Smart glasses:
interaction, privacy and social implications

01.04.2014

Marica Bertarini

maricab@student.ethz.ch

How to interact with smart glasses

Hand-held devices

- point-and-click and controllers, joysticks
- one-handed keyboards
- smartphones

Smartwatches

Gestures on smart glass itself

Voice commands

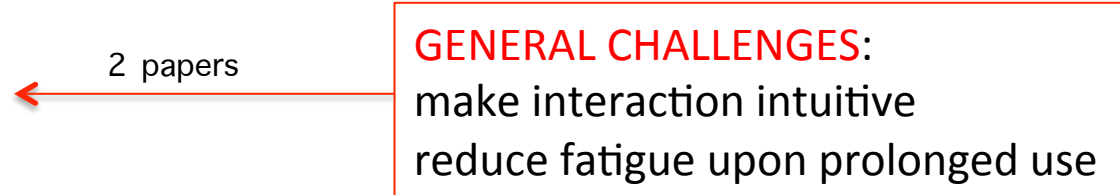## Eye-tracking and winks

Hand/fingers gestures

FREE-FORM interaction

Gesture-based interaction

- On-body
  - face-based
  - palm-based
- In-air

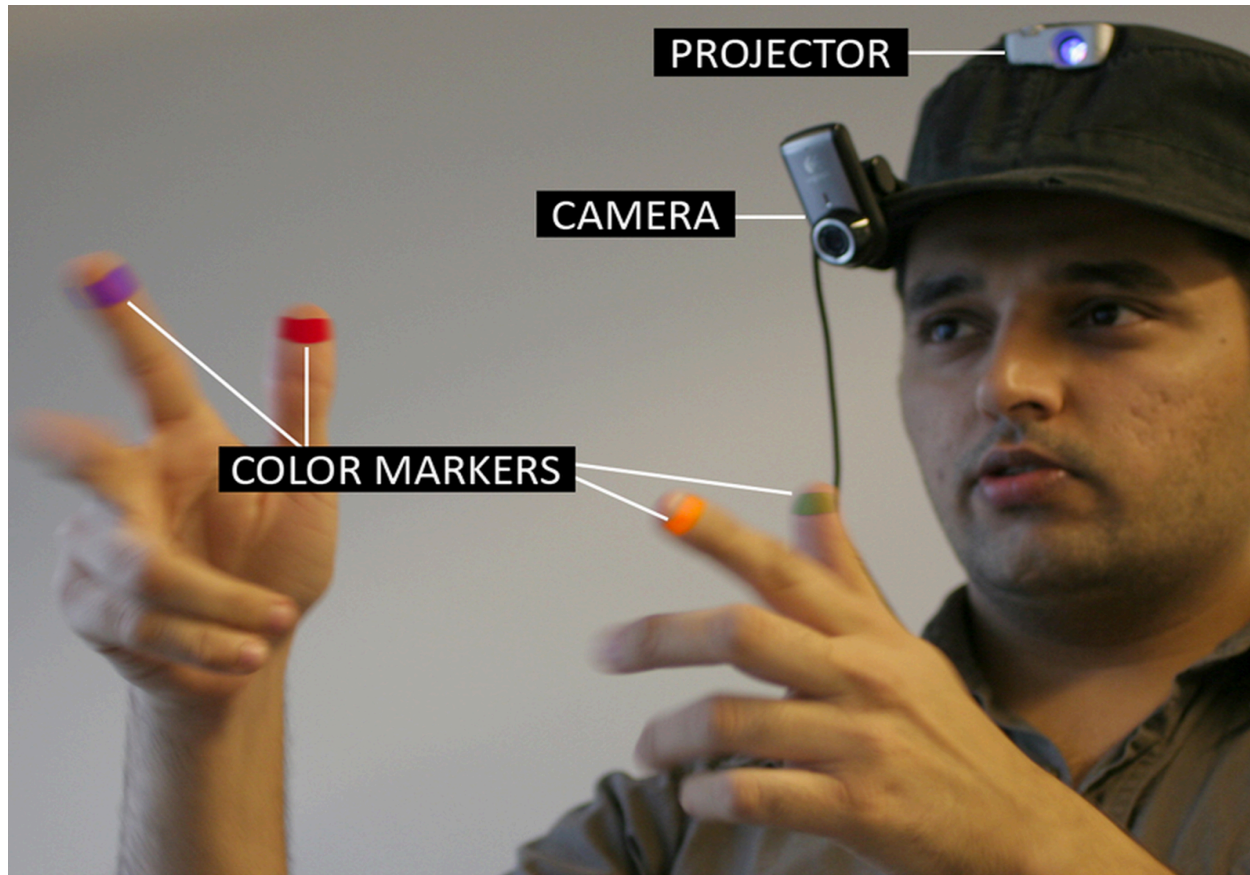|	
2 papers	GENERAL CHALLENGES: make interaction intuitive reduce fatigue upon prolonged use

1 paper

multi-tasking on-the-go

RECOGNITION TECHNIQUES

- Reflective/infrared/color markers
- Devices fixed to wrist/hands/fingers
- Free-form
  - RGB cameras
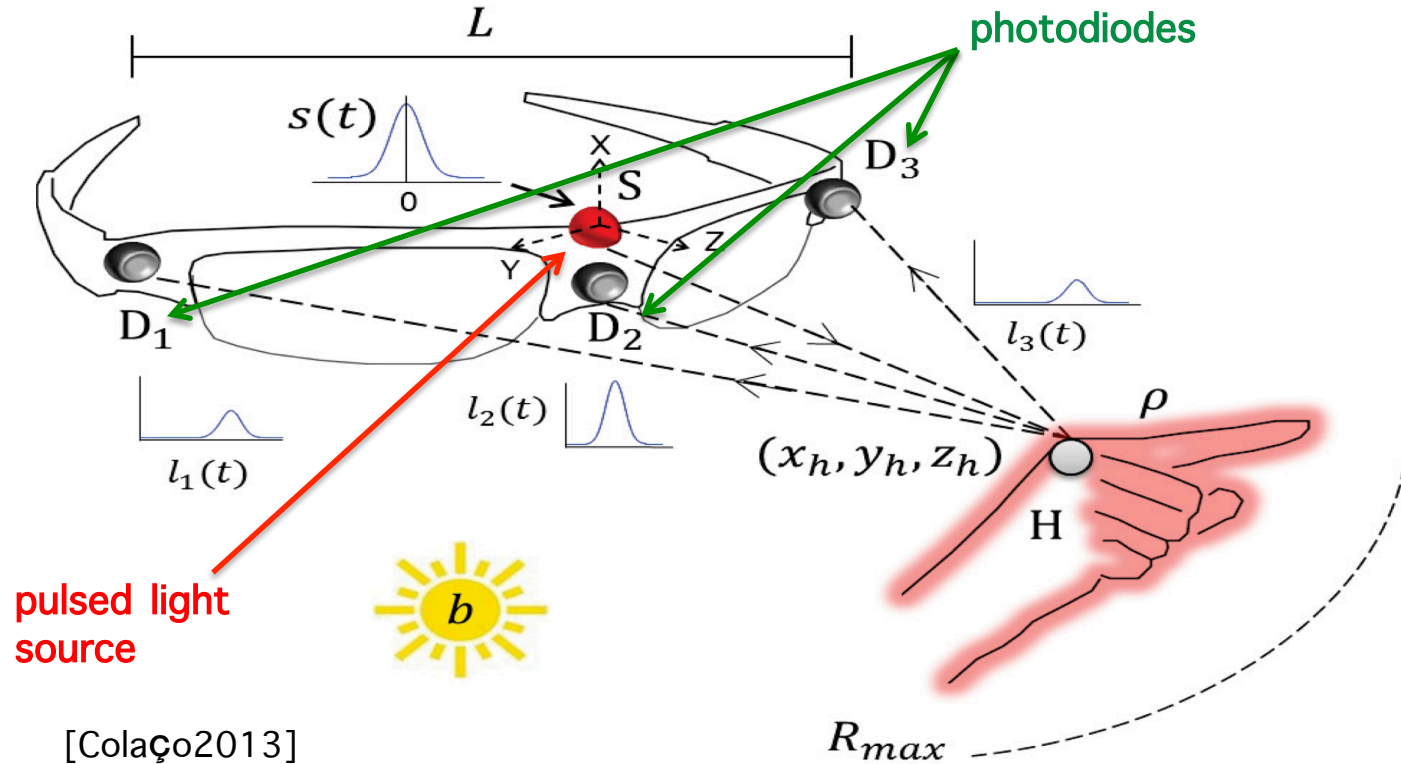 - 3D cameras
  - depth-sensors
  - eletrical fields

