New ways of interacting with mobile devices

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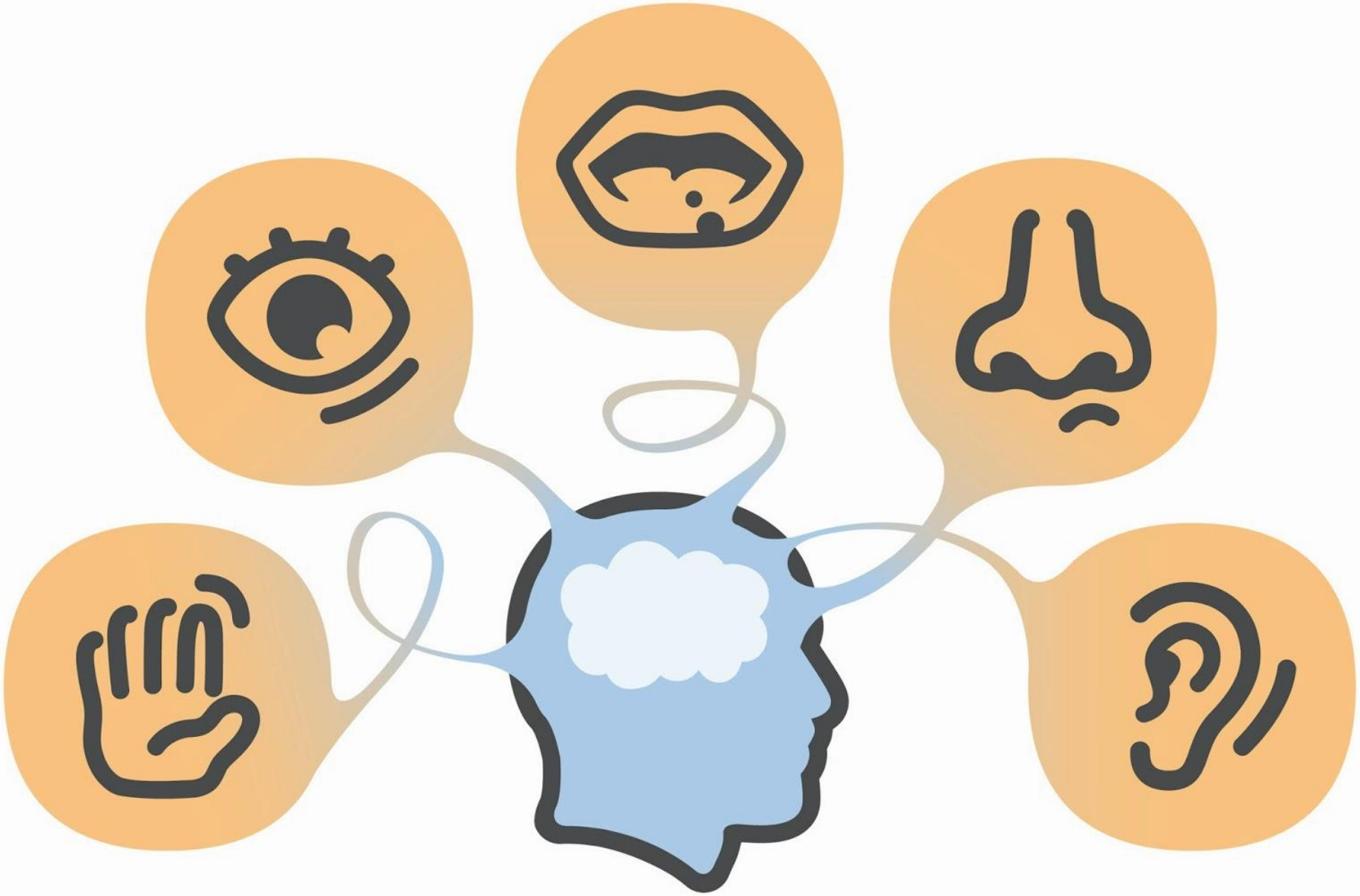

Multimodal interaction

Key area of work is *Multimodality*

More human way to work

- Not everyone has all senses
- May not always be available all of the time

No one sense can do everything on its own

New interactions using multiple senses and control capabilities

Research areas

Novel multimodal interaction techniques

Touchscreen and mobile user interfaces

- Improving the usability and user experience

In-car UIs

Interaction with TV, VR

User interfaces for cameraphones and digital cameras

Accessibility

- Blind users and visualisation, Older adults, navigation, mobility
- Multimodal home care

Mobile health apps / sports performance apps

Modalities

Non-speech audio

- Earcons, 3D sound, sonification, Musicons

Computer haptics

- Force-feedback, pressure input, temperature output
- Tactile (vibrotactile and pin arrays)
- Ultrasound haptics

Gestural interaction

- On-screen, in-air, multi-touch, capacitive sensing

Smell

Overview of talk

Motivation

- Interaction issues with touchscreens

Multimodal solutions

- Novel modalities for user interfaces

- Haptics: Pressure for input, thermal displays
- Non-speech audio for output

Examples from our research

Touchscreens

Wide application of touchscreens

- Phones, tablets, TV remotes, ….

Larger display area, direct interaction with finger, more flexible use of device, no need for physical keyboard

Touchscreens lose important tactile features

- Smooth
- More errors on input
- ‘Feel’ is poor

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Touchscreens

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Touchscreens

Touchscreen input finger

- Buttons are small
- Input difficult and error prone
- Requires much visual attention
- Two hands
- ‘Fat finger’ problem

User experience can be worse than physical controls

- These kinds of issues now affecting cars …

Solutions?

