

Conversations with your home: designing for end-user programming through voice

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Pioneering research
and skills

End-user programming?



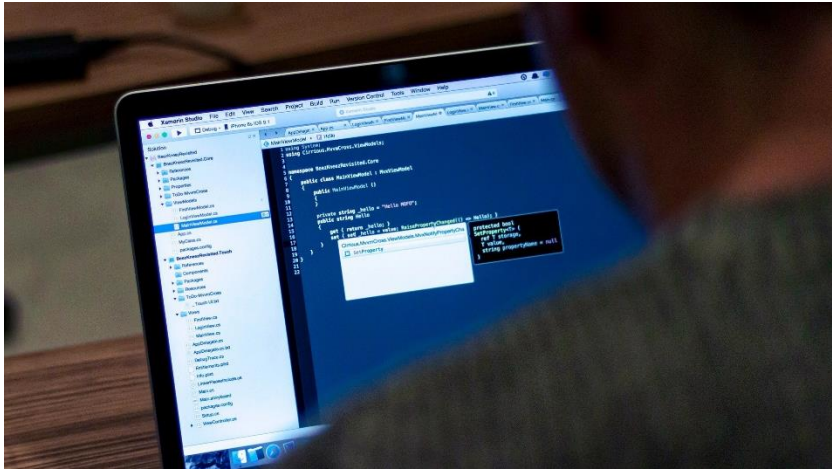
End-user programming?



End-user programming?



Programming through voice?



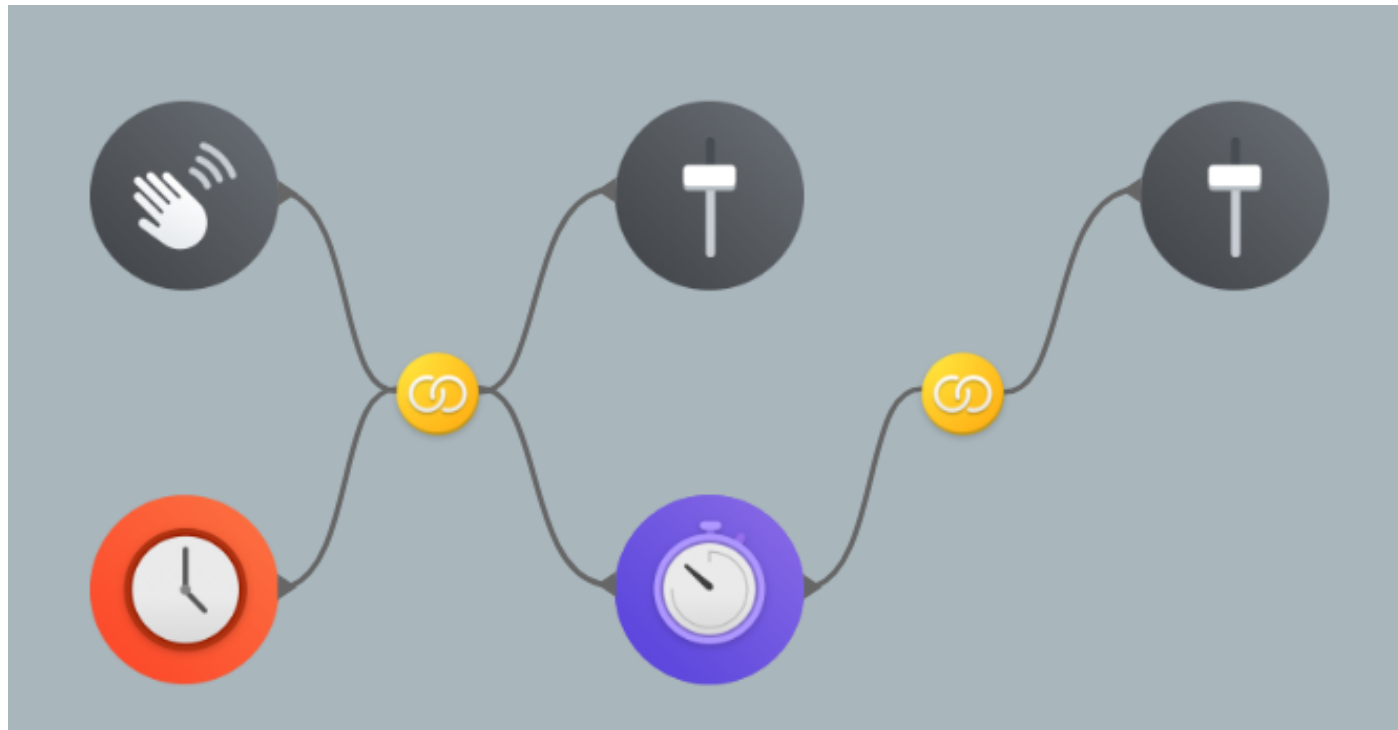
Voice user interfaces (VUIs) are increasingly seen as an intuitive interface for **smart home control**, but provide **little support for querying, debugging and customising** rules defining automated behaviours through voice

