

Soft Actuation for Home and Office

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Soft Actuation for Home and Office

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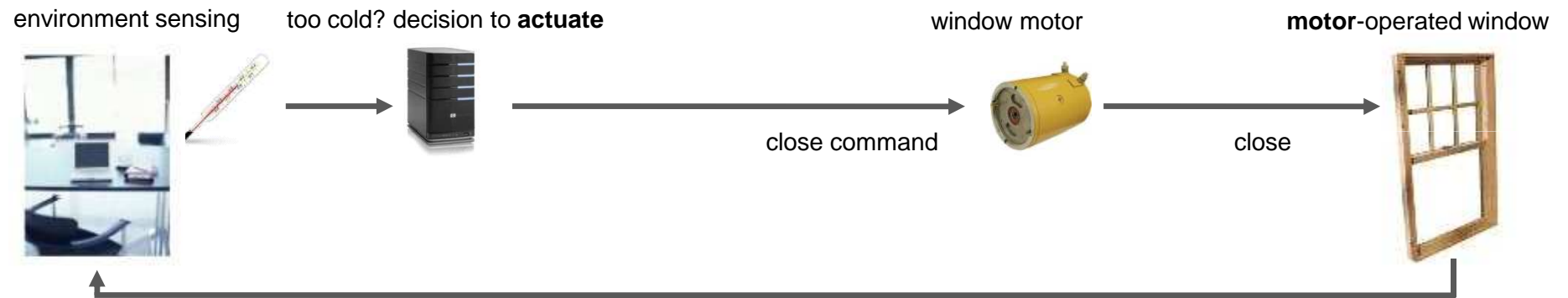
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- Soft actuation defined
- Example: soft actuation in the office
- Related products and related work
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Proactive pervasive computing and its opponents

Pro-active actuation



Some problems with pro-active actuation

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- Thus it may appear to offer most added value, **but** ...

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objective errors in context sensing and inferences

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 - "I know it's cold, but *I still want some more fresh air*"



inability to determine what the user desires at the moment

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 - "I know it's cold, but *I still want some more fresh air*"
 - "it's so *unexpected* when the window closes by itself"



causing distraction/disturbances/stress to the user

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 - "why closing the window? actually, *it's not cold* at all"
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 - "it's so *unexpected* when the window closes by itself"
 - "it's a reasonable thing to do, but I do not feel *in command*"

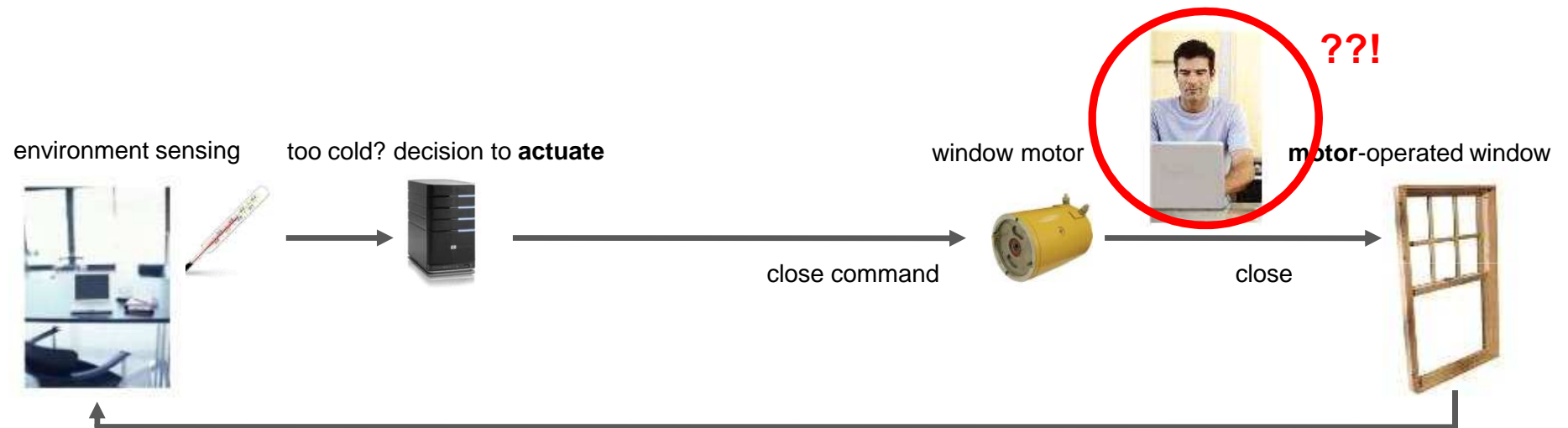


taking the sense of control away from the user

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 - "I know it's cold, but *I still want some more fresh air*"
 - "it's so *unexpected* when the window closes by itself"
 - "it's a reasonable thing to do, but I do not feel *in command*"
- ... some actuating actions may be psychologically unacceptable .

Result: pro-active actuation as a nuisance



Some voices against proactive actuation

- “... human initiative is frequently required to determine what to do next ...”

Bellotti, V., Edwards, W. K.: *Intelligibility and Accountability: Human Considerations in Context-Aware Systems*, in *Human-Computer Interaction*, 16(2), pp. 193-212, 2001.

