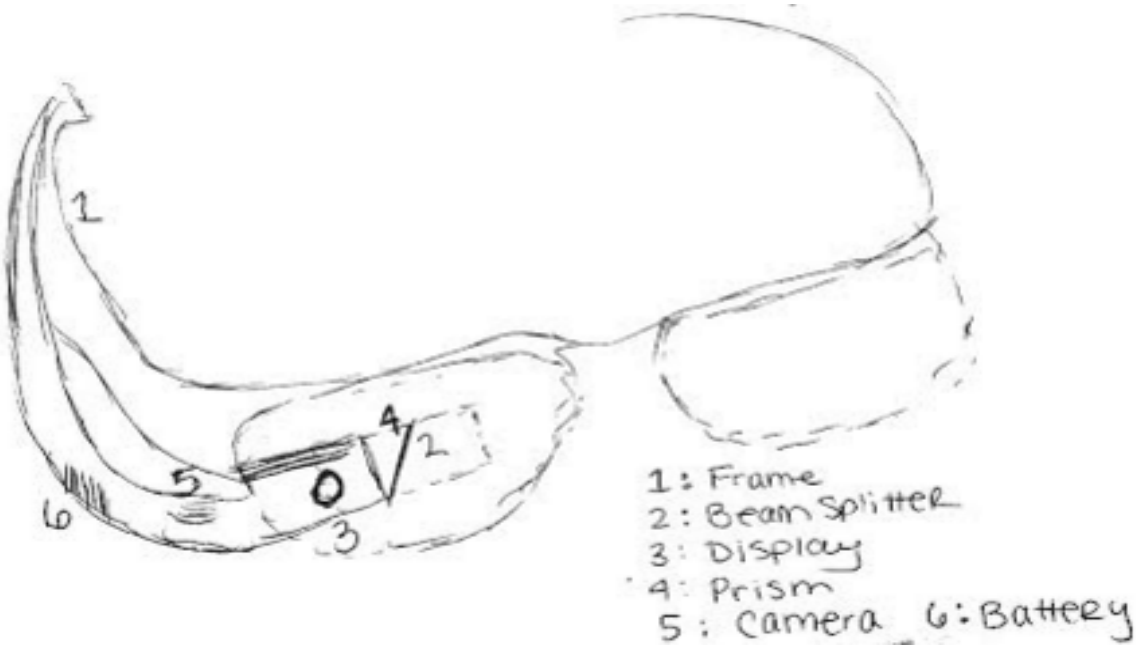


Figure 2: This is the sketch of our designed glass. It's similar to Google glass, however, our design only magnifies the camera image. Comparison and details of Google glass see Appendix.

2.7. Project Scope

Deliverables:

- Optical system design of the glasses: include parts list, specifications, and cost
- Design a mechanism to change the magnification so the customer wearing it can vary the zoom
- Construct the optical system containing a camera, display, and prism with the right specifications
- Prototype: put the above together into one piece and create a pair of glasses that magnifies the part of the vision blocked due to the blind spot caused by the destruction of the macula. (Not Required by the customer)

What We Are Not Responsible For:

- The Optical Engineering senior design team is not responsible for the framework/sensor of the glasses
- The Optical Engineering senior design team is not responsible for the software implications associated with the glasses

2.8 Specifications

Prism Specification [1]	
Material	N-BK7 or Fused Silica
Size	3mm to 20mm
Dimensional Tolerances	+/- 0.012mm to +/- 0.25mm
Clear Aperture size	Up to 90% of edge dimension
Surface Quality	Per MIL-PRF-13830_B; ISO 10110
Bevels	0.127mm to 0.25mm face width
Surface flatness	λ./20 – λ/4
Angles/Deviation	<1arc second to <5 arc minutes
Coatings	broadband anti-reflection

Camera and Display Specification	
Display Native Resolution	640x360 in color sequence
Display size	4.8mm x 2.7mm
Support color sequence	RGBRGB,RRGGBB,RRGGBBGG
Capture Resolution of camera	5 megapixel, 2560x1920
Aperture of camera	f/2.2

Al-Coated Concave Mirror	
Weight	0.05lb
Focal length	9.5mm
Center thickness	3.0mm
Radius of curvature	19.0mm
UV-enhanced Aluminum Coating	250-450nm
Substrate	N-BK7

System Specification	
weight	150g
Size	140x70x8mm
Lifetime	10 years
Battery	2600 mAh Lithium polymer
Cost	< $1000 (appendix)