There is renewed interest in programming through voice, but there are many challenges, and there is sparse evidence on **whether/how users without a programming background can understand and express** such rules through voice

Programming using **natural language** has long been an aspiration in **end-user and novice programming** research, but has so far not lived up to hopes



EUP for Home Automation



- Limited uptake beyond early-adopters and tech savvy hobbyists

Night Light

Description:

Turns lights on at night when motion is detected.

How it works:

WHEN there is Motion detected in the hallway,
AND the Time is nighttime...

THEN turn on my Dimmer to 15% brightness,
AND set a Timer for 7 minutes...

THEN turn the Dimmer off.

Things included in this flow



EUP for Home Automation

Email your ZEEQ sleep data to yourself at noon everyday

ZEEQ ZEEQ Smart Pillow by REM-Fit

 22

ZEEQ 

Play a spoken notification when someone unlocks the door

|ON Oticon

 49

|ON 

- Limited uptake beyond early-adopters and tech savvy hobbyists

‘Natural’ expression for Home Automation

Existing work has led to some consensus:

- Trigger-action rules are a simple but powerful format (Ur et al., 2014; Catala et al., 2013)
- Users tend to rely on implicit rather than explicit specification (Truong et al., 2004; Ur et al., 2014)
- Users tend not to mention specific sensors or devices (Truong et al. 2004, Ur et al. 2014, Dey et al., 2006)

Dey, A. K., Sohn, T., Streng, S., & Kodama, J. (2006). iCAP: Interactive prototyping of context-aware applications. In *PerCom2016*

Ur, B., McManus, E., Pak Yong Ho, M., & Littman, M. L. (2014). Practical trigger-action programming in the smart home. In *CHI2014*



Catala, A., Pons, P., Jaen, J., Mocholi, J. A., & Navarro, E. (2013). A meta-model for dataflow-based rules in smart environments: Evaluating user comprehension and performance. *Science of Computer Programming*, 78(10),

‘Natural’ expression for Home Automation

But, existing work has not been carried out in real-world contexts.

- Natural language descriptions have been collected in isolation from other communicative modes, such as gesture, using:
 - online surveys (Ur et al., 2014), post-it note instruction tasks (Perera et al. 2015) and non-contextual interviews (Dey et al., 2006).
- Given the importance of context for smart environments, it is likely that existing findings only provide a limited picture.

Dey, A. K., Sohn, T., Streng, S., & Kodama, J. (2006). iCAP: Interactive prototyping of context-aware applications. In *PerCom2016*

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CONVER-SE Project Objectives

1. Use **contextual studies** to gain an understanding of how end-users understand and specify rules for smart environment behaviours **through conversational speech**
2. Create a **toolkit for implementing and testing spoken conversational interfaces in situ**
3. Implement a **prototype conversational interface for understanding and programming** rules for smart environment behaviours
4. Investigate how far the **conversational approach** used in the prototype can support **understanding, debugging and elicitation of accurate and complete rules.**

Domestic Studies

Goals

- Gather contextual 'natural expression' data from diverse user group
- Evaluate conversational approaches

Participants

- Have some existing smart home tech
- No programming background, mixed genders
- Including older and disabled users (mobility and vision impairments)