http://www.pranavmistry.com/projects/sixthsense/

Future scenario: all-in-one smart glasses

Sixth Sense

modified from http://www.pranavmistry.com/projects/sixthsense/

Mime

photodiodes

pulsed light source

[Colaço2013]
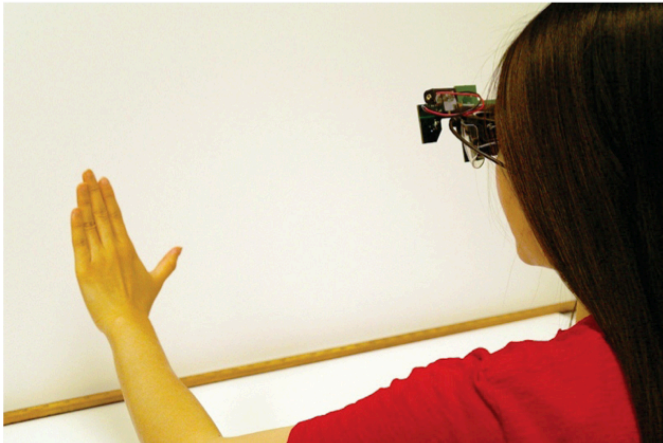
3D Time of flight (TOF) sensor
- basic gestures
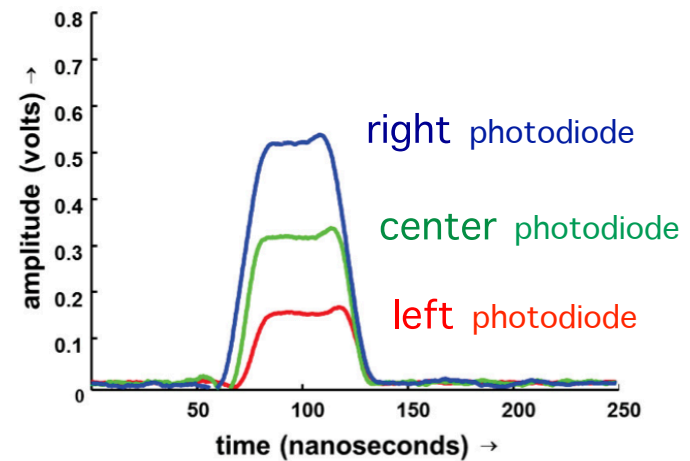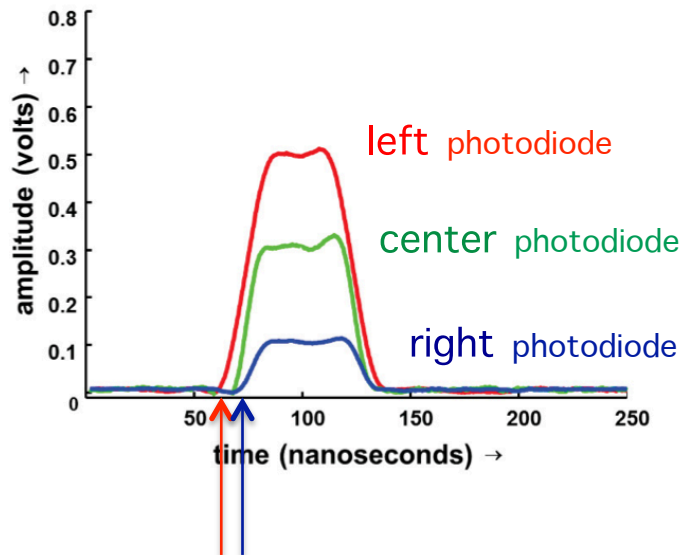- determines 3D hand coordinates

RGB camera
- finer shape-based gestures
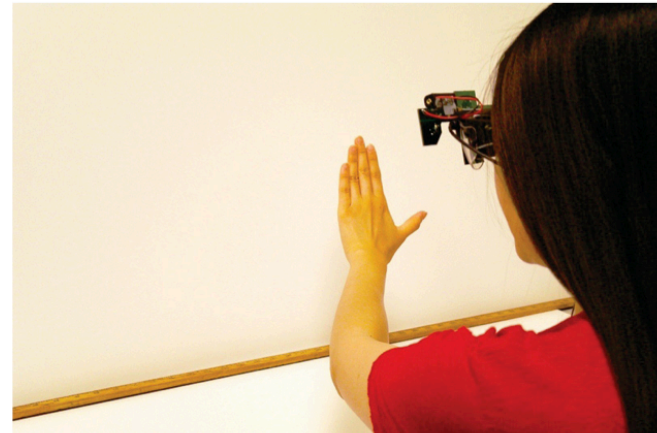- computationally expensive
- fails with cluttered background
- gestures recognition algorithms on selected Region of Interest

[Colaço2013]

Mime - applications

In-air drawing and immersive gaming (3D TOF only for these examples)