- “No matter how hard the system designer tries to program contingency plans for all possible contexts, invariably the system will sometimes frustrate the home occupant and perform in unexpected and undesirable ways.”

Intille, S. S.: *Designing a Home of the Future*, in *IEEE Pervasive Computing*, 1(2), pp. 76-82, 2002.

- “system-oriented, importunate smartness”
vs. “people-oriented, empowering smartness”

Streitz, N. et al.: *Designing Smart Artifacts for Smart Environments*, in *IEEE Computer* 38, 3, pp. 41-49, 2005.

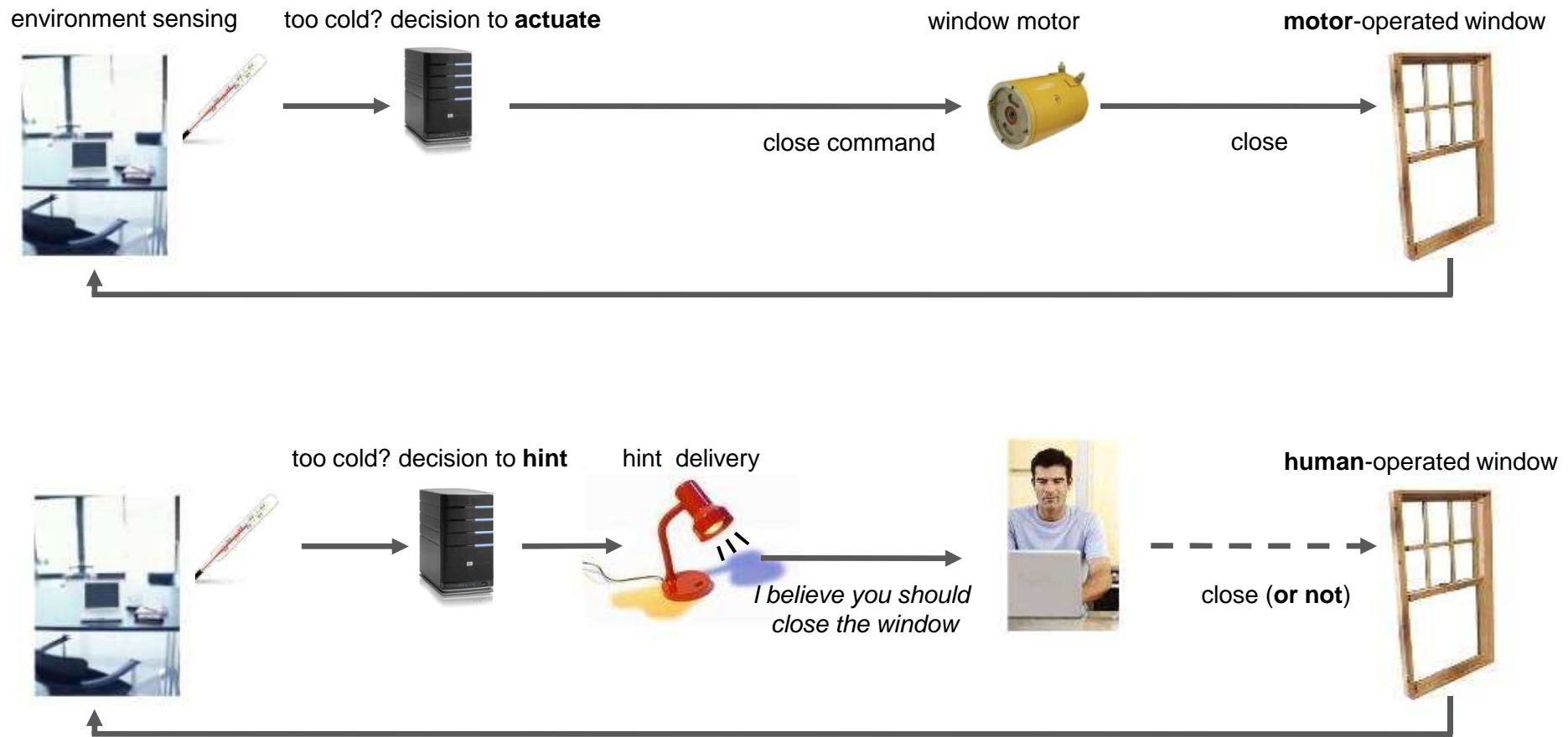
- All the above point to context-aware systems that make suggestions, rather than take actions.

