Matrix Algorithms for Massive MIMO signal recovery

Project Proposal, SOA/OS – Autumn 2014

Index terms: project scope
Keywords: 5G, massive MIMO, multiple antennas, matrix algorithms, parallel computing
Team size: 1

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2 Project Description

In the context of evolution of mobile communication network technology and emerging application challenges such as Internet of Things, there is a continuous need for increased robustness of data transmission and increased data rate.

Multiple-input and multiple-output (MIMO) antenna systems come as a response to the following demands:

- Increased data transmissions throughput
- Link reliability

The current maximum configuration of MIMO specified for LTE Advanced, currently, in 3GPP is 8×8.In the next generations of wireless data networks, such as 5G, there might be enough only 10×10 for high data rates, but what if we need hundreds (or even more) of antennas, at both transmitter and receiver?

For a base station containing k receive antennas there are two major challenges:

- Channel estimation, based on signal received at each antenna

- Once the channel is estimated, how can I recover the original transmitted signal?

A simplified MIMO model consists of a transmitter having an array of M antennas and a receiver having k antennas.

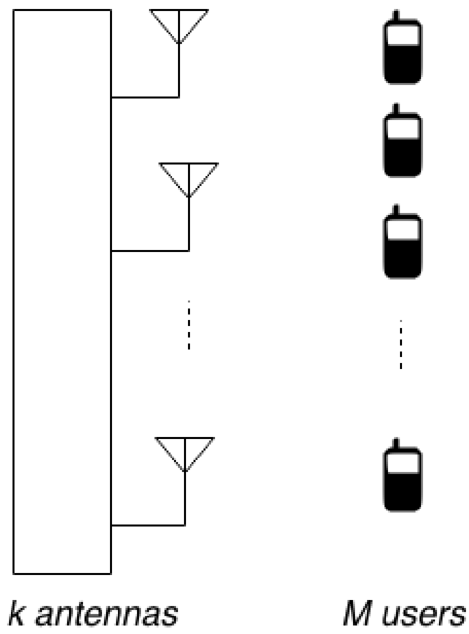

Figure 1: Simplified MIMO

Data received from mobile stations can be modeled using the following simplified equation: $y = Hx + n$, where:

- H = channel matrix
- x = transmitted (original) signal
- y = received signal
- n = noise

There steps required for recovering original signal are:

- Channel estimation: determine the complex matrix H
- Signal recovery: Determine x, depending on prior estimation and MIMO model

3 Objectives

Having as input: received signal y and some information used in channel estimation (e.g.: channel pilots pattern) we need to develop efficient matrix algorithms for:

- Channel estimation (from which results a $\tilde{H}$)
- Research for efficient huge matrix computations required for MIMO:
  - Research massive MIMO context
  - Research for algorithm candidates
- Benchmarking of algorithms that might be used in massive MIMO of both serial and parallel implementation, for a given MIMO model.

4 Bibliography

References

[1] Thomas L. Marzetta, Fredrik Tufvesson, Ove Edfors, Erik G. Larsson *Massive MIMO for Next Generation Wireless Systems*. IEEE Signal Processing Magazine, January 2013.

[2] Fredrik Rusek, Daniel Persson, Buon Kiong Lau, Erik G. Larsson, Thomas L. Marzetta, Ove Edfors, and Fredrik Tufvesson, *Scaling up MIMO: Opportunities and challenges with very large arrays*. IEEE Signal Processing Magazine, January 2013.

[3] A. Chockalingam, B. Sundar Rajan *Large MIMO Systems*. Cambridge Press, February 2014.

5 Prerequisites

Fields of study:

- Digital communications
- Signal processing
- Parallel algorithms

Technologies:

- MATLAB
- C
- Python or Bash for benchmarking scripts