https://www.youtube.com/watch?v=bEO1FVibl44

Mime - applications

Interactive capture tool for photography (3D TOF + RGB)
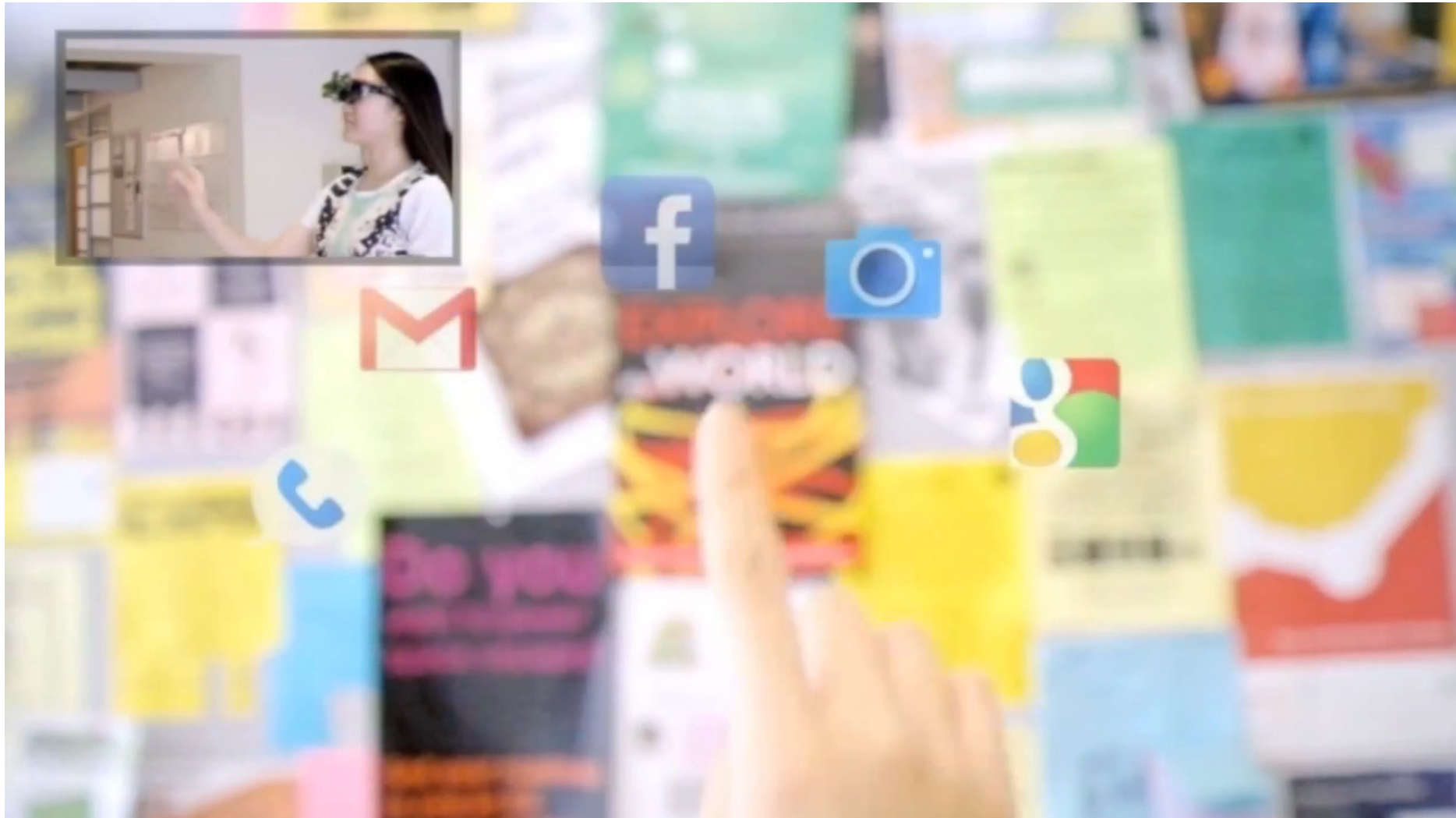
Mime — state-of-the-art comparison

Mime - state-of-the-art comparison

more precise, more control →

digits

hand-held
controllers

gestures
with gloves,
markers,
IR trackers

3D gestures with
compact depth
cameras

Mime
(this paper)

2D gestures
with RGB
cameras

voice control

wearable/external sensor | HMD peripheral | HMD embedded

high ← **encumbrance** → low

[Colaço2013]
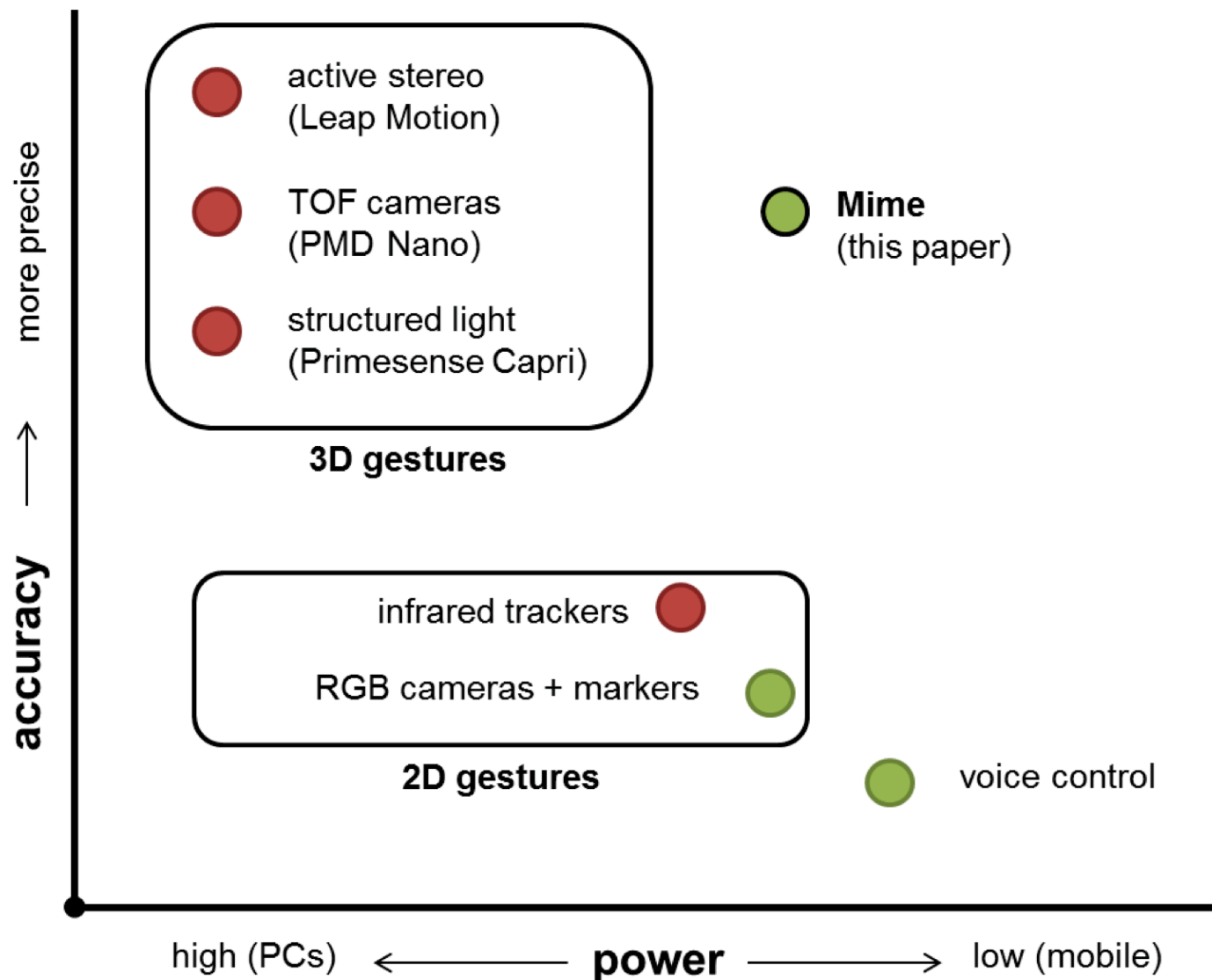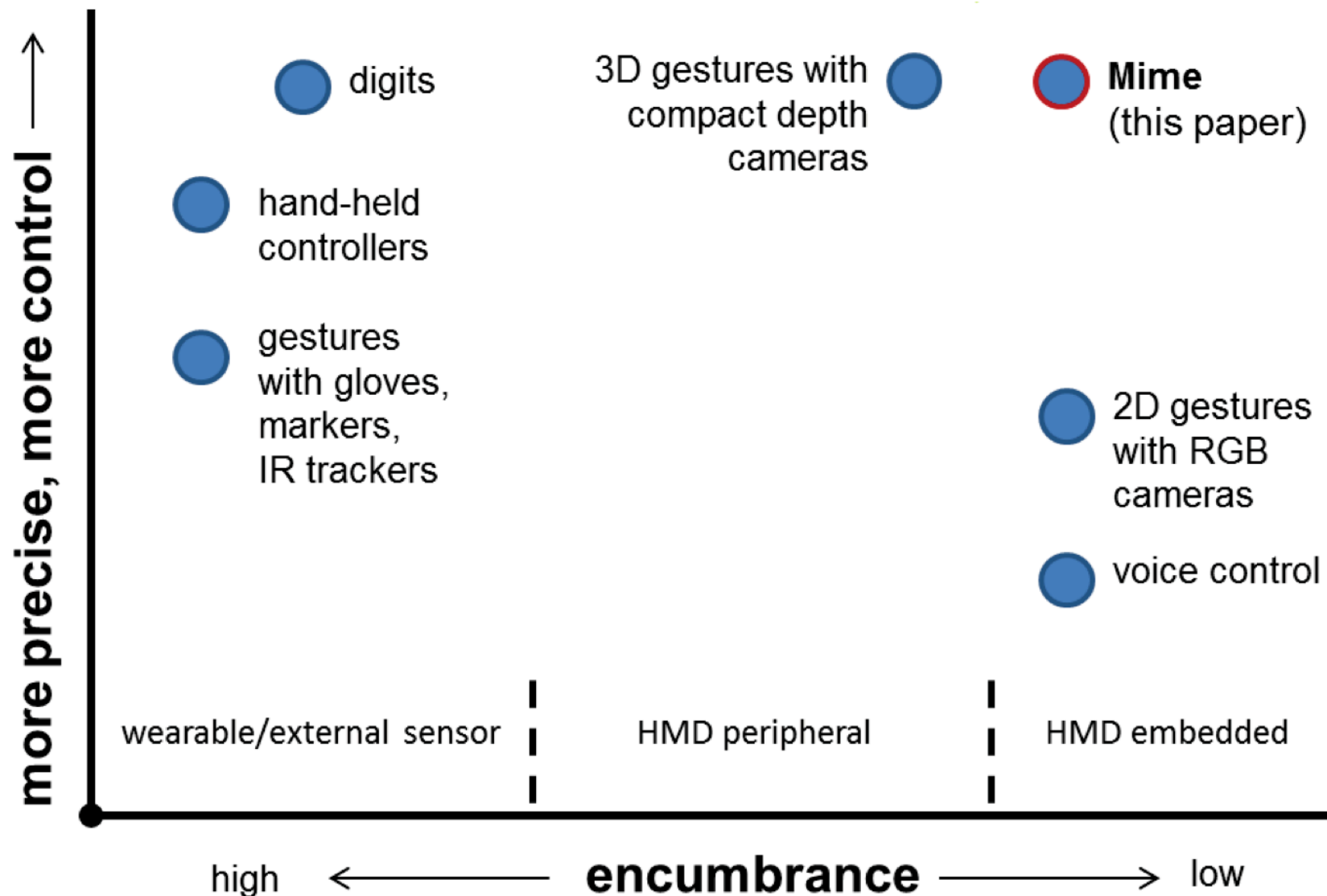
Mime – advantages and limitations

