An Efficient and Robust Eigenvalue Method for Small-Signal Stability Assessment in Parallel Processing

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Parallel Processing in Small-Signal Stability Analysis and Control

Methodology:

- Partial Eigensolution of Large Matrices

On-line and Off-line Applications:

- Electromechanical Stability

- Voltage Stability

Parallel Processing ...

- Algorithms for Partial Eigensolution are Parallelizable

- Parallel Computers are Available

- Only way to achieve required speed at reasonable cost

Results

$$Test\ \ System\ \ :\ \left\{ \begin{array}{l} 6000\ \ equations \\ 1200\ \ state\ \ variables \end{array} \right.$$

$$Computer\ \ :\ \ iPSC/860\ \left\{ \begin{array}{l} 1\ \ node \\ 4\ \ nodes \\ 8\ \ nodes \end{array} \right.$$

$$Algorithms\ \ Utilized\ \ :\ \left\{ \begin{array}{l} Lop-sided\ \ Simul- \\ taneous\ Iteration \\ \\ Bi-Iteration \\ \\ Hybrid \end{array} \right.$$

Algorithms Utilized

Lop-sided Simultaneous Iteration (LSSI)

- Sequential code available

- Parallel code reported in [1]

Bi-Iteration Algorithm (BI)

- Developed for non-symmetric matrices

- Obtains both right and left eigenvectors

- Quadratic convergence rate for eigenvalues

- Linear convergence rate for eigenvectors

- Requires more computational effort and memory space than LSSI
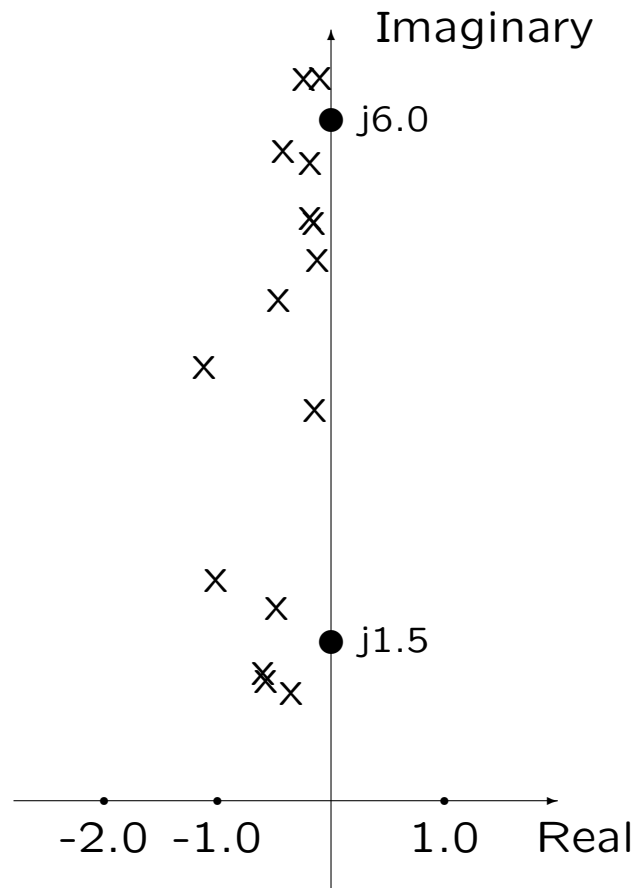
Hybrid Algorithm

- Combination of two methods

  - Bi-iteration ($1^{st}\ stage$)

  - Inverse Iteration ($2^{nd}\ stage$)