2.9 Budget

Parts (optics)	Qty	Price	Vendor	PN
Camera	1	$140	Aegis Electronic Group Inc.	(Sony) FCB-MA130
Concave Mirror	1	$35.70	Thorlabs	CM127-010-F01
Broadband PBS	1	$305	Newport	05FC16PB.3
Unmounted quarter wave plate	1	$165	Lambda Research Optics Inc.	WPZM-25.4-12.7CQ-0-
Parts (electronics)				
LCOS Microdisplay	1	Quote in process	Holoeye Photonics	HED 7200
USB Board Interface	1	$190	Aegis Electronic Group. Inc	FCBMVDEV
Battery power for USB Interface	1	$5.99	Docooler	B00DU4F8DM
Parts (other)				
Common spectacle frame	1	$12	Zenni Optical	
Total		$853.69		
Budget from customer		$3000		

Reference:

1. Precision Optics. http://www.precisionoptical.com/corner-cube-prism.php

2. Nasdaq, Breaking Google Glass Into Pieces: The Costs of Production and Likely Retail Price, http://www.nasdaq.com/article/breaking-google-glass-into-pieces-the-costs-of-production-and-likely-retail-price-cm269835

3. Hamxi Display, http://himaxdisplay.com/en/product/HX7309.asp

4. An Evaluation of Google Glass, Johan Hager, June 2015.

5. http://www.slashgear.com/google-glass-part-2-will-have-dual-eye-displays-24271177/

Timeline

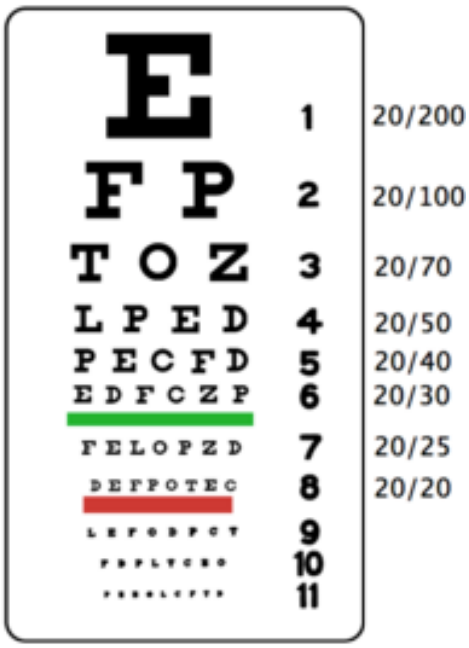
Fall Semester Team Schedule			
Week 1 October 25 - 31	Monday: Meeting customer Wednesday: PRD Review	Friday day: Weekly Group Meeting	PRD version 1.0. Determine the customer requirements Project objectives and come out with ideas about products (two methods)
Week 2 November 1- 7		Friday day: Weekly Group Meeting	Work out the first methods, research for principles and basic concepts behind our methods
Week 3 November 8-14	Monday: Meeting customer	Friday day: Weekly Group Meeting	PRD version 2.0 Determine the final method of the products and start the design and research
Week 4 November 15 – 21		Friday day: Weekly Group Meeting	Research and start to design the first part of the product. The imaging system. The glass frame and camera
Week 5 November 22 - 28	Monday: Meeting customer	Friday day: Weekly Group Meeting	PRD version 3.0 Research and design the system
Week 6 November 29 –December 5		Friday day: Weekly Group Meeting	Final design for the system and research on important aspects
Week 7 December 6 - 12	Monday: Meeting customer	Friday day: Weekly Group Meeting	Final version PRD. Ready to do the fabrication and testing of the system in Spring semester

Spring Semester Team Schedule		
January	Monday and Friday weekly team meeting and with customer	Design the system and ordering parts for the glasses; research of the principles
February	Monday and Friday weekly team meeting and with customer	Keep design and modify our design
March	Monday and Friday weekly team meeting and with customer	Putting parts together, test and modify the design
April	Monday and Friday weekly team meeting and with customer	Put things together and ready to present

