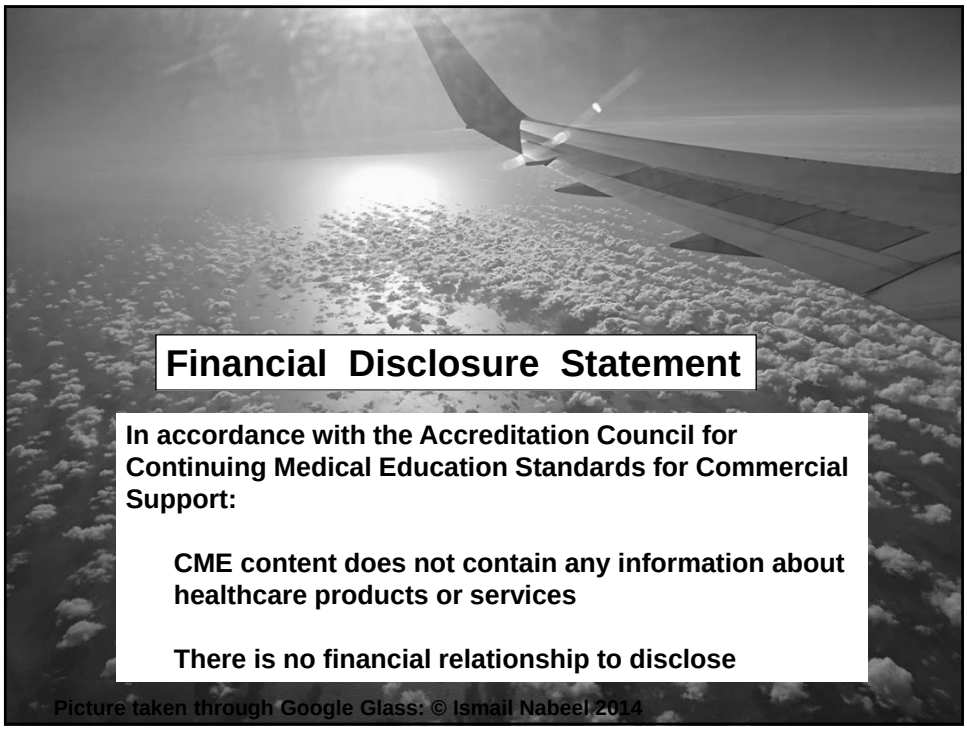
Wearable computers in Medicine – New Frontier

# New Uses of Internet Technologies in Medicine

**Ismail Nabeel, MD, MPH, FACOEM**
Assistant Professor – Clinical
Division of General Internal Medicine/Occupational Medicine
The Ohio State University Wexner Medical Center



## Financial Disclosure Statement

**In accordance with the Accreditation Council for Continuing Medical Education Standards for Commercial Support:**

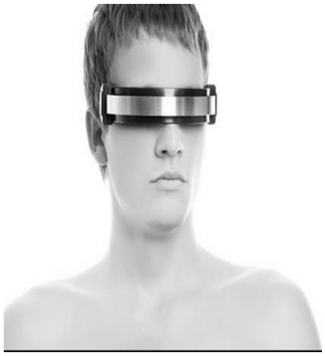
**CME content does not contain any information about healthcare products or services**

**There is no financial relationship to disclose**

**Picture taken through Google Glass: © Ismail Nabeel 2014**

# Wearable computers the next Frontier

Image courtesy of Apple



**Wearable computers, also known as body-borne computers or wearables are miniature electronic devices that are worn by the bearer under, with or on top of clothing.**

Morrison, Jessica. ""Electronic Skin"equipped with Memory." Nature.com. Nature Publishing Group, 03 Mar. 2014. Web. 09 Sept. 2014.

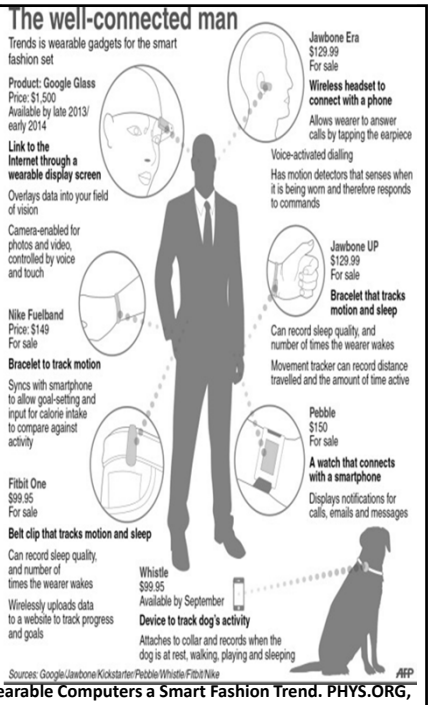
# Complete transformation of technology over the years

Steve Mann's "wearable computer" and "reality mediator" inventions of the 1970s have evolved into what looks like ordinary eyeglasses.


http://wearcam.org/glass.pdf

# Science fiction versus reality


# Science fiction versus reality

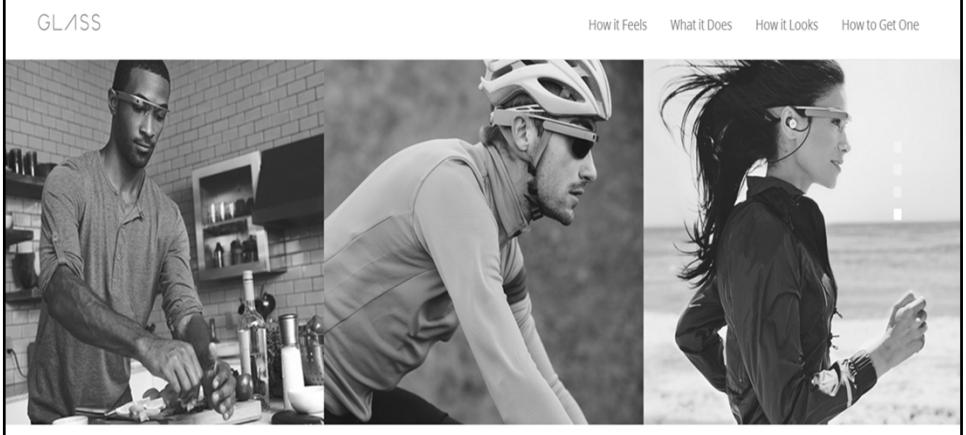




**Source listed on the slide (AFP)**

**Chapman, Glenn. "Wearable Computers a Smart Fashion Trend." Wearable Computers a Smart Fashion Trend. PHYS.ORG, 27 June 2013. Web. 09 Sept. 2014.**