Domestic Study 1 – 2018

Part 1 – Contextual Interview

- Use and understanding of smart home tech and VUIs
- Capturing natural descriptions of rules for smart home behaviours

Part 2 – Wizard of Oz Prototype

- Testing conversational approaches for editing and generating of rules

Part 3 – Roleplaying

- Users demonstrating ideas for effective support



Domestic Study 2 - 2019

User testing

- User testing of (more) functional prototype based on findings from study 1 – built on Google's Dialogflow platform
- Returned to test in same homes to examine whether our improved approaches work with voice-recognition
- Longer interactions with increasing difficulty



Study 1

- Participants:
 - 15 (5 men, 10 women)
 - Had at least one 'smart' device in their home
 - 3 people with visual impairments, 3 people with mobility and/or dexterity impairments
 - Aged: 30-35 (2), 36-45 (5), 46-55 (2), 56-65 (5) and 66-75 (1).
- Analysis: inductive thematic analysis and detailed text-level analysis of behaviour descriptions.

Interview - behaviour descriptions

*Damian: But if I could sort of do things like- if I could put something in the oven and say (2.5) “**Turn on at three o'clock so as it's cooked when I come home**” and things like that, that would be so useful.*

*Barbara: Opening the front door - that would be good.... Just **coming in and it recognises me** and **the door just opens**... that would be good.*

Interview - behaviour descriptions

*Rosa: [It] would be good, to say ‘**Alexa, are the curtains closed?**’ ...*

Interviewer: So if you- would there be any scenarios where you’d like the curtains to shut automatically if a certain situation arose...?

*Rosa: I guess if it got dark enough... yeah, **if it got to a certain point where it worked out the light level was low**, then it would **close the curtains** in the aft- you know, **in the evenings**.*

Wizard of Oz

Isabel: Hey CONVER-SE, edit rules for the bedroom light.

*CONVER-SE: OK, I have two rules for the Bedroom Light. Rule one: **At 7:30pm every day**, **turn on the bedroom light and set the colour blue**. Rule two: **At 10:30pm every day**, **turn off the bedroom light**. Which rule would you like to change?*

Isabel: Rule one

CONVER-SE: What would you like to change?

Isabel: Change the colour from blue to white.

CONVER-SE: (10.0) OK, rule one changed. At 7:30pm every day, turn on the bedroom light and set the colour white.

Role-playing

Nicole:... So ahm... “Hey Jim, **in the morning** could you ahm...
(2.0) **turn the heating up to 19°** (1.0) and then **30 minutes later**
turn on the lights (1.0) **in the downstairs**, (1.0) **open the**
curtains in the lounge and pull the blinds in the kitchen. (1.0)
And don't forget to **turn the kettle on for me.**” (1.0) I think that's
everything.

Role-playing

Danielle: Yeah, I could say (2.0) “Jim.” [LAUGHS] “I’m going to wake the kids from their nap at three. At four, (1.0) please can you put CBeebies on for one hour whilst I make dinner.”

Trigger action rules, but messier

- Less rigid triggers:
 - Sunset, dusk, dawn
 - When it's the cheap rate of electricity
 - In the morning, at night, in summer
- Conditionals – often only emerge through prompting
- Devices and sensors mentioned explicitly – often the focus
- Complex sequences and routines:
 - Routines might be independent of triggers - chunking – object oriented
 - Interest in 'teaching' home complex routines

Information over automation?

Preference for:

- Notifications and alerts
- Queries of status
- Vetos – check with me

Automation usually only preferred when you can't do it yourself:

- When you are asleep or not home
- When you have an impairment

Trust and control

- Confirmation – has system understood, and will it really do it?
- Rules for others – a number of examples related to children or pets

Design implications

- Voice interaction helpful for queries, simple edits and live debugging
- Possible to author simple rules from scratch with voice, but limited
- For sighted users, visual support can help
- Turn-based authoring and editing can work (but natural language understanding struggles with shorter utterances)
- Programming by demonstration through voice (recording macros) for complex routines

Thank you

- Any questions?