

HOBBS: Head Orientation-Based Selection in Physical Spaces

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Smart Lock
Lockitron



Smart Thermostat
Nest

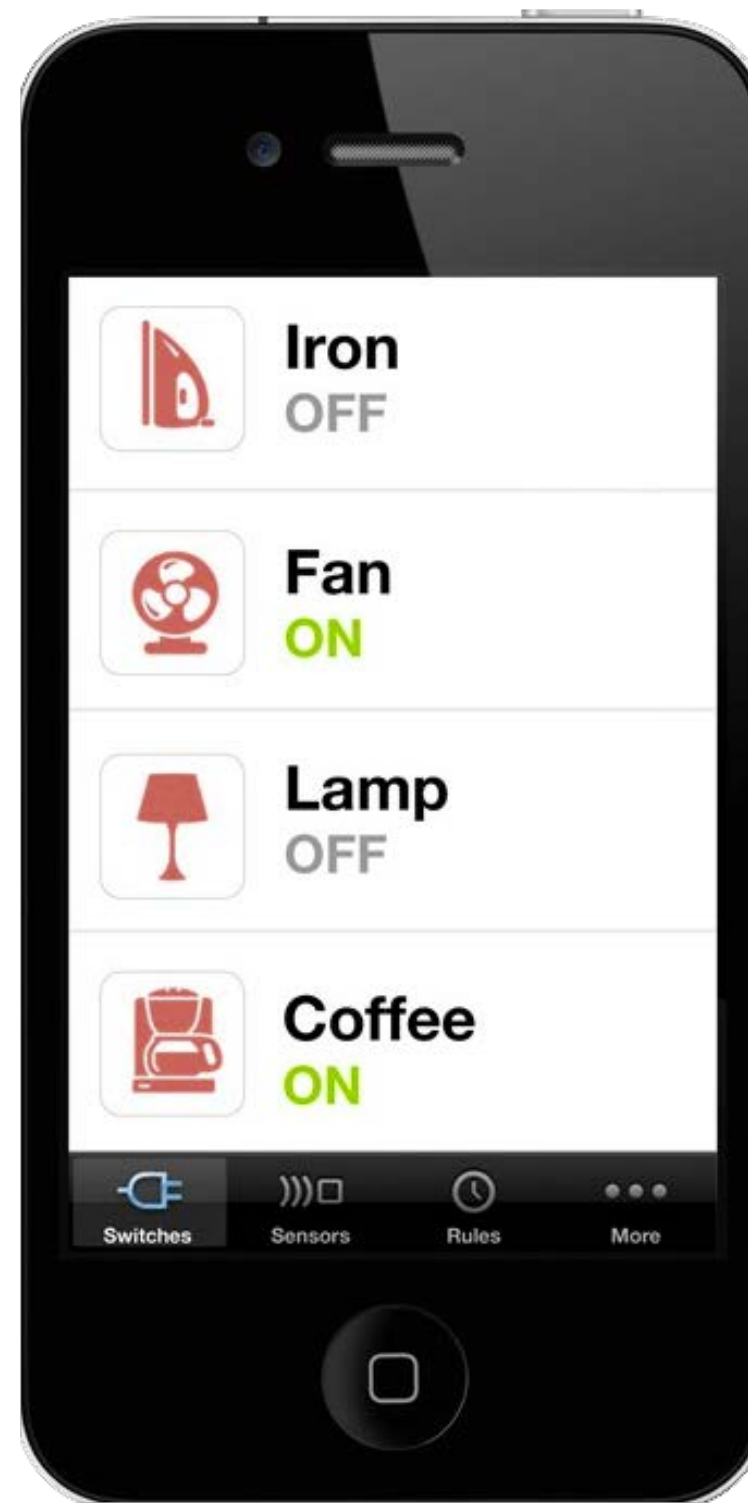
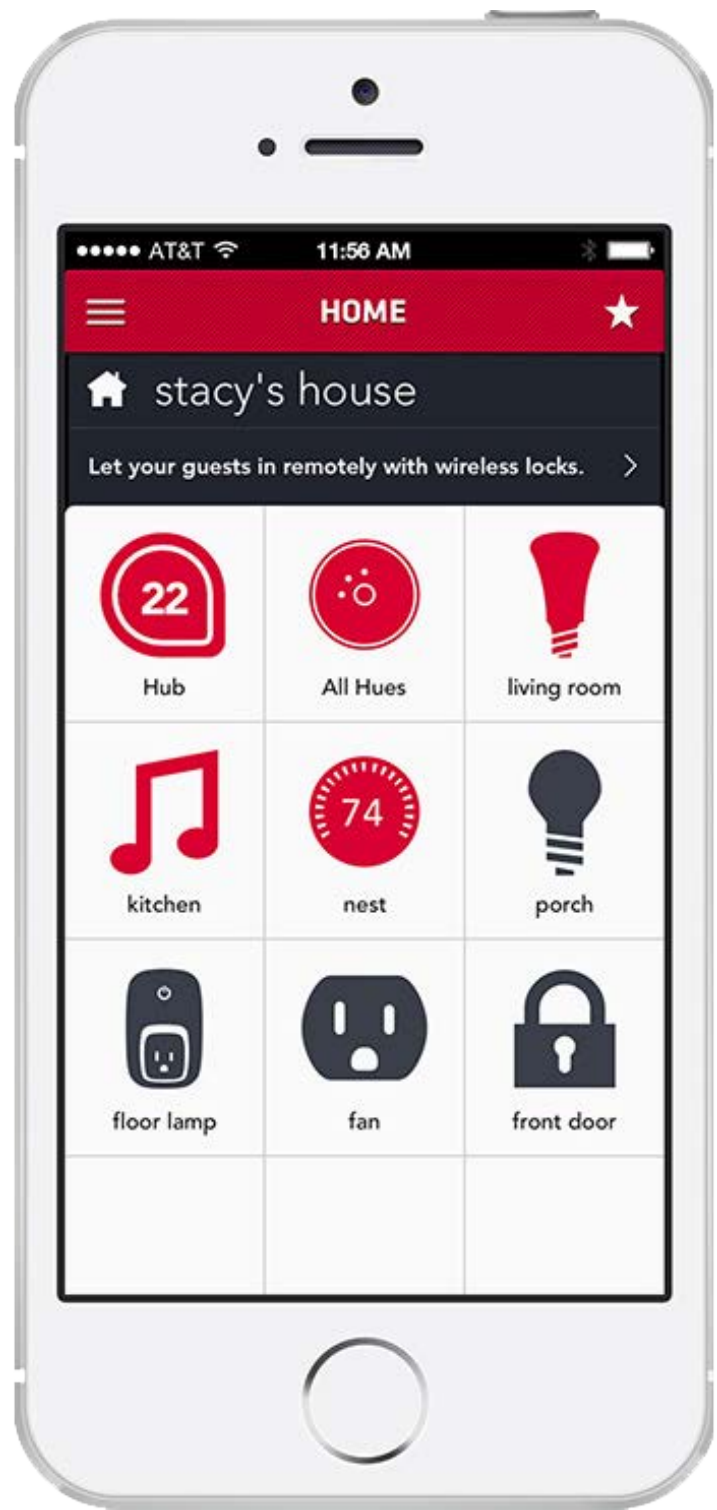


Smart Light
Philips Hue

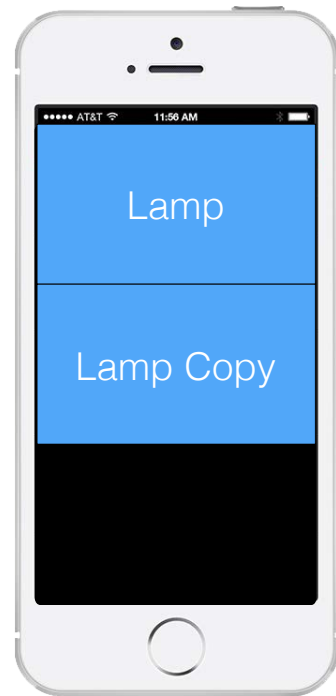


Smart Outlet
Belkin WeMo





naming



scaling



visual divide



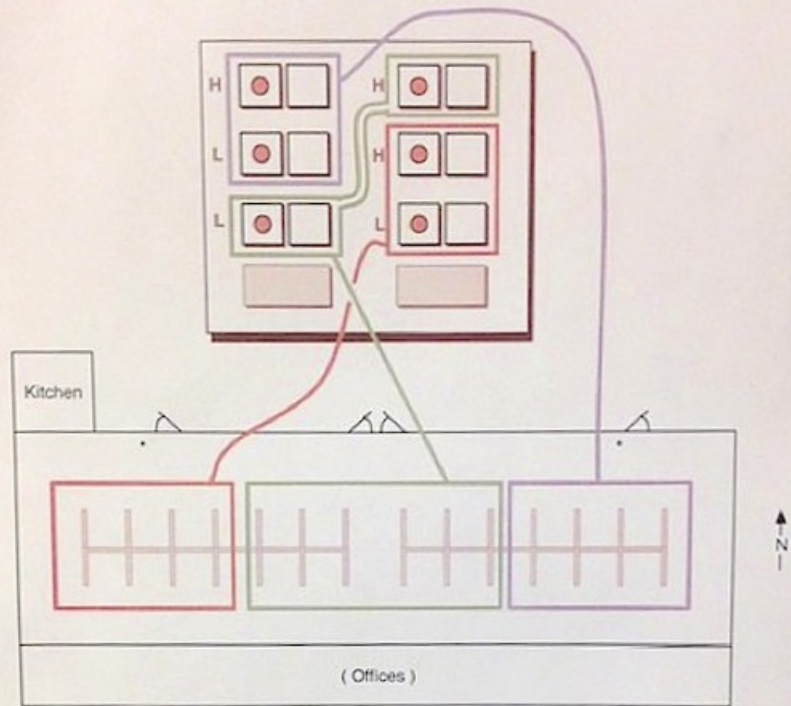


Lamp

Lamp Copy

Light Controls Explained

The cubicle area is divided into three lighting zones (shown below in different colors). Each zone is controlled by a pair of switches: the upper switch turns on the "high beams" and the lower switch turns on "low beams". If both switches are turned on, the lights go up to maximum brightness. Each switch is turned on by the red button and turned off by the adjacent blank button.



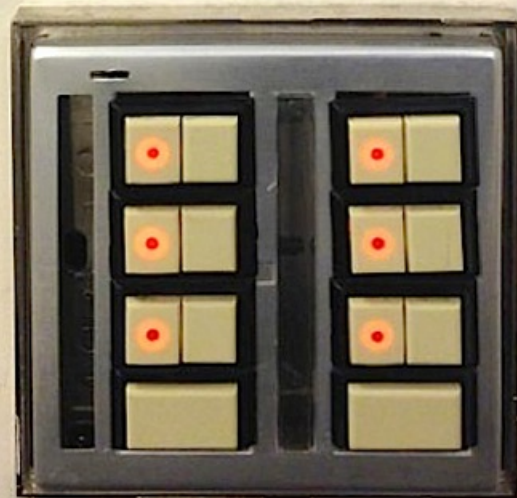
* Stairwell switches

There are another set of light switches by each stairwell.

The switch with the red dot controls the light over the nearby lounge.

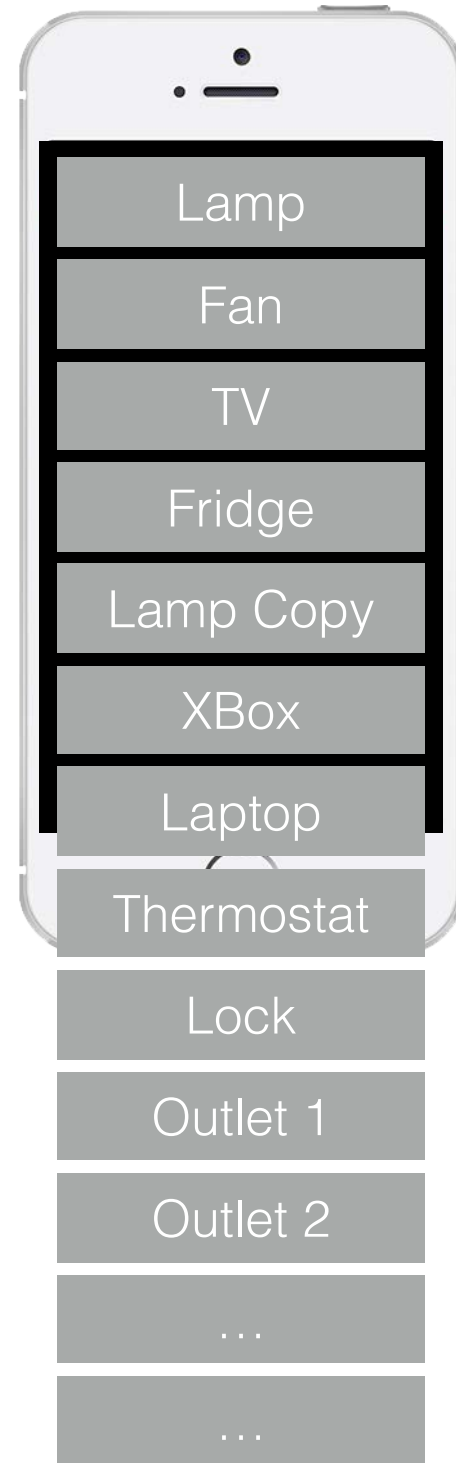


The switch without a red dot is a master control for the cubical area.



Light Controls Explained

The cubicle area is divided into three lighting zones...

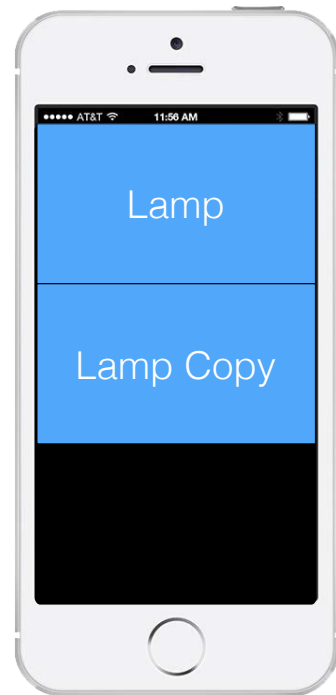




The visual divide of
controllers and
controlled objects.