- Specially suited for parallel processing

- Excellent performance in sequencial processing

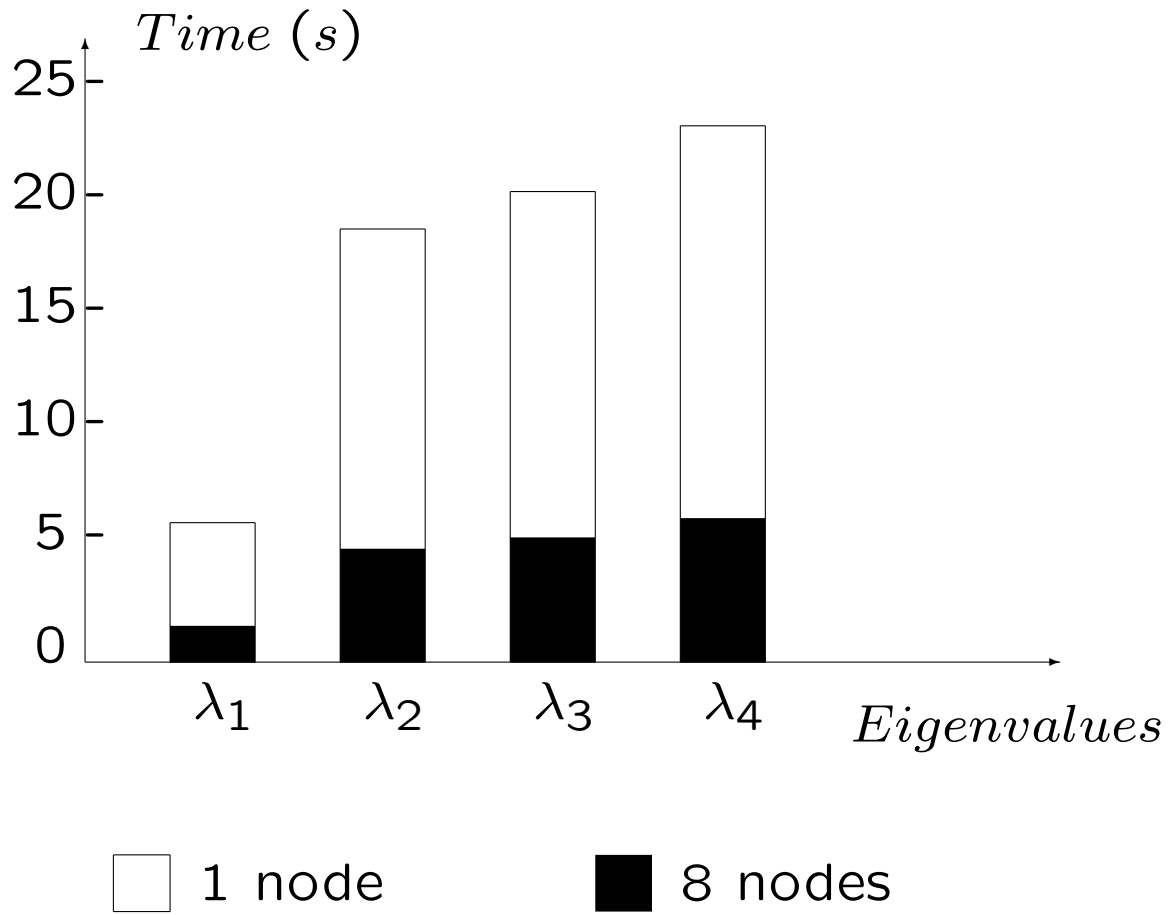# Location of System Eigenvalues and Shifts
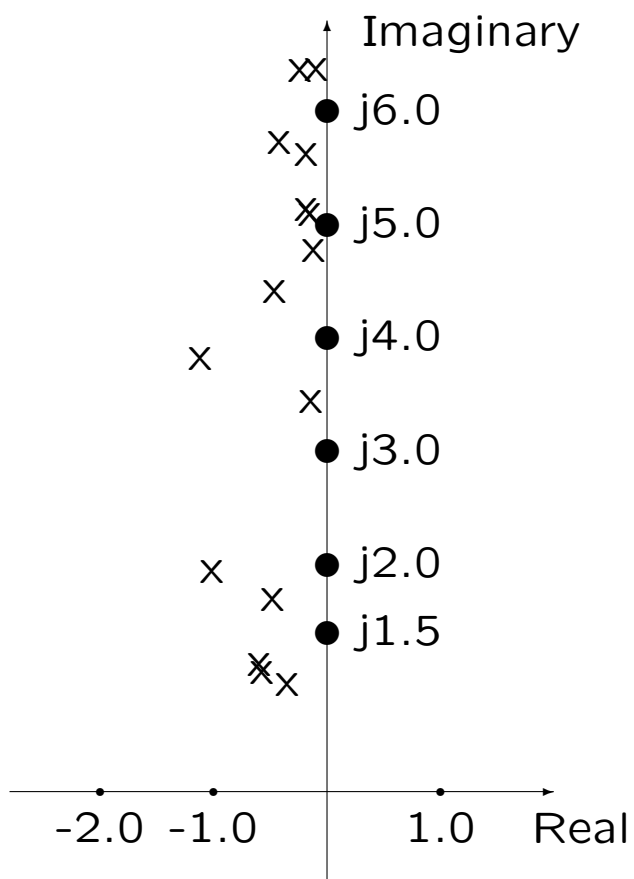
● − complex shifts
x − converged eigenvalues

