ANNEX: SURVEY AND RESULTS

This appendix is to show the data collected by the survey. Demographics data got from questions Q1-Q5 in group 1 are already shown in the main paper. We will start with questions in group 2.

A. Group 2: familiarity with smart devices

Q6: “Do you know some other functions of air conditioner except cooling and heating?". This question asks whether people are familiar with the common household devices around for years. The survey results are shown in Fig. 2. It is surprising to see that more than half of users (54.32%) have no idea of other functions of air conditioners. The rest of the participants mostly give the answer of “dehumidify" (28.40%) or “timer" (7.05%). Other answers include “sleep mode", “purifier mode", “defrost mode" and so on, accounting for about 10% in total.

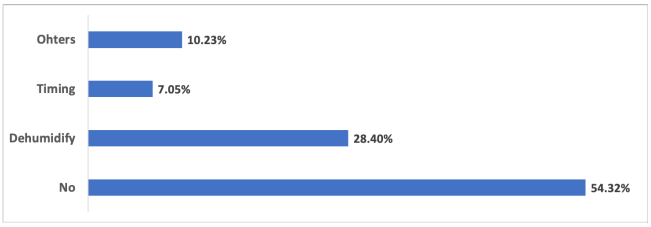


Fig. 2. Participants’ knowledge of air conditioners’ other functions: Q6

Q7:“Do you know some other functions of tower fan except fanning the wind?". 93.83% participants answered “no". Some of them had never heard of such a device before according to their offline feedback. Only 6.17% participants answered “yes" and listed some functions, which mainly included “purify" and “dehumidify".

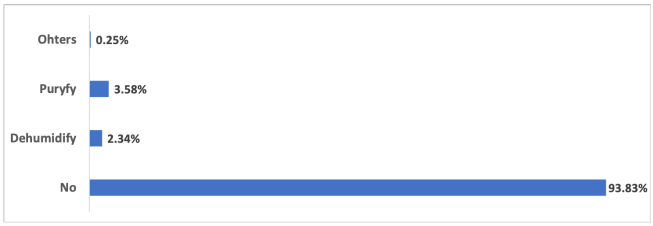


Fig. 3. Participants’ knowledge of tower fans’ other functions: Q7

Q8: “Do you know about the energy consumption of your household devices? ". The results are shown in Fig. 4. It can be seen that 11.82% participants know nothing of the energy consumption of their devices, 31.39% know little and 41.45% know some. Only 15.34% participants say they know the power of most or all of their devices.

B. Group 3: requirements expressions

There are 6 single choice questions to find out end users’ preferences on device-related or unrelated expressions. For each question, we give two kinds of expressions, Choice *A* and *B*. Both of them represent the same meaning. Participants

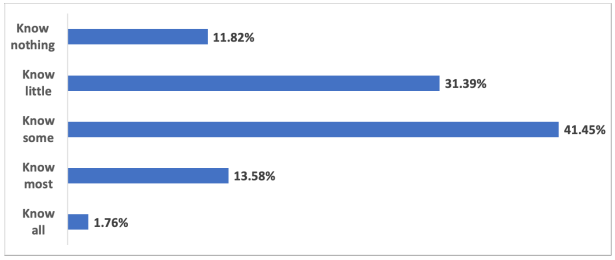
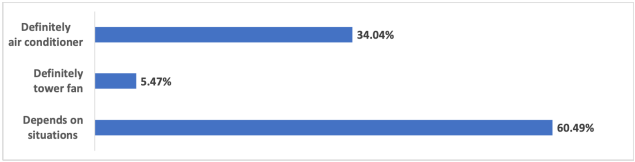


Fig. 4. Participants’ knowledge of devices’ energy consumption: Q8

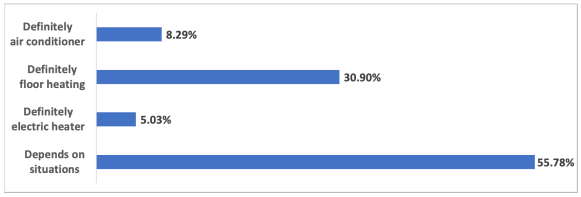
are asked to choose one expression. Choice *A* is a device-related expression in the TAP form allowing users to control devices directly. For example, “if the temperature is too high (say 30^oC), then turn on the cold air conditioner". Choice *B* is device-unrelated expression which is close to users’ feelings or preference. One example of choice *B* is “maintain the temperature in room at 22^oC". Since exact numbers seem to shift users’ concerns, we replace all the exact numbers with generalized expressions, such as a certain value. The questions and results are shown in Table II. From the table, we can see both of these choices are chosen by a certain number of participants. Moreover, it is obvious that participants prefer device-unrelated expressions to device-related ones.

Q15: “What device will you use when the temperature is too high?"

Q16: “What device will you use when the temperature is too low? " Optional choices of Q15 and Q16 include several devices, and an uncertain answer-“depends on situations". The results are shown in Fig. 5. We can see that each device is chosen, while most of the participants choose “depends on situations".



