OPTIMIZED AIR MOVEMENT FOR THERMAL COMFORT CONTROL
LIU Shuo, YIN Le, Stefano SCHIAVON, HO Weng Khuen, LING Keck Voon

MOTIVATION AND CONTRIBUTION

- Increased air movement can lead to energy savings and thermal comfort improvements
- Fans commonly generate a strongly non-uniform air speed field and they are not coordinately controlled
- For the first time, multiple fans are controlled collectively and cooperatively. A provisional patent was granted

PROBLEM FORMULATION

Minimax-error problem:

\[
\text{Minimize } ||K \cdot P - V_d||_{\infty}
\]
subject to \(P_{\min} < P < P_{\max}\)

Equivalent linear programming problem:

\[
\text{Minimize } [0 \cdots 0 \ 1] \begin{bmatrix} \bar{P} \\ \bar{E} \end{bmatrix}
\]
subject to \([\begin{bmatrix} K & -1_j \\ -K & 1_j \end{bmatrix}] \begin{bmatrix} \bar{P} \\ \bar{E} \end{bmatrix} \leq \begin{bmatrix} V_d \\ -V_d \end{bmatrix}, P_{\min} < P < P_{\max}\]

EXPERIMENT 1: CONFERENCE ROOM WITHOUT HUMAN SUBJECTS

SYSTEM OVERVIEW

NUMERICAL OPTIMIZATION

Minimax-error problem:

\[
\text{Minimize } ||K \cdot \Delta P - \Delta V_d||_{\infty}
\]
subject to \(-\bar{P} < \Delta P < P_{\max} - \bar{P}\)

Equivalent linear programming problem:

\[
\text{Minimize } [0 \cdots 0 \ 1] \begin{bmatrix} \Delta P \\ \bar{E} \end{bmatrix}
\]
subject to \([\begin{bmatrix} K & -1_j \\ -K & 1_j \end{bmatrix}] \begin{bmatrix} \Delta P \\ \bar{E} \end{bmatrix} \leq \begin{bmatrix} \Delta V_d \\ -\Delta V_d \end{bmatrix}, -\bar{P} < \Delta P < P_{\max} - \bar{P}\]

EXPERIMENT 2: CLASSROOM WITH HUMAN SUBJECTS

“\text{This research project is funded by the National Research Foundation Singapore under its Campus for Research Excellence and Technological Enterprise (CREATE) programme.}”