👍 Free-form interaction

Very small size (embedded into Head-worn display)

Daylight insensitivity

Low power consumption

Inexpensive technology

Centimeter-accurate 3D localization

👎 Single-handed operation

Multiple-finger detection by RGB camera

[Colaço2013]

Privacy and social implications

Expected wearable device market value by Business Insider

from 2010 to 2018 (in million U.S. dollars)

Year	Market value (million U.S. dollars)
2010	6.3
2011	630
2012	1,260
2013	2,520
2014	5,166
2015	7,140
2016	8,862
2017	10,920
2018	12,642

?
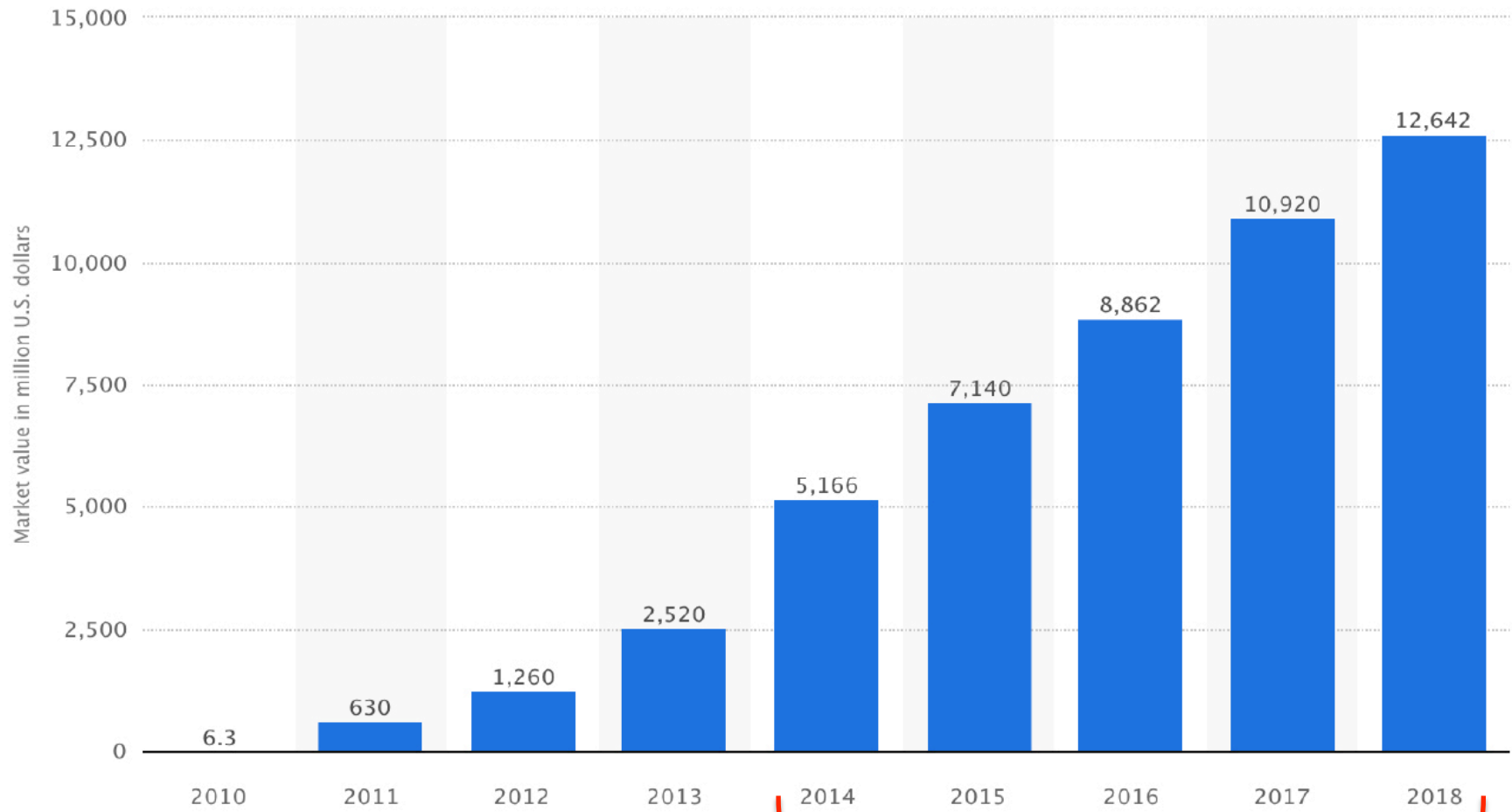
Would you consider buying and wearing Google Glasses?