Our contributions

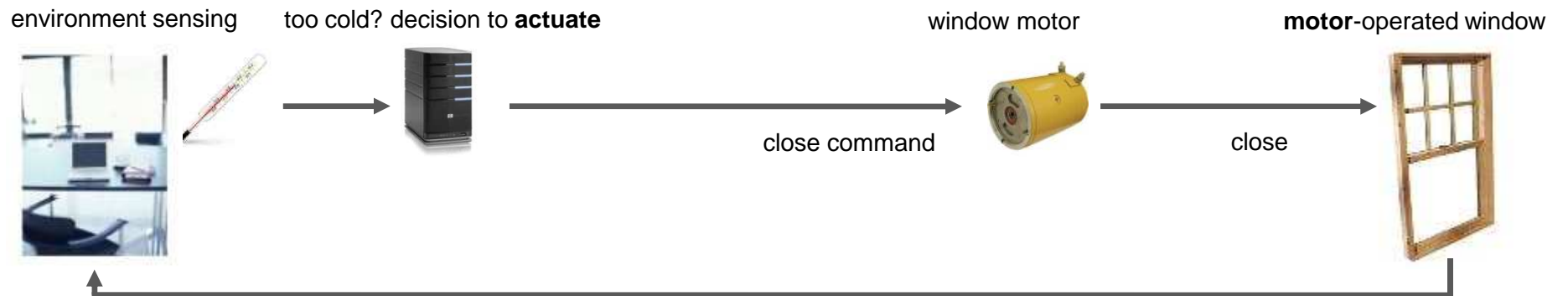
- Narrowing down the general idea of context-aware suggestion-making
 - we made some value judgments in the process ...
 - ... as a result, a clear concept emerged
 - we call the concept “soft actuation”
- Discussing related products and related work
- Providing basic information on a validation experiment
- Identifying research challenges
 - some preliminary ideas are included

“Soft actuation” defined

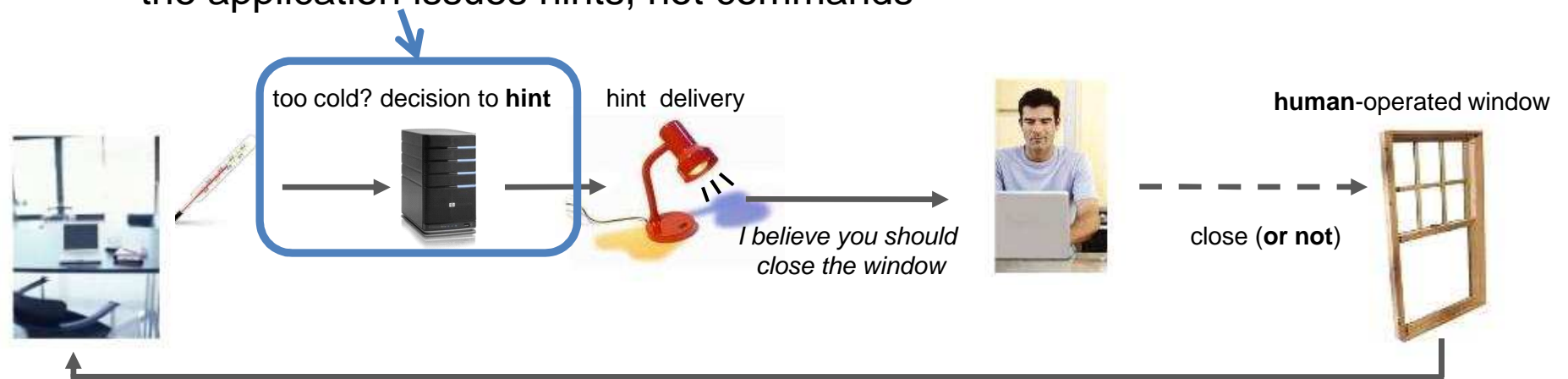
Soft actuation vs. pro-active actuation



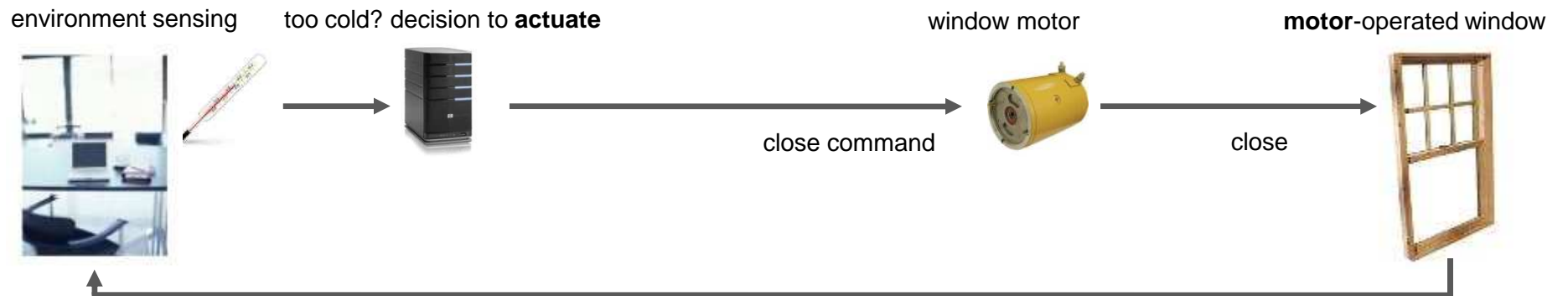
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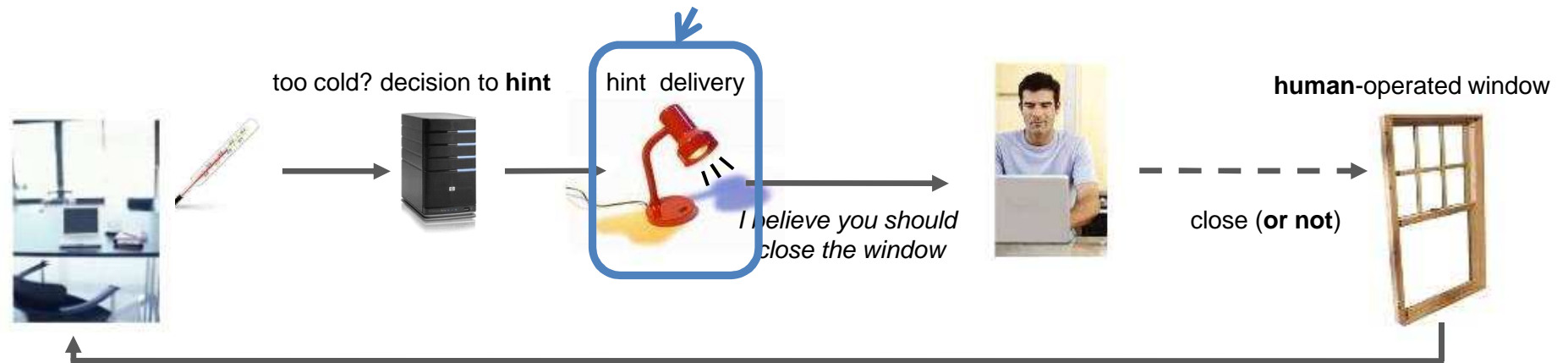
the application issues hints, not commands