Need to develop new interaction techniques that enhance device usability in real contexts of use

- Novel forms of multimodal input and output
- Haptics
  - Pressure input
  - Thermal displays
- Non-speech audio
  - 3D sound

HAPTICS – PRESSURE INPUT

Pressure/isometric force input

Little studied in HCI, but a rich source of input and control

- Musical instruments
- Drawing (graphics tablet), holding / grasping

Can we uses pressure as another input mechanism?

No need for spatial positioning of finger

- Easy to do ‘eyes free’
- Can use the z-axis
- Does not require change of grip, allows interaction while gripping

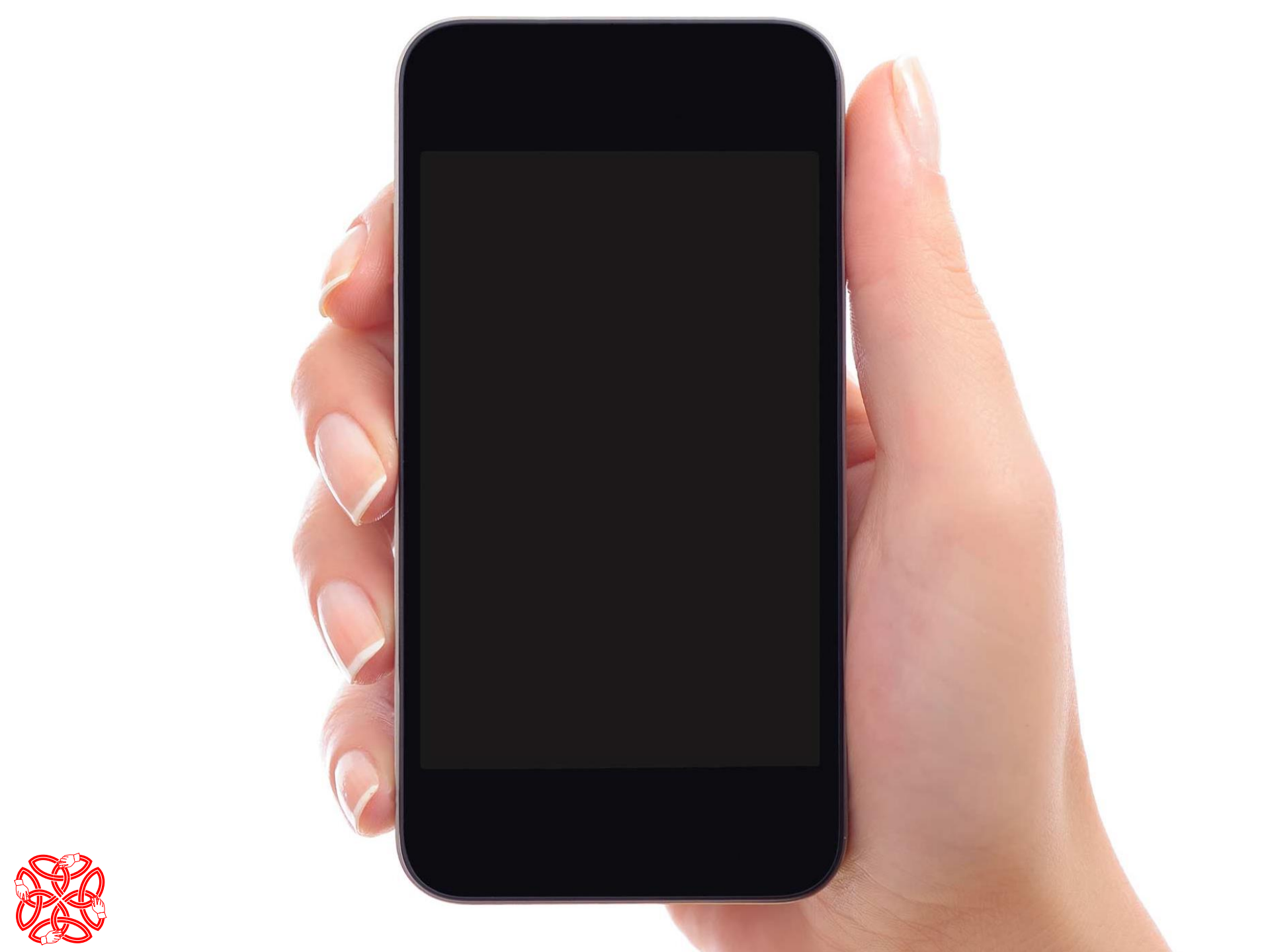
Apple 3D Touch

Pressure

Pressure sensing does not require manipulation of angle of the device

- Unlike accelerometers or gyroscopes for tilt control

Pressure can be distributed over a large area meaning it can be accessed using multiple postures



Hardware

Many types

We (mostly) use force sensing resistors

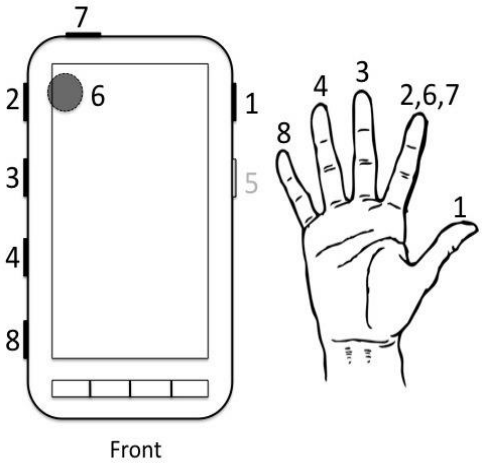
- Thin
- Flexible
- Cheap

Pressure keyboard

Grip and grasp

Can we use the way we grip a device to control it?

