The House Knows What You Are Up To: Personal Informatics meets home

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Workshop on 'Making Home: Asserting Agency in the Age of IoT'

Abstract
Smart technology and Internet of Things has provided people the freedom to control built environments with a click of a button. For example, heat is no longer a shared resource which is adjusted centrally. Houses are fitted with distributed systems which allows each person to adjust the temperature to their comfort level at all times. Some of these systems are not only controllable, but also hackable. With open data and platforms with Application programmable interfaces (API), people can create their own control systems. There is already a variety of different technologies available, but for the most part they provide links and easy triggers for the house to actuate. Thinking about the already available Personal Informatics tools that could be linked up with the house, we propose a more intrusive system where the house tries to 'understand' the activity engaged in and adjusts the temperature per calculated thermal comfort of the people connected.

Author Keywords
Thermal comfort; Personal Informatics; smart home; Internet of You (IoY).

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

With the promise to save consumers 20-30% on their heating bill, smart thermostats [11] are becoming more and more popular. In order to get your money's worth from the smart heating control, you need to give it some personal information (e.g., location, schedule, personal preferences). Although you are giving away personal information, these heating systems at the moment are more focused on the house and the location, rather than people. The promise is that they will provide a comfortable environment while saving money. However, achieving human's thermal comfort levels are extremely complicated [8] and measuring the outside temperature and flicking the switch when somebody is home, is not sufficient for that. We propose that we should try to implement systems that are more adaptive [3] and focus more on people rather than the thermostat. Existing work in this area has investigated the use of location (GPS) data in order to predict when the home occupant would return home and heat the space in advance [5]. However, in-occupancy adaptation in response to variations in comfort has not been addressed. In order to do this we need to understand the current levels of comfort and activities (as a proxy for metabolic rate) that people engage in - inside and outside of the house. Also, work done by Ming Jin et al [6] demonstrates the potential of sensor fusion for better user comfort and energy management.

With this workshop, we are interested in exploring and trying out how could we meaningfully combine self-tracking and house automation to give people more customised and personal experience of a smart home heating system. Furthermore, having the house identify the activities and making decisions about peoples' comfort levels, will surface questions around agency, privacy and control which can be explored further.

From Internet of Things (IoT) to Internet of You (IoY)

The purpose of Internet of Things (IoT) is to embed intelligence into our environment. The assumption is that by making the environment smarter, we are also improving our lives and experiences of engaging with it. By attaching or embedding sensors to our environments we can collect data about how we use the spaces or what affects them, but how could we use this data to interact with the space and make our lives better and easier? The next logical step is to merge this data with data collected form our bodies, to enable richer interactions with our built environments. Things and devices are not only observing and collecting data from us, but also feeding information back and acting based on our actions [10].

As the popularity of wearable technologies like Fitbit and Jawbone rise, we could see a shift from Internet of Things (IoT) to Internet of You (IoY) [12]. This means that the control of technology is in our hands and, bringing this interaction full-circle, as we are trying to quantify and understand our lives through numbers we are also influencing the environments we live in, as a result of the insight they provide us with.

Thermal Comfort

Per ANSI/ASHRAE Standard 55-2010, thermal comfort is defined as "that condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation" [1]. It is a highly personal measurement which shows individuals' satisfaction with the surrounding thermal conditions. To

determine an individual's comfort level we need to consider both: environmental and personal factors. There are six factors to take into consideration when designing for thermal comfort [13]:

- Metabolic rate (met): The energy generated from the human body
- Clothing insulation (clo): The amount of thermal insulation the person is wearing
- Air temperature: Temperature of the air surrounding the person
- Radiant temperature: The weighted average of all the temperatures from the surfaces surrounding a person
- Air velocity: Rate of air movement given distance over time
- Relative humidity: Percentage of water vapor in the air

Thermal comfort standards define comfortable indoor temperatures according to subjective measurements recorded in lab-based studies. In applying standards in practice, assumptions are made about personal factors and their constancy, mainly due to the difficulty in measuring clothing levels and metabolic rate [7]. Predicted Mean Vote (PMV) draws on standards to predict the proportion of uncomfortable occupants for a given indoor temperature using constants for these personal factors. However, with IoT technologies like personal trackers and location-based temperature measurements, we can better predict the comfort levels of individual occupants in real-time. The interesting thing here is that although we could calculate the thermal comfort for an individual and adjust the environment based on that, people are usually sharing spaces with other individuals. What are the implication for design, when people are just sharing spaces going on with their day-to-day routines and when they are also engaging in activities together? What interfaces are appropriate in such scenarios? How would these systems cope with peoples' individual preferences/lifestyles and who would have the final say?

Adaptive Thermal Comfort System

Taking in count of ANSI/ASHRAE Standard 55-2010 [14] and adaptive model of thermal comfort [3,7,8] we would attempt to build a system that reacts to peoples activates recorded via personal informatics tools and feedback given by individuals. By using open source sensing technology [2] and wearable personal trackers [4] we are hoping to build a prototype of personalised adaptive thermal comfort system.

As an experiment, we will be bringing along some Fitbits to workshop participants to wear while commuting to and staying the Airbnb house. We will then try to visualise and assess the energy expenditure of people in order do adjust the system's temperature. This also includes adding sensor information from the house using sensor kits. We will also experiment with Amazon Alexa [15] as a feedback device to interact with the thermal comfort system. It could provide feedback about the house, but also about a person's physical and physiological indicators.

POINT OF DEBATE

Whether people think that they are becoming a part of this home/house infrastructure by feeding information about themselves and their bodies into it?

About the Researcher

Aare Puussaar is currently pursuing his PhD in digital civics at Open Lab in the School of Civil Engineering & Geosciences at Newcastle University. Prior to that he worked as a data scientist studying people mobility using spatial tracks obtained from mobile phones. He has always been fascinated how people use and interact with their spaces and how could we use our environments more sustainably and playfully [9]. His current work involves around looking into more meaningful interactions with (personal) data and developing tools for people share and collaboratively make sense of data. This includes looking at shared experiences in personal datasets, but also adding sensor data from surrounding environments contextualise and make sense of everyday activates.

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