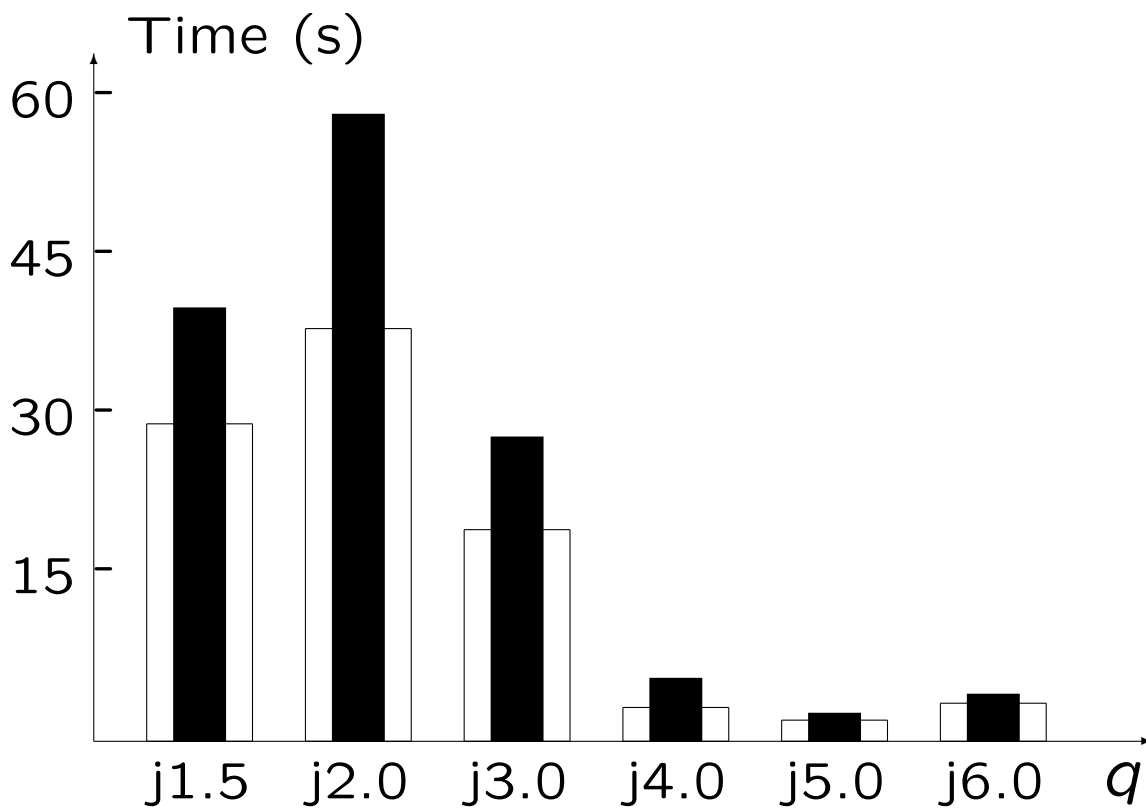# Eigenvalue Convergence for Different Shifts

● − complex shifts
x − eigenvalues
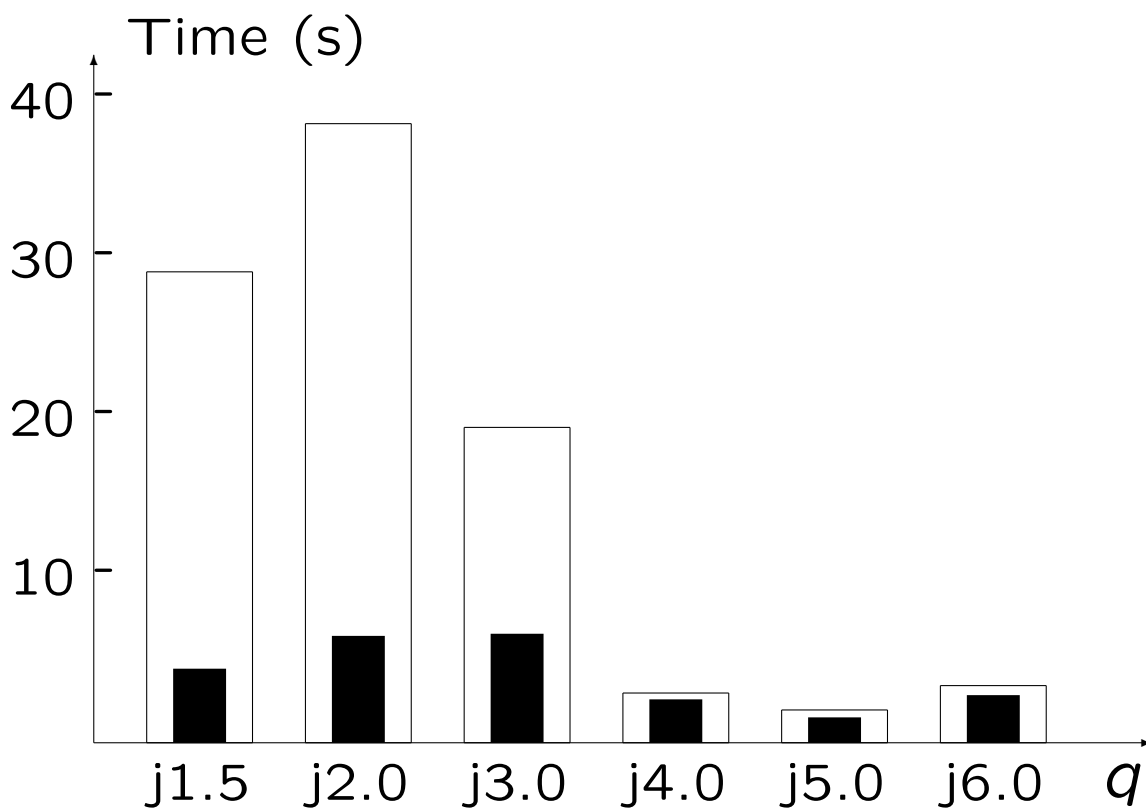
LSSI Computation Time