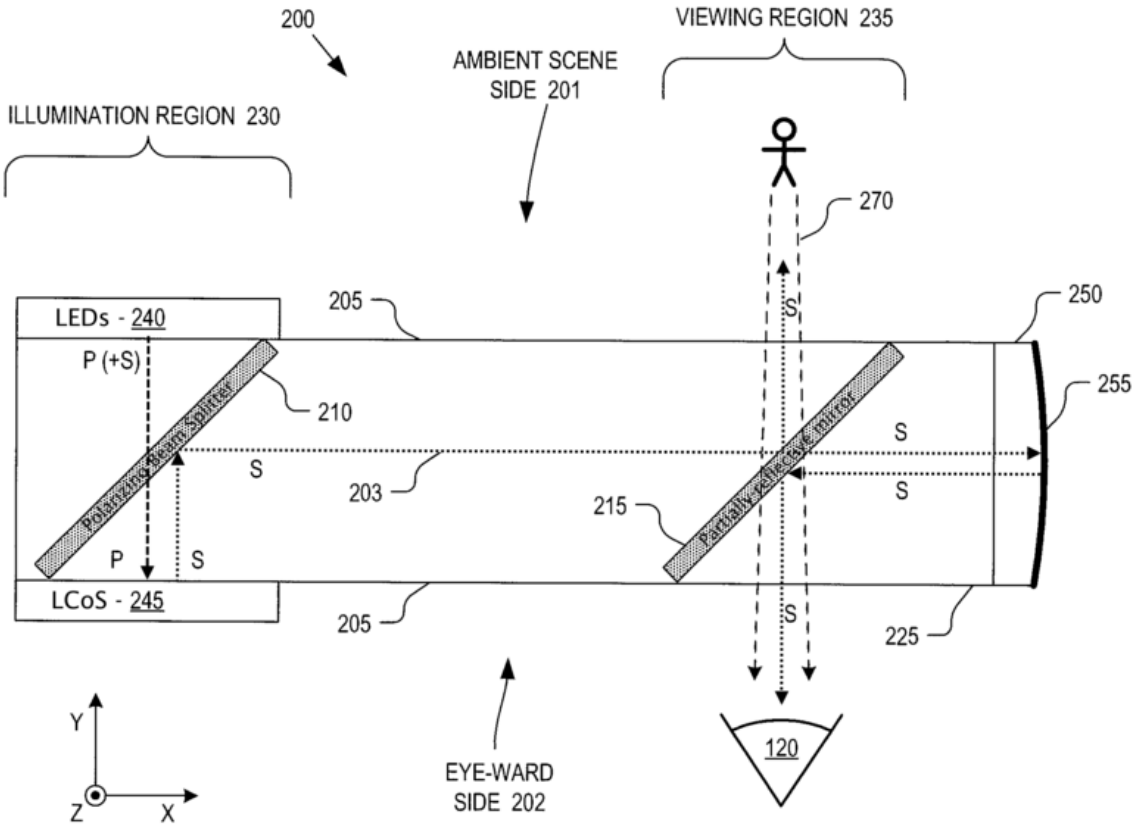
Appendix:

[1]: Visual acuity is a number that indicates the sharpness or clarity of vision. A visual acuity measurement of 20/70 means that a person with 20/70 vision who is 20 feet from an eyes chart sees what a person with unimpaired (or 20/20) vision can see from 70 feet away. In the United States, the Snellen Eye Chart is a test used by ophthalmologists and optometrists to measure a person's distance visual acuity.

The number 20/20 is the normal vision. The number 20/70 is the vision to pass the driving test. The worst case is 20/400.



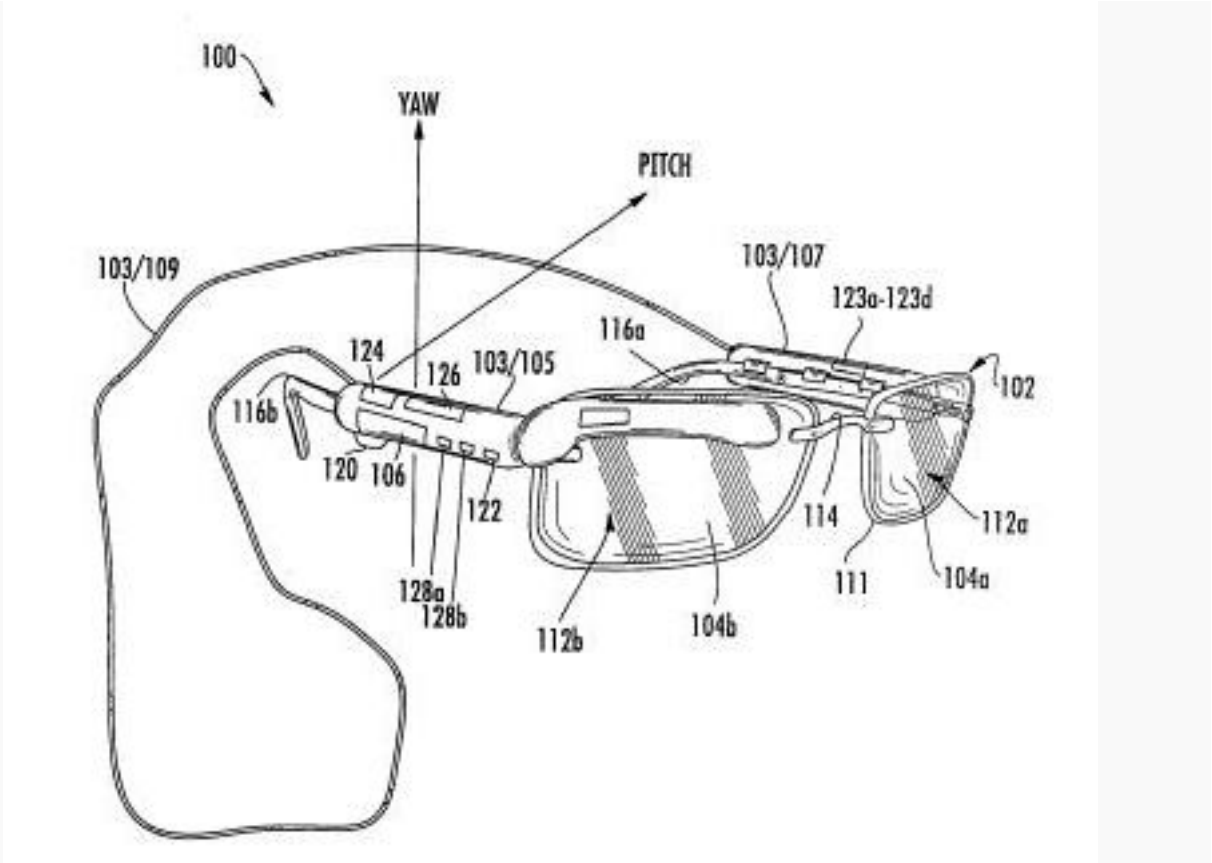
[2] Google Glass Explorer Optics Schematic

