Scalable Personalized Thermal–Comfort Platform (SPET)
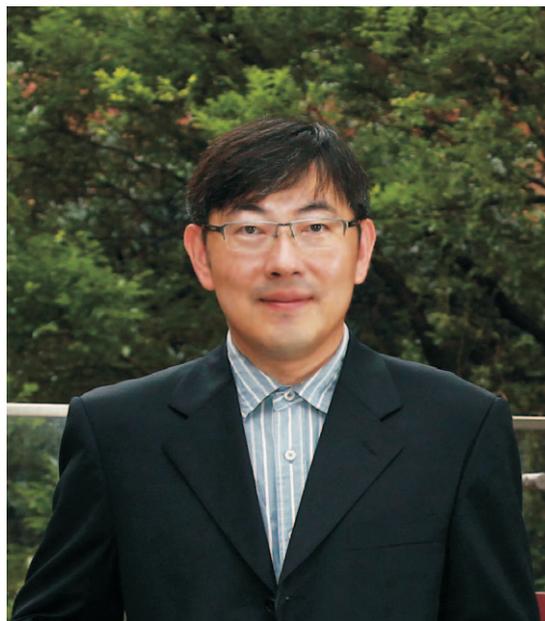# SPET 節能空調調節平台

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Summary

Some opine that air conditioner is a need instead of a luxury in the humid and sizzling summer in Hong Kong. But setting the air conditioner at a temperature too low is wasteful and may even make users feel uncomfortably cold. Until researchers from PolyU's Department of Computing developed the Scalable Personalized Thermal-Comfort Platform (SPET), there was no technology to let users of centralized air-conditioned offices express their feelings. The platform takes into account environmental factors, personal data and user feedback to calculate the best temperature most users are comfortable with. It also proves to save 18% of energy and improve user thermal comfort by 33.8% in a test trial.

Main Story

One of the key purposes of scientific researches and inventions is to make our life better. For example, air conditioning system is supposed to make us feel cool and comfortable in summer. But feelings are subjective and one man's comfortable temperature could be too low for others. In Hong Kong, most people working for prolonged hours in offices with central air
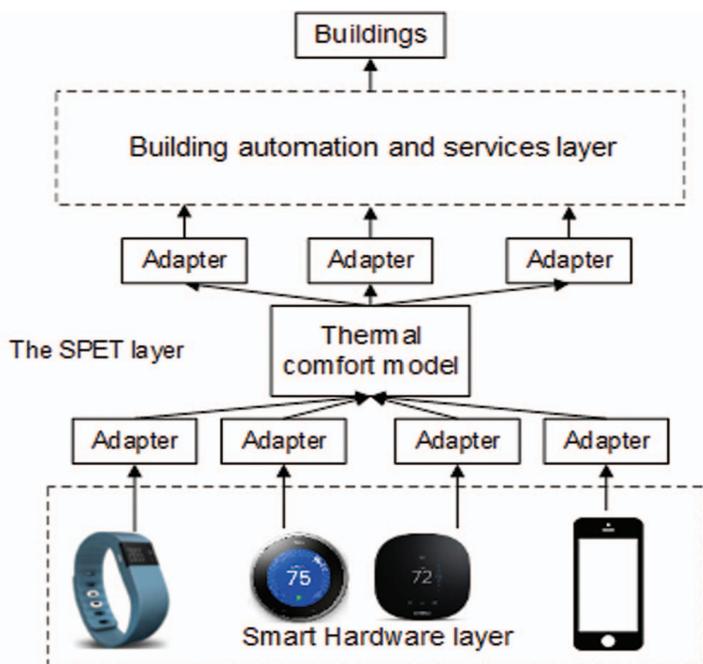

The SPET Platform was developed by Dr Dan Wang, PolyU.
SPET節能空調調節平台由理大的王丹博士研發

The structure of SPET platform
SPET節能空調調節平台的結構

引言

有人認為，在香港夏季炎熱潮濕的天氣下，空調是基本需要，而不是奢侈品。但若把溫度定得太低，不但會浪費能源，更會令使用者因過冷而感到不適。市場上暫未有可以兼顧中央空調使用者感受的技術；為此，理大電子計算學系的研究團隊開發了節能空調調節平台 (SPET)，結合環境因素、個人數據和用戶反饋，來計算大部分使用者認為最舒適的溫度。經過測試，該平台不但節省了18%電能，更把使用者的溫感舒適度提高了33.8%。

內文

科學研究的其中一個重要目的是改善生活，例如，空調系統就是為了令人涼快、舒適而誕生的。可是，感覺是主觀的，一個人認為舒適的溫度不一定適合其他人。在香港，大多數長時間處於中央空調辦公室的人都覺得室溫偏低，這不但導致電費高昂和浪費能源，更犧牲了使用者的舒

conditioning find the temperature on the low side. This incurs tremendous cost and energy wastage while sacrificing the comfort of the users. In light of this, Dr Dan Wang, Associate Professor, Department of Computing, The Hong Kong Polytechnic University (PolyU), led a research team in devising the Scalable Personalized Thermal-Comfort Platform (SPET) that allows users to vote on the temperature they prefer. In a test trial, the platform helped save 18% of energy and improve user thermal comfort by 33.8%.