# What is Google Glass

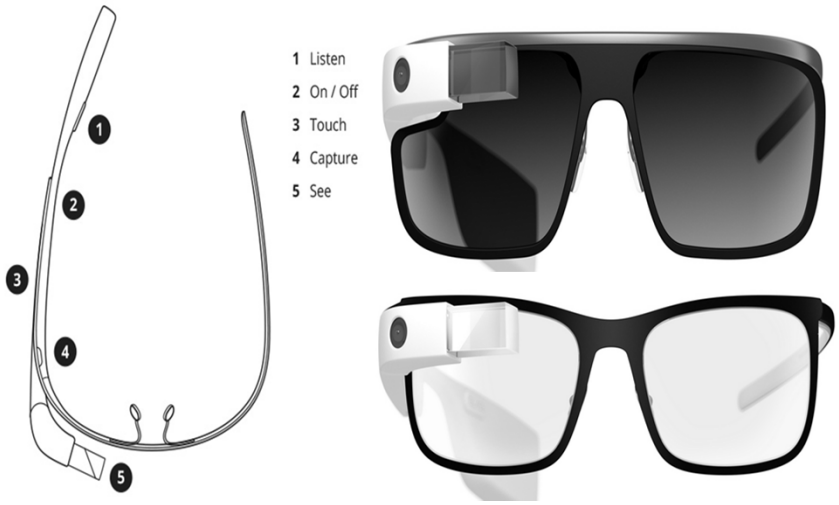
https://www.google.com/glass/start/




8

https://www.google.com/glass/start/

# How the Glass works



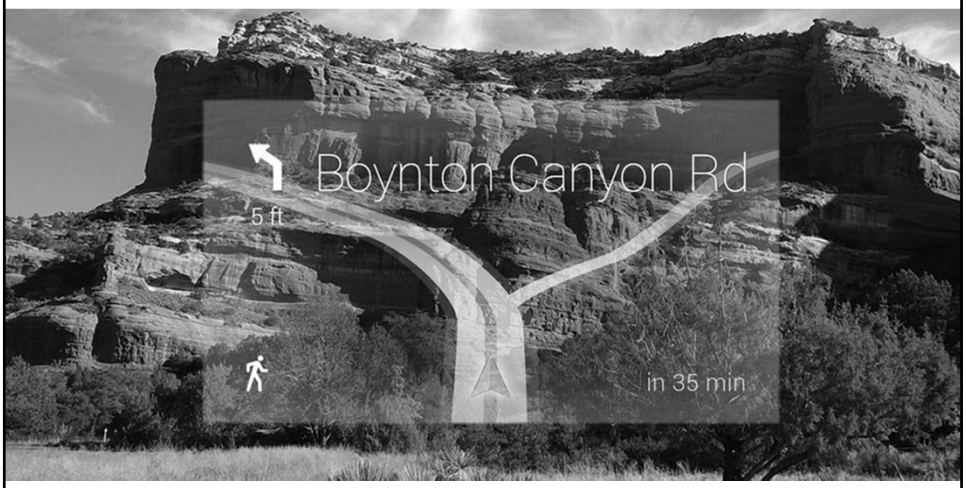

https://www.google.com/glass/start/

# Picture and images Hovers in front reminiscent of minority report (2002)


http://www.imdb.com


https://www.google.com/glass/start/

# Traveling is a breeze with google Glass



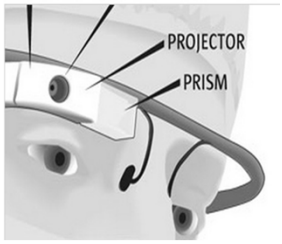

https://www.google.com/glass/start/

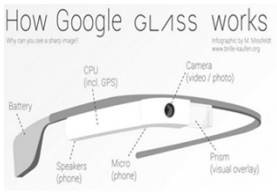
## Translation services in real-time

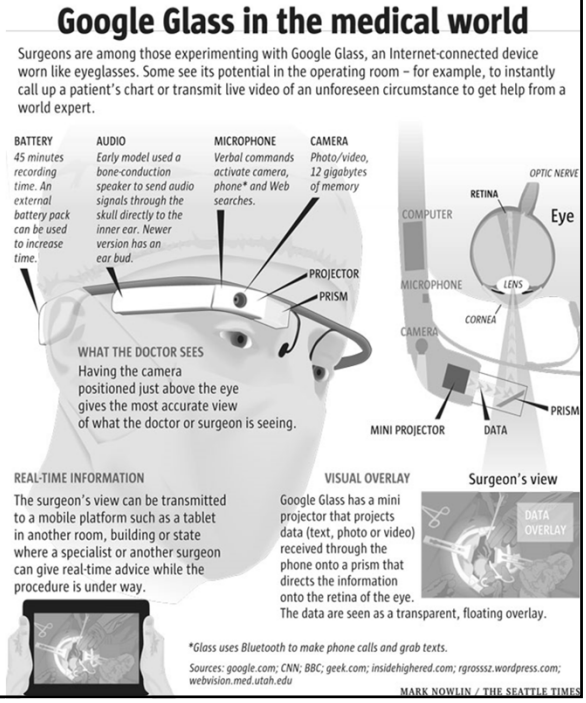

https://www.google.com/glass/start/

## Catching a flight: Using predictive computing


https://www.google.com/glass/start/

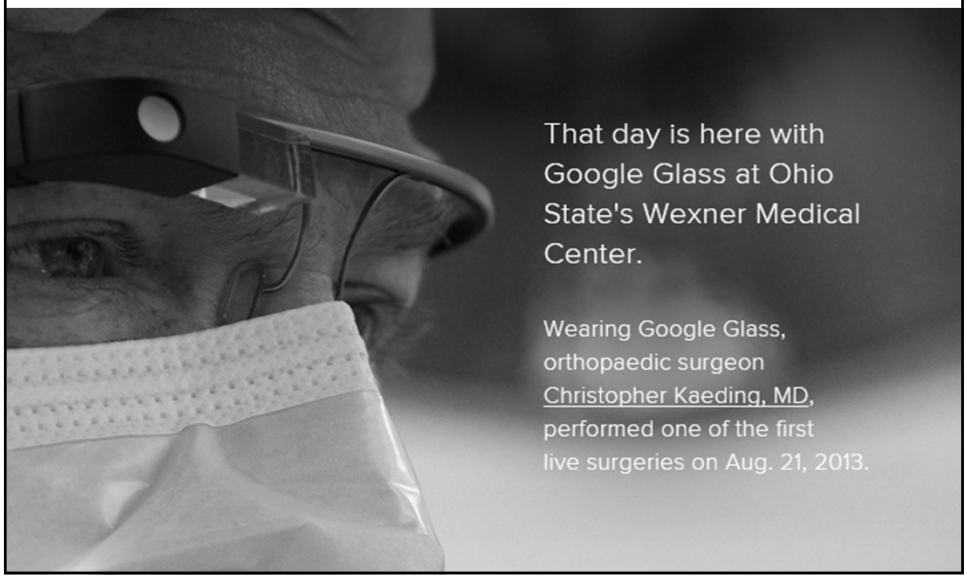



**Ostrom, Carol M. "Harborview Surgeon Test-drives Google Glass in the Operating Room." The Seattle Times, 17 Nov. 2013. Web. 09 Sept. 2014.**