Indirect Interaction

naming



scaling



visual divide



Head Orientation-Based Selection

“What You See Is What You Get” in **physical spaces**

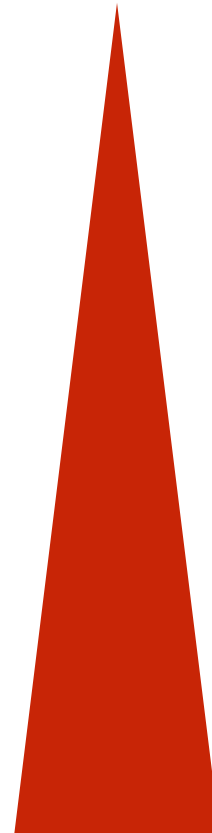




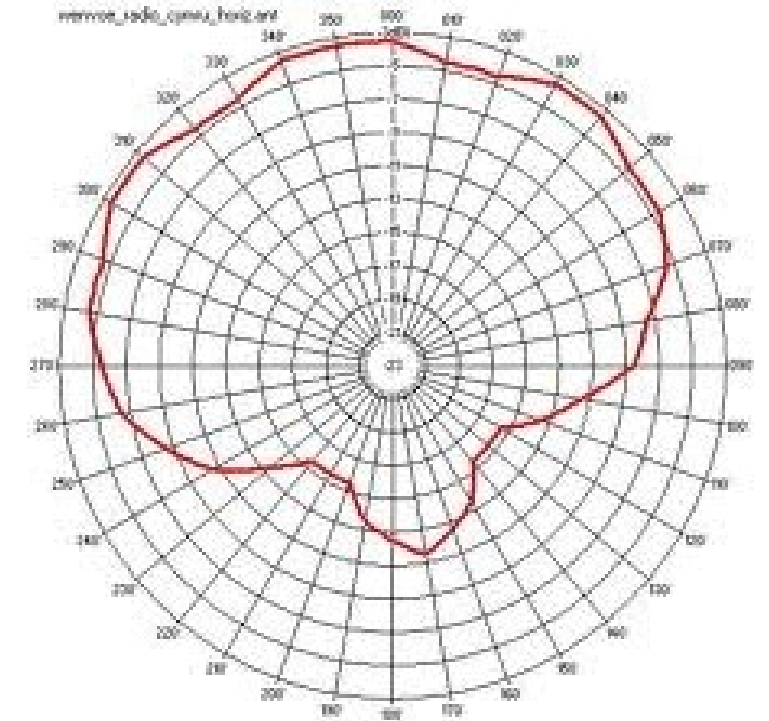
laser



infrared



radio



Head orientation has limited precision

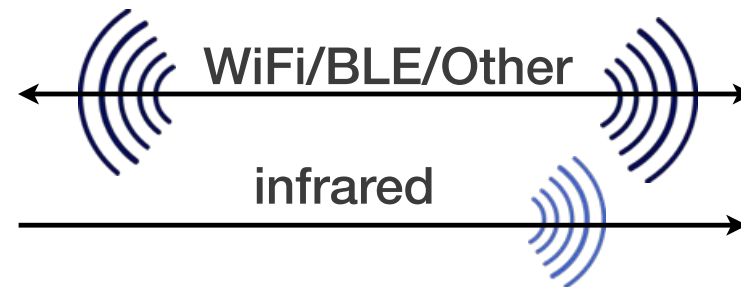
System Architecture



Android App

Glass

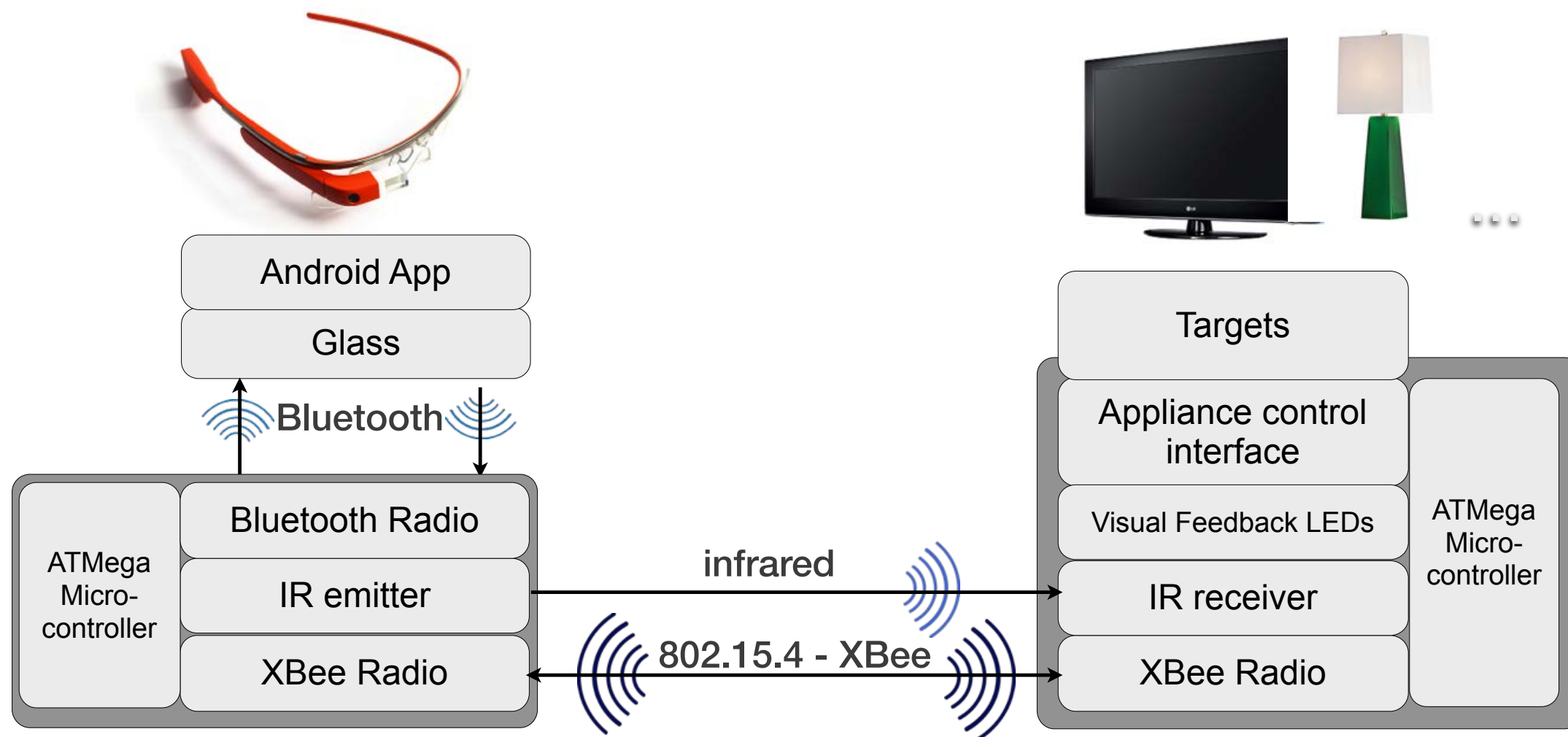
IR emitter



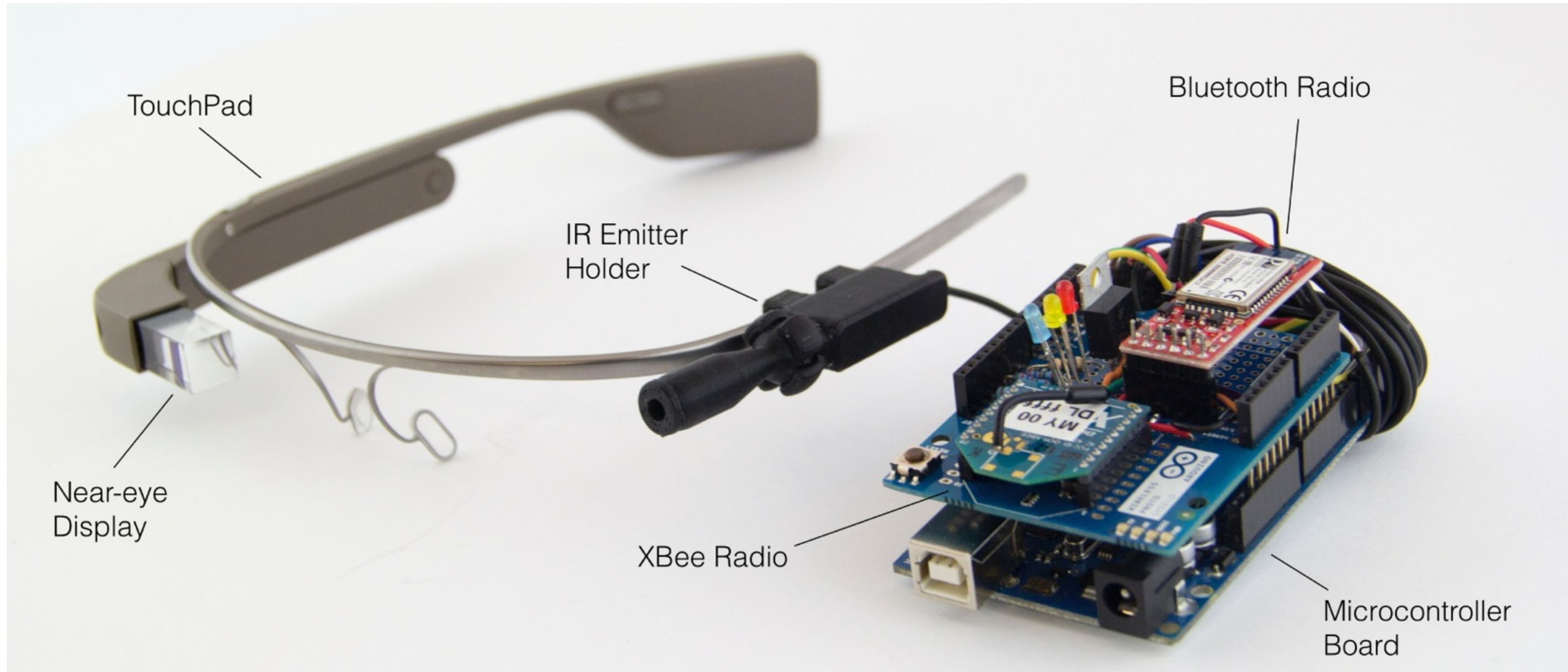
Targets

IR receiver