- Can we use this for interaction?
- Make a two-handed interaction into a one handed version



52 sec

Grip results

Compared rotate and zoom

- Pinch/rotate using multitouch and 2 hands
- Grip

One handed grip equal to or better than traditional method

- Less time hunting for small buttons
- No finger occlusions
- No ‘fat finger’ problem
- Also works well when walking

Squeezing devices very effective for input

HAPTICS - BIMANUAL PRESSURE INTERACTION

Pressure for two-handed input

Bimanual interaction with objects very common

- Kinematic Chain - Guiard

Non-dominant hand supporting device

- Cannot move
- But could provide pressure input

Dominant hand doing the interaction

Simple hardware additions

Bi-manual input

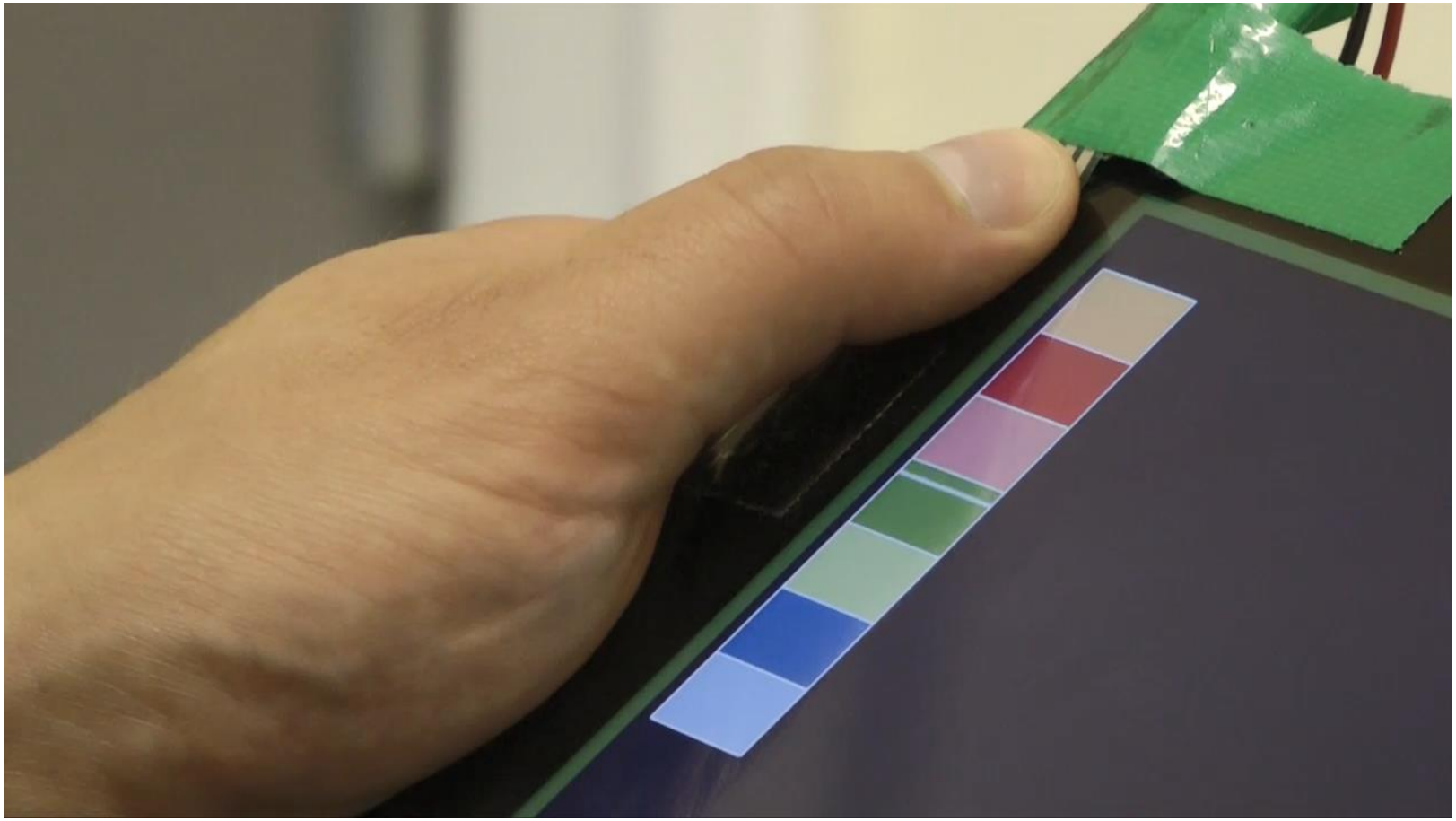
Can users operate pressure input without having a negative effect on dominant hand interactions?

Targeting

- How accurately can users a provide two-handed combination of pressure and touch input

Maintaining

- How accurately can users maintain different levels of pressure during a bimanual interaction



Results

Low impact on dominant hand accuracy

Pressure accuracy high across all conditions

Accurately select targets by both applying and releasing pressure

Maintain pressure more accurately as the target pressure increases

More complex dominant hand interactions

✓ Non-dominant hand pressure works very well

FineTuner

HAPTICS - TACTILE FEEDBACK

Design of Tactons

Tactons are tactile messages that can be used to communicate non-visually

Encode information using parameters of cutaneous perception

- Waveform
- Duration/rhythm
- Body location

Tactile button feedback

Touchscreen phones have no tactile feedback for buttons

- More errors typing text and numbers

Compared performance of real buttons to touchscreen, to touchscreen+tactile

- In lab and on Glasgow subway

Touchscreen+tactile as good as real buttons

- Touchscreen alone was poor

Tactile feedback for typing

Previous studies showed adding tactile feedback to touchscreen typing increases performance

- Can we use the tactile feedback to communicate more?