# One of kind experiment with Google Glass at Ohio State University, Wexner Medical Center



http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx

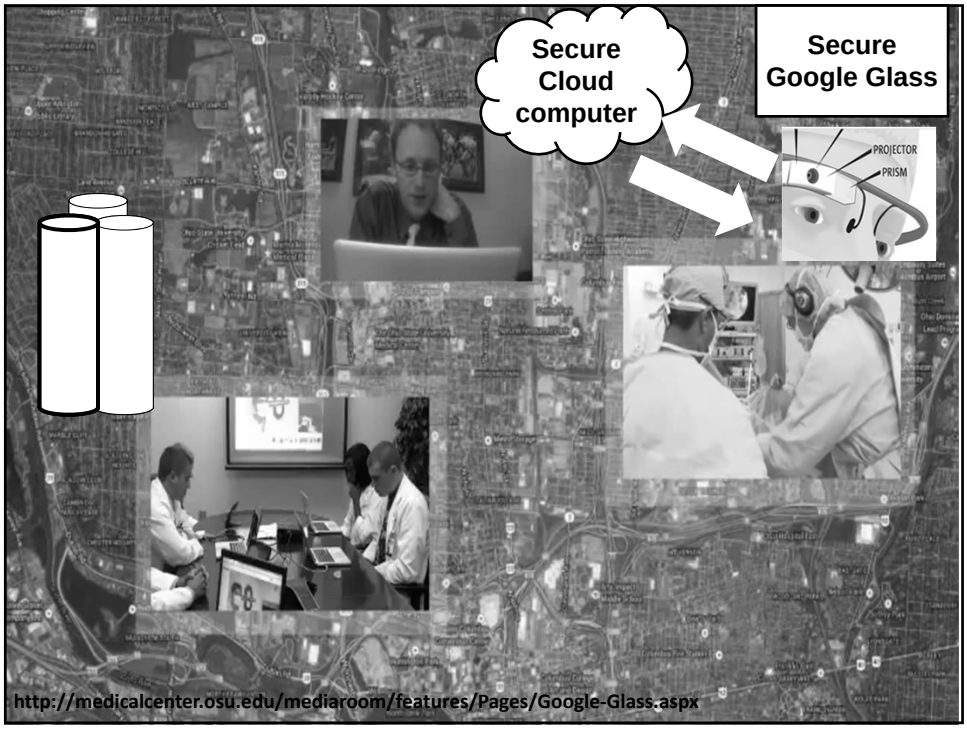
# ACL surgery through Google glass

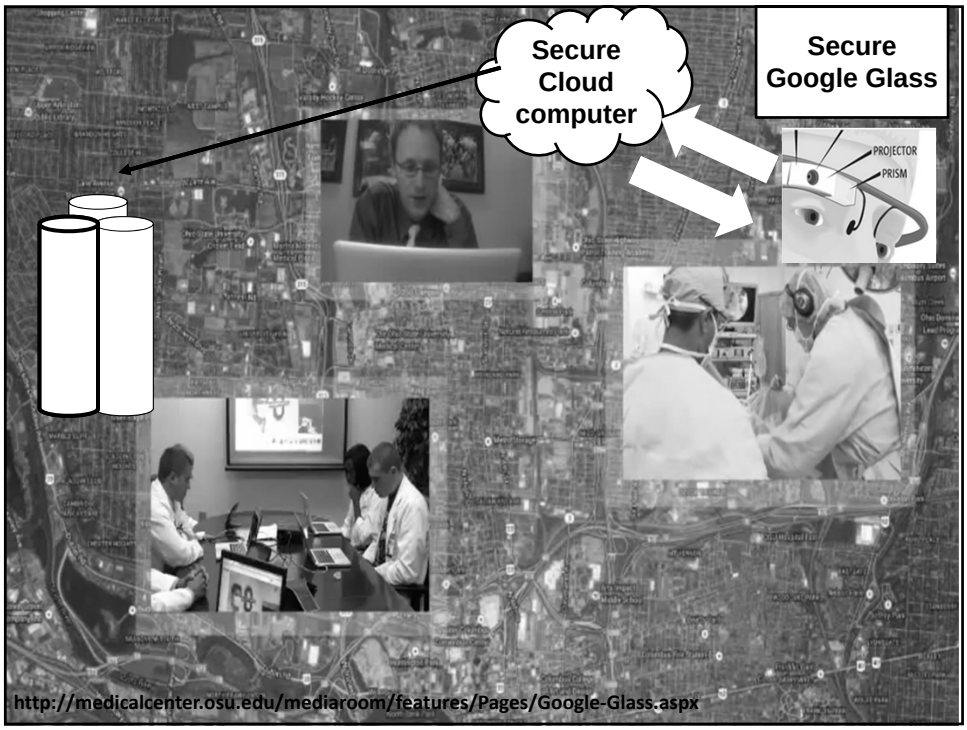
**Video 0:**
http://youtu.be/Hf799LKU7TA

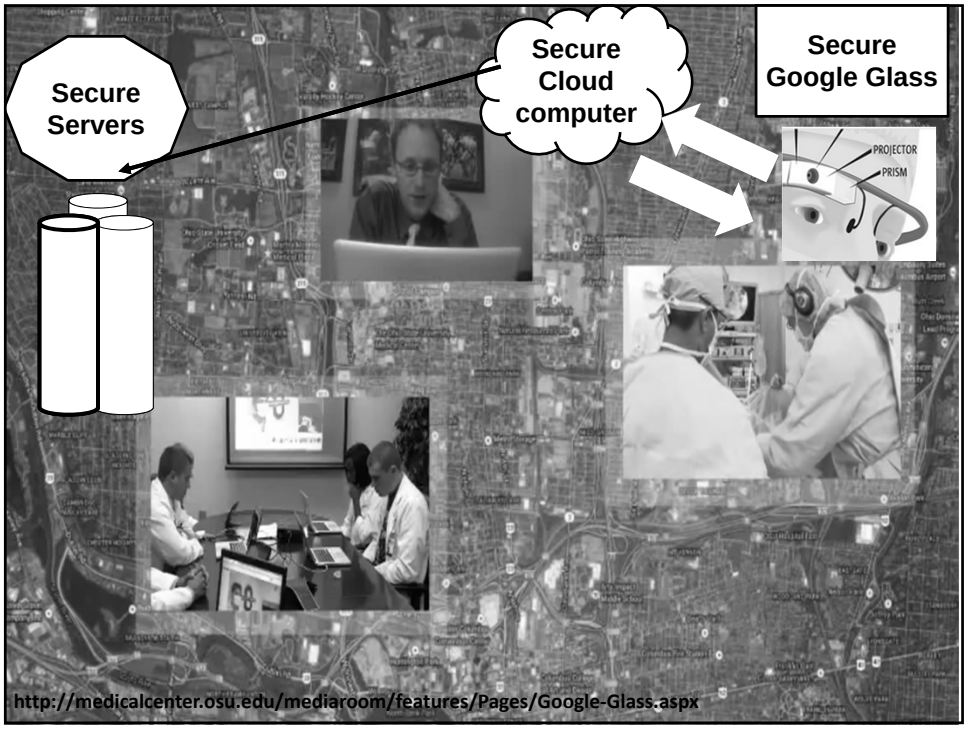
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx

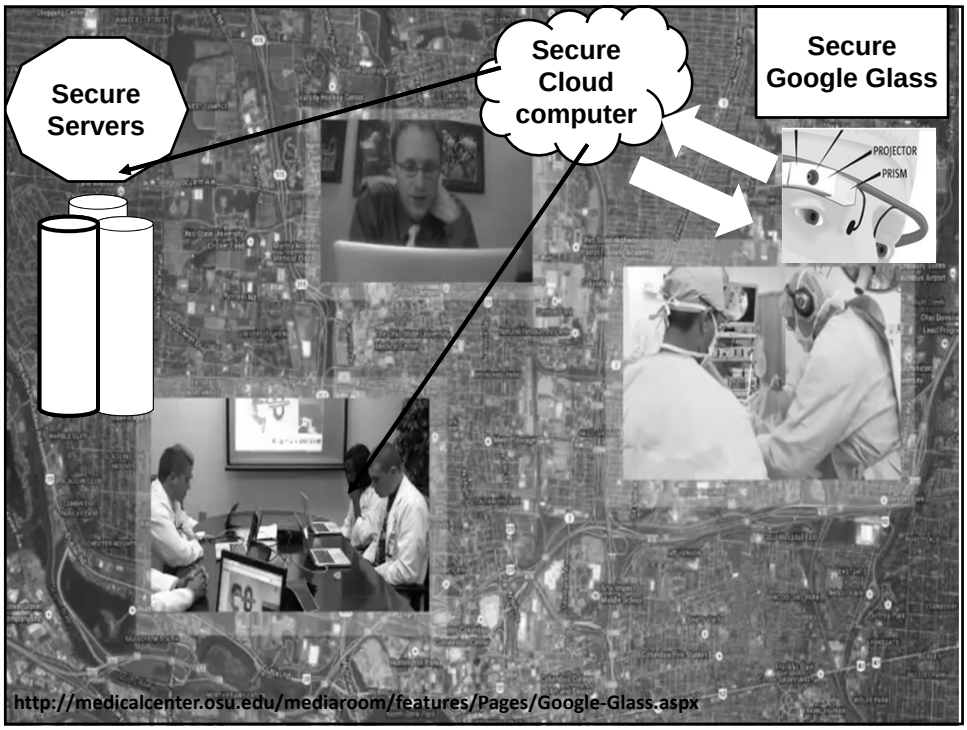

Secure
Google Glass
PROJECTOR
PRISM
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx

