Energy efficient thermal comfort service controller in home network environment

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Recently, the applications of sensor network in home environment become more variety and give more solution for the smart home service. In some related research, the method of controlling the air conditioning system in suitable operation for increasing comfort and decreasing unnecessary energy use based on make utility of the outdoor air is proposed and give some results in energy efficient. For the better energy efficient of a human comfort system, another approach is proposed by taking the advantages of outdoor air and try to use the another human-comfort-related-devices, as less as possible using the air conditioner.

Thermal comfort is the state of humans that expresses satisfaction with the surrounding environment, includes a lot of factors such as air temperature, humidity, wind, meant radiant temperature. A cooling system is just balance the two factors of air temperature and humidity to achieve the human comfort and consume a lot of energy. In this research we will research strategies to achieve thermal comfort by balancing all the above thermal comfort factors, propose a thermal comfort system for the users under a variety of scenarios and different home configurations but and less using the air conditioner while making utility of outdoor air for better energy efficient.

In high humidity (higher than 85%) environment, human feels not very comfort. People tend to feel most comfortable at a relative humidity of about 25-65%, best in 45-50% percent. We feel much hotter than the actual temperature when the relative humidity is high. If the relative humidity is low, we can feel much cooler than the actual temperature because our sweat evaporates easily, cooling us off. Wind blows also make the human sensible temperature decrease, feels cold (wind chill). Sensible temperature decreases when has wind. For example, when the air temperature is 25℃ and relative humidity is 50%, if the wind speed is 0.5 m/s the sensible temperature is 24℃. When air conditioner ups 1℃, the system can save 10% consumption energy. Therefore, the use of electric fan to create the air flow, set air temperature higher can bring the better electric efficiency.

In this research, thermal comfort service controller (called by TCSC) gets the outside /inside temperature and humidity, process the operation of air conditioner, window, curtain, fan suitably try to using the outdoor air if it is acceptable with the aim to get the thermal comfort in home environment and good energy efficient.

The indoor thermal comfort will be evaluated through two index: the non-comfort index (NCI) and sensible temperature (NET). NET formula is the index taken from the Improved Missenard formula that is using by the Hong Kong's weather bureau, it calculates the sensible temperature by three factors: air temperature, humidity and wind speed . Human comfort can be achieved if NCI in the range of 60-70 and NET about 19-24℃.

In circularly, our system checks whether the indoor comfort is achieved or not. Then check out the home device status and outdoor air, give the control requests to the suitable devices. The outdoor is acceptable in case: NCI about 60-70, relative humidity lower than 90%, wind speed lower than 9 m/s and no rain.

In control algorithm, the system reads the status of inside door continuously to know whether inside air achieves thermal comfort or not, the information of outdoor air also get updated rapidly. If the outdoor air acceptable, the window opens for take the outdoor air to inside. While the use of fan makes the inside air circulation and reduce the energy consumption from the air conditioner by setting higher temperature. In case the inside humidity is high, the dehumidifier will be active.

The experiment environment are two the same structure houses called and TANS2A. They have the same square area, inside structure, and constructed by the same material. The Implemented TCSC system is installed in the TANS2A with the aim that controls the human-comfort-related-devices for achieve thermal comfort. While in TANS2B, another system just used air conditioner with the same purpose is to achieve the inside thermal comfort is implemented and installed. The performance of two methods is evaluated by three indexes : NCI, NET and power consumption. Under some different scenarios, whether the outdoor air is acceptable or not, the TCSC system in TANS2A gives better result in energy consumption and makes more thermal comfort environment for people with the lower NET.