Optimization with 1.0.2 0.3 0.2 1 0.1 10 0.6 85x174 *

Real time pricing of power market involves dynamic coupling between market participants. Classical (non-)tâtonnement process assumes market participants solve (2b) instantly when the price is announced. The goal is to achieve (x', p') optimally (in H2 or H∞, measure)

\[
\begin{align*}
&\text{Global objectives (e.g., maximizing social welfare) with global constraints (e.g., power balancing, physical limitations on infrastructure)}
\end{align*}
\]

Large scale multi-agent system comprised of power generators/consumers

Desired properties of solution algorithm

Decentralized to scale well with large networks

Give natural incentives to local agents to cooperate

Price-based Approach

Dual Decomposition

Lagrangian Dual Formulation of Problem (1)

\[
\max \{p\} \quad \text{subject to} \quad \sum_{i} J_{i}(x_{i}) + \frac{1}{2} \sum_{i} R_{i}(x_{i}) - c_{0}
\]

Interpretation of Problem (2) : Price-based Optimization

Market operator solves minimization problem (2b) to achieve (x', p') optimally (in H2 or H∞, measure)

Control design does not require knowledge of \( (x', p') \)

Convergence to \( (x', p') \) is guaranteed under mild assumption

Control Design with Limited Market Information

In practice, complete plant model is not available since each market participant’s decision making process is private.

If market participants agree to disclose partial information about their decision making process so that the market operator can design almost optimal controller, what kind of information should be disclosed?

Application of Control Theory to the Price Mechanism

Assumption : Dynamics of each Market Participant's consumption (production) is characterized by a linear model

\[
\begin{align*}
&\text{System} \\
&\mathbf{x}(t+1) = A \mathbf{x}(t) + B \mathbf{u}(t) + C \mathbf{y}(t) \\
&\mathbf{y}(t) = D \mathbf{x}(t)
\end{align*}
\]

\[
\begin{align*}
&\text{Controller} \\
&\mathbf{u}(t) = K \mathbf{y}(t)
\end{align*}
\]

Properties of proposed control approach:

The target \( (x', p') \) to which the plant is stabilized is not known in advance

Control design does not require knowledge of \( (x', p') \)

Convergence to \( (x', p') \) is guaranteed under mild assumption

Conclusions and Future Work

Future work

Justifying proposed heuristic rigorously.

Optimal power allocation with two market participants

- Global constraints: Power balance over network 1,2,3.
- Quadratic utility functions \( a_{i,j} \)
- Each player solves minimization problem (2b) by gradient descent.
- Each player has linear dynamics \( (A, B, C) \), \( F_{i} \) are private parameters
- Partial information is selected by LASSO and sent to the market operator
- Market operator designs \( h_{t} \), optimal controller based on received parameters

Optimal parameter selection obtained by LASSO.

- It is typical that an improvement in performance occurs by disclosing only a small subset of private parameters to the operator