Ambient display

- Change the feel of buttons based on external factor
  - Arrival of email, proximity of friend
- Roughness and duration
  - Duration indicated proximity
  - Roughness indicated friend or family
- Users could identify meaning while typing very accurately

HAPTICS - THERMAL FEEDBACK

Temperature Based Interaction

Temperature an unused part of touch feedback

- It is always present
- Humans are very sensitive to temperature

Can we use it for communication?

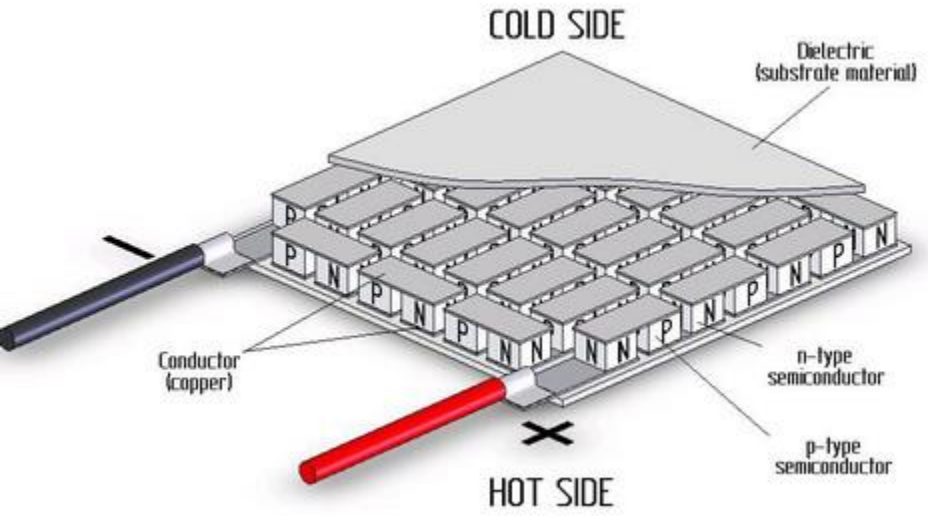
- Very strong emotional response to temperature
- Key technique for determining material properties
- Children's hotter/colder game

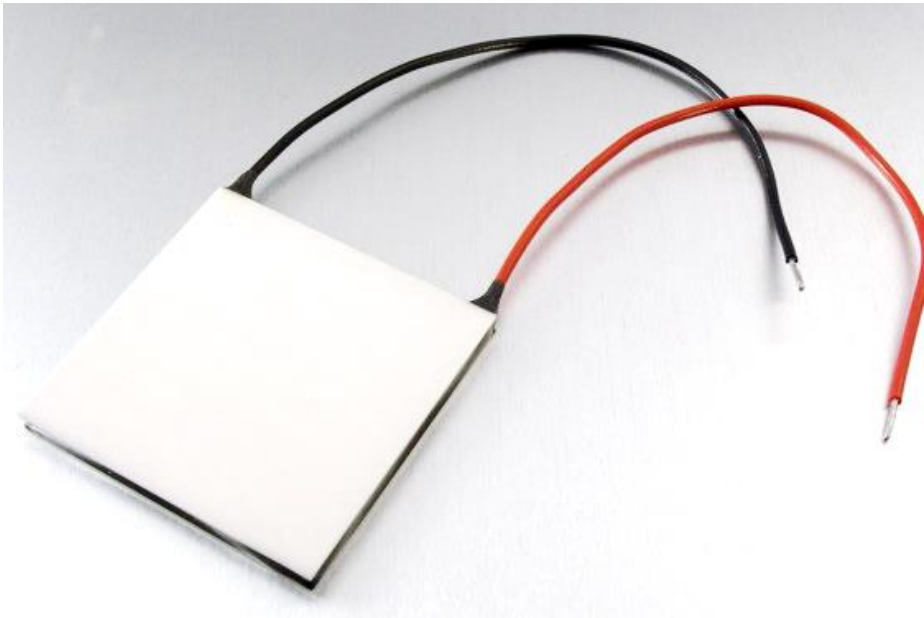
Alternative to vibration?