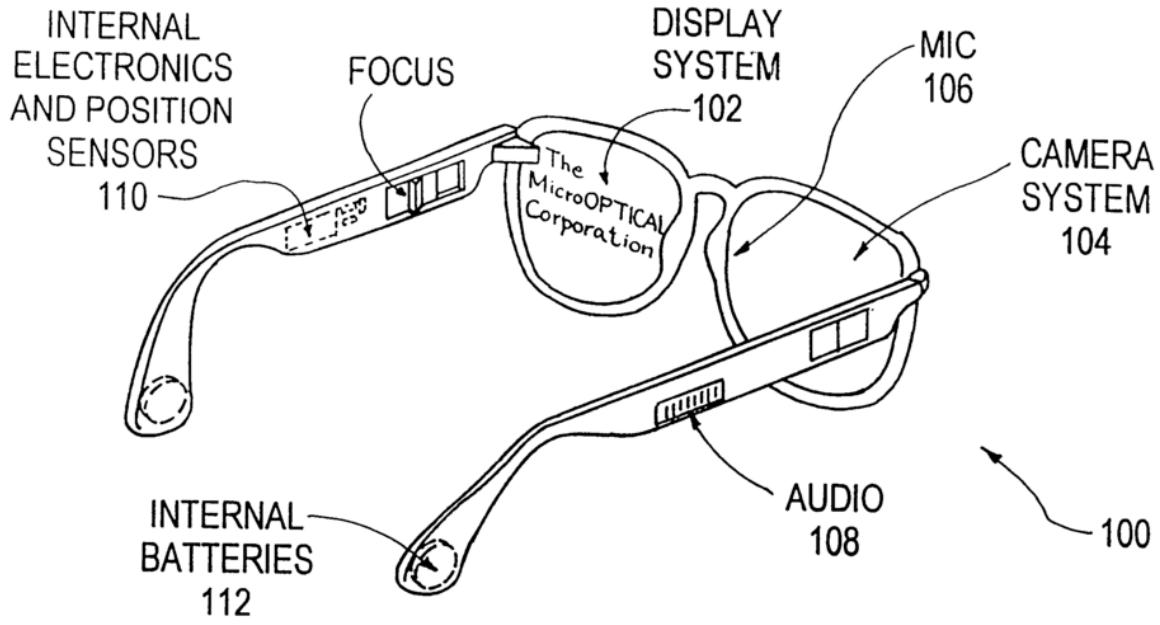


120- viewer's eye
200- heads-up display eyepiece including:
201- ambient scene side of eyepiece
202- eyeward side of eyepiece

203- forward light propagation path
204- reverse light propagation path
205- frame holding components
210- in-coupling Polarizing Beam Splitter (PBS)
215- out-coupling partially reflecting mirror beam splitter
230- illumination region
235- viewing region
240- illumination assembly including an LED array with red, green, and blue LEDs, Brightness Enhancement Films and a P polarizing film
245- Liquid Crystal on Silicon (LCoS) display
250- plano-convex collimating lens with astigmatism correction; 81.87mm vertical radius, 83.20mm horizontal radius
255- reflector; formed using a reflective coating on lens
270 - external scene