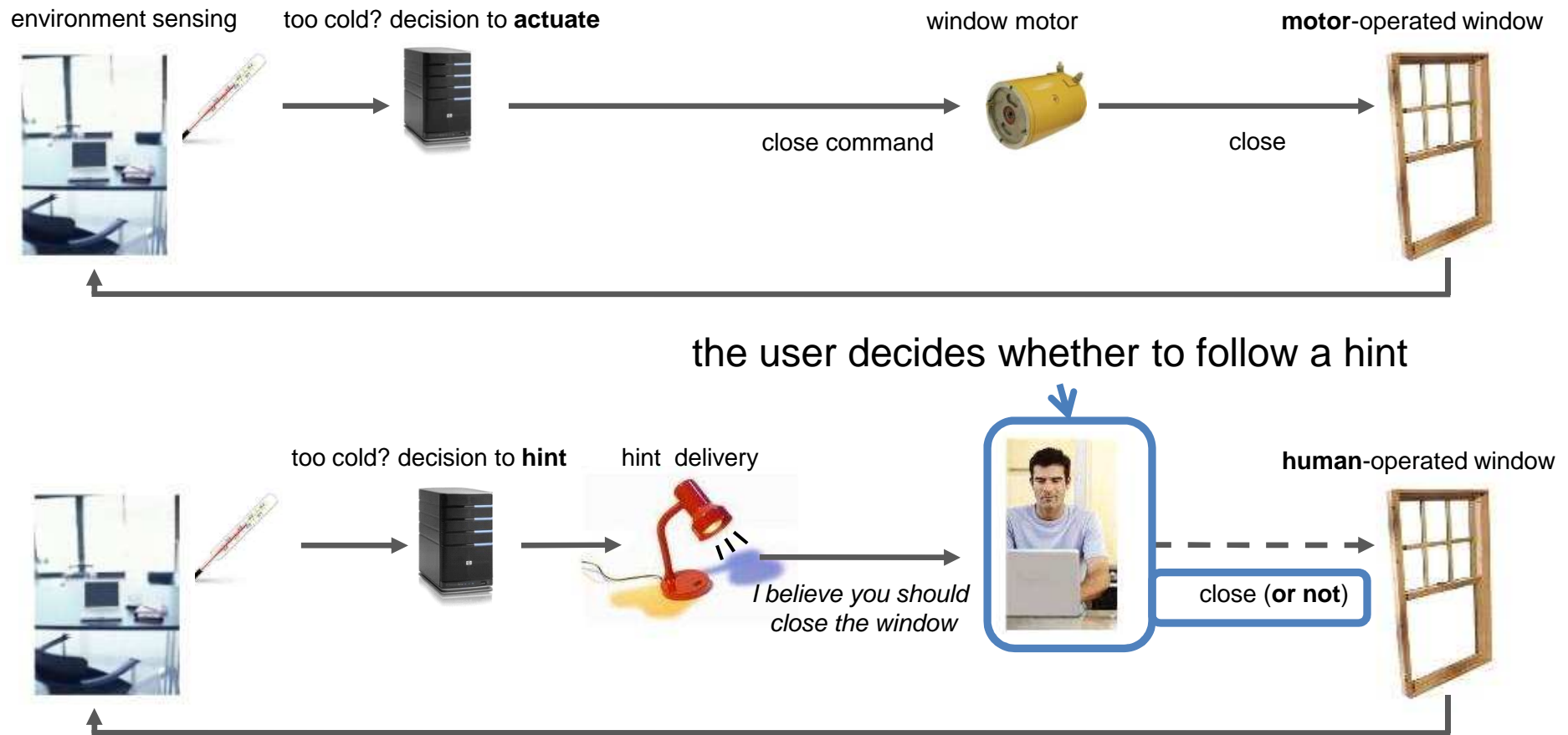
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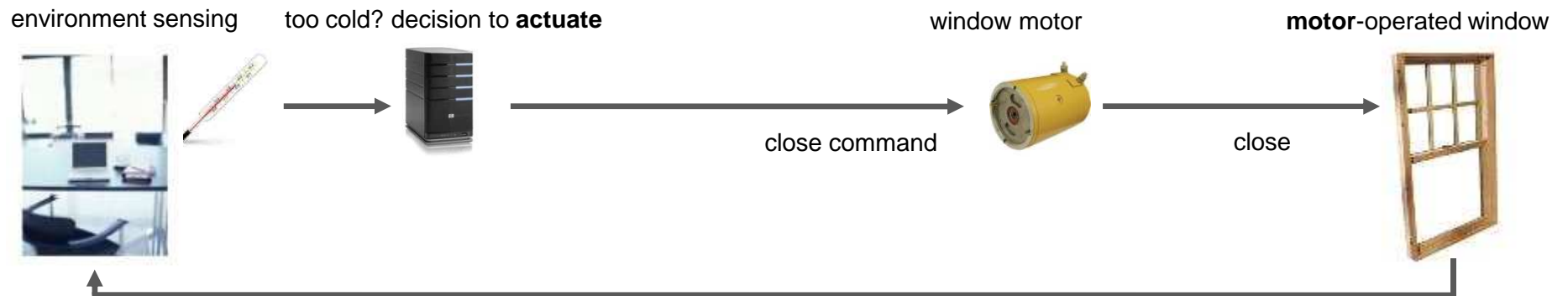
the hints are delivered via a peripheral display