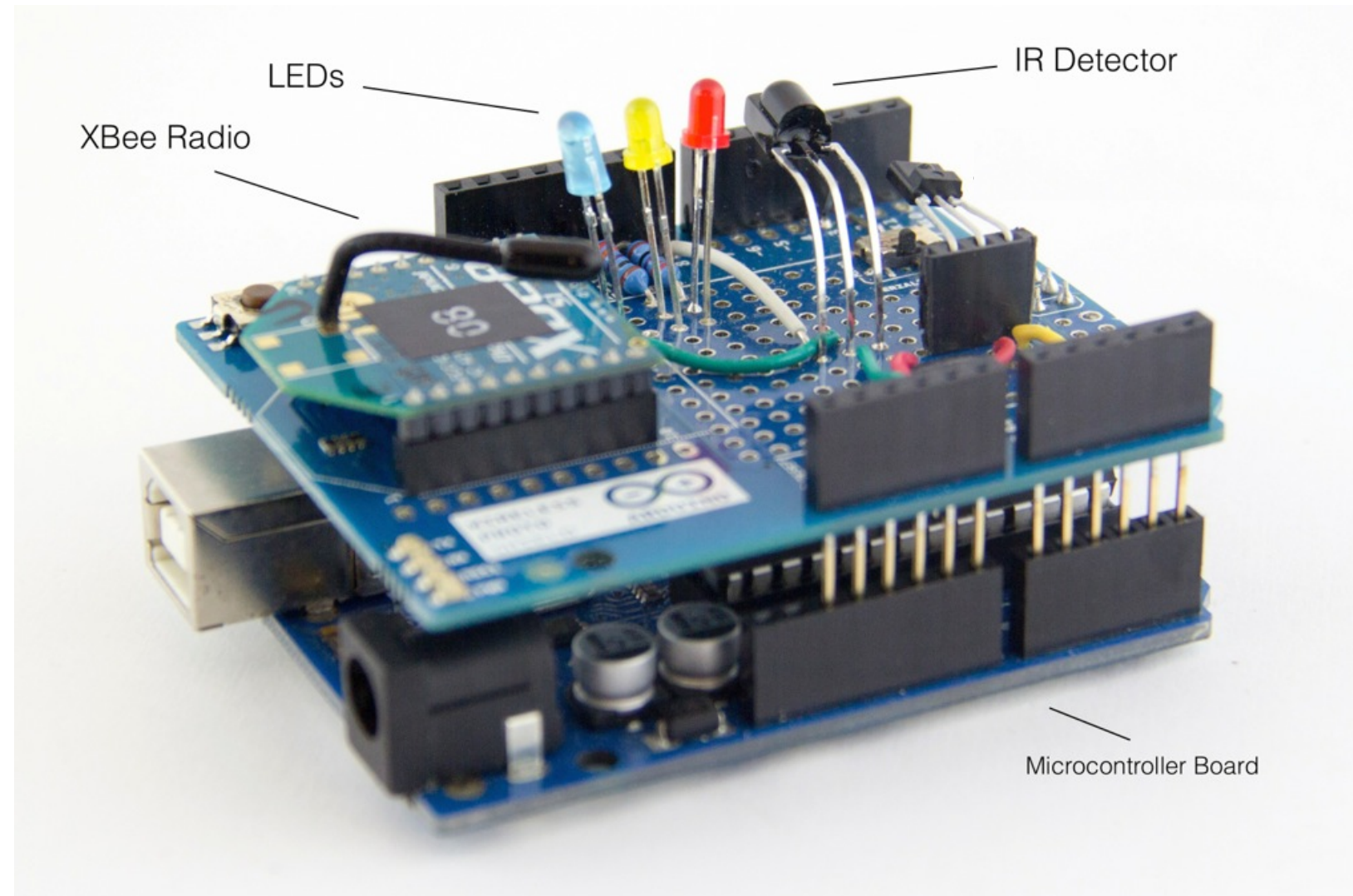
Prototype Architecture

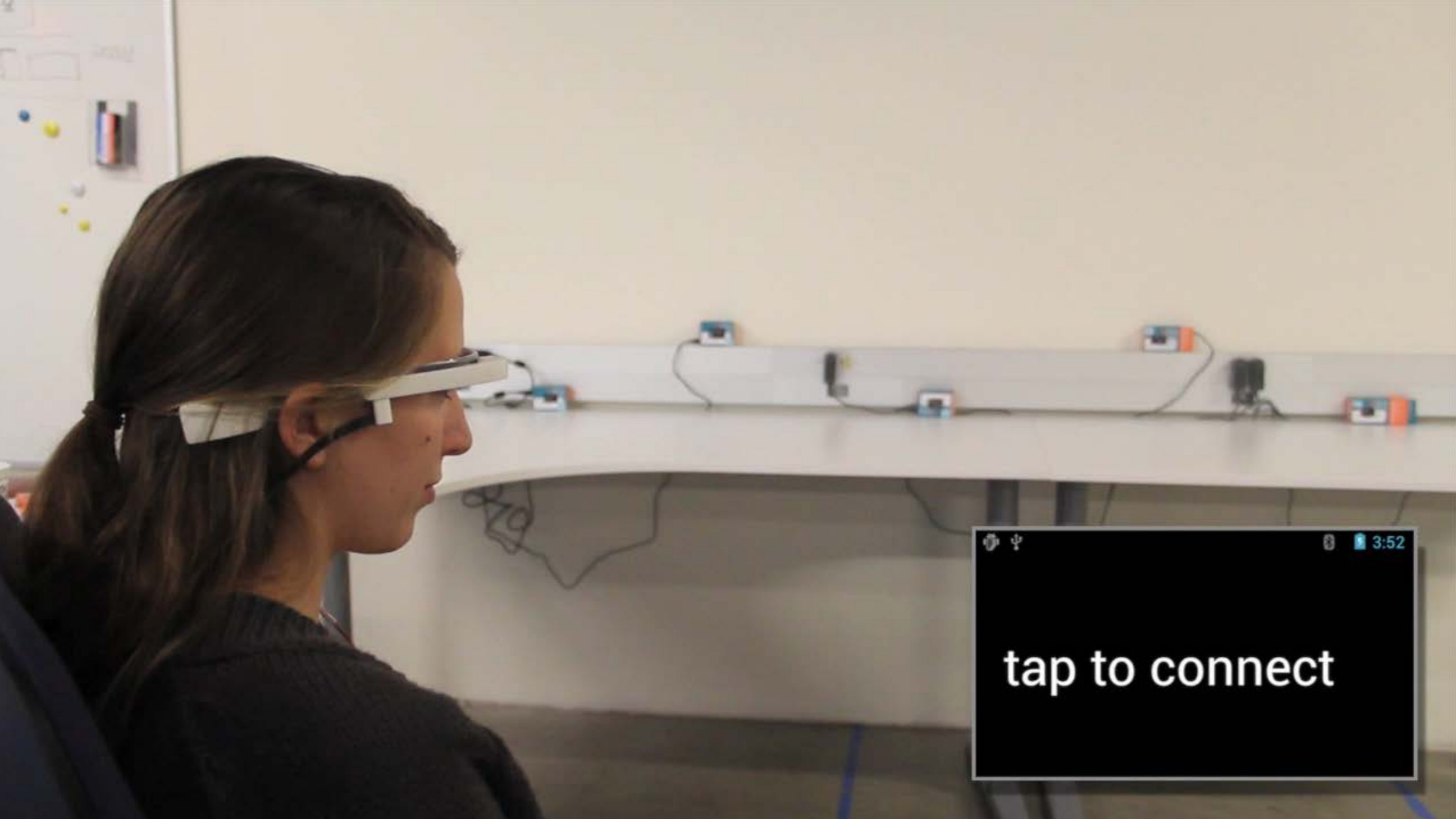


Prototype - Augmented Glass



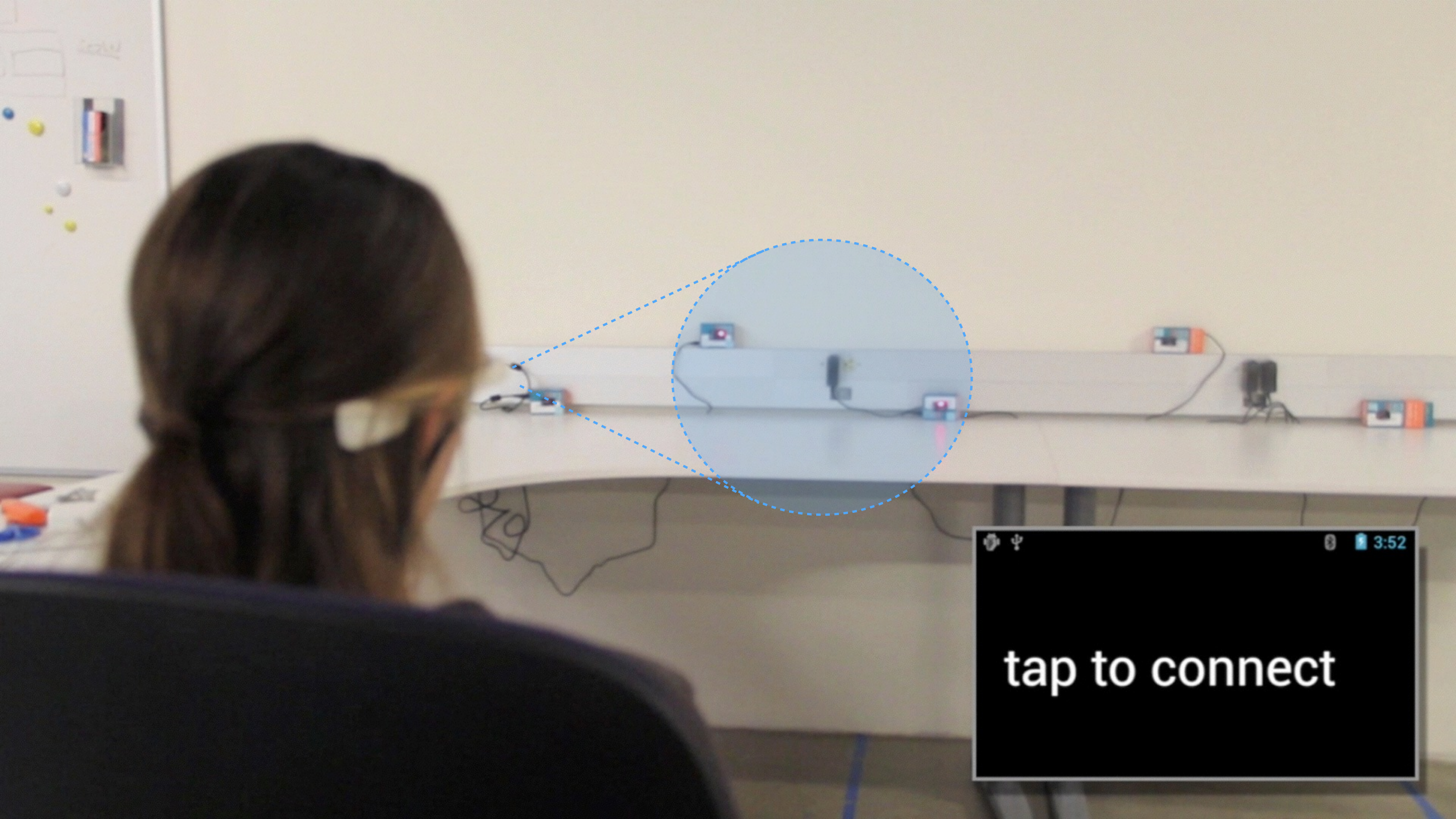
Prototype - Target Device





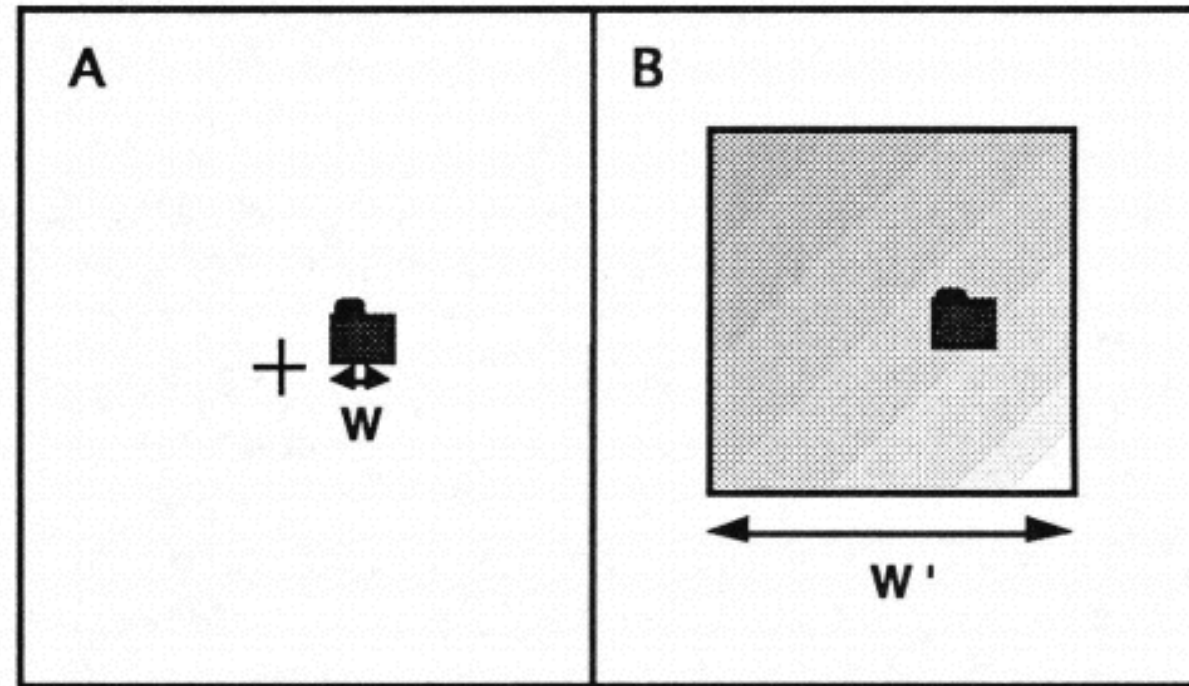
📶 🔌 3:52

tap to connect

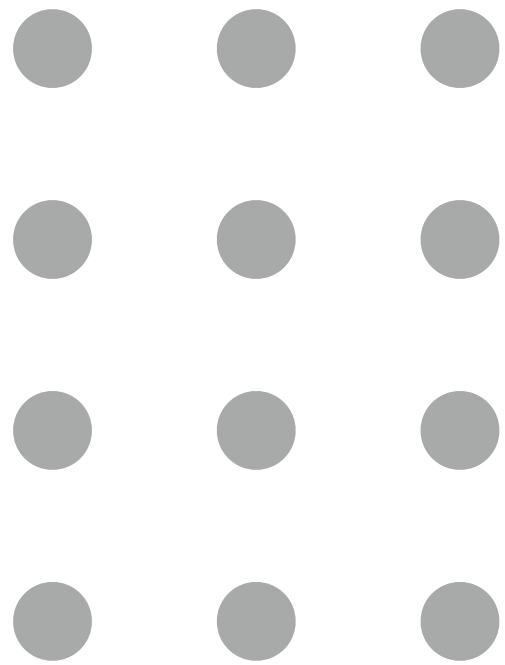


tap to connect

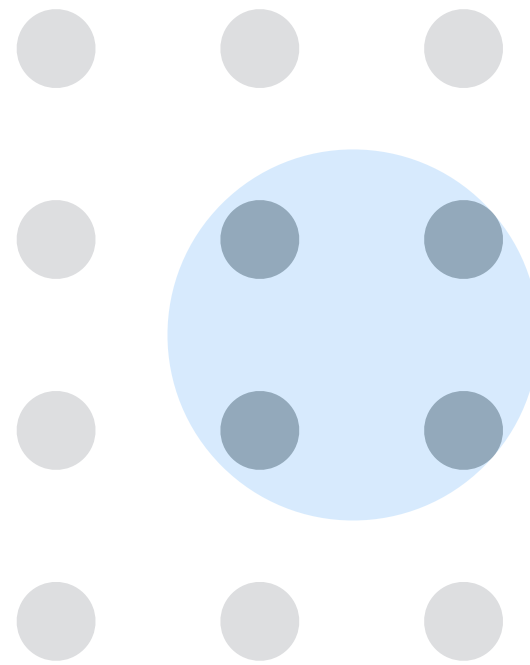
⌘ ⌘ 3:52



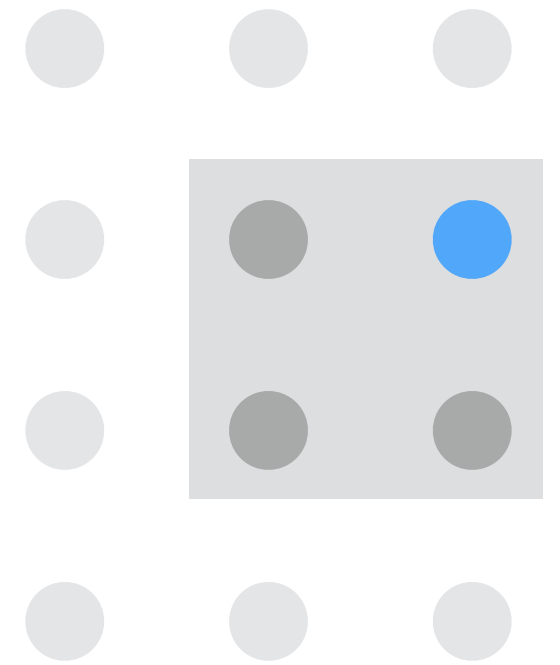
Area Cursors, The “Prince” Technique [Buxton CHI’95]
Enhanced Area Cursor [Findlater UIST’10]