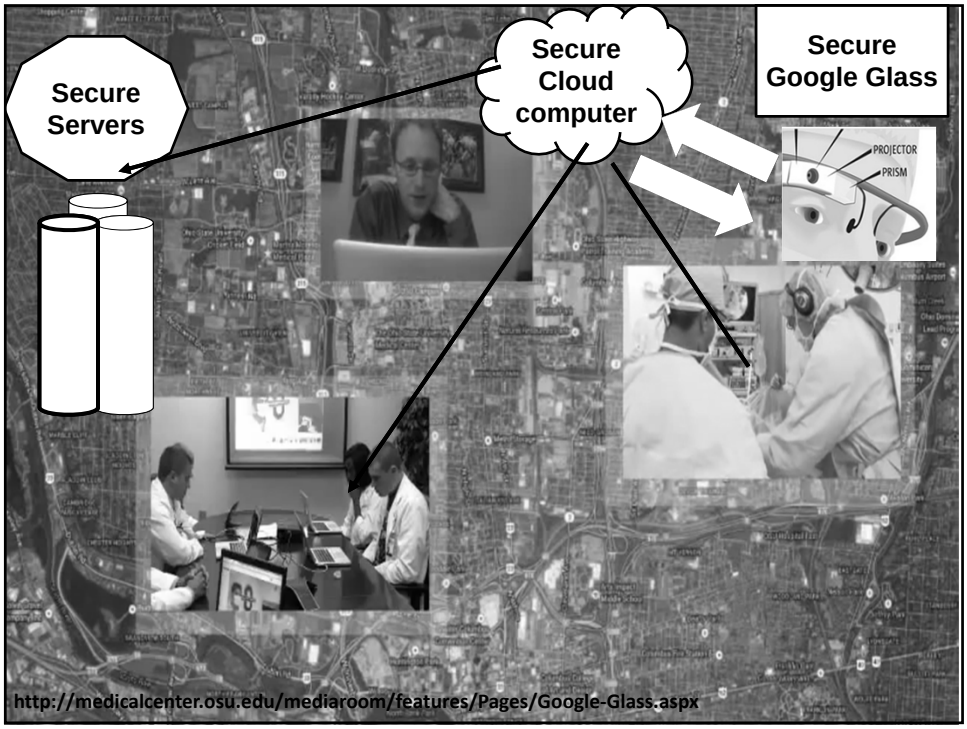

Secure
Google Glass
PROJECTOR
PRISM
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx


Secure
Cloud
computer
Secure
Google Glass
PROJECTOR
PRISM
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx


Secure
Cloud
computer
Secure
Google Glass
PROJECTOR
PRISM
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx


Secure Servers
Secure Cloud computer
Secure Google Glass
PROJECTOR
PRISM
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx


Secure Servers
Secure Cloud computer
Secure Google Glass
PROJECTOR
PRISM
http://medicalcenter.osu.edu/mediaroom/features/Pages/Google-Glass.aspx




## Creating “hangouts” (unfortunately A Tight Google universe integration)
## The Health Insurance Portability and Accountability Act of 1996 compliance


2

## Google glass ACL repair surgery

- Introduction and history about leading up to the experiment with Google Glass at the Ohio State University, Wexner medical center

## Google glass ACL repair surgery

- Introduction and history about leading up to the experiment with Google Glass at the Ohio State University, Wexner medical center
  - Comfort level of the surgeon during the surgery
  - Able to transmit real-time data to participants across the room in the OR and around the campus
  - Conversation with other surgeon in real time to discuss important aspects of surgery to provide critical feedback

## Google glass ACL repair surgery

- **Lessons learned during the experiment: Multiple steps to improve on our initial experiment**

## Google glass ACL repair surgery

- **Lessons learned during the experiment: Multiple steps to improve on our initial experiment**
  - **Quality image capture, focal length in image capture, bright OR lights, simulating the real point of view**

# Google glass ACL repair surgery

- Lessons learned during the experiment: Multiple steps to improve on our initial experiment
  - Quality image capture, focal length in image capture, bright OR lights, simulating the real point of view
    - Transmission of video feed over a secure network over multiple servers from encrypted Google Glass to other encrypted computers screens

# Google glass ACL repair surgery

- Lessons learned during the experiment: Multiple steps to improve on our initial experiment
  - Quality image capture, focal length in image capture, bright OR lights, simulating the real point of view
    - Transmission of video feed over a secure network over multiple servers from encrypted Google Glass to other encrypted computers screens
    - Transmission of on-demand real-time images back to surgeon's the Google Glass for critical decision-making

# Google glass ACL repair surgery

- **Lessons learned during the experiment: Multiple steps to improve on our initial experiment**
  - **Quality image capture, focal length in image capture, bright OR lights, simulating the real point of view**
    - **Transmission of video feed over a secure network over multiple servers from encrypted Google Glass to other encrypted computers screens**
    - **Transmission of on-demand real-time images back to surgeon's the Google Glass for critical decision-making**
    - **Creating Hangouts for individual participants**

# Real-time information about traffic patterns

- **Google Glass vignette can transmit traffic information in real-time.**
- **Critical communications during accidents**
  - **Shared instantly in real time with the Emergency responders, EMS, 911, ED, OR**


2001 Ford Expedition- Profile (Right)
https://www.google.com/glass/start/explorer-stories/


https://www.google.com/glass/start/explorer-stories/


# Google Glass Use in Medical Education


**Use of Google Glass in Interventional Nephrology**

**Procedure:**

**Angioplasty of the stenosed artery to improved access for Dialysis.**


THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER


Iodixanol:
Iodinated Contrast Media;
Radiological/Contrast Media
(Nonionic, Iso-Osmolality)


# Benefits and shortcomings


**Benefits:**

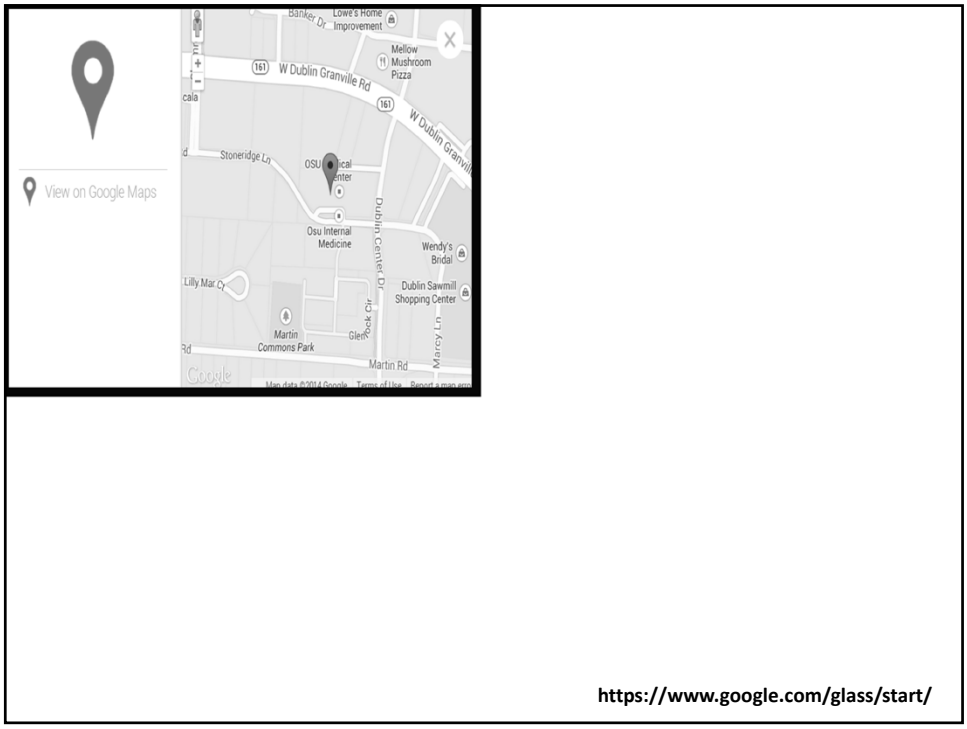
- 1st person view
- Original content
- Physician/Surgeon able to emphasize on different point during multiple steps of the procedure