72% of people would only buy the tech if it looked good

67% said devices would need to fit with their personal style

http://www.dailymail.co.uk/sciencetech/article-2536435/Would-YOU-wear-gadgets-Wearable-tech-set-2014s-biggest-trend.html#ixzz2xRO9gimW
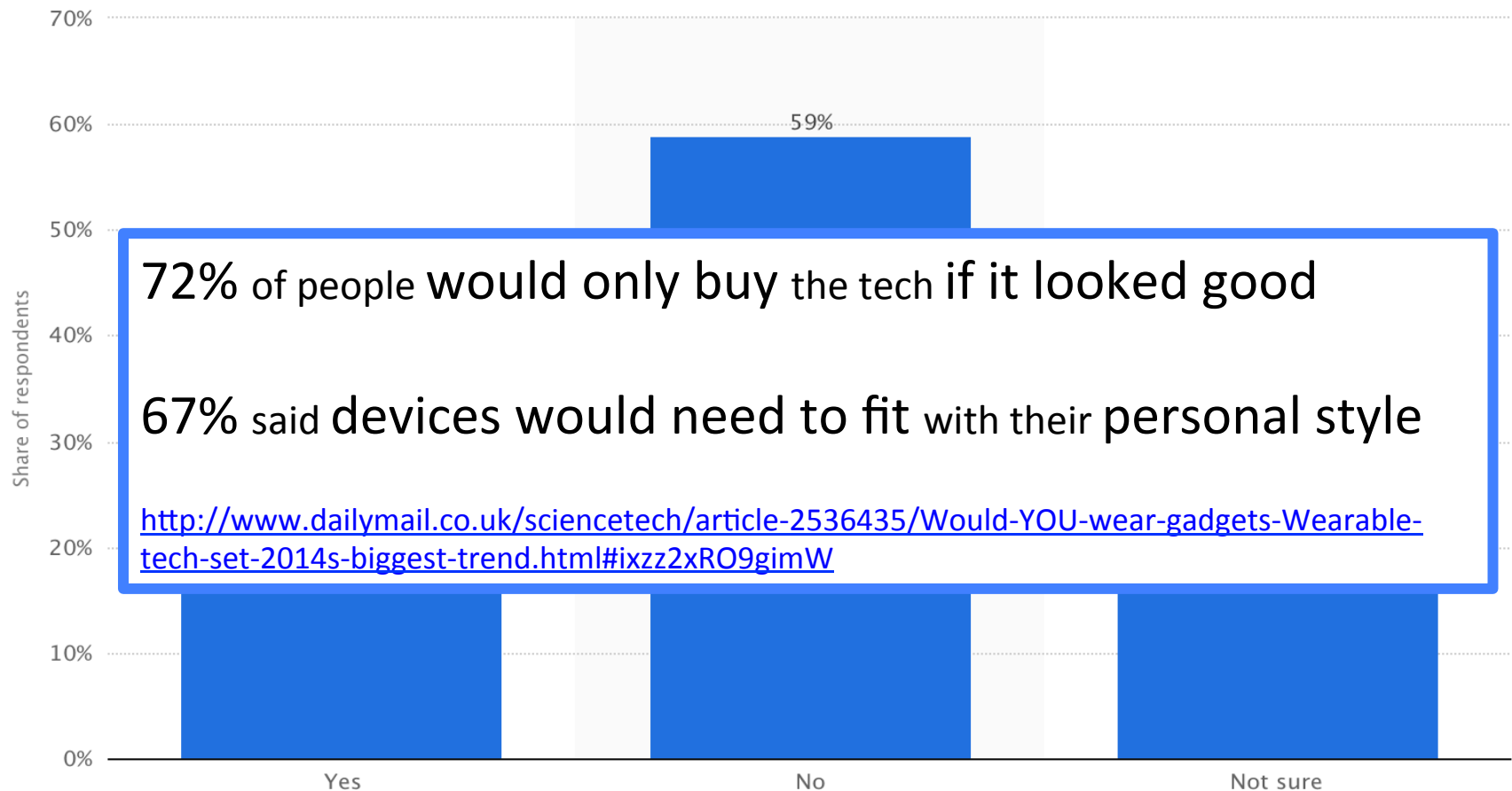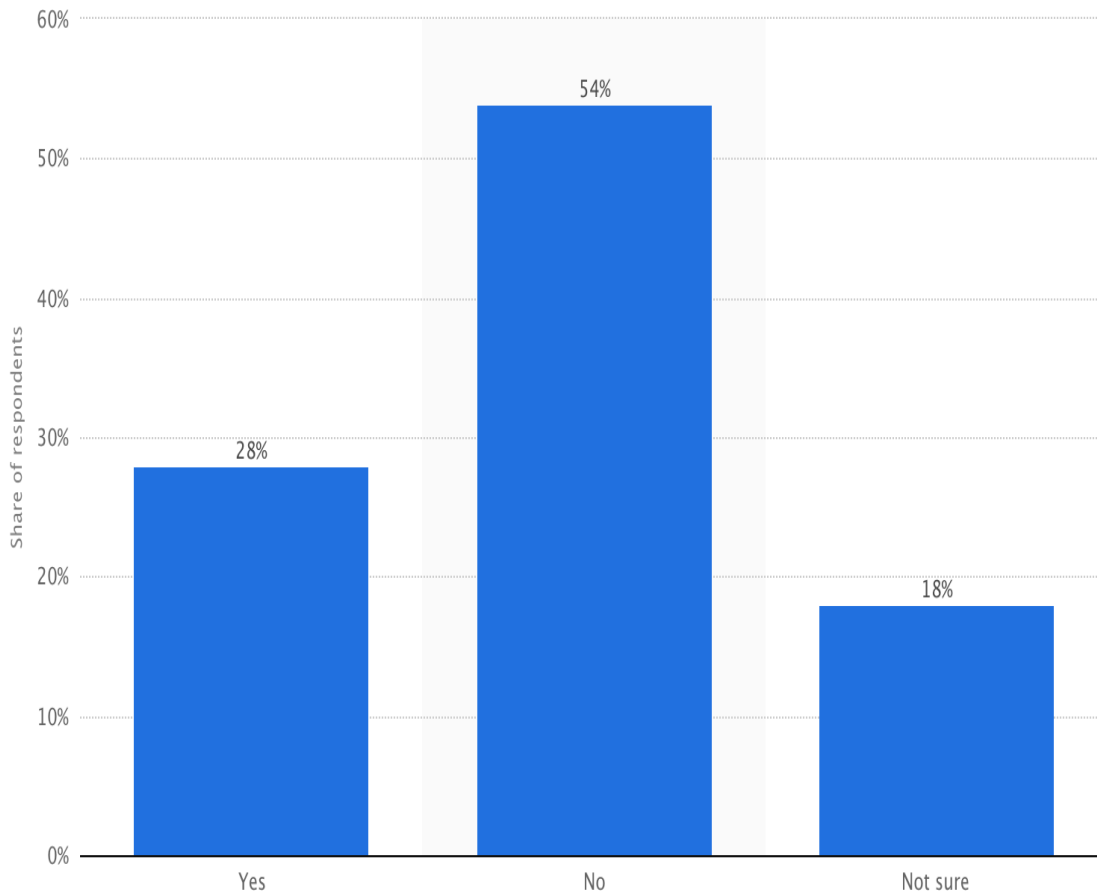
Additional Information
United States

Conditions under which this result has been obtained are unknown.
This is not a scientific study.

Would you feel comfortable interacting with someone wearing Google Glasses?

Share of respondents

- 60%
- 54%
- 50%
- 40%
- 30% — 28%
- 20% — 18%
- 10%
- 0%

Yes | No | Not sure

Conditions under which this result has been obtained are unknown.
This is not a scientific study.