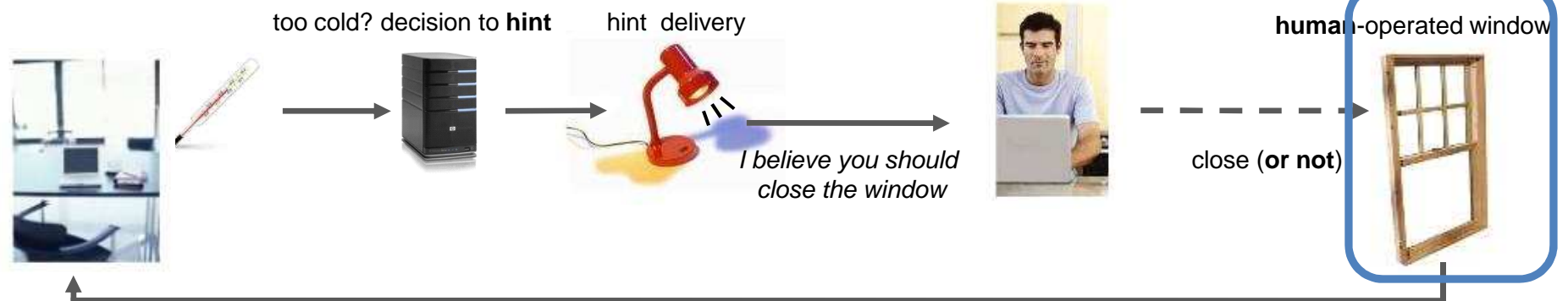
Soft actuation vs. pro-active actuation



Soft actuation vs. pro-active actuation



the actuating action consists in a manual operation on a nearby object



Soft actuation: domains & applications

Regular users in the home or office.

- The user acts as an unreliable actuator.

Non-critical applications.

- All hints should be of low importance and low urgency.

Soft actuation: hints

- A **hint** refers to an optional, simple, manual operation on a nearby object (the target object).

$$\textit{hint} \equiv (\textit{object}, \textit{operation})$$

- Hint's **contextual condition**: triggers hint delivery.
- Hint's **rationale**: captures the contextual condition with a brief, natural language description.