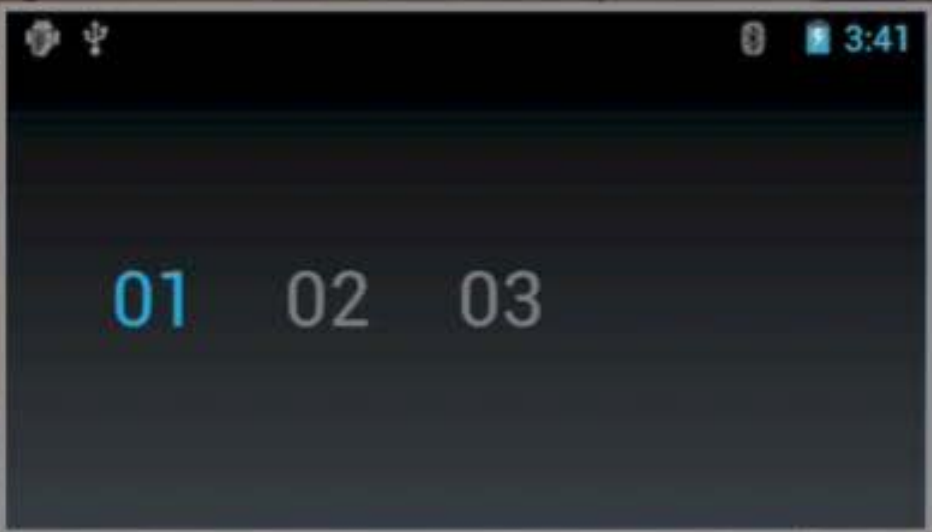


Scanning
→

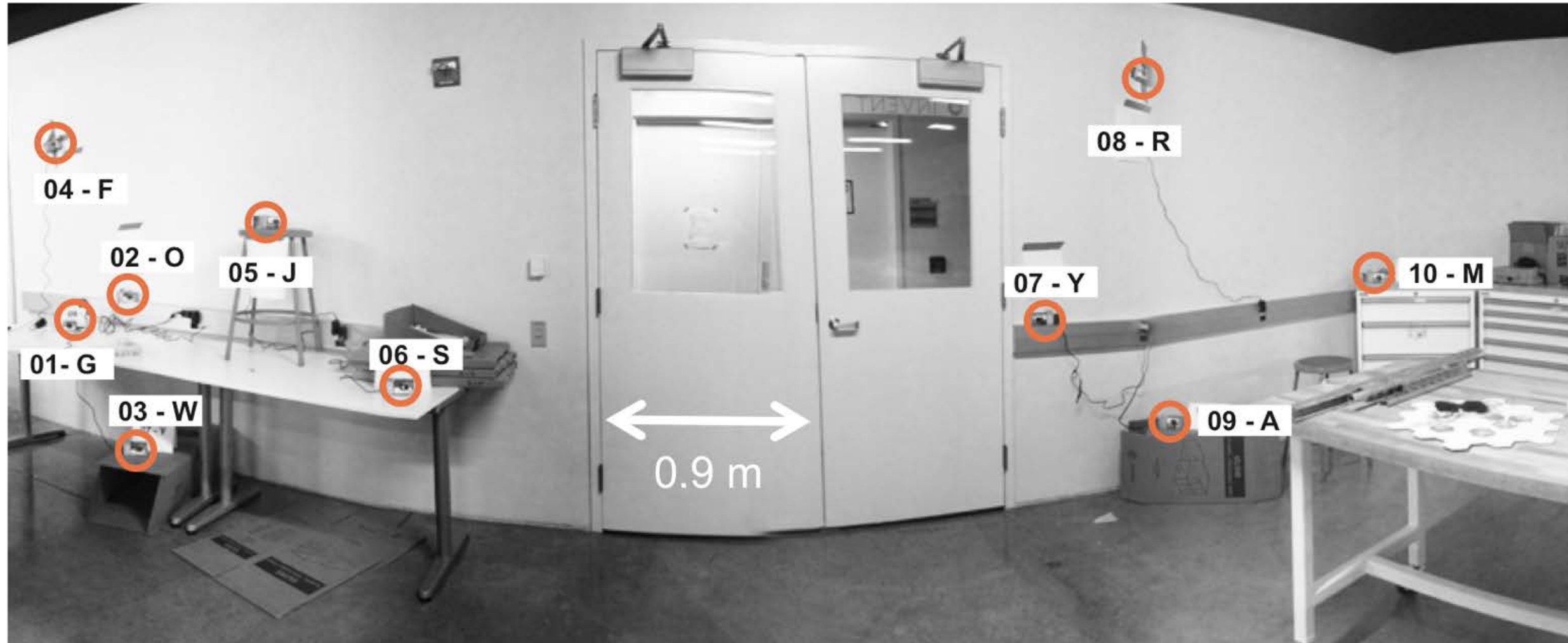


Refinement
→





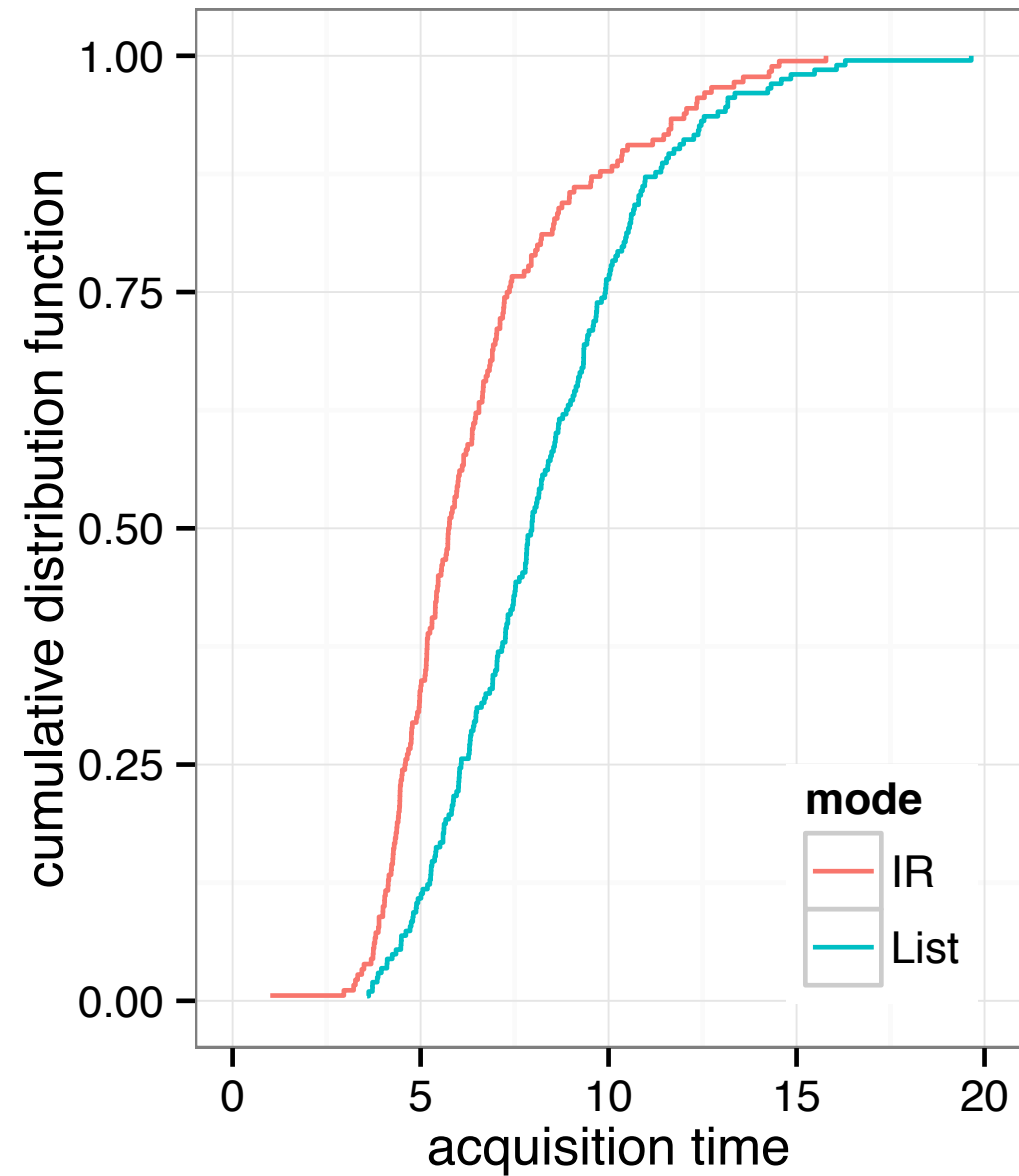
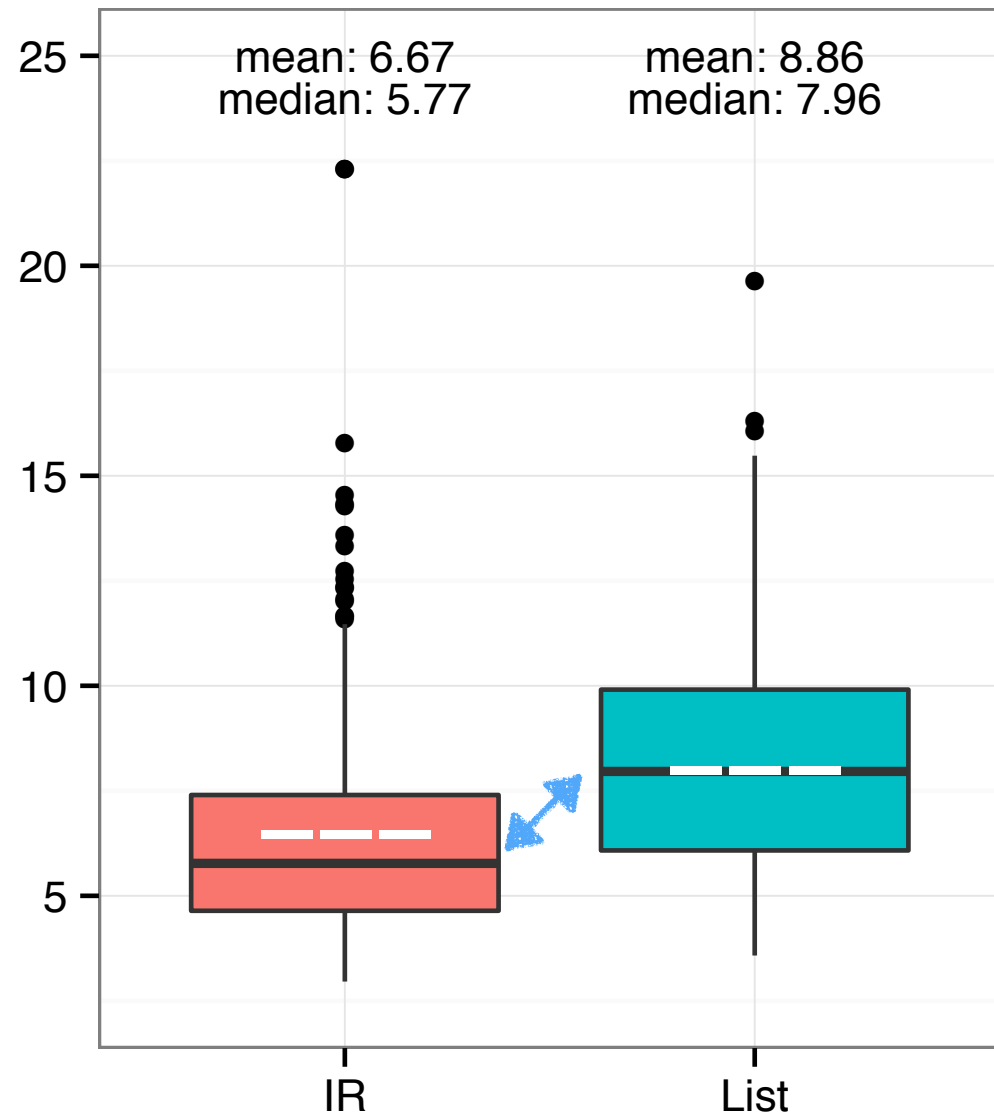
Study Apparatus



HOBBS vs. List

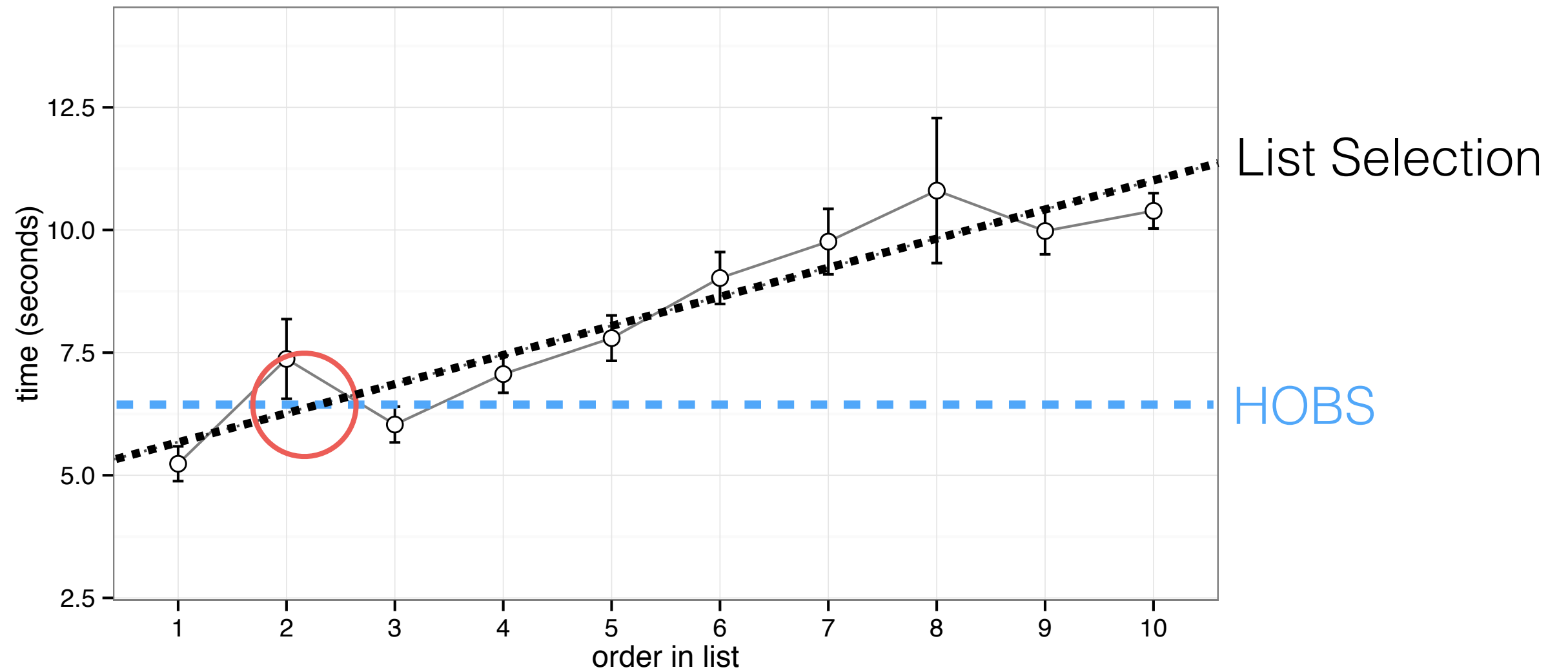
target acquisition time

- Head-worn
 - Near-eye Display
 - Glass touchpad
 - IR for selection
- Head-worn
 - Near-eye Display
 - Glass touchpad
 - List for selection