Source:
YouGov
© Statista 2014

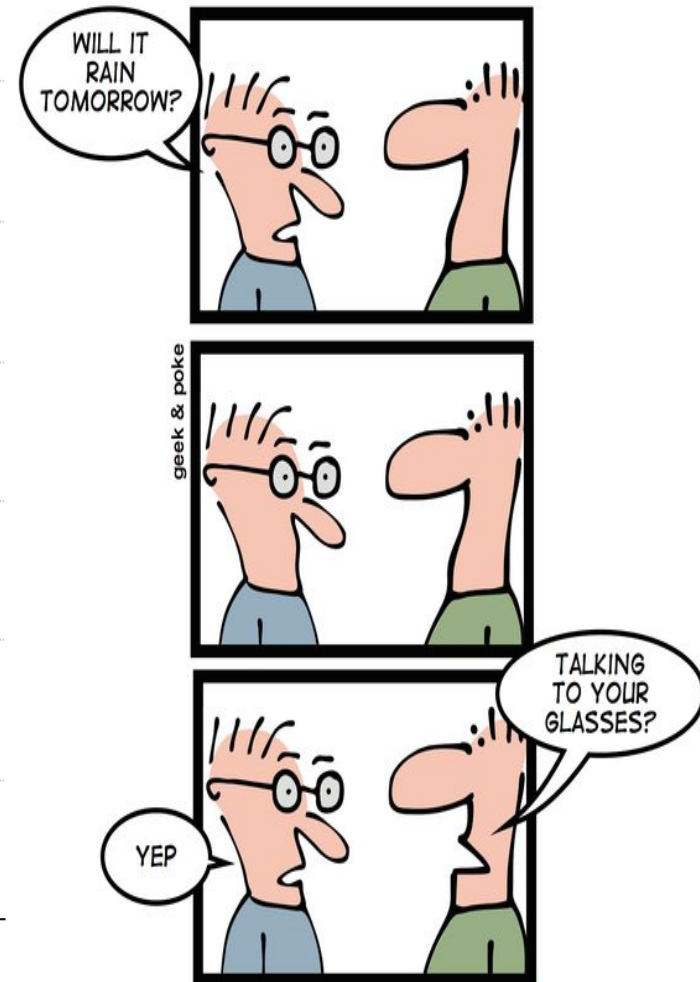http://geekandpoke.typepad.com/.a/
6a00d8341d3df553ef017d423eeb69970c
-800wi

16

Social implications

PERCEIVED DRAWBACKS

Acceptance (appearance, social interaction)

Security

Privacy

Loss of self-governance, control and skills

Changes in human behaviour

Health

BENEFITS

Everyday life positively affected: human senses and abilities empowered

Enhanced security and sometimes privacy

Scientific progress

Business opportunities

MAIN APPLICATIONS

Face-to-face collaboration and telepresence

Live streaming

Enhanced Context-awareness

Language translation and on-the-fly audio ←→ video conversion

browser history

bank details

SMS

wage

medical information

gender

posts on social networks

calls

PERSONAL DATA

purchases

activities

location

email address

religion

name

bookmarks

photo

phone number

age

emails

mood

Privacy

"**The right to be let alone**" and "**general right to the immunity of the person, the right to one's personality**" Warren and Brandeis (1890)

"**Privacy is the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others.**" Alan Westin (1970)

ISSUES RAISED BY:
- Telegraphs and telephones
- Cameras
- Databases
- Internet and e-commerce
- Mobile devices
- Ubiquitous computing and wearable devices

Ubiquitous computing related issues

Focus on **ORDINARY ACTIONS** rather than **special events**

Smart: fridges, cars, phones, heating, bracelets/watches, TVs, cloth, toys, forniture, **glasses**,…

collect huge amounts of data continuosly

↓

Data mining => patterns and preferences

↓

tailored services for individuals and the crowd

Although
* devices are secure
* trusting the service providers

Users do not know

* **who** can legitimately access their data
* **what** they do with it

Who accesses our data

Digital dossiers may contain:

finances, health, psychology, religious/political beliefs, interests, and lifestyle

accessed by

- Governments
- Financial institutions and banks
- Employers
- Law enforcement officials
- Companies

All data recorded by Google Glass will be on Google's servers

Google scans emails of Gmail users to target advertising

not very intimate data → no direct injury

Law does not respond

users accept terms and conditions

Main dreaded issue with smart glasses

Being captured/recorded by strangers

end-user vs. end-user problem

Capturing and recording ANYTHING AND ANYONE

- **Public space: Legal**, rare exceptions (e.g. Hungary, some touristic
  attractions, concerts -> copyright)
- Private places from inside: may be prohibited or restricted by the owner
- Private property generally open to the public: usually permitted unless explicitly
  prohibited by signs

Google bans facial recognition Glass Apps (saves from "labelling" effect)

Individuals do have an expectation of ANONYMITY

Smart glasses may lead people to change their social/public behaviour

Content provided by smart glasses

Smart glasses represent the interests of both users and third parties

Smart glasses supply companies with:

- Same data a smartphone can supply (sensors data, browsing history, etc.)
- Data about purchases in real life
- What the user looks at in a scene
- How the user reacts to what s/he sees

New business models

- direct access to consumers, ads more tailored than before
- if smart glass becomes trusted agents, firms could rely on its authority to convince users

WHO HAS THE POWER TO DECIDE HOW WE WILL PERCEIVE AND SEE THE WORLD?

We lose control of ourselves

Are smart glasses more likely to

enhance human autonomy and freedom or diminish it?

Devices may have a better understanding of people than people have themselves

👍

proactively anticipate users' needs and **take action** on their behalf

=> humans can focus on **higher-level tasks, less cognitive and physical effort**

👎

- actions may not correspond to real needs or intentions

=> corrective actions required

- preferences of people change over time
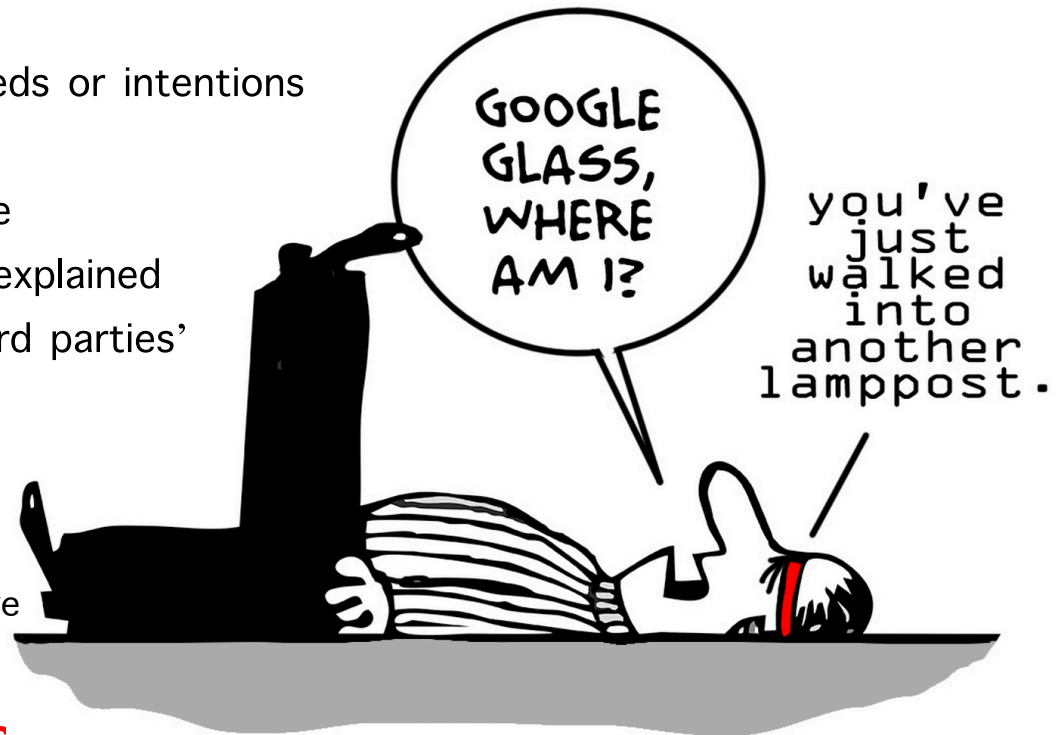- complex algorithms, results cannot be explained
- devices disloyal to users to respect third parties' interests

↓

Cognitive dissonance

device becomes psychologically obtrusive

GOOGLE GLASS, WHERE AM I?

you've just walked into another lamppost.

