ACB based Room Temperature Control

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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: \( \frac{\partial \tau}{\partial t} = \alpha \nabla^2 \tau + d \)

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 \( \alpha \) 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:

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

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.