Temperature hardware

Peltier heat pumps

- Elements that can be heated or cooled rapidly
- Standard components, low cost





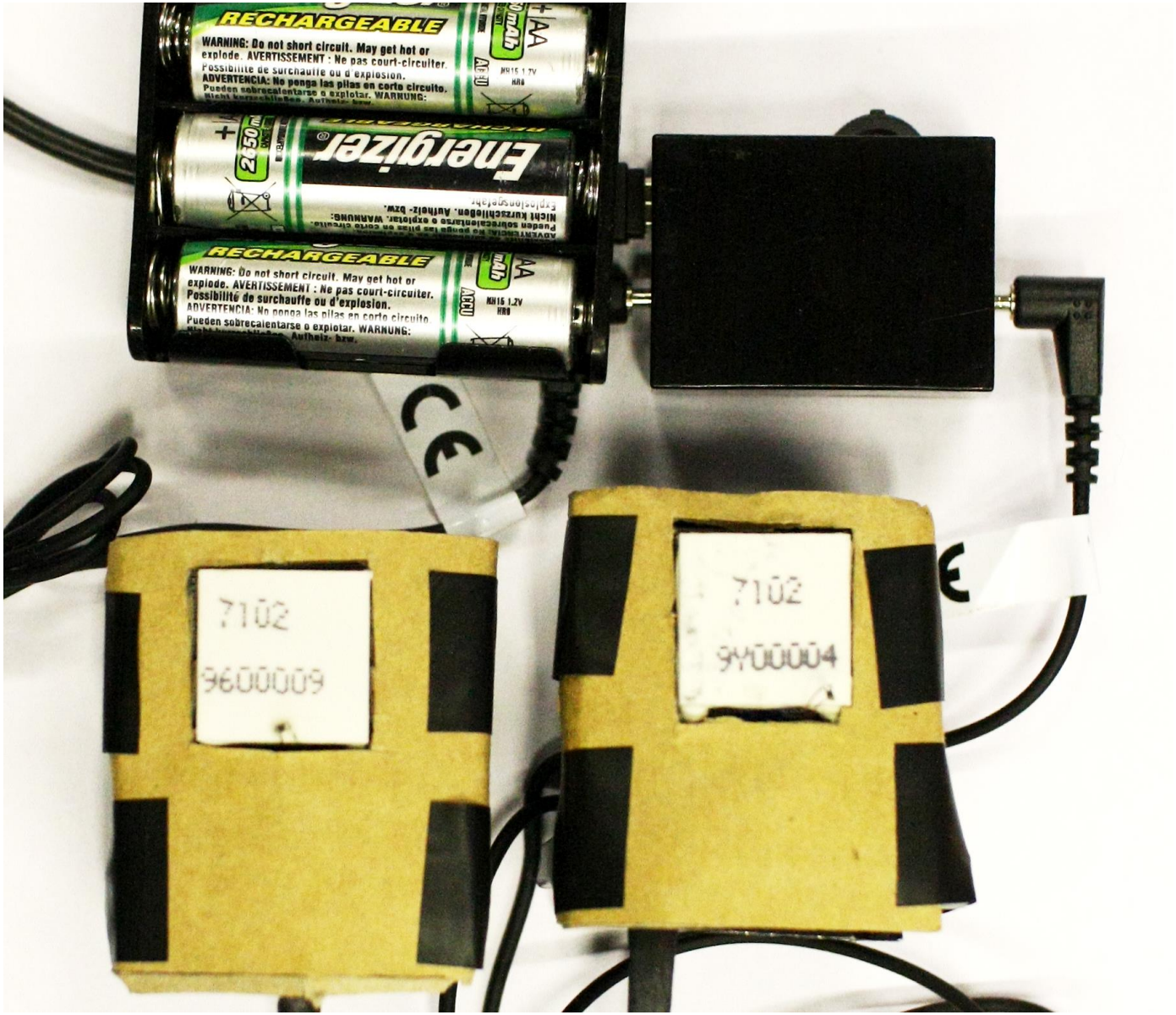
Temperature

Peltier device

- 4 heat pumps (2 pairs of hot and cold)
- Can be mobile or desk based

Ran a detailed series of psychophysical studies to investigate ranges of temperatures that should be used

- Also tested these mobile to see more real-world effects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Indoor mobile thermal study

Effects of changing environment

Front of School

Back of School

Design Recommendations

Palm is most sensitive but wrist and arm are acceptable

Stimulus intensities should be at least 3°C to guarantee detection but 6°C at most for cooling and <6°C for warming to ensure comfort

Both warm and cool stimuli are detectable and comfortable but cool stimuli are preferred

- Cool detected fastest

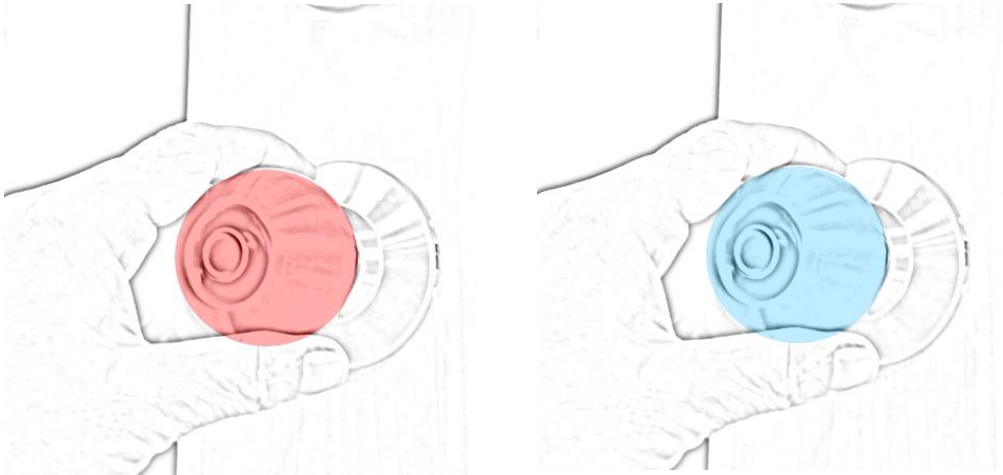
Moderate rate of change (2-3°C/sec) provide good saliency but lower rate of change required for high intensity stimuli

Subjective interpretations

How do people map thermal feedback to interaction?