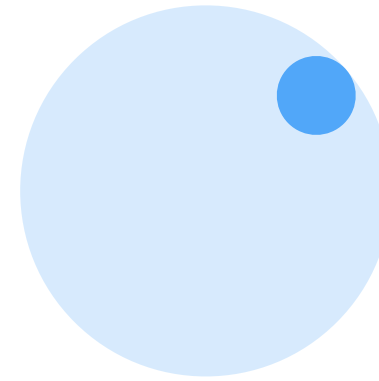
~25% time reduction $p < 0.0001$

HOBBS scales well

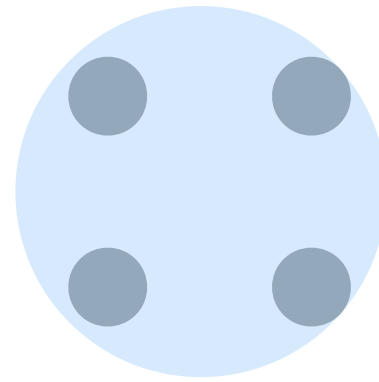
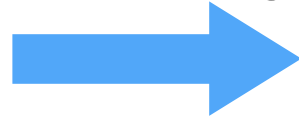




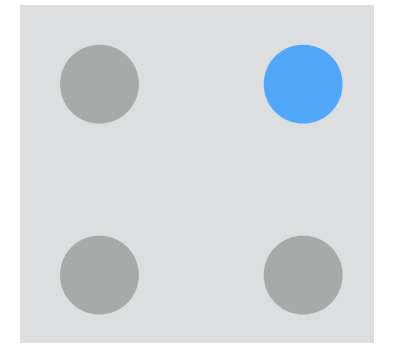
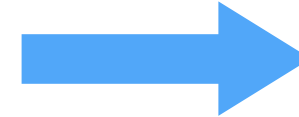
Scanning



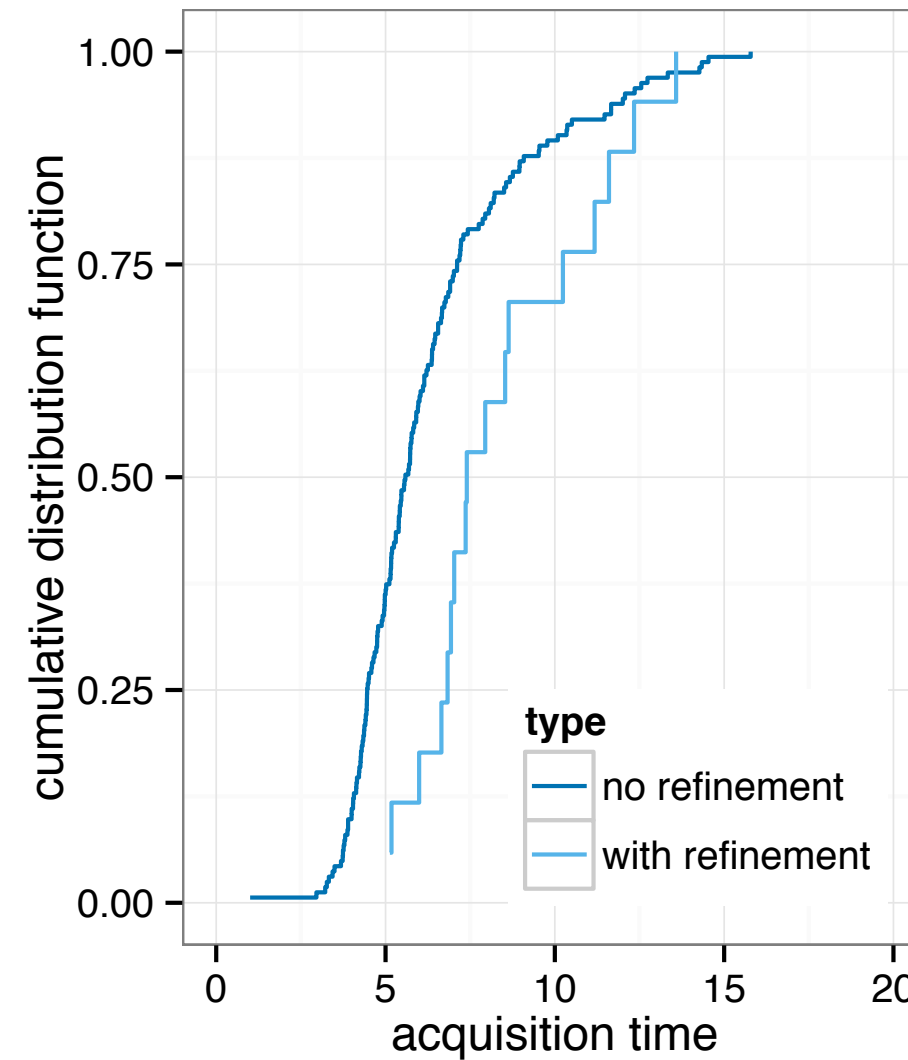
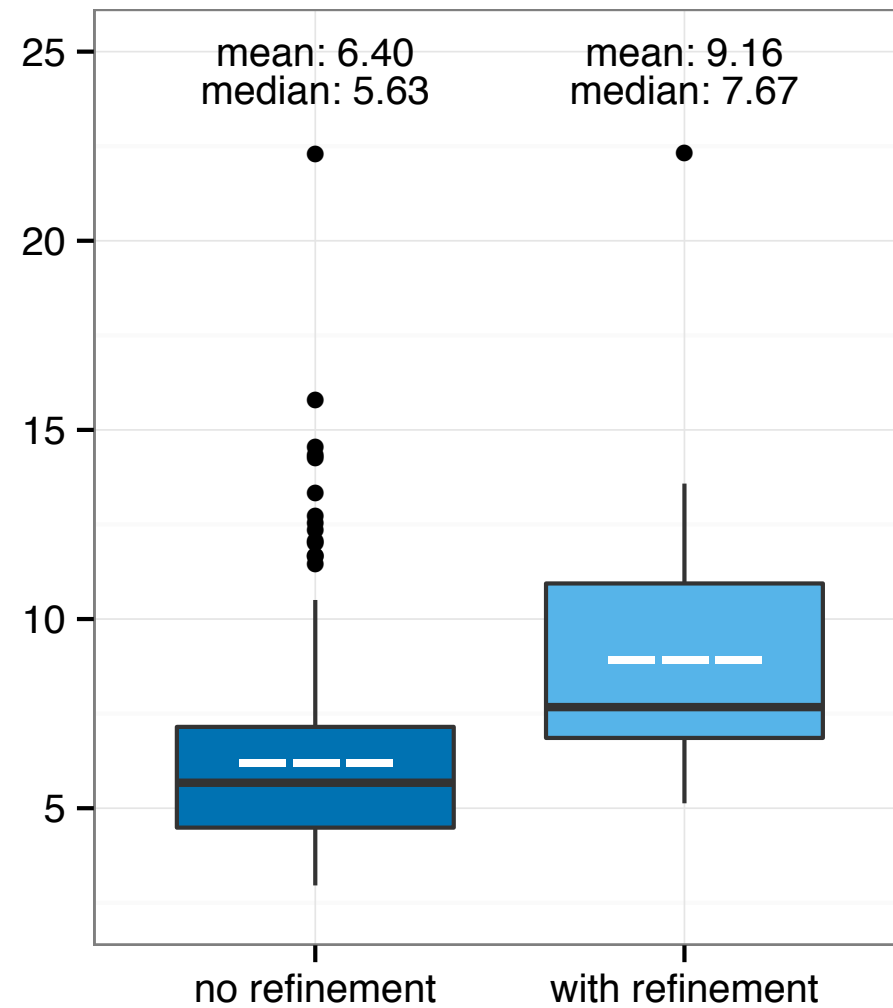
Scanning



Refinement



But, refinement is bad...