**Shortcomings:**

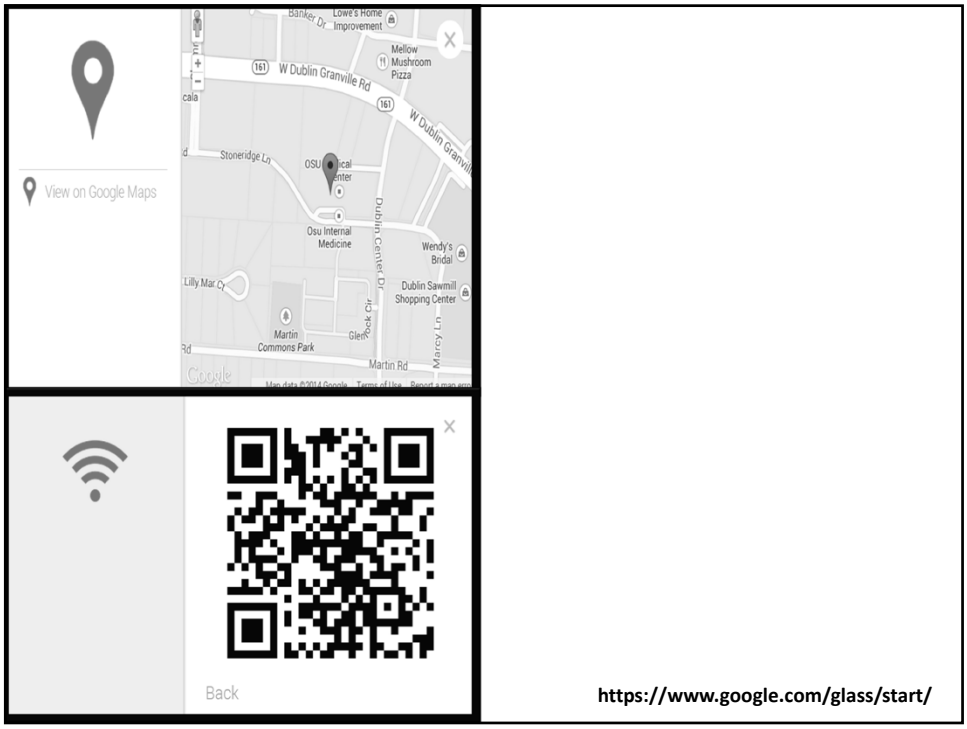
- Surgeons/physician need to know how to stabilize the image
- Non zoom able lens
- Proper placement of camera in the field
- Editing and post production


wearable intelligence
PRODUCTS INDUSTRIES ABOUT JOBS BLOG CONTACT
wearable intelligence in
HEALTHCARE
Improve efficiency, team coordination and patient satisfaction.
Hands-free. HIPAA compliant. Cutting-edge wearable technology.
Play Video
http://wearableintelligence.com/


Test right arm motor drift
0:05
Say 'SEND' or 'CANCEL'




**https://www.google.com/glass/start/**




**https://www.google.com/glass/start/**

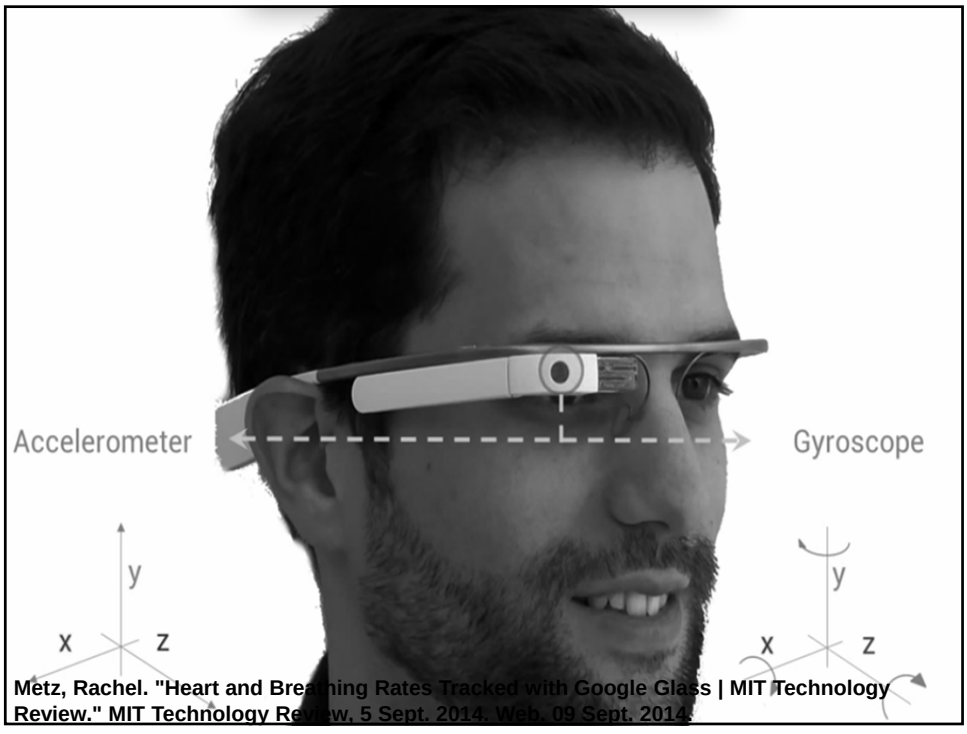

View on Google Maps
Lowe's Home Improvement
Mellow Mushroom Pizza
W Dublin Granville Rd
Stoneridge Ln
Osu Internal Medicine
Dublin Center Dr
Wendy's Bridal
Lilly Mar Ct
Dublin Sawmill Shopping Center
Martin Commons Park
Martin Rd
Marcy Ln
Google
Back
Ride with Strava
Strava for Glass makes it easy to track your rides, visualize your progress, and challenge your friends, all while keeping your hands on the handlebars.
26:53
Valley View
https://www.google.com/glass/start/


View on Google Maps
Lowe's Home Improvement
Mellow Mushroom Pizza
W Dublin Granville Rd
Stoneridge Ln
Osu Internal Medicine
Dublin Center Dr
Wendy's Bridal
Lilly Mar Ct
Dublin Sawmill Shopping Center
Martin Commons Park
Martin Rd
Marcy Ln
Google
Back
Ride with Strava
Strava for Glass makes it easy to track your rides, visualize your progress, and challenge your friends, all while keeping your hands on the handlebars.
26:53
Valley View
4:30 PM
Check in
Best Western Plus Yosemite Gateway Inn
https://

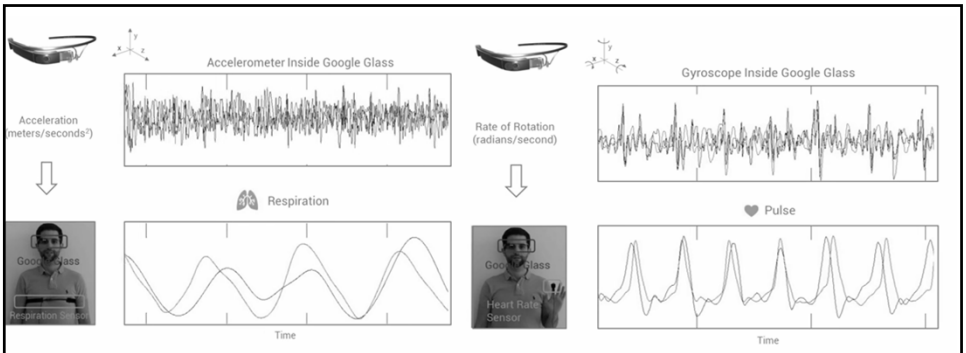

**ER doctors use Google Glass and QR codes to identify patients**
**Custom medical application for Glass keeps data off Google servers.**

**Hospital in Boston developed a custom information-retrieval system for Google Glass, which lets ER doctors scan a QR code on the wall of each room to call up information about patients.**

**Kerr, D. "Doctors Testing Google Glass to Get Real-time Patient Data." CNET. 12 Mar. 2014. Web. 24 Mar. 2014.**




**Metz, Rachel. "Heart and Breathing Rates Tracked with Google Glass | MIT Technology Review." MIT Technology Review. 5 Sept. 2014. Web. 09 Sept. 2014.**




12 participants
Still body postures before/after exercising
Google Glass vs traditional biosensor