- Social media activity (recent/old)
- Presence (here/away)
- Restaurant recommendations (good/bad)

22°C to 38°C in 2°C intervals



Subjective interpretations

Lots of commonality in people's responses

Warmth = More recent activity

Warmth = More recently present

Cold = not present, very hot = busy, do not disturb

Warmth = Better restaurant experience

Rating	★☆☆☆☆	★★☆☆☆	★★★☆☆	★★★★☆	★★★★★
Temp	25°C	27.5°C	30°C	32.5°C	35°C

Thermal emotion

Leverage inherent associations of temperature and emotion

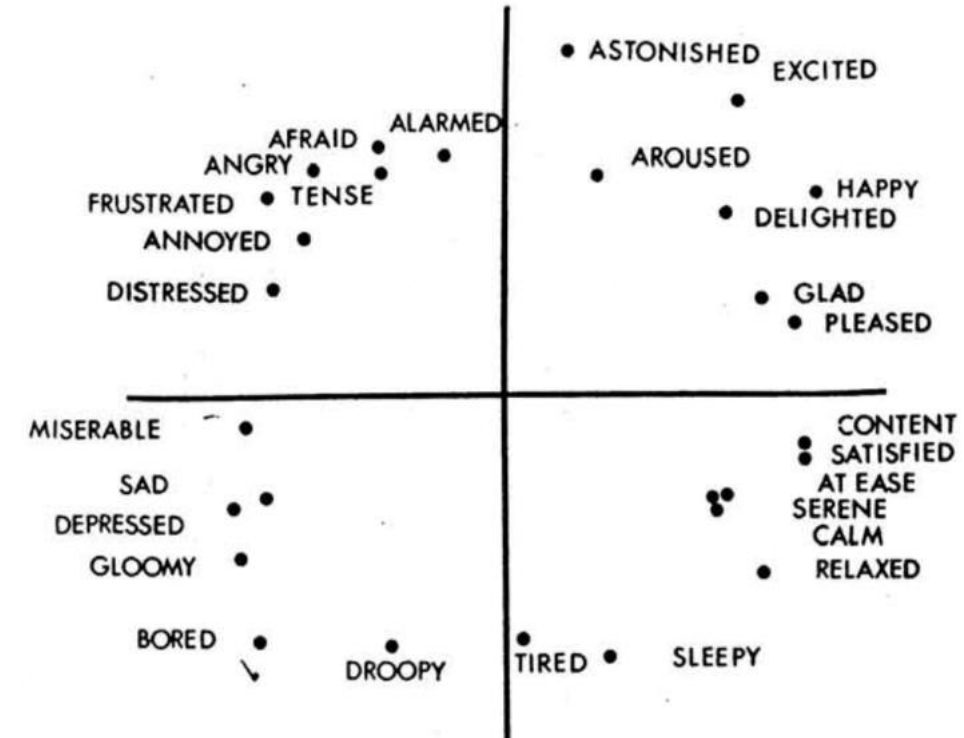
“warm and loving”, “cold and distant”

Emotional Signals

Emotions commonly placed within a two-dimensional model

Measured in terms of valence (emotional pleasantness, horizontal axis)

and arousal (physiological activation, vertical axis)