© D.Fletcher for CloudTweaks.com

- **LOSS OF AUTONOMY AND SKILLS**

Paradoxes about smart glasses

- Smart glass: master/slave

- Smart glass will know us better than we do

- One more device to threaten users' safety, but it also makes users feel safer

- Advertisement plays fundamental role, but apps for diminished reality

- Designed to bring users back to live interaction and society, but you can browse while looking into someone's eyes

- While driving, it would help with texting, calling and checking directions, but it will be forbidden

A week with Glass

Glass made for micro-interactions but he watched video and read long document without trouble and sight problems

Other people:

- know if you interact with glass
- can see if screen is on
- recognize what's on the screen if they get close enough

People kept staring at Glass instead of looking into my eyes

3 typical reactions – acceptance

- WOW, cool! Can I try it?
- Stop violating my privacy!
- What's wrong with this guy? He wears a medical device!

Very **obvious if a person is using the device/taking a picture**

To take covert pictures/videos of people, maybe easier with

today's smartphones or spy cameras.

Grandparents with Google Glass

Easy for them to **setup** and **use**

Both saw HIGH POTENTIAL in Google Glass and could imagine
wearing it during the day

Proposed really interesting applications
- Glass, did I take the pills?
- During garden work
   - Hand-free
   - Live streaming to get advice
- Shopping

Privacy concept depends on the ethnic group and the geographical area

↓

India: human density is very high and personal privacy is not presumed

People not worried at all

rather

Smart Glasses have enormous potential there

- They love taking plenty of pictures
- There are many software developers
- They are really willing to adapt wearable technologies to their needs

What happens these days

A girl cited for driving while using Google Glass by a law enforcement officer in California

↓

Not enough evidence to prove Glass was on = unguilty

California

"Each officer has to take each case on a case-by-case basis" (CHP Public Affairs Officer)

Some states

Have already forbidden it while driving

CLEAR NEED OF AD-HOC REGULATIONS

(for activities and places, e.g. institutional buildings, schools, etc.)

TO BE CONSIDERED for SENTENCES:
- Was Google Glass **active**?
- If Google Glass was active, **what was it doing**?

Forensics able to answer analysing LOGS

Conclusions

A default **flash should be incorporated** as standard in camera phones to prevent people taking covert pictures. The popularity of camera phones has made it much easier to take illicit photos without permission. (London-based Privacy International – 2004) http://news.bbc.co.uk/2/hi/technology/4017225.stm

"There is a **Big Brother component**... The thinking goes that if my friends can find me, the **telephone company** knows my location **all the time**, too."
(Privacy Lost: These Phones Can Find You – 2007 http://www.nytimes.com/2007/10/23/technology/23mobile.html?_r=0)

YES/NO technology and expectations of privacy change

No clear answer from research and Google about future measures

New Apple patent may help

Biggest and more popular issue is nothing really new

Thank you!

?

maricab@student.ethz.ch

Backup slides

Mime - state-of-the-art comparison

more precise, more control →

- digits
- hand-held controllers
- gestures with gloves, markers, IR trackers
- 3D gestures with compact depth cameras
- **Mime** (this paper)
- 2D gestures with RGB cameras
- voice control

wearable/external sensor | HMD peripheral | HMD embedded

high ← **encumbrance** → low
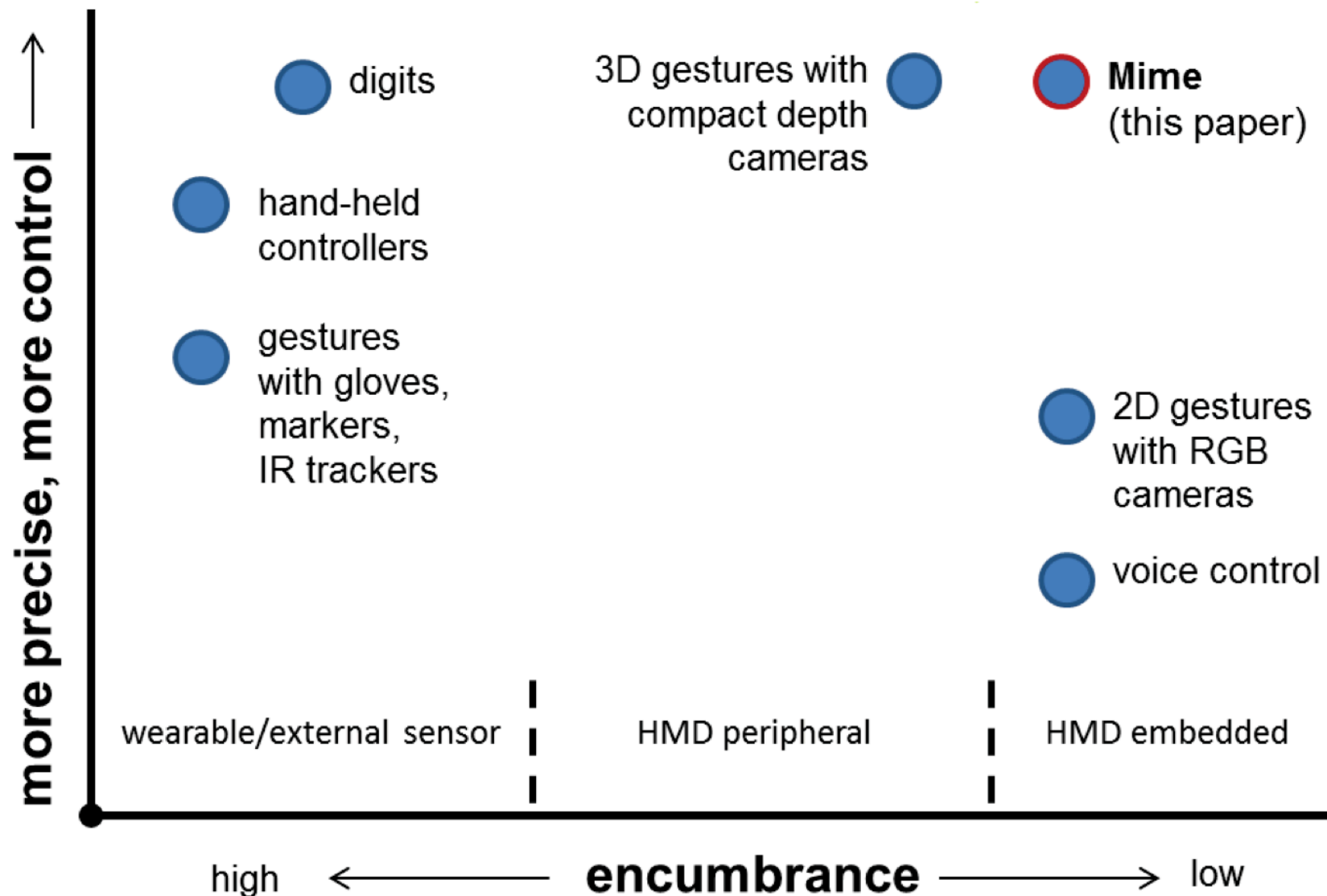
Imaginary Interfaces: spatial non-visual interfaces for mobile devices

Browsing Touch-and-explore interface exploits

user's tactile and proprioceptive senses

[Gustafson2013]