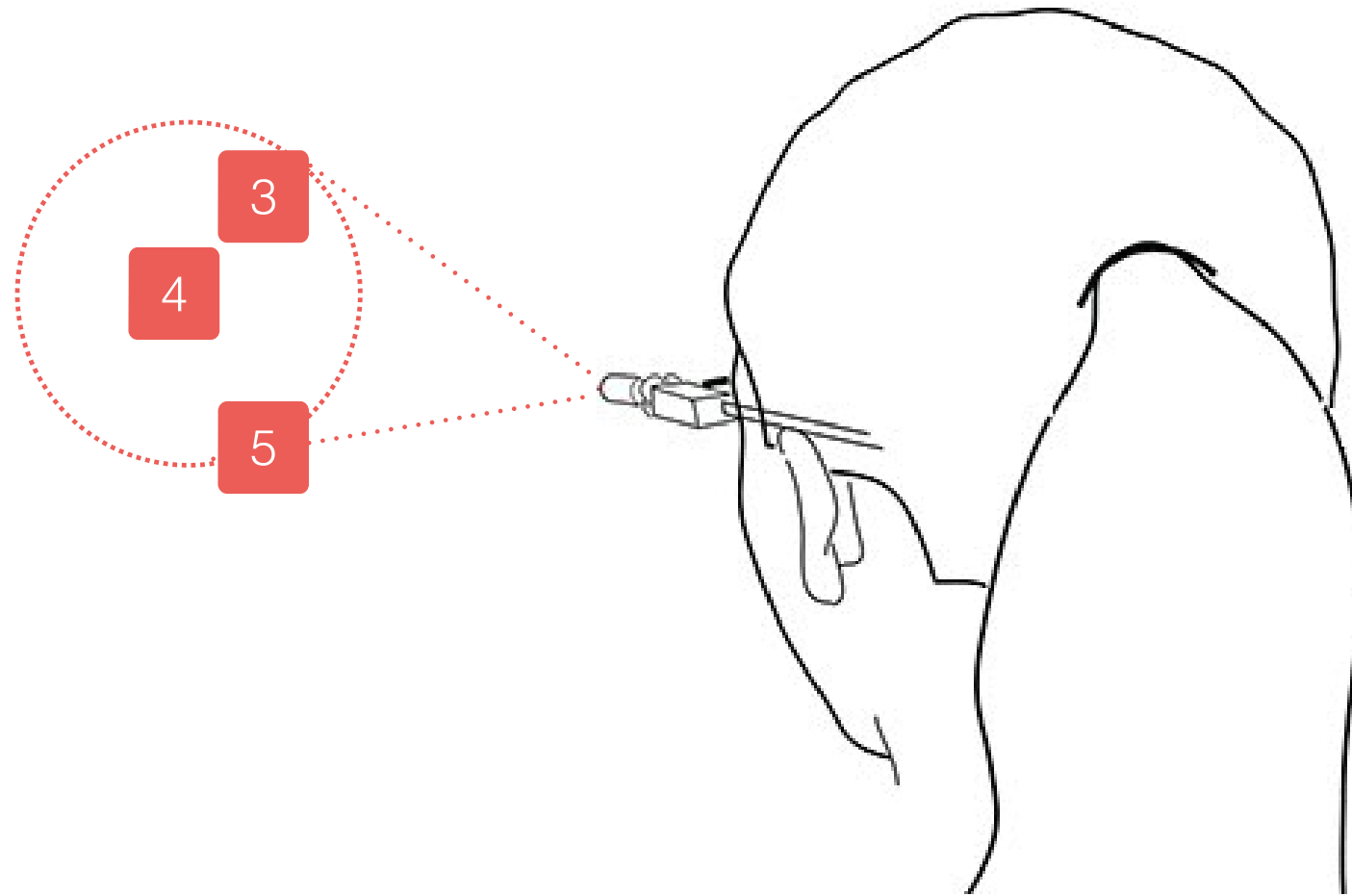


refinement is **43%** slower than “no refinement”, $p < 0.001$

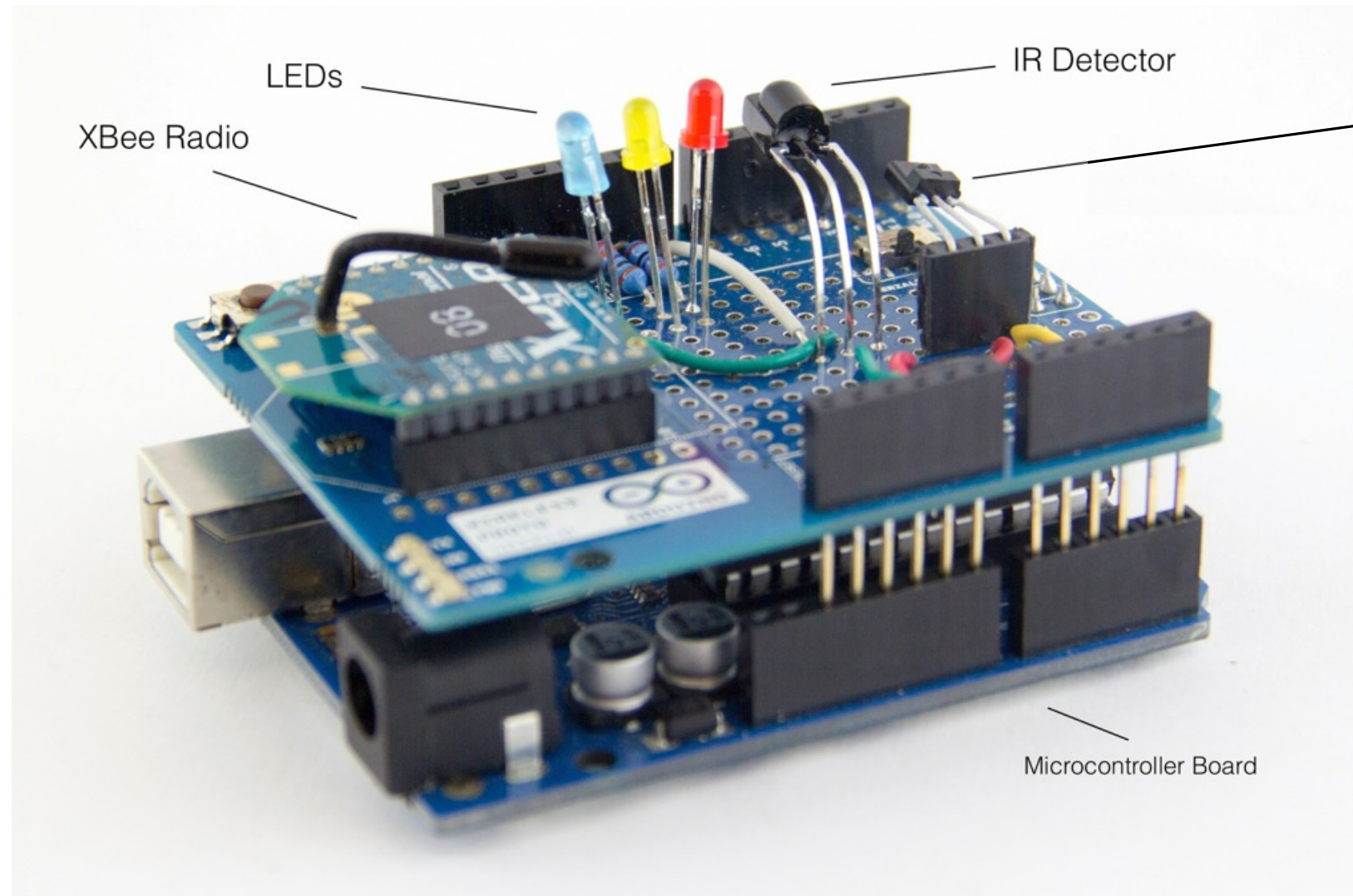


Naive IR

1



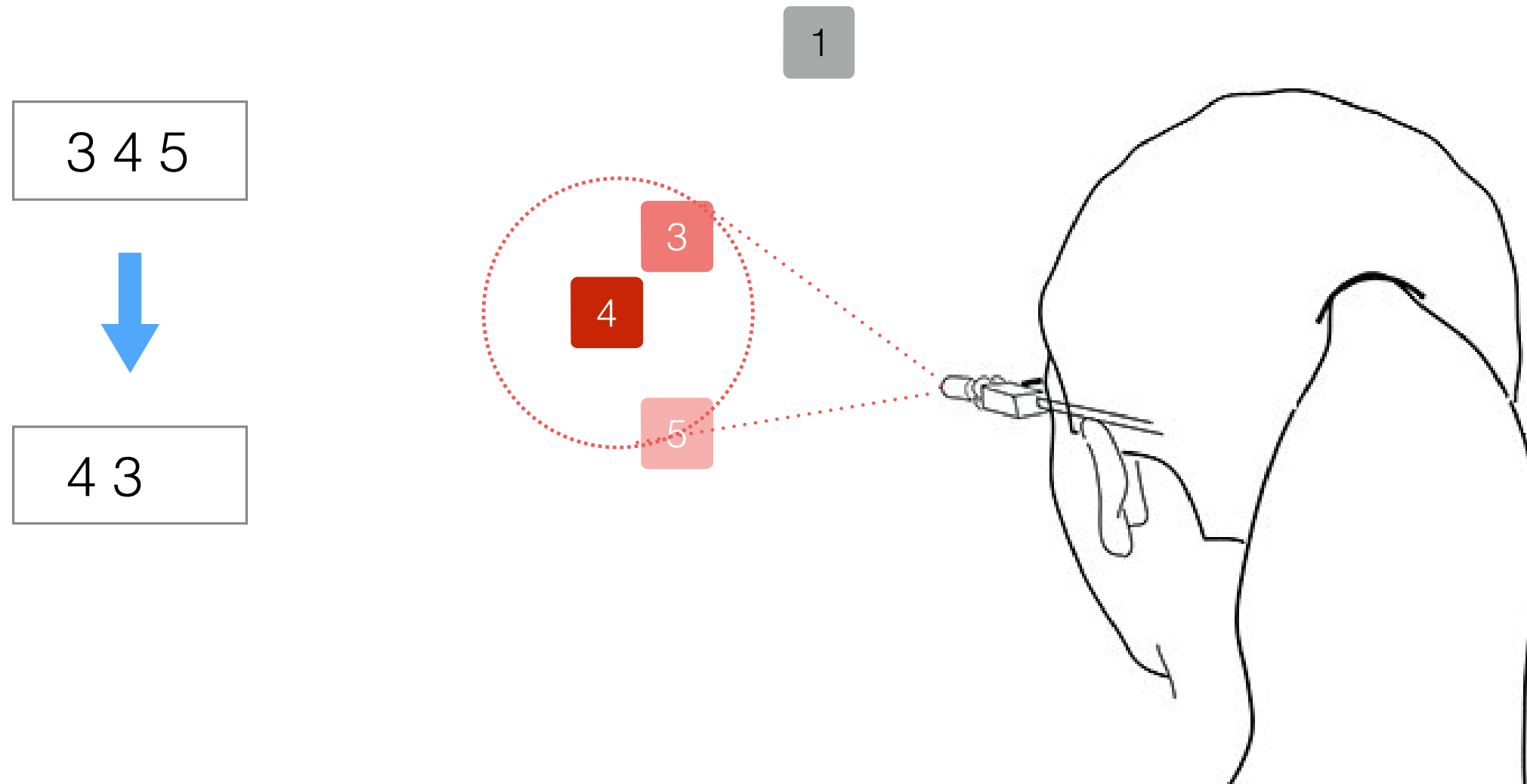
Iteration 2 - Intensity IR

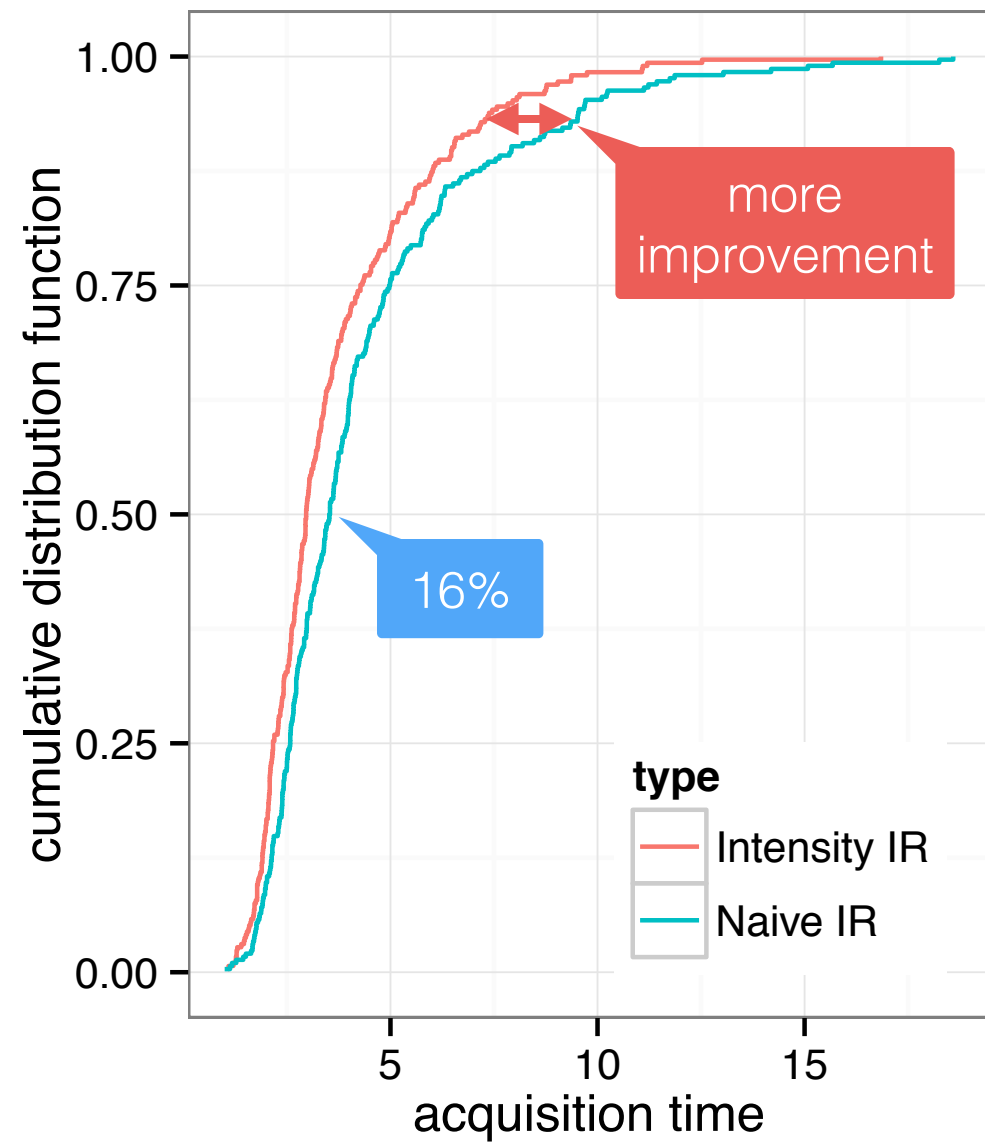
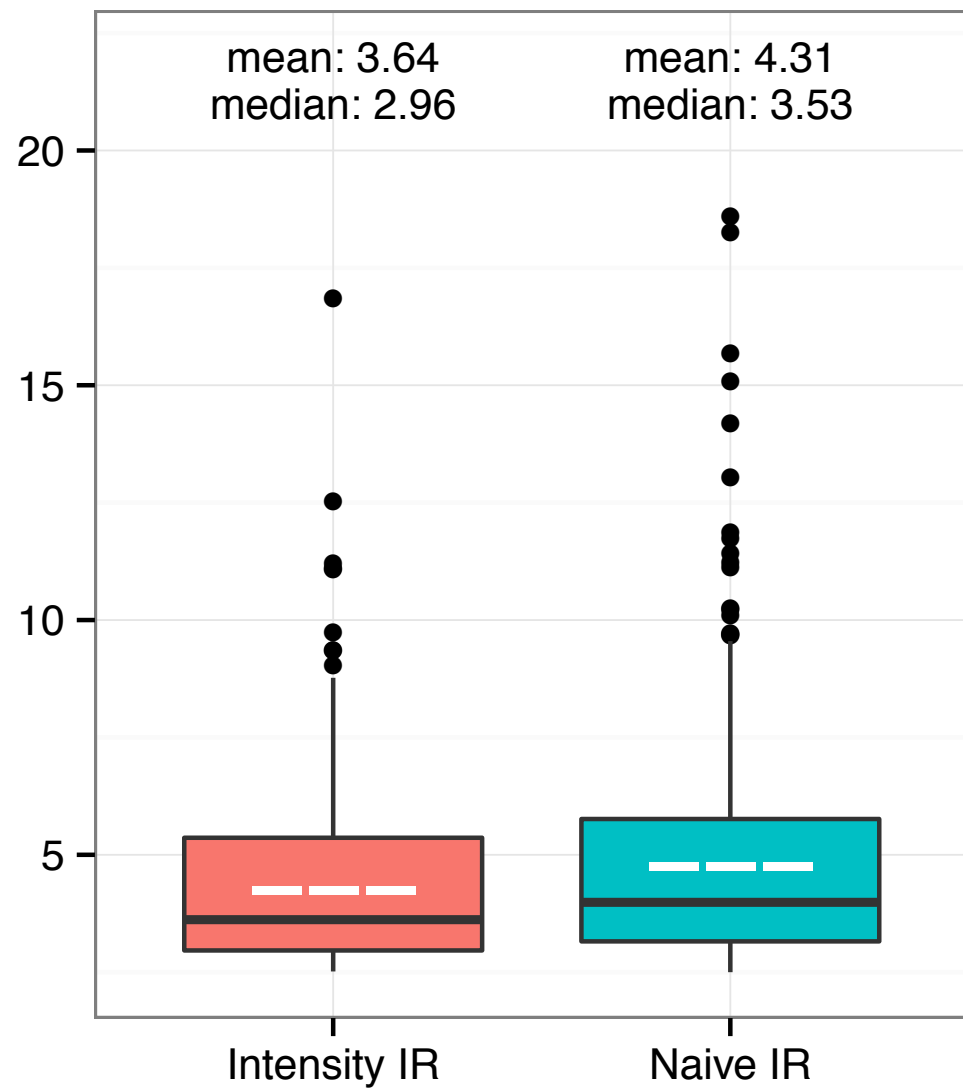