Physiological thermal comfort model

"Smart" has been one of the most mentioned tech buzzwords in our daily life. Our phones are smart. Our cars are smart. Our homes are smart and of course, a city can only be smart if most of its skyscrapers are smart. One criterion to judge whether a building is smart is its energy efficiency. According to a report by EMSD, energy consumed by the commercial sector accounted for 65% of Hong Kong's total energy consumption in 2014. Half of that energy went to air conditioning. In other words, to conserve energy, starting with air conditioning makes a lot of sense.

Dr Wang believed most building managers would rather set the temperature lower than needed because users may complain if it's

適感。有鑑於此，香港理工大學 (理大) 電子計算學系副教授王丹博士與其團隊合力設計節能空調調節平台 (SPET)，讓使用者可以「投票」的方式調節冷氣溫度。在一項測試中，該平台有效地節省了18%電力，而使用者的溫感舒適度亦大幅提升了33.8%。

生理溫感舒適模型

現今，「智能」一詞充斥著我們的日常生活：智能手機、智能汽車、智能家居等……當然，要稱得上智能城市，當中的建築物也必須具備相同的智慧才行。我們可以循多個準則判斷建築物是否具備智慧，其中一個是節能效率。機電工程署的報告顯示，2014年香港商業用電量佔全港總耗電量65%，而空調的耗電量又佔商業用電量一半以上。由此可見，要節約能源應先從空調著手。

王博士認為，大多物業管理人寧願將空調溫度調得過低，也不想被用戶投訴不夠冷。他說：「過去幾十年間，研究人員一直建議把辦公室溫度設定在攝氏21至23度之間，以達到最高的生產力。不過，舒適度是主觀的；要真正提升生產力，最有效方法莫過於建立一個共通的平台，讓使用者一起表達感受。」自1970年代

Individual/group user feedback 個人或群體用戶回饋

not cold enough. "For decades, researchers have been suggesting an office temperature between 21 to 23°C to optimize productivity. But user comfort is subjective and we believe a platform that lets users express how they feel would be useful," said Dr Wang. In 1970s, researchers started publishing papers on the physiological thermal comfort model, outlining the factors that influence people's feeling about a certain temperature. "Generally speaking, a person would feel hot when the body generates more heat than the heat loss. Personal factors such as metabolic rate, sex, weight, body fat level, age and clothing all affect thermal comfort. So are other external factors. We tried to factor them in as far as possible."

A voting system for indoor temperature

The Scalable Personalized Thermal-Comfort Platform (or SPET in short) collects personal information of the users, such as weight, height, sex and BMI, via a smartphone app. Then users may vote whether the existing temperature is perfect, too cold or too warm. "The platform also collects external data such as the time, outdoor and indoor temperature, fan speed and ultraviolet index. Such figures alongside the personal data of all users would be incorporated in a formula to calculate the best indoor temperature that most users are comfortable with. The air conditioning system would then be set at that temperature," explained Dr Wang.

However, not all users in an office would vote. In such cases, the platform has a cross-learning algorithm to make the result more representative. "The platform can learn from past records to deduce the user's preference on a similar day at the similar time. Besides, the BMI of the user not voting is used as a basis and cross reference to preferences among other voting users of the similar BMI is made for calculation," he added.

In a three-week trial in a 484-square-foot office with 13 workers, users expressed a level of thermal comfort increased by 33.8% while 18% less energy was consumed on air conditioning. Average indoor temperature was raised 1.75°C. The platform can be easily retrofitted on existing central air conditioning system without large-scale modification.

The original article was published in the March 2018 issue of "Technology Frontier", an e-Newsletter of The Hong Kong Polytechnic University.

起，學者陸續發表有關生理溫感舒適模型的論文，概述什麼因素會影響人們對溫度的感覺。「一般來說，當人體產生的熱量多於熱量流失時，人便會感到悶熱。其他個人因素如新陳代謝率、性別、體重、脂肪水平、年齡和衣著等，以及各式外在因素，都會影響溫感舒適度。所以在設計節能空調調節平台的時候，我們盡量涵蓋所有因素。」

投票選擇室內溫度

通過SPET平台的智能手機應用程式，用戶首先輸入體重、身高、性別和身體質量指數等個人資料，其後即可進行投票，指出目前的溫度是剛好、太冷還是太熱。王博士解釋道：「SPET還會收集其他外在因素的數據，如時間、室內外溫度、風扇速度、紫外線指數等，然後把這些數據連同用戶個人數據、投票結果一併納入公式中。在平台計算出最多用戶感到舒適的最佳室內溫度後，空調系統就會把溫度重新定為那個溫度。」

當然，不是每個員工都會投票，所以SPET特備交叉學習演算功能，以令結果更具代表性。王博士說：「舉例說，平台可從過去的記錄中學習，推算該員工在類似天氣、時間的偏好；甚至將並未投票員工與身體質量指數相約的員工進行相互參考，以推算出未投票員工的喜好。」

理大團隊曾於一間484平方尺、有13名員工的辦公室，對節能空調調節平台進行了為期三個星期的測試。結果顯示，空調使用者的溫感舒適度提高了33.8%，用電量減少了18%，而室內溫度則上升了攝氏1.75度。SPET平台安裝簡便，毋須對設備作出大型改動，即可連接現有的中央冷氣系統，達到理想的效果。

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