Soft actuation: hint delivery

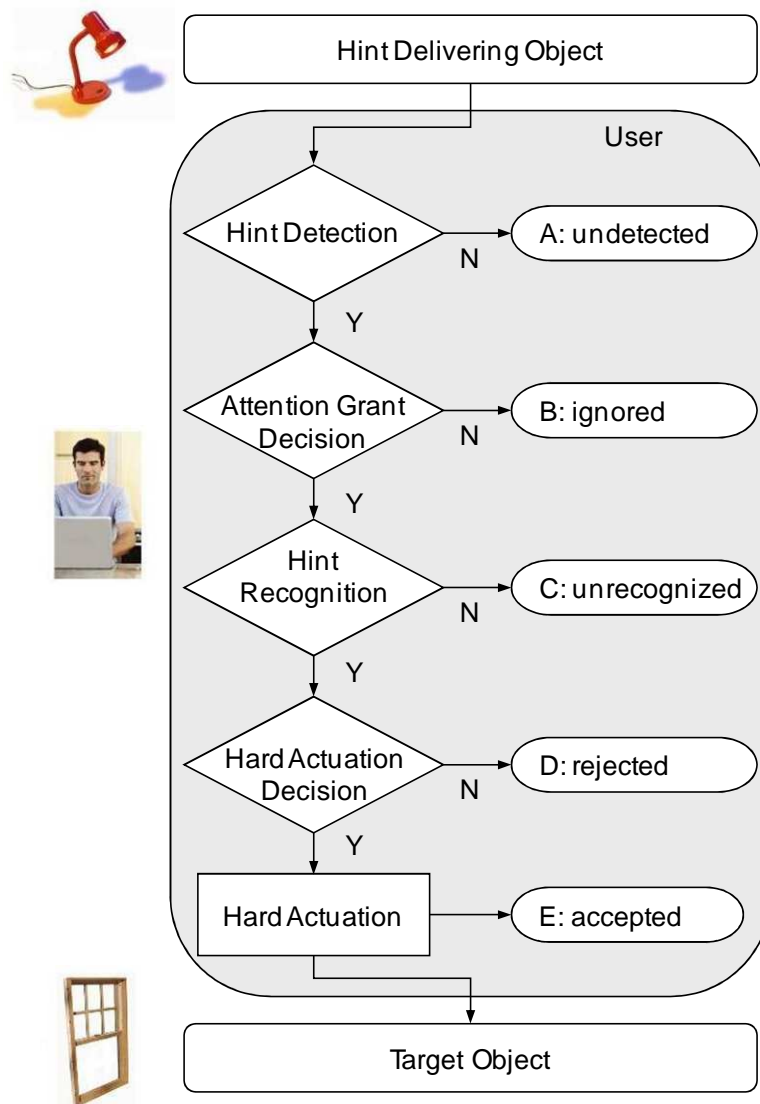
- In the spirit of calm technology.
- Subtle, non-intense.
- Non-verbal.
- Non-screen-based.
- One-way interaction – the user does not need to acknowledge hints.

Soft actuation: hint delivery

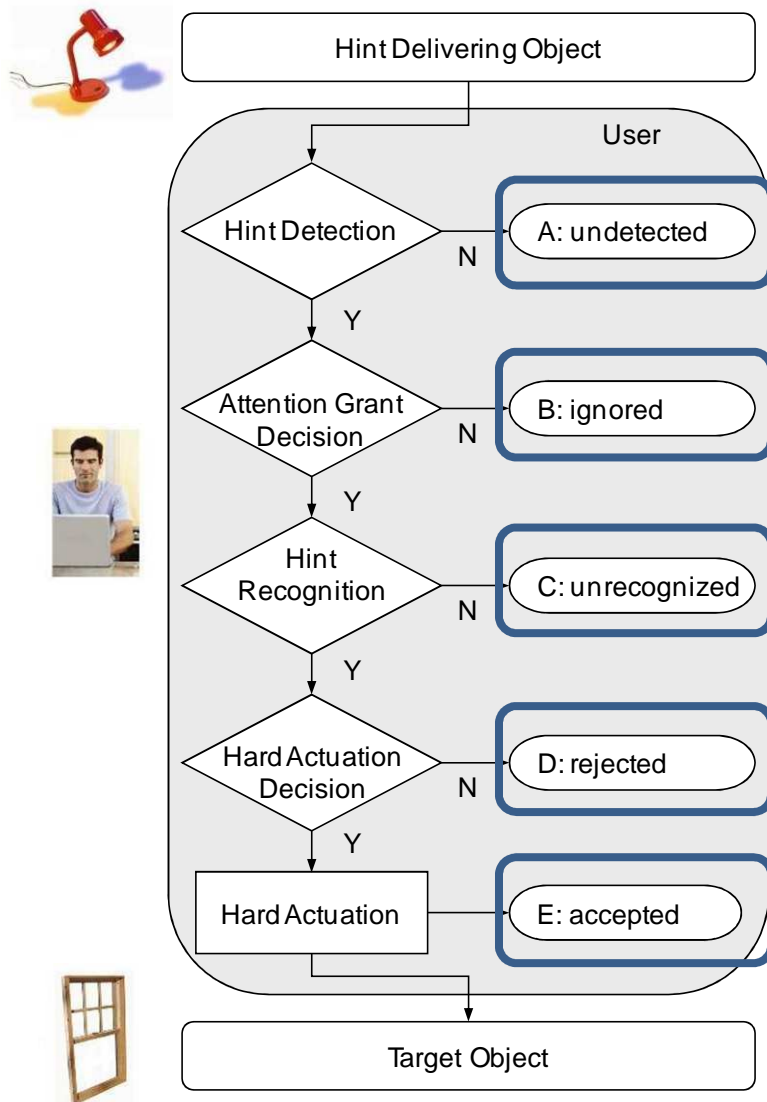
- In the spirit of calm technology.
- Subtle, non-intense.
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- One-way interaction – the user does not need to acknowledge hints.

Low intrusiveness of hint delivery is key.

Soft actuation: hint reception process



Soft actuation: hint reception process



All outcomes are perfectly legitimate!