IR Light-to-voltage
Converter

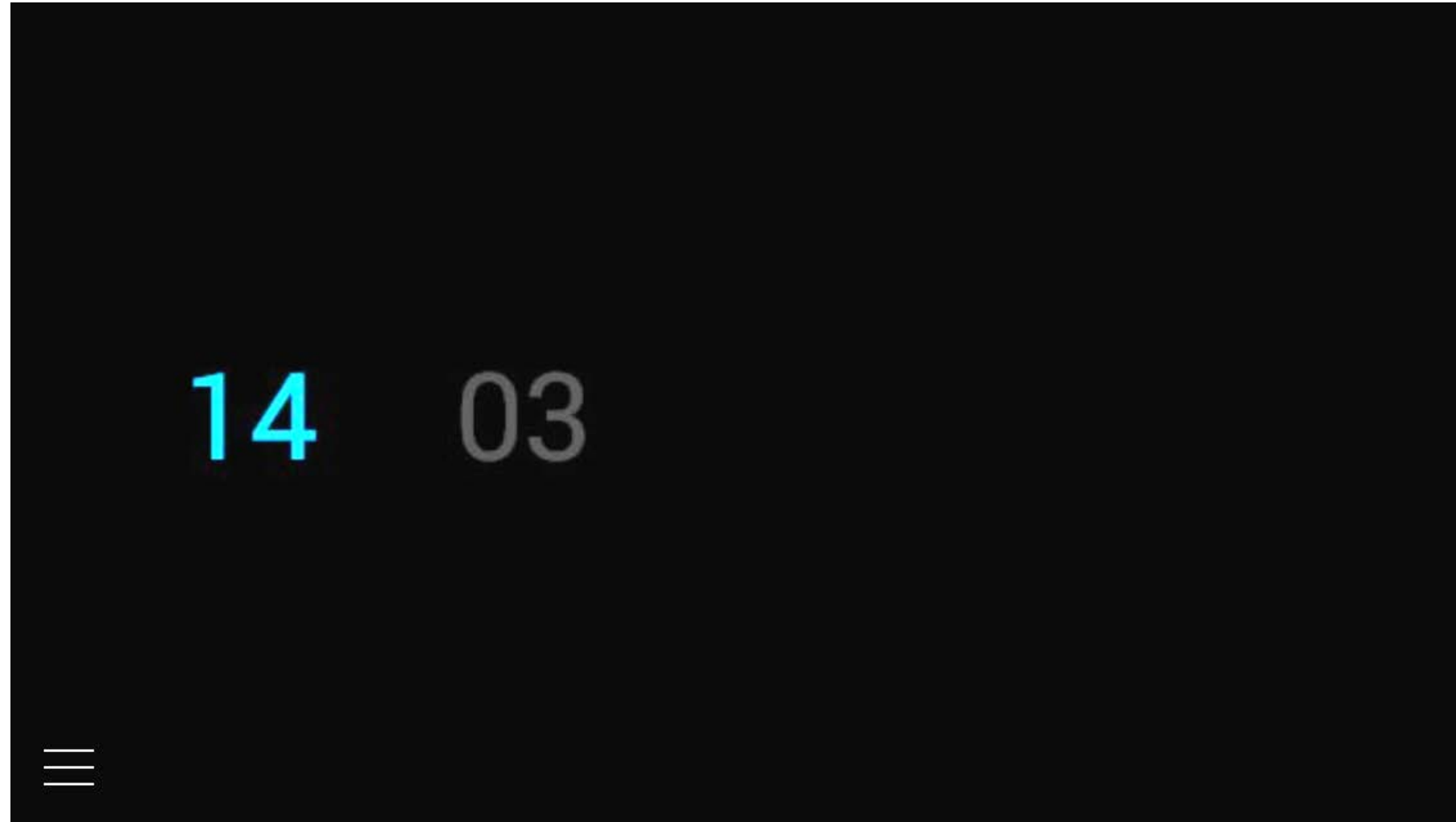


Intensity Based Ordering



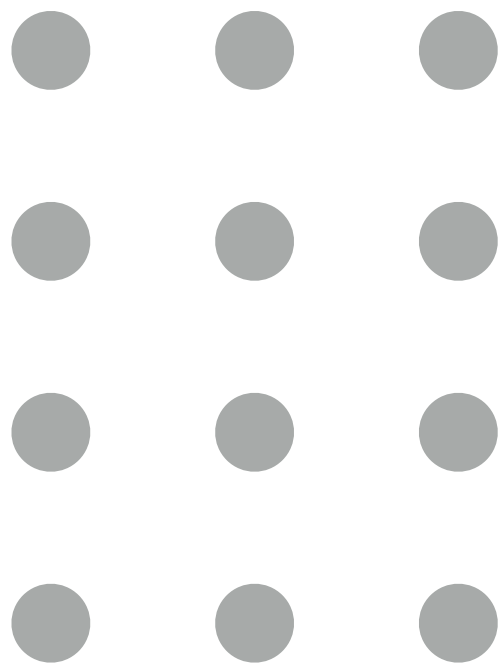


~16% time reduction $p = 0.0001$

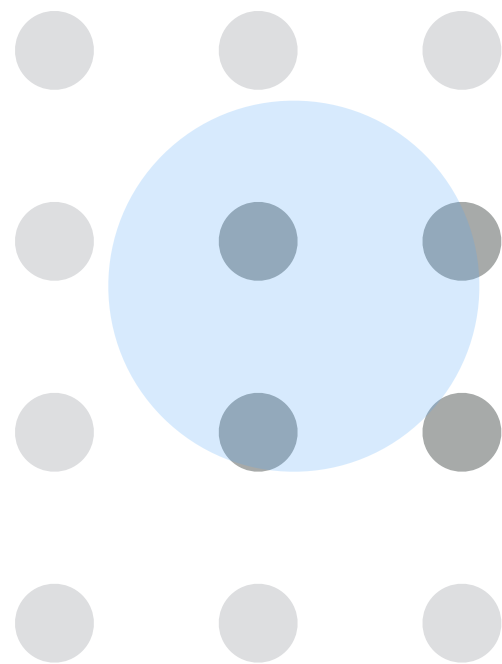
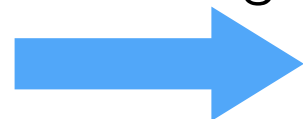


Iteration 2 - still a **list**

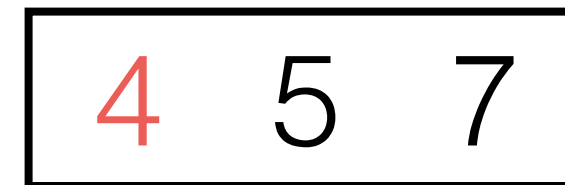
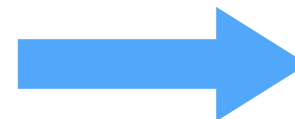
“Spatial”



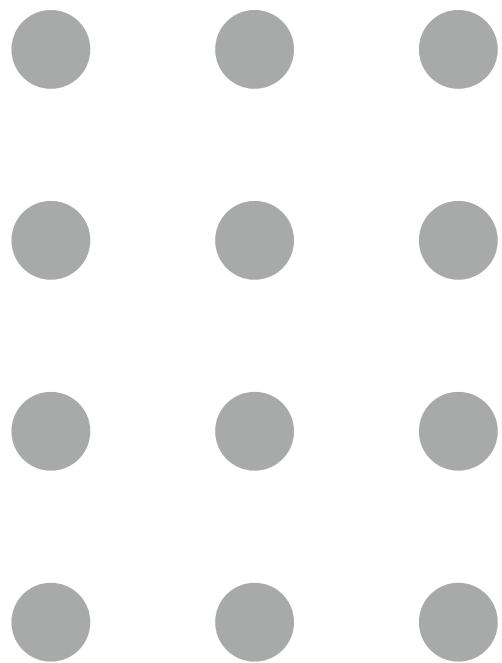
Scanning



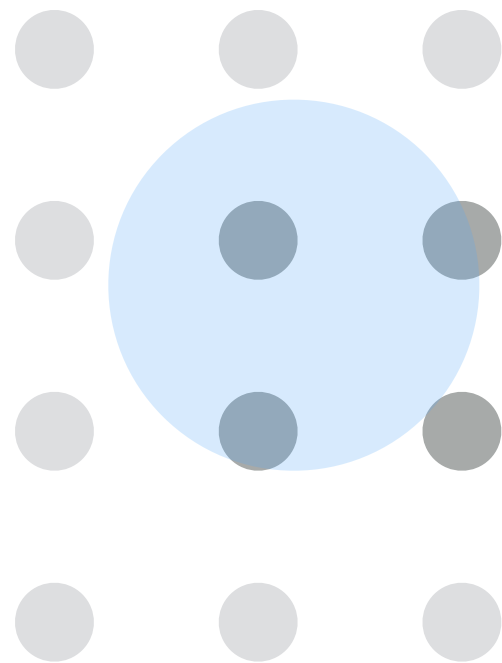
Refinement



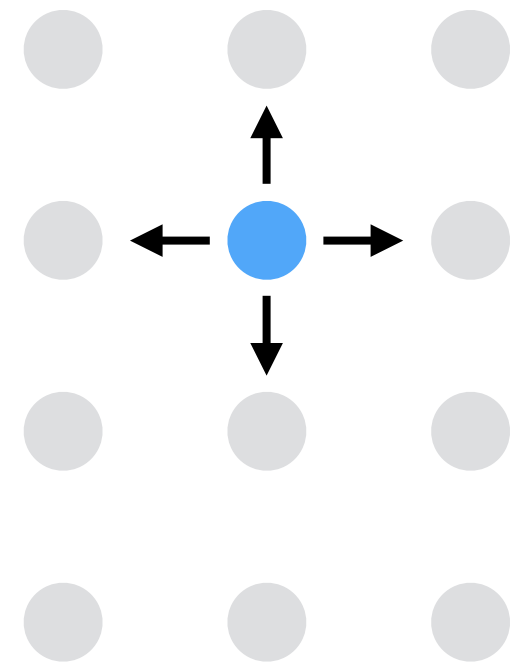
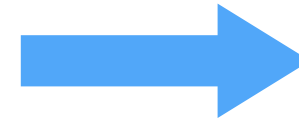
“Spatial”



