Near-Optimum Power Control for Two-Tier SIMO Uplink Under Power and Interference Constraints

Baris Yuksekayya*, Hazer Inaltekin**, Cenk Toker*, Halim Yanikomeroglu***

*Department of Electrical and Electronics Engineering, Hacettepe University, Ankara, Turkey
**Department of Electrical and Electronics Engineering, Antalya International University, Antalya, Turkey
***Department of Systems and Computer Engineering, Carleton University, Ottawa, Ontario, Canada

INTRODUCTION

- The demand of both society and industry for increasing data rates is currently growing.
- Earlier types of wireless networks are designed to minimize aggregate power consumption.
- Next generation communication networks needs power control policies that maximize information theoretic bit rates.
- Wireless systems such as CR networks and HetNets are expected to include multiple tiers of users.

PREVIOUS WORKS

- Ghasemi and Sousa found a modified water-filling solution where the water level is found using the interference constraint.
- Zhang extended these results to multilayer communication scenarios by considering multiple access and broadcast channels.
- Inaltekin established the optimality of the binary power control for the SISO single cell uplink.

OBJECTIVES

- Include multiple tiers of users operating in the same spectrum.
- Maximize information theoretic bit rates under appropriate system and technological constraints.
- Derive optimum transmit power allocation in a two-tier SIMO uplink network.

SYSTEM MODEL

- Two-tiers in the same spectrum.
- Interference and noise impaired system.
- SIC is not available, only linear receive filters are allowed at the STB.
- The optimization problem to solve is:

\[
\begin{align*}
\text{maximize} & \quad R_{\text{total}} \\
\text{subject to} & \quad P_i \geq 0, \quad \forall i \\
& \quad P_i \leq P_{\text{max}}, \quad \forall i \\
& \quad \sum_{i=1}^{N} |g_i|^2 P_i \leq Q
\end{align*}
\]

- The optimization problem to solve is:

\[
P^* = \arg \max_P \sum_{i=1}^{N} \log_2 \left( 1 + P_i |\mu_i|^2 \right)
\]

\[
\text{s.t.} \quad P_i \geq 0, \quad \forall i \\
& \quad P_i \leq P_{\text{max}}, \quad \forall i \\
& \quad \sum_{i=1}^{N} |g_i|^2 P_i \leq Q
\]

- Optimum power allocation for the simplified problem is a modified water-filling algorithm.

\[
P_i^* = \min \left( \frac{1}{\ln 2 \cdot |g_i|^2}, \frac{1}{|\mu_i|^2} \right) \cdot P_{\text{max}}
\]

\[
\sum_{i=1}^{N} |g_i|^2 P_i^* \leq \sum_{i=1}^{N} \left( \frac{1}{\ln 2 \cdot |g_i|^2}, \frac{1}{|\mu_i|^2} \right) \cdot Q
\]

- Interference-filling rather than power-filling.
- Water level has an additional multiplier.
- Transmit power of each antenna is upper limited.
- Solution is optimum for the simplified problem.

RESULTS AND CONCLUSIONS

- Multiple antennas do not only eliminate the interference, but also increase the data rate.
- A tighter lower bound to the original problem is also found.

REFERENCES


This work was supported by The Scientific and Technological Research Council of Turkey under Grant 112E024 and under Grant 2214-A.