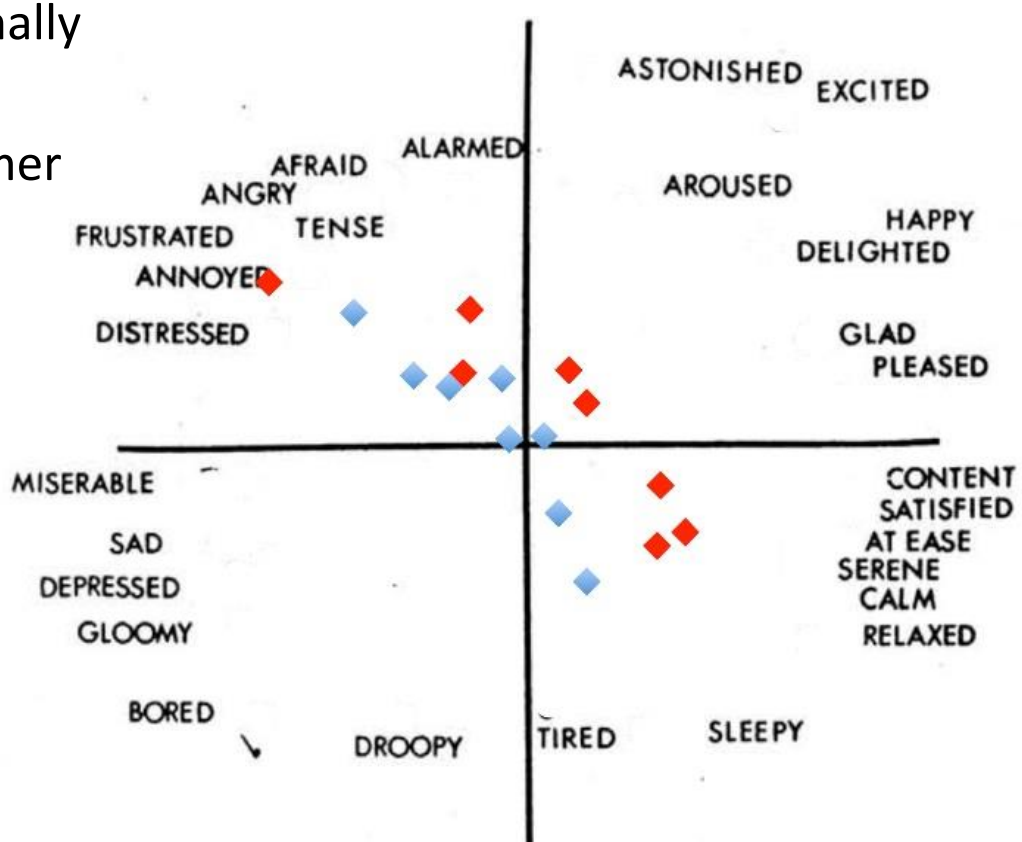
Emotional Signals

Assessed emotional aspects of thermal (and multimodal) feedback

Warmth indicates positive emotion, cool = negative emotion

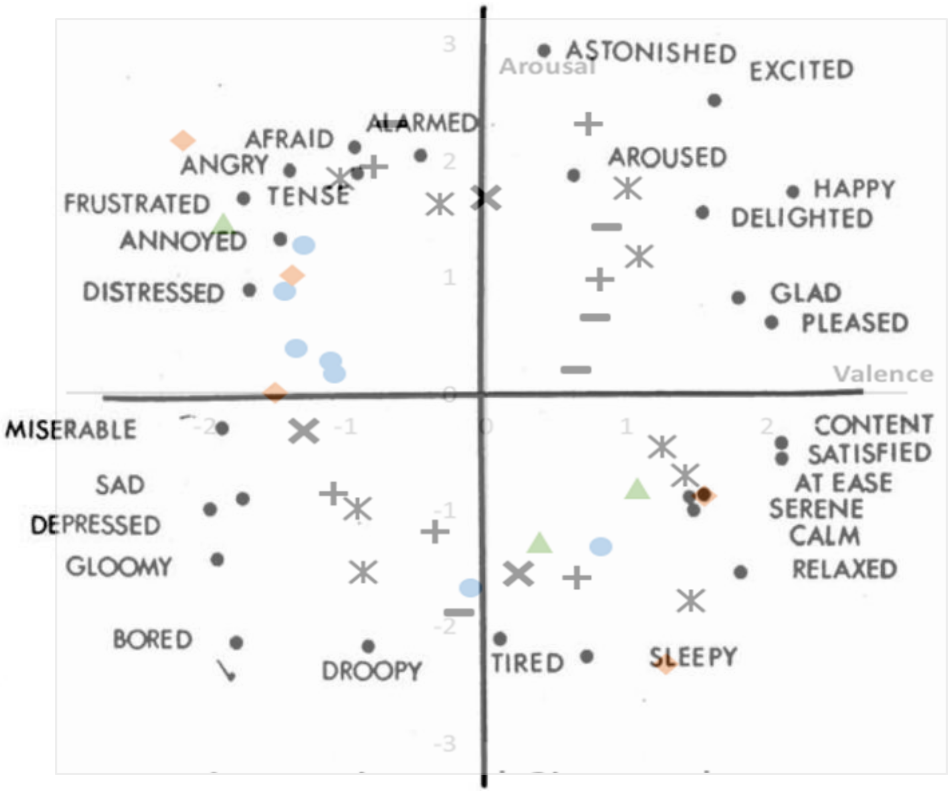
Larger and/or faster temperature changes were more emotionally negative (e.g., anger, fear)

Smaller/slower changes calmer and positive (calm, relaxed)



Multimodal signals

Thermal, audio, visual combinations



AUDIO FEEDBACK

Non-speech audio feedback

Music, structured sound, sound effects, natural sound

Why non-speech sound?

- Icons vs text, non-speech vs speech
- Good for rapid non-visual feedback
- Trends, highly structured information

Earcons

- Structured non-speech sounds
- Change pitch, timbre, rhythm, volume, location to encode information

3D audio interaction

Need to increase the audio display space

- Deliver more information
- Quickly use up display space

3D audio

- Provides larger display area
- Monitor more sound sources
- Non-individualised HRTFs, headphones
- Planar sound (2D)

‘Audio windows’

- Each application gets its own part of the audio space

AudioFeeds

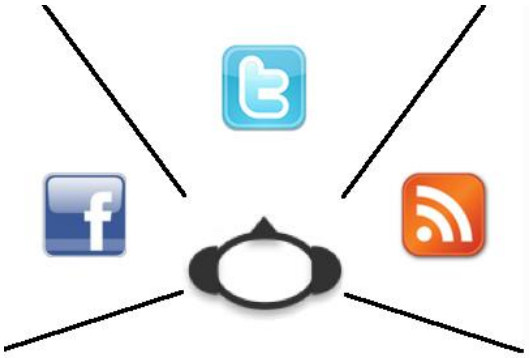
Mobile application for monitoring activity in social media

- Monitoring state of feeds
- Spotting peaks of activity in one feed

Twitter, FaceBook, RSS

Spatialized sound

- Placed each type of activity in different location
- Each type had different sound
- Within that different actions have related sounds