(a) Answers to too high temperature



(b) Answers to too low temperature

Fig. 5. Choices of devices in a certain scenario: Q15 & Q16

Q17: Multiple choice questions. Ask the participants whether they would like to describe requirements with the following expressions.

1) The air conditioners and windows can never be on together at bedrooms. (Never I)

TABLE II
QUESTIONS AND ANSWERS OF DEVICE-RELATED EXPRESSIONS

ID	Choice A (device-related expressions)	Choice A Result	Choice B (device-unrelated expressions)	Choice B Result
Q9	If the temperature is too high then turn on the cold air conditioner. If the temperature is too low then turn on the hot air conditioner.	20.63%	Maintain the temperature in room at a certain value.	79.37%
Q10	If it is not raining, open the window and curtain.	35.45%	Ventilate the room when it is not raining.	64.55%
Q11	Start the sweeper every day.	31.92%	Keep the floor neat and tidy.	68.08%
Q12	When the cold air conditioner is turned on, turn on the tower fan. (Tower fan can make the temperature drop more quickly)	29.45%	When the cold air conditioner is turned on, the temperature should drop quickly.	70.55%
Q13	The monitor should always be on.	9.56%	I want to be able to monitor my home at any time.	90.44%
Q14	If it is raining, close the window.	29.15%	If it is raining, the window should be closed.	70.85%

2) The concentration of CO should never be above a certain value. (Never II)
3) The humidity in bedroom should never be below a certain value. (Never III)
4) The concentration of CO should always be below a certain value. (Always I)
5) The humidity in bedroom should always be above a certain value. (Always II)
6) None of the above. (None)

The results are shown in Fig. 6. We can see that the expressions containing keyword “never" are very common as well as the “always" expressions. Very few people do not consider them at all.

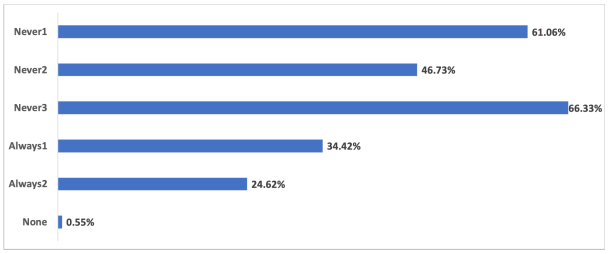


Fig. 6. The result of never and always questions: Q17

Q18. Please write down your own requirements in a smart bedroom (kitchen)(study). We collect answers and find that they can be classified into three kinds. The first kind is called an auto adjustment, which adjusts to living environment attributes automatically such as temperature, brightness, the concentration of CO, humidity and so on. Take brightness as an example, the usual expressions they use are “automatically adjust the brightness", “the brightness needs to make me comfortable", and “the brightness should maintain at a certain value or range". They use living environment attributes to express users’ expectations of a comfortable home.

The second kind is called device automation which directly controls devices. The usual expressions are like “automatically open the window", or "automatically turn on the exhaust fans". They use device-related operations to express the capabilities that a smart home should have.

The last we term scenario specific answers. They are related to some functions under certain scenarios. For example, many participants answer “automatic cooking" or “automatic washing" in the kitchen scenario. These requirements only specify the to-be achieved effects. Maybe various devices are needed to realize these effects. The distributions of these answers in different rooms are shown in Fig. 7. It can be seen that among the 3 scenarios, auto adjustment takes place mostly in the study, device automation happens mostly in the bedroom, and the scenario specific occurs mostly in the kitchen.

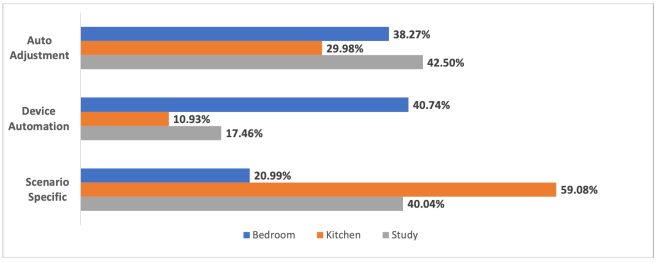


Fig. 7. Result of free writing: Q18

C. Group 4: non-functional preferences

Q19: “Will you consider safety or security requirements when writing requirements? If yes, what kind of safety or security requirements will you consider?". As we expected, most of (97.71%) participants selected “yes". Among these answers, most of them are electrical safety, fire safety, power safety and property safety.

Q20: investigates the privacy requirements using a similar question with Q19. Also as expected, 95.06% participants will consider the privacy requirements. In these answers, personal privacy, data privacy and remote control access are their priorities.

Q21: The last question asks participants to write non-functional preferences unmentioned before. We provide the choice of “environment protecting", “noise free" and a blank for them to fill in. 71.61% participants select environment protecting and 91.83% select noise free. Also, many of them mention cool appearance of devices, ease of use, energy-saving, etc.