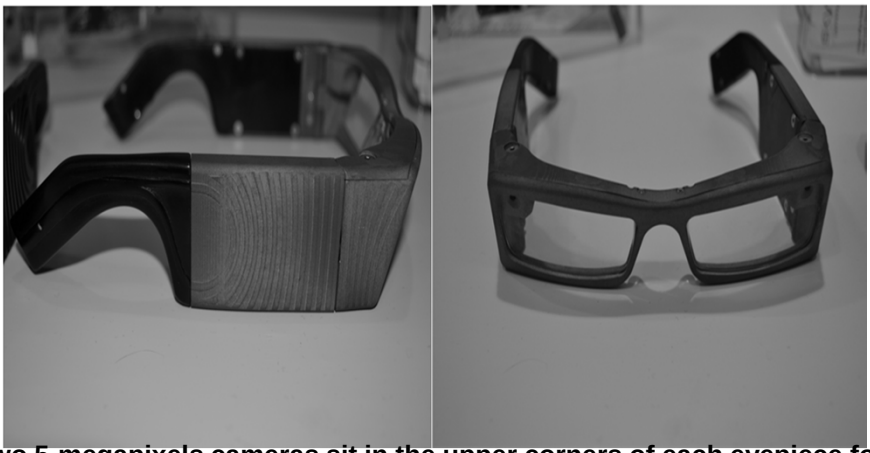
from 45 to 150 beats/minute
from 8 to 45 breaths/minute
< 1 BPMs error

Massachusetts Institute of Technology
Georgia Tech
Expeditions in Computing
Google

## Using Accelerometer & Gyroscope to predict Heart rate and Respiration

**Metz, Rachel. "Heart and Breathing Rates Tracked with Google Glass | MIT Technology Review." MIT Technology Review, 5 Sept. 2014. Web. 09 Sept. 2014.**

## Use of wearable computers in industrial settings



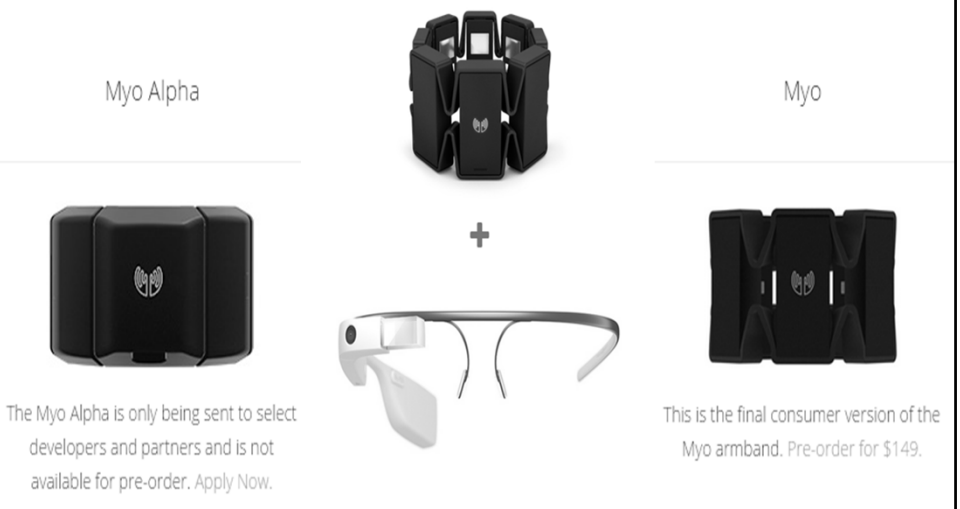
**Two 5-megapixels cameras sit in the upper corners of each eyepiece for taking photos, live streaming video in real time, and recording footage. The eyewear looks like a chunkier version of your typical pair of glasses since its accelerometer, gyroscope, processor and other components are housed in its sides.**

**Franzen, Carl. "XOne Brings Google Glass-like Interactivity to Safety Glasses." Yahoo! News. Yahoo!, 07 Jan. 2014. Web. 09 Sept. 2014.**

## Google Glass hack allows brainwave control



Lee, David. "Google Glass Controlled by Brainwave." BBC News, 9 July 2014. Web. 09 Sept. 2014.




Etherington, Darrell. "Thalmic Reveals Its Enterprise Play For the Myo Armband, Including Google Glass Integration | TechCrunch." TechCrunch, 19 Aug. 2014. Web. 09 Sept. 2014.

**Use of “Myo” and “Google Glass”: connecting Technologies**

Etherington, Darrell. "Thalmic Reveals Its Enterprise Play For the Myo Armband, Including Google Glass Integration | TechCrunch." TechCrunch. 19 Aug. 2014. Web. 09 Sept. 2014.

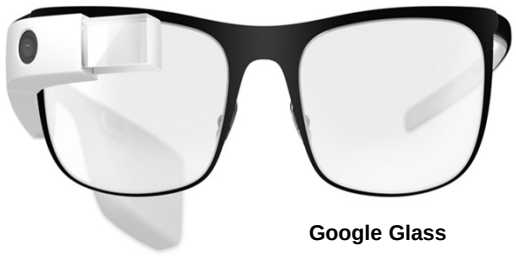
## Potential uses of wearable technologies at work & Glass at Work


5
6


**Google Glass use in an underserved setting:**

**A trip to Cape Town South Africa. Providing a platform to build health solutions in the country's first health hackathon**

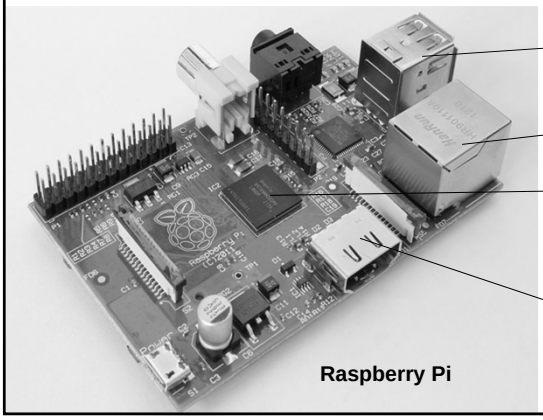
Stock pictures
http://www.raspberrypi.org/



Google Glass

**Combining resources:**

- **Developing a different solutions for the Glass**
- **Creating different ecosystem for the Glass.**



Raspberry Pi

**Connectivity with wired networks**

**Additional USB ports**

**Programmable processor on board**

**HDMI output**

Stock pictures
http://www.raspberrypi.org/

# Transmitting the images back to the surgeon's point of view through Google glass

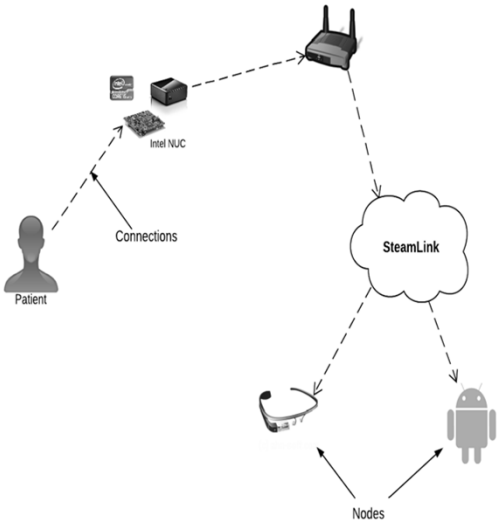
- **Transmit the data back to the surgeon's point**
- **Neurosurgeon Dr. Rezai and his team who are involved in Deep brain stimulation surgery**
- **During the OR surgery, videos were captured and optimized to be seen through Google Glass1**