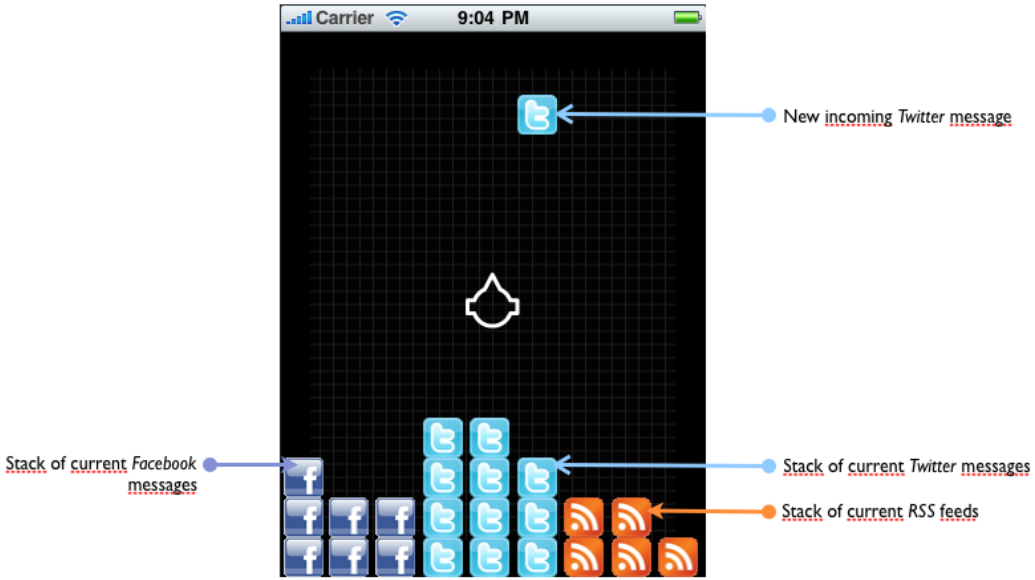


AudioFeeds

Users able to monitor feeds and maintain overview

- Even with complex soundscapes
- When mobile

FaceBook (water)	Twitter (birds)	RSS (abstract instruments)
Inbox msg (splash)	Friend feed (chirp)	CNN (digeridoo)
News feed (bubbles)	Direct msg (crow)	BBC (zither)
Notification (pouring)	Reference (junglefowl)	TechCrunch (wind chime)
Friend request (drops)	Hashtag (canary)	Uni News (pan flute)



Pulse: an auditory display to present a social vibe

Presenting ‘vibe’ or ‘pulse’ of an area while you move through it

- ‘Play’ geo-located tweets
- Sonification

Presented around the user in 3D sound

- Message volume (water splashes)
- Message density (flow rate of river)
- Topic diversity (bubbling sound)

Tested in lab and in Edinburgh during the festival

Effective at giving awareness

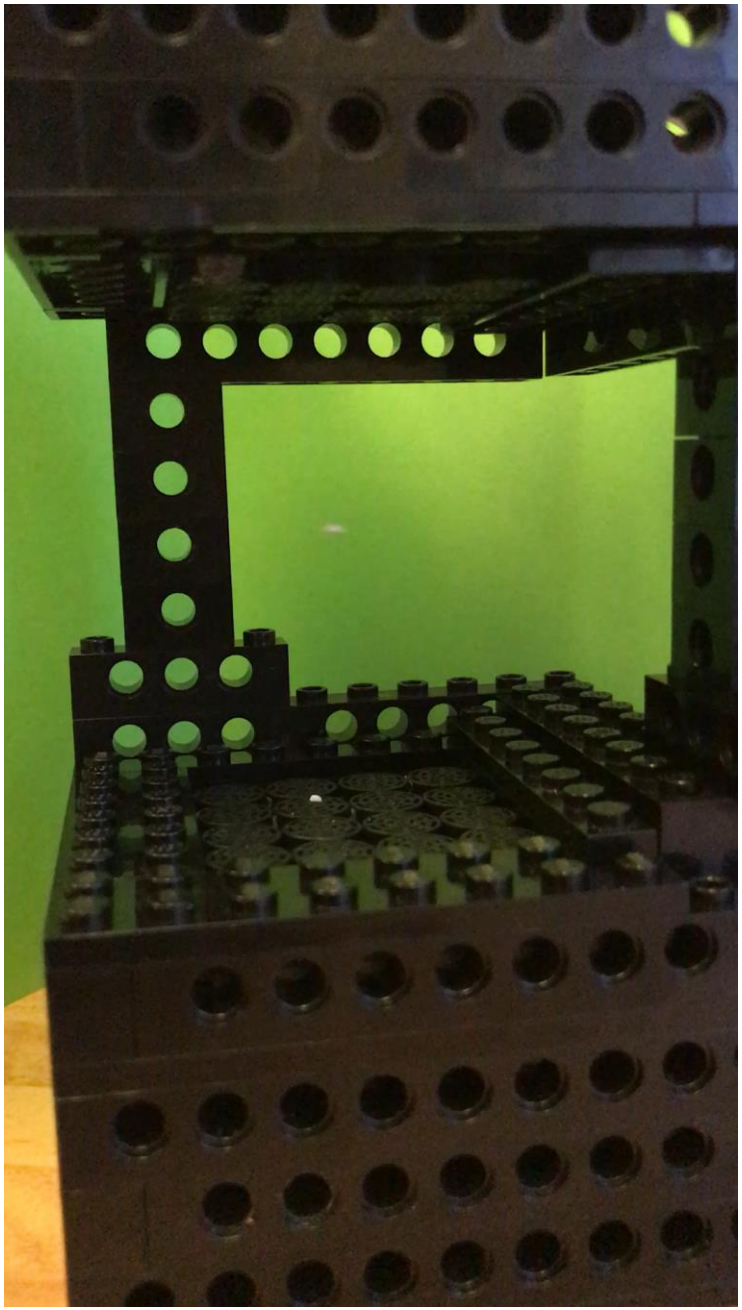
LEVITATION

Levitate project

New project combining

- Ultrasound haptics
- Parametric audio
- Levitation
- Projection

Create dynamic multimodal 3D surfaces



Conclusions

Touchscreens can limit our interactions

- Interactions not optimised to users' capabilities

Multimodal interactions allow us to more of the capabilities our users have

- Haptics / touch
- Non-speech audio

Pressure input

- Pressure can use the z dimension of the device
- One finger, multi-finger, bi-manual

Conclusions

Thermal output

- Thermal gives rich new output options

Non-speech audio

- Spatial sound allows for low attention interactions

Multimodal interaction techniques provide new opportunities and applications

New ways of interacting with mobile devices

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