[3] Google glass sketch (reference 5)





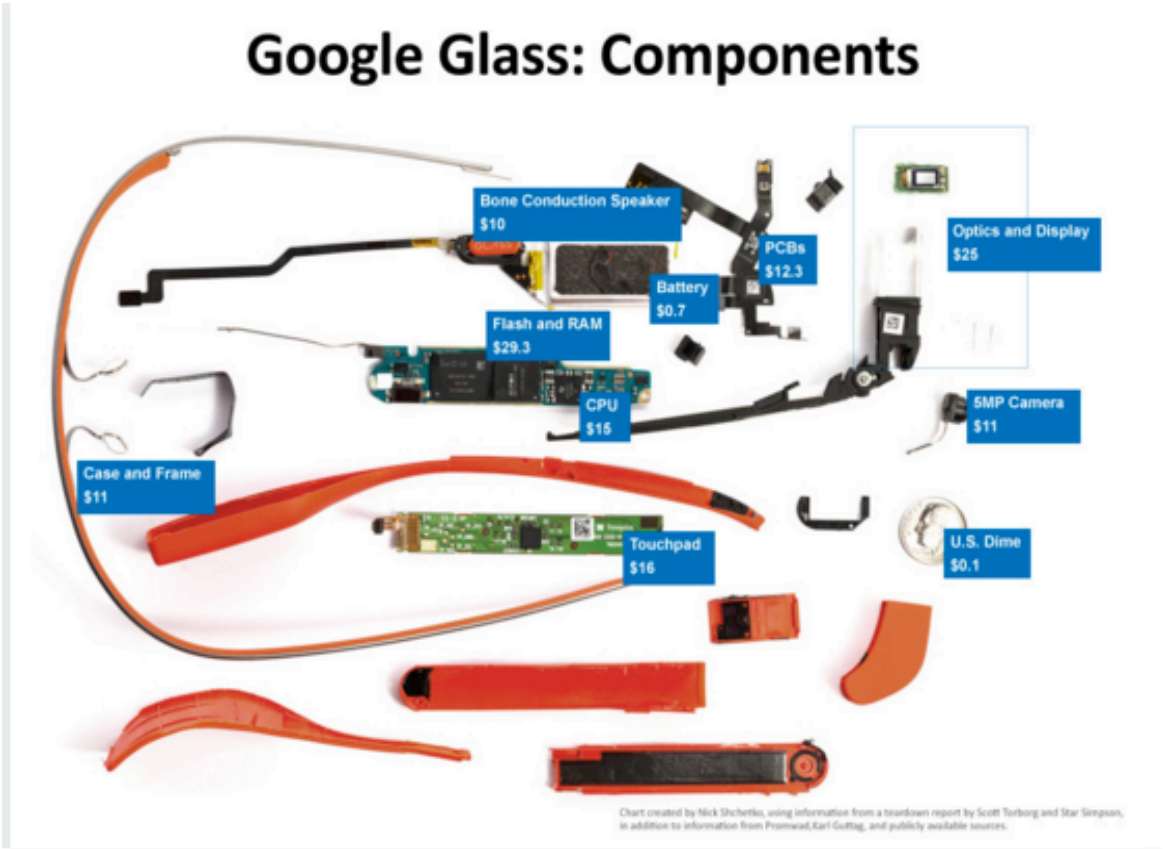
These two drawings illustrate the basic frame and components of Google glass. Details refer

http://pdfaiw.uspto.gov/.aiw?PageNum=0&docid=20130044042&IDKey=E0F0CC34B073&HomeUrl=http%3A%2F%2Fappft.uspto.gov%2Fnetacgi%2Fnph-Parser%3FSect1%3DPTO2%2526Sect2%3DHITOFF%2526u%3D%25252Fnetahtml%25252FPTO%25252Fsearch-adv.html%2526r%3D13%2526p%3D1%2526f%3DG%2526l%3D50%2526d%3DPG01%2526S1%3D%2820130221.PD.%252520AND%252520Google.AS.%29%2526OS%3DPD%2F20130221%252BAND%252BAN%2FGoogle%2526RS%3D%28PD%2F20130221%252BAND%252BAN%2FGoogle%29

The patent for Google glass.

[4] Google Glass: Components:

Based on the research it should cost less than $ 210 to produce one device. However, our



designed device would replaced the camera and the display to a more high quality device in order to deign a higher-performance device.