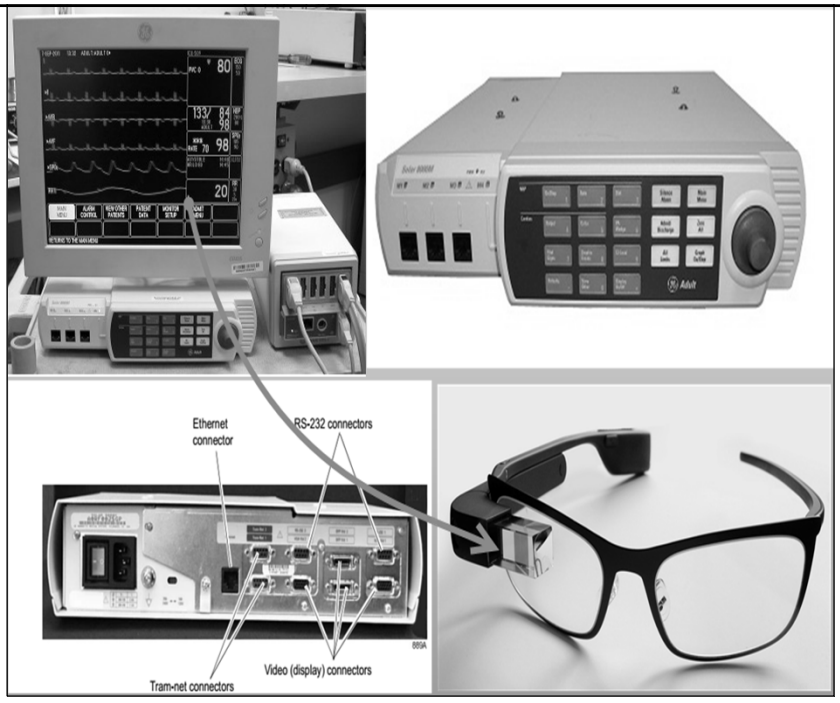
1. http://www.newswise.com/articles/breakthrough-technologies-and-devices-revealed-at-congress-of-neurological-surgeons-annual-meeting

## Ohio State University Computer science and engineering capestone project:

**To utilize the Google Glass to display vital patient information**

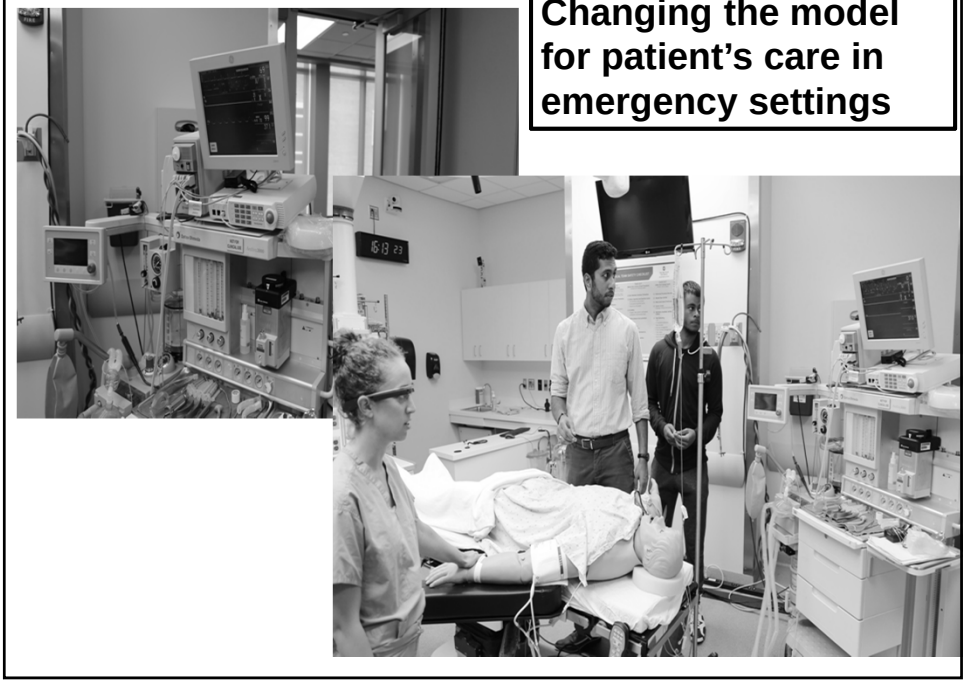
**From the legacy medical device**




Stock pictures - GEHC-Service-Manual_Solar-8000M-i-Patient-Monitor-v5-2008

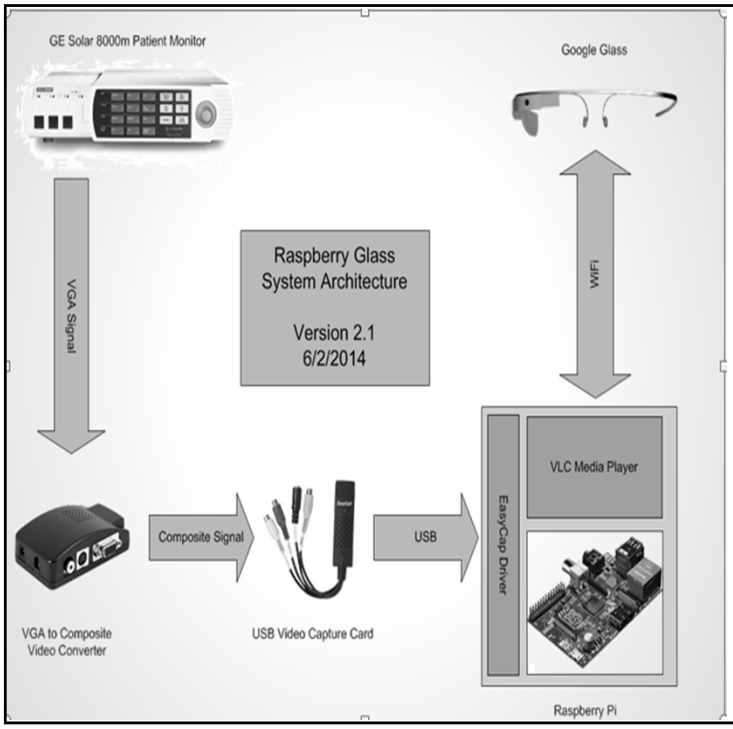
**Changing the model for patient's care in emergency settings**



## High Level Project Plan

Done | In progress | To-do

| Tasks \ Week | 1<br>5/5 - 5/11 | 2<br>5/12 - 5/18 | 3<br>5/19 - 5/25 | 4<br>5/26 - 6/1 | 5<br>6/2 - 6/8 | 6<br>6/9 - 6/15 | 7<br>6/16 - 6/22 | 8<br>6/23 - 6/29 | 9<br>6/30 - 7/6 | 10<br>7/7 - 7/13 | 11<br>7/14 - 7/20 | 12<br>7/21 - 7/27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| First Meeting with sponsors | | | | | | | | | | | | |
| Project Architecture | | | | | | | | | | | | |
| Obtain Hardware | | | | | | | | | | | | |
| Hello World Glass App/Mockup | | | | | | | | | | | | |
| Finalize Requirements | | | | | | | | | | | | |
| Video input/output to NUC | | | | | | | | | | | | |
| Develop Glass App | | | | | | | | | | | | |
| Finalize Glass App Code | | | | | | | | | | | | |
| Test in Sim-OR lab with volunteers | | | | | | | | | | | | |
| Freeze Code and finalize project | | | | | | | | | | | | |