OptiTrack motion tracks reflective markers (limitation)
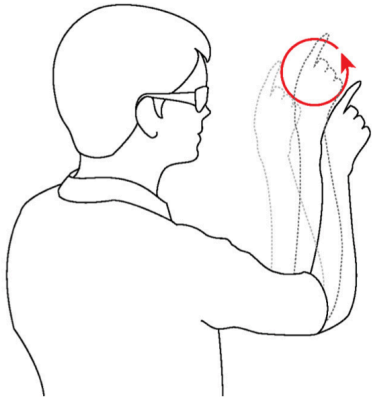
34
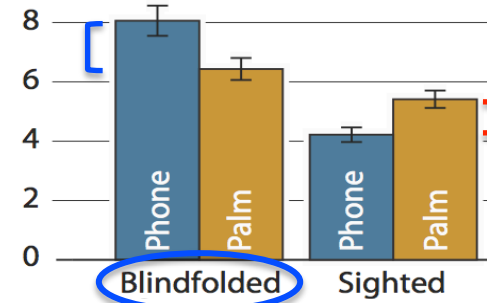
Tactile cues
Drawn grid
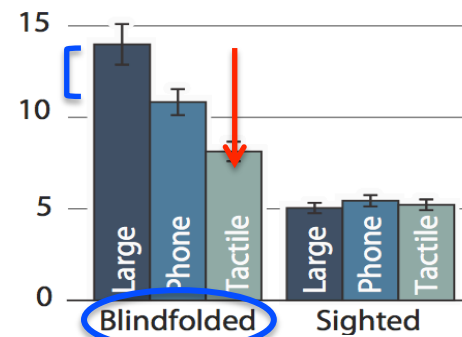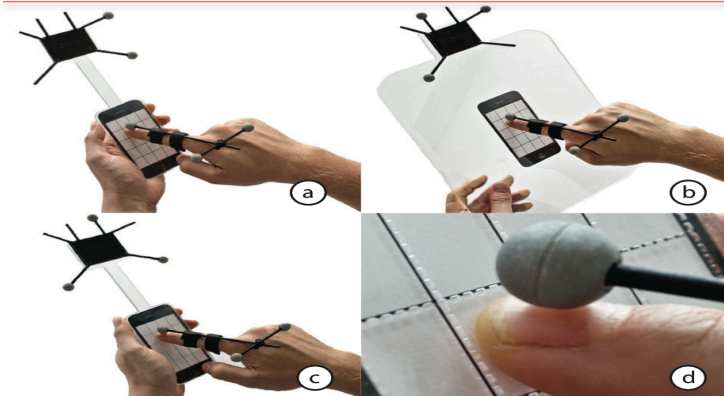
Bezel
Tactile grid
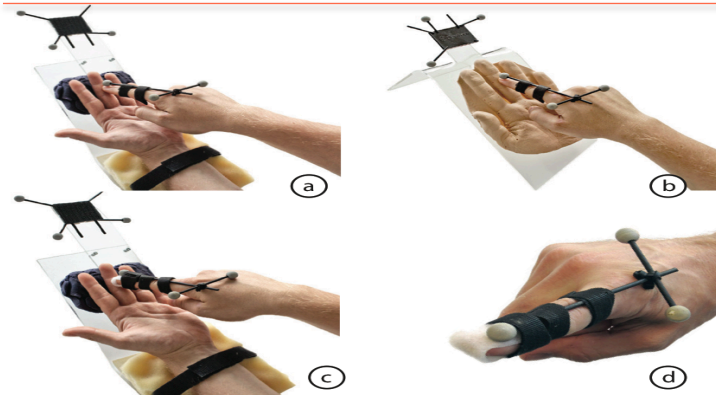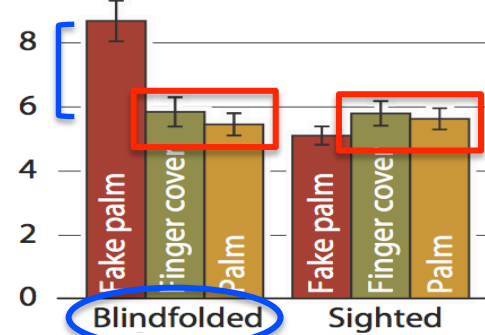
Palm
Finger

Smartphone screen in-air

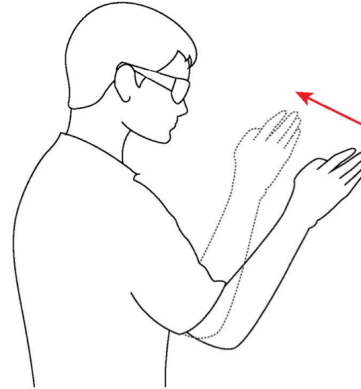modified from http://upload.wikimedia.org/wikipedia/commons/4/47/Regent_Street_London.jpg
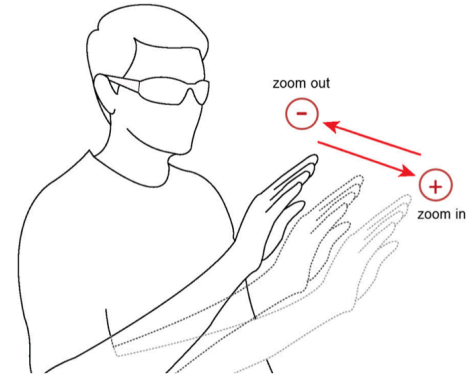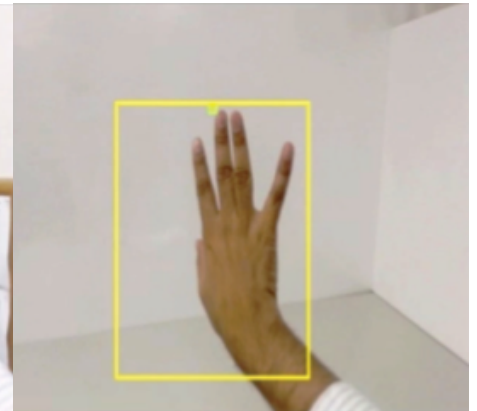
3D TOF sensor

circle   point-and-click   swipe   zoom in-out

RGB camera

[Colaço2013]

We lose control of the data
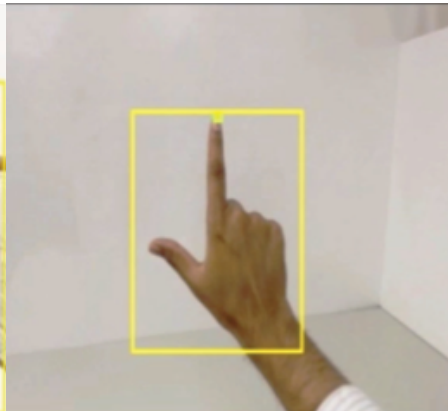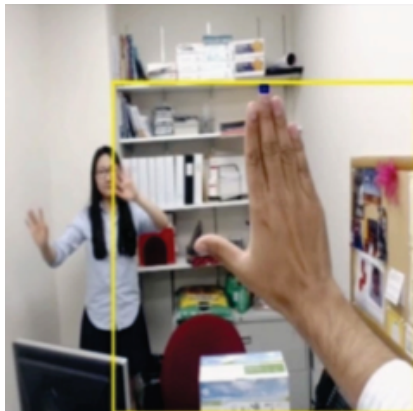
Attitudes towards data protection

- Just over a quarter of social network users **(26%)** and even fewer online shoppers **(18%)** feel in **complete control** of their personal data.
- **74%** of Europeans see **disclosing personal information** as an increasing part of modern life.
- **43%** of Internet users say they have been asked for **more personal information than necessary**.
- Only **one-third** of Europeans are aware of the existence of **a national public authority** responsible for **data protection (33%)**.
- **90%** of Europeans want the **same** data protection rights across the EU.

Special Eurobarometer 359
Attitudes on Data Protection and Electronic Identity in the European Union, June 2011

http://ec.europa.eu/justice/data-protection/document/review2012/factsheets/1_en.pdf