Soft actuation: living with imperfection

- **Puzzling hint:** suggests an action that is impossible to perform, or that clearly does not make sense.
- **Undesirable hint:** suggests an action that is contrary to the user's actual desires.

Soft actuation: living with imperfection

- **Puzzling hint:** suggests an action that is impossible to perform, or that clearly does not make sense.
- **Undesirable hint:** suggests an action that is contrary to the user's actual desires.

Occasional puzzling and undesirable hints are unavoidable and a part of normal operation.

- An easy way to handle such hints: simply reject.
- Just think about the consequences of such imperfections in proactive actuation ...

Example: soft actuation in the office

Sensing infrastructure

Sensor	Location	Measurement/Detection Purpose
Temperature	Desk	Room temperature
	Window	Window opening/closing
	Radiator	Thermostat setting
Brightness	Desk	Room brightness
	Window	Brightness due to sunlight
Motion	Desk	User presence
Noise	Desk	User activity
Magnetic	Door	Door opening/closing
Software	PC/phone	Phone/Skype call

Indicative hints

Hint		Hint Rationales		Functionality Cluster
Object	Operation			
Lights	Switch Off	R1	There is enough sunlight to illuminate the room.	Lighting (energy saving, ergonomics)
		R2	Lights should be switched off for the night, before leaving.	
	Switch On	R3	It is considered unhealthy to work in the dark.	
Thermostat	Turn Down	R4	The room is too warm.	Heating & Ventilation (energy saving, comfort)
		R5	The window is now open, avoid wasteful heating.	
		R6	Heating should be turned down for the night, before leaving.	
	Turn Up	R7	The room is cold.	
		R8	The window has been closed, heating can be turned on again.	
		Window	Close	
R10	The window should be closed for the night, before leaving.			
Open	R11		The window has been closed for long, let some fresh air in.	
Door	Close	R12	The window is open, no need to reduce temperature in the halls.	Social Aspects (office policy, privacy, etc.)
		R13	You are having a phone/Skype call, you may want to keep it private.	
		R14	It is too loud in the room, avoid bothering your colleagues.	
	Open	R15	The door has been closed for a long time, respect open door policy.	

Why soft actuation? (1/3)

Hint		Hint Rationales		Functionality Cluster
Object	Operation			
Lights	Switch Off	R1	There is enough sunlight to illuminate the room.	Lighting (energy saving, ergonomics)
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Window	Close	R9	The room is getting cold.	
		R10	The window should be closed for the night, before leaving.	
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Replacing actuators:

e.g., R5, R8 (realize the open window function found in advanced thermostats).

Why soft actuation? (2/3)

Hint		Hint Rationales		Functionality Cluster
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Avoiding undesirable actions:
e.g., R9.

Why soft actuation? (3/3)

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Avoiding actions that are invasive and psychologically unacceptable:
e.g., R15.

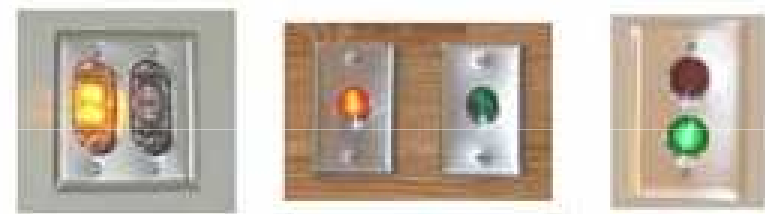
Related products and work

Related products/systems in home and office

- Familiar home products



- Window signaling systems



Ackerly K., Brager G.: *Window Signaling Systems: Control Strategies & Occupant Behavior*, Proc. 7th Windsor Conference: The changing context of comfort in an unpredictable world, 2012.

- Electricity rate indicators on smart meters



D 097-0905 B01, *2nd Generation In-Home Display*, User Manual, Aztech Associates Inc., 2013.

Related work

- The voices against proactive actuation (see above).
- **Passive context awareness**
 - ... but soft actuation triggers specific actions; it does not just inform.
- **Ambient displays**
 - ... but soft actuation hints are more like assorted, irregularly occurring events.
- **Reminder systems**
 - ... but soft actuation hints point to unscheduled and optional actions.
- **Persuasive technologies**
 - ... but soft actuation is not related to habits or longer-term personal priorities.
- Some connections to explore
 - human interruption
 - smart city applications with human actuators
 - human computation

A glimpse on the validation experiment

The experiment was performed as part of the SmartSantander FP7 project, in cooperation with the University of Surrey (Guildford, UK), using the Smart Campus IoT testbed at the University of Surrey

The objective

- Find out how people react to soft actuation hints and what they think of soft actuation in general.
- Do this by applying the technique “in the wild”, in a real-world office environment.

Hint delivery via LED panel

- An array of nine green LEDs.
- Between hints, no diode glows.
- To display a hint, selected diodes glow, forming a hint-specific pattern.