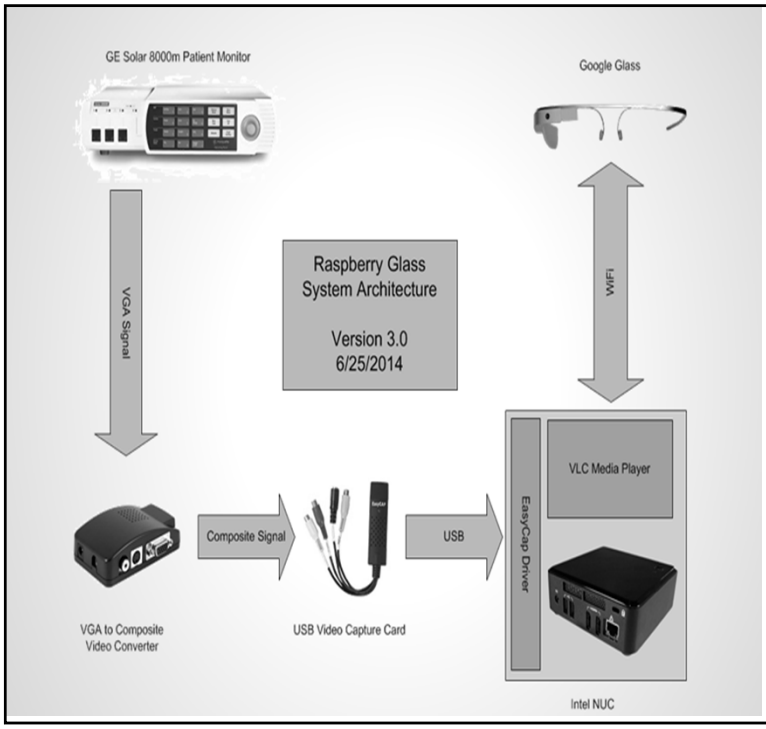



## Raspberry Pi Limitations

**Transcoding is CPU Intensive**
**Converting raw video to a recognized format 'Translating Languages'**

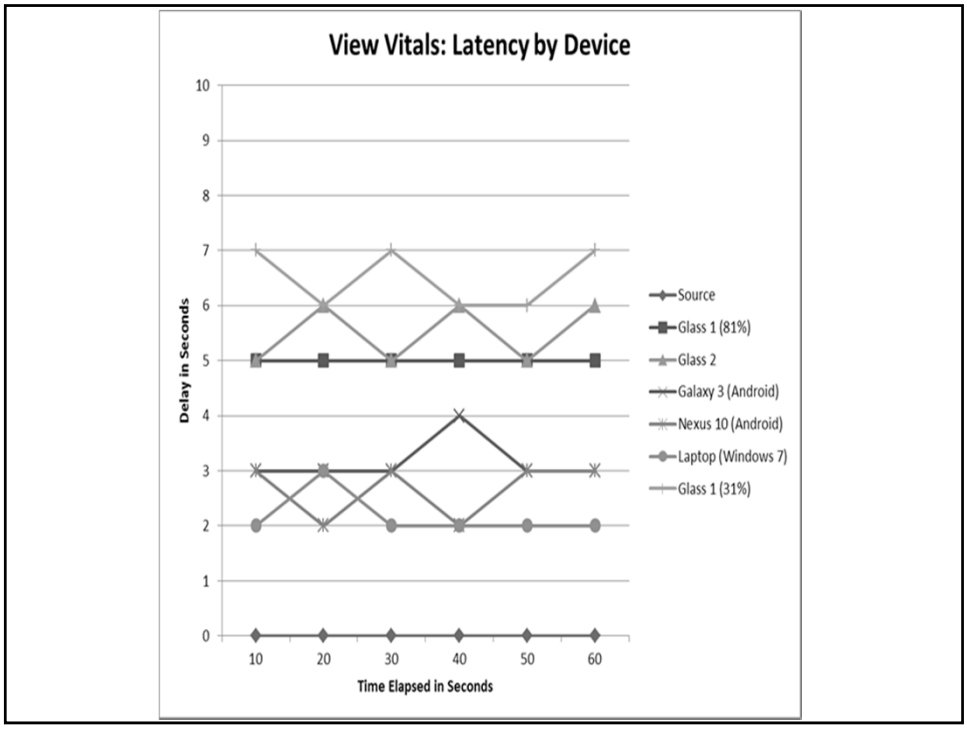
**Raspberry Pi CPU**

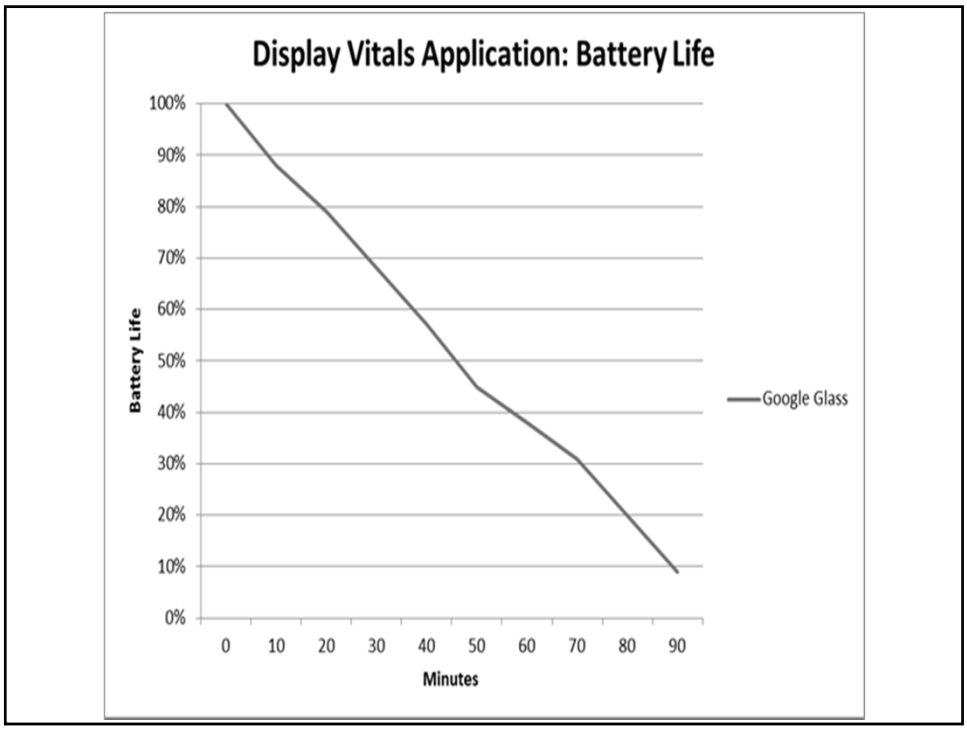
**700 Mhz**
**Low power usage ARM SoC**
**90% - 95% of CPU Resources**
**Lag on Video Output**

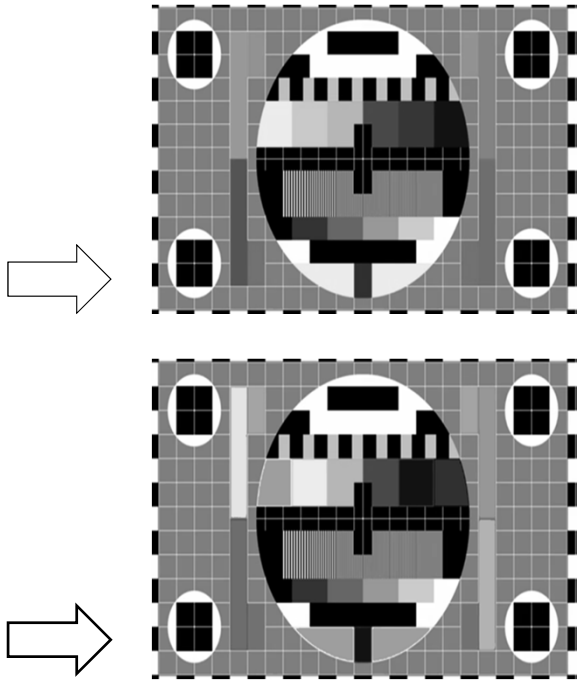



## Intel NUC

**i5-3427U**
**Dual Core**
**1.8GHz Base**
**2.8GHz Turbo**
**8GB DDR3**
**USB 3.0**
**Ethernet**
**Wireless N**


View Vitals: Latency by Device
Delay in Seconds
Time Elapsed in Seconds
0
1
2
3
4
5
6
7
8
9
10
10
20
30
40
50
60
Source
Glass 1 (81%)
Glass 2
Galaxy 3 (Android)
Nexus 10 (Android)
Laptop (Windows 7)
Glass 1 (31%)


Display Vitals Application: Battery Life
Battery Life
Minutes
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
10
20
30
40
50
60
70
80
90
Google Glass



**Google Glass projection of the virtual screen**

**Real time transmission of visual data.**

## Furture development of wearable technologies in medicine

## Furture development of wearable technologies in medicine

- **Enhancing the delivery of care, diagnosis of patterns in Healthcare**

## Furture development of wearable technologies in medicine

- Enhancing the delivery of care, diagnosis of patterns in Healthcare
- Excellent teaching tool with real case senarios for Medical Education

## Furture development of wearable technologies in medicine

- Enhancing the delivery of care, diagnosis of patterns in Healthcare
- Excellent teaching tool with real case senarios for Medical Education
- Lead, Innovate and deliver disruptive solutions on demand produce a paradigm shift in the status quo


**Capstone Project Video:**
**http://youtu.be/YfNTITV5TRo**