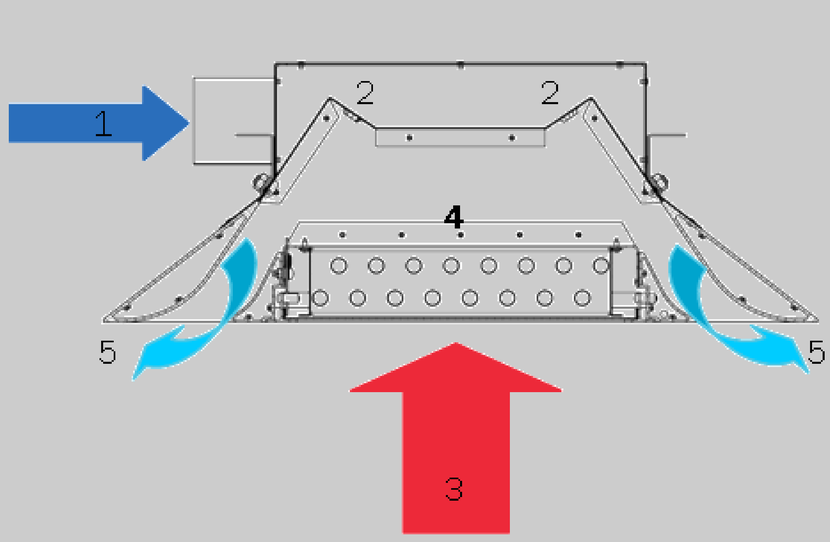
ACB based Room Temperature Control

Mr. Long Yushen I YLONG002@e.ntu.edu.sg
Prof. Claire Tomlin | Prof. Lihua Xie

Supported by:

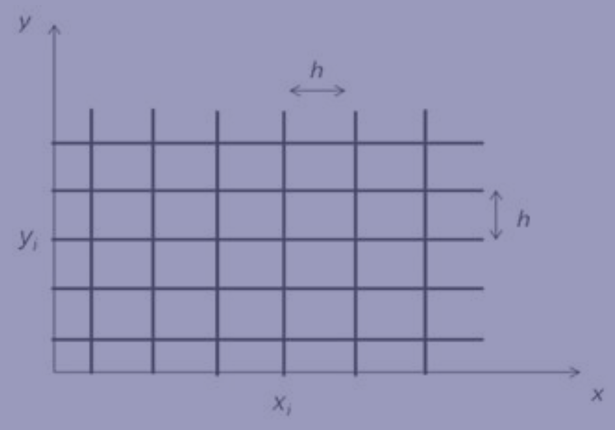
Funded by:
NATIONAL RESEARCH FOUNDATION

ACTIVE CHILLED BEAM



Primary air (1) is introduced by fan into the active chilled beam and by passing some nozzles (2), it will be mixed with cooled air from water coil (4). The mixed air (5) is cooler and denser so will fall to the floor. Then warmer air (3) will move up through the water coil and cause a constant air flow automatically.

UNIFORM MESH IMPOSED ON SPATIAL COORDINATES FOR HEAT EQUATION NUMERICAL SOLUTION



Heat from ACB and other heat source:

$$d_i = u_i K_1(l-\tau_i) + K_2(s-\tau_i)$$

where l is the temperature of cool air from ACB and s is temperature of heat source. u_i is the damper ratio of corresponding ACB.

MOTIVATION

1. High energy consumption is due to heating, ventilation and air-conditioning (HVAC) system in large buildings.
2. Active Chilled Beam, as a new kind of HVAC system used to heat or cool large buildings, is 85 percent more efficient at heat exchange.
3. For designing more efficient control strategy, thermal dynamic model of HVAC system and room temperature is required.

Problems

1. Thermal dynamic model is complex because of distributed parameter and nonlinear. So an approximate model is necessary.
2. The stability of approximate model under certain control law.

Approximate model

Fourier heat equation: $\dfrac{\partial \tau}{\partial t} = \alpha \nabla^2 \tau + d$

By taking difference on both sides, we get approximate model:

$$\dot{\tau}_i = \frac{\alpha}{h^2}\left(-4\tau_i + \sum_{j \in N_{m,i}} \tau_j\right) + d_i$$

Where α and h are thermal conduction constant of air, $N_{m,i}$ is the neighbour zones of i-th zone and d_i is heat comes from ACB and other heat source.

CONTROL LAW FOR DAMPER RATIO:

$$\dot{u}_i = c(\tau^* - \tau_i)$$