LED panel designed by Aleksander Pruszkowski

Hint delivery via LED panel

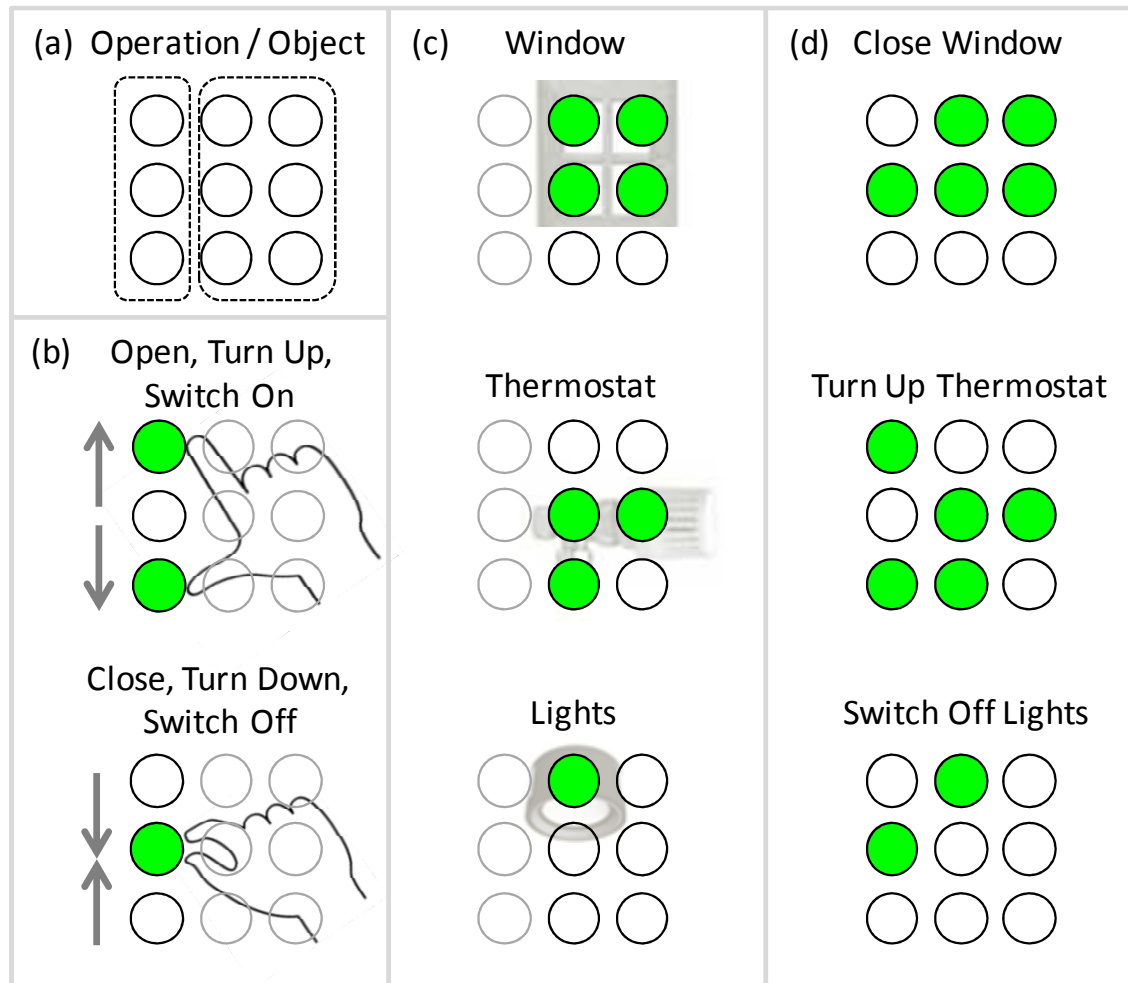
- An array of nine green LEDs.
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*I believe
you should close the window*

LED panel designed by Aleksander Pruszkowski

Hint patterns



Outcome

- Participation:
 - 14 users of the Guildford campus volunteered to participate
 - soft actuation system run for about 5 weeks on a 24 hours basis
 - roughly 30 million sensor values were recorded
 - about 1000 hints in total were issued by the application
 - 14 participants filled in a questionnaire, 13 took an interview

- Main conclusions:
 - the LED panel was too non-intrusive
 - a large number of hints went unnoticed
 - participants liked the concept of soft actuation
 - they were also positive about the idea of having such a system installed in their office and/or home

Research challenges

Research challenges ahead

Hint design issues

- hint modality
- concept of hint delivering object
- hint delivery notification level
- hint pattern design
- hint reception capacity
- hint learning
- hint intelligibility
- hint replay policy

UI extensions

- hint inspection

System-level issues

- centralized vs. distributed hint delivery
- hint related middleware services
- intrusiveness control

Control-theoretic issues

- unreliable actuation

Conclusions

- Soft actuation is (meant to be) simple, low-profile, unremarkable.
- Soft actuation provides the user with the benefits of arbitrarily complex machine-based context sensing and inferences, while delegating to him simple manual operations.
- Soft actuation, by design, allows the user to retain control over his personal environment.
- Soft actuation is widely applicable.
 - a wide variety of possible hints
 - no assumptions about the underlying context-aware infrastructure
 - low cost of deployment (sensors only)
- **Could this be *the* way to actually introduce pervasive computing in the home and office?**

Thank you!