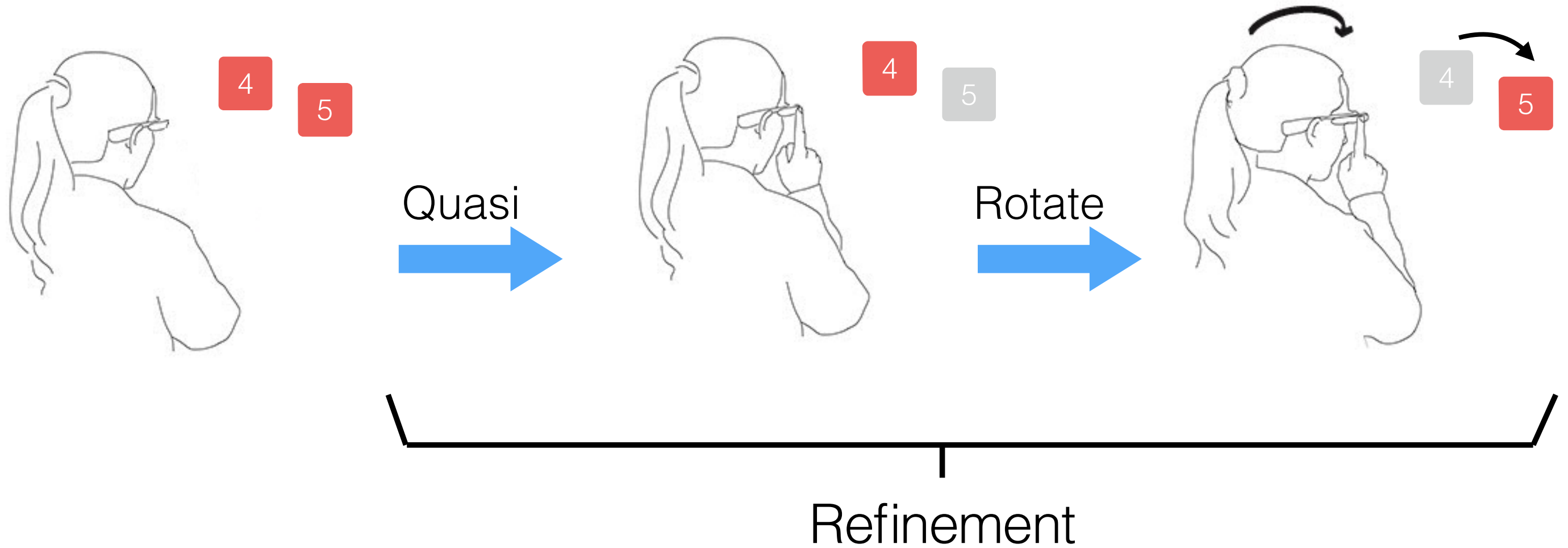
Scanning



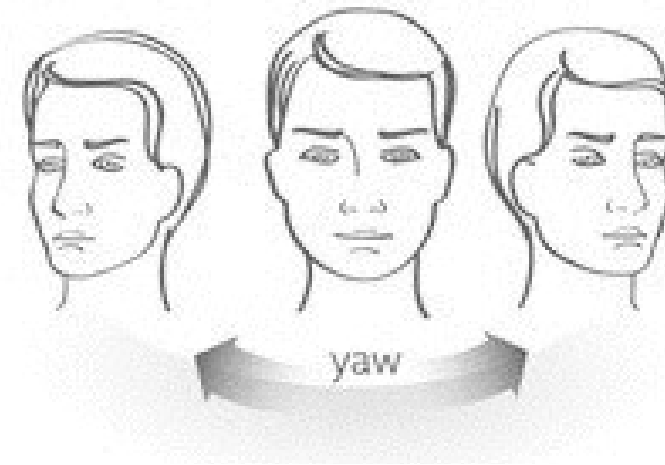
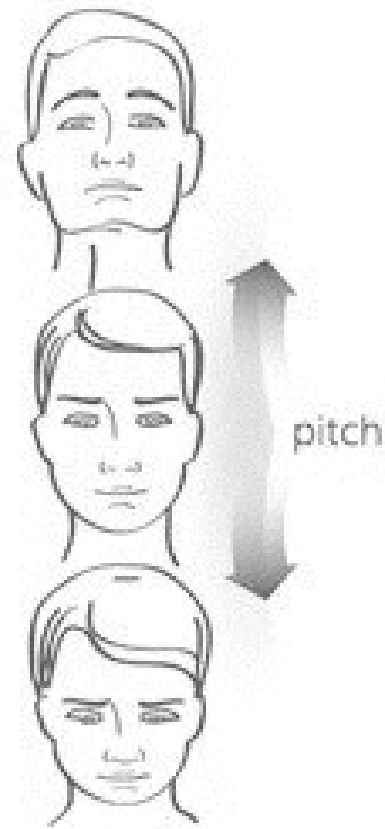
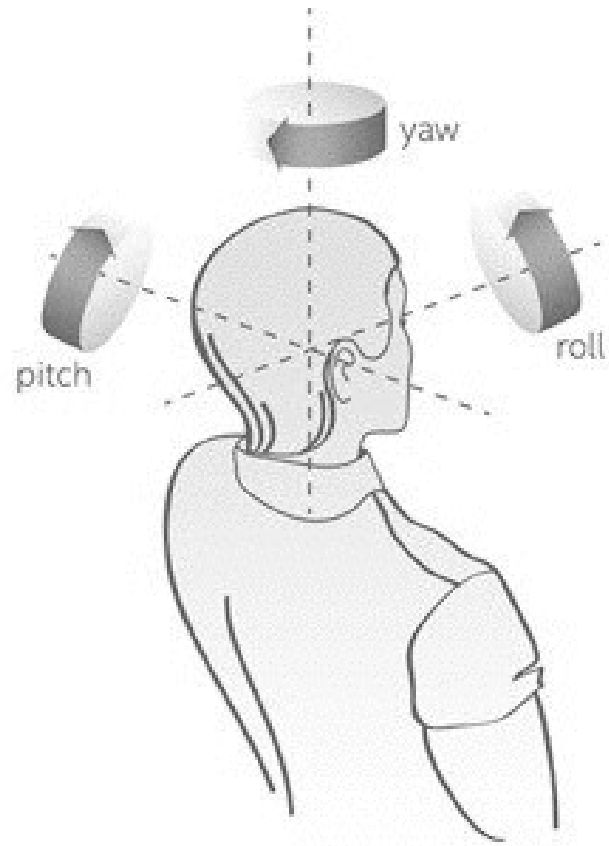
Refinement



Iteration 3 - Head Motion



Head Motion



Learning the Map



targe 4, pitch: 0, yaw: 0

Learning the Map



targe 4, pitch: 0, yaw: 0

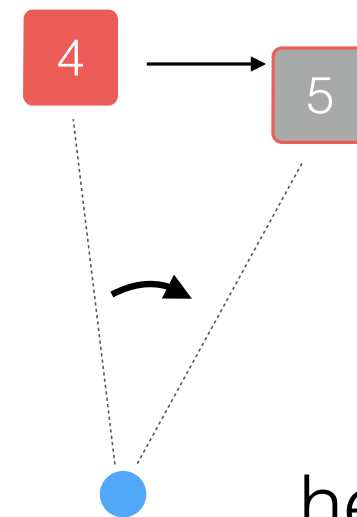
targe 5, pitch: -3, yaw: 6

Adjacency Map For Selection

target	pitch	yaw
4	0	0
5	-3	6

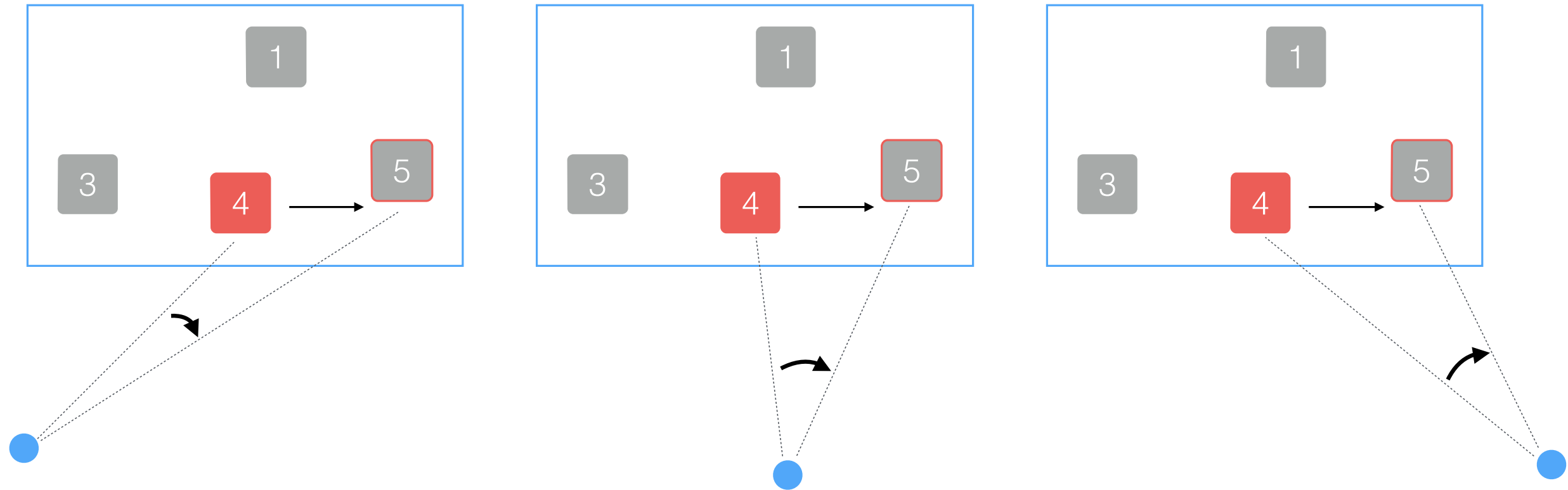


prediction



head motion
pitch: 0
yaw: 10

Invariant on Relative Position



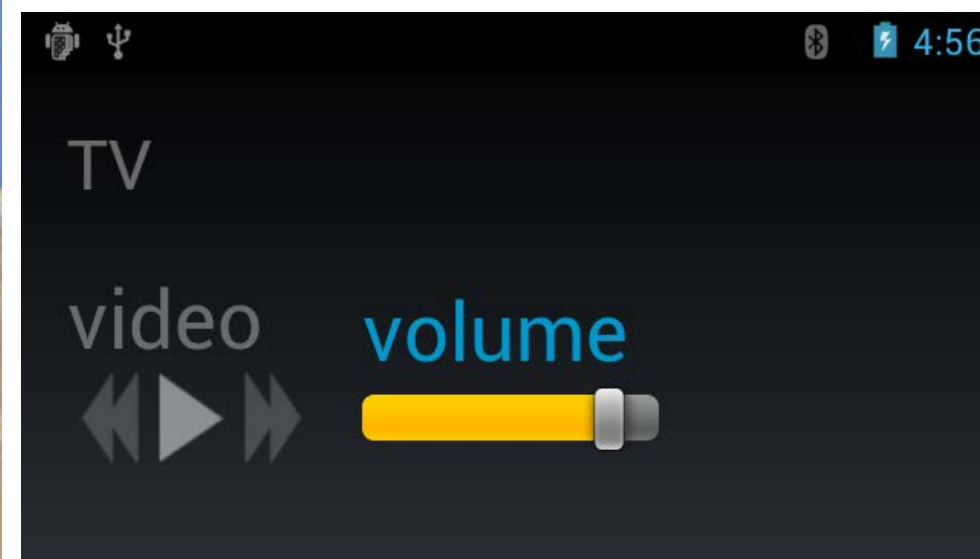
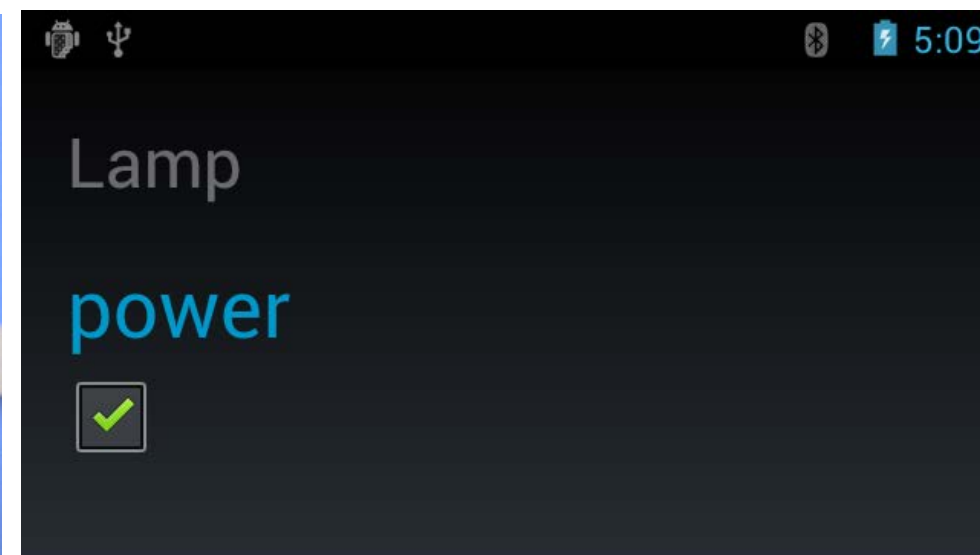
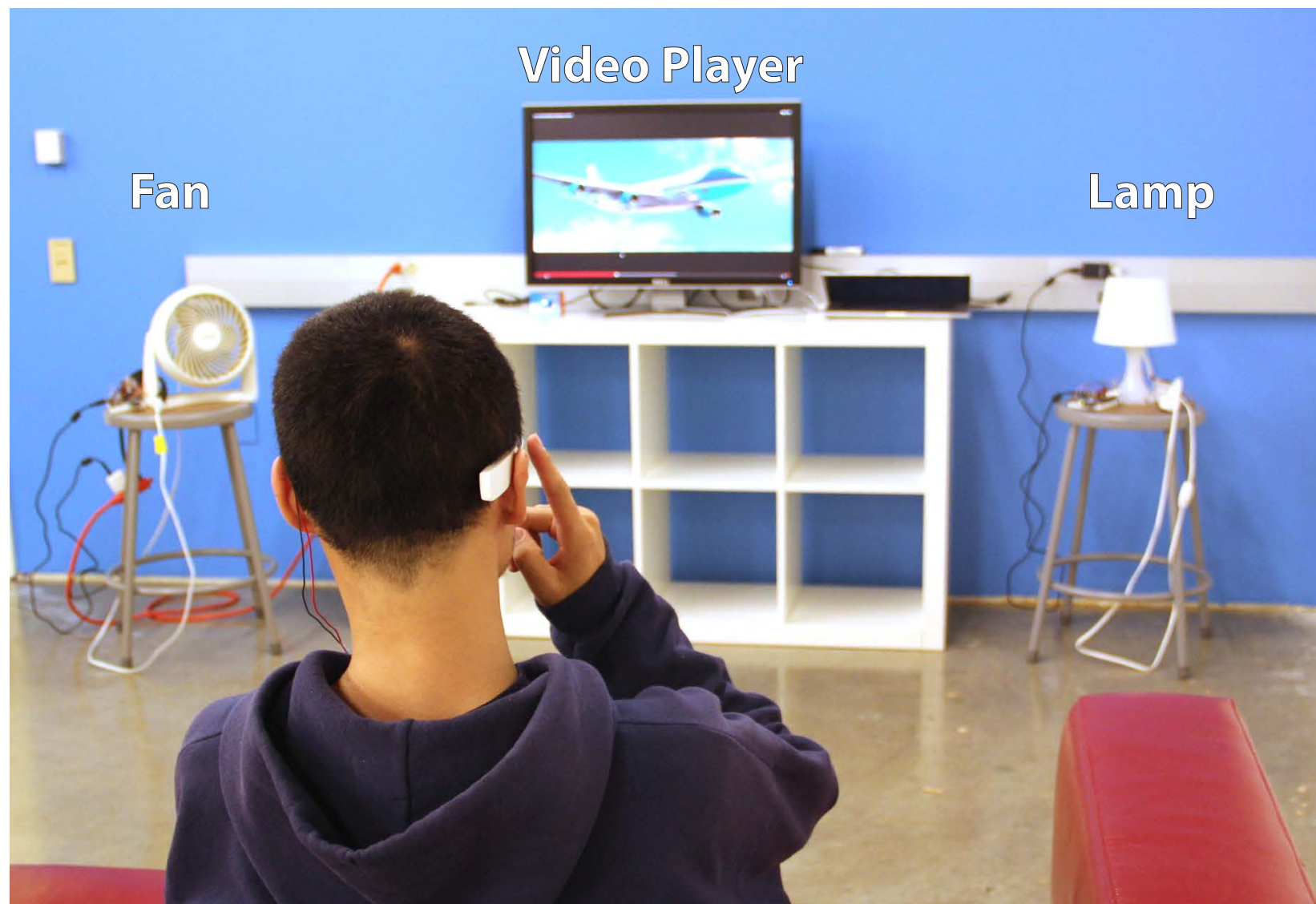
- Assumption: targets live on the periphery of spaces

Feedback

- “more **natural** way for demonstrating intentionality”
- “it leveraged the **spatial sense** that I already had just by using the system”
- “matching visual cues **rather than numbers**”

Limitation and Future work

- The adjacency map could be learned on the fly by correlating [head motion](#) and IR [intensity](#) reading.
- Our study design:
 - not yet systematically studied target [density](#) variation
 - performed in a [lab](#) environment
 - only measured [first use](#).



Come to our DEMO

Conclusion and Contribution

- We proposed HOBS to interact **directly** with physical targets.
- We presented **three iterations** of design:
 - Naive IR, Intensity IR, Head Motion
- We contributed **user studies** on this novel interaction.
- We demonstrated our home control **application**.

**People don't use
buttons, menus and sliders
to talk with each other**



People don't use
buttons, menus and sliders
to talk with devices



Thank you!
Questions?

Acknowledgement: This work was supported in part by the TerraSwarm Research Center, one of six centers supported by the STARnet phase of the Focus Center Research Program (FCRP) a Semiconductor Research Corporation program sponsored by MARCO and DARPA. Additional support was provided by a Sloan Foundation Fellowship and a Google Research Award.

Head Orientation-Based Selection