(8 trial vectors and $K_f = 3$)

Computation Times for Parallel LSSI and Parallel BI Algorithms

Time (s) vs **q**

Legend:
■ - BI   *q - complex shift*
□ - LSSI

(Convergence for 3 eigenvectors out of 4 trial vectors)
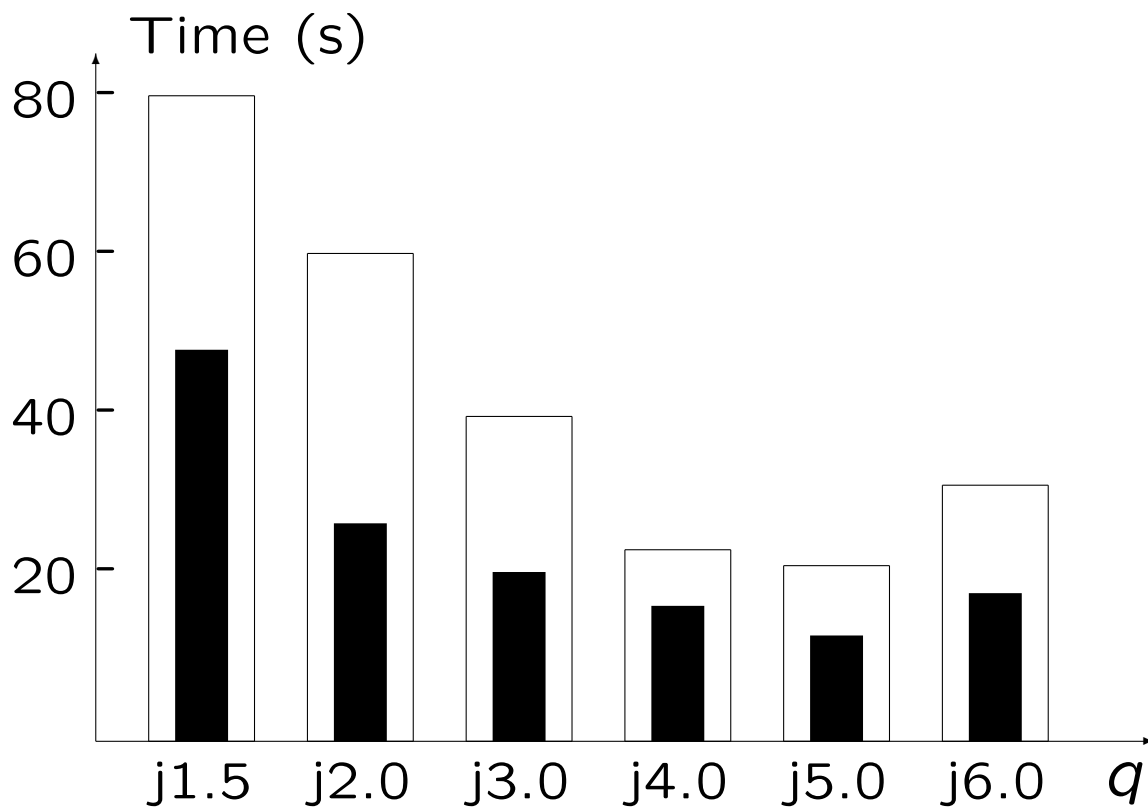
Computation Times for Parallel Hybrid and Parallel LSSI Algorithms

- ■ - Hybrid q - *complex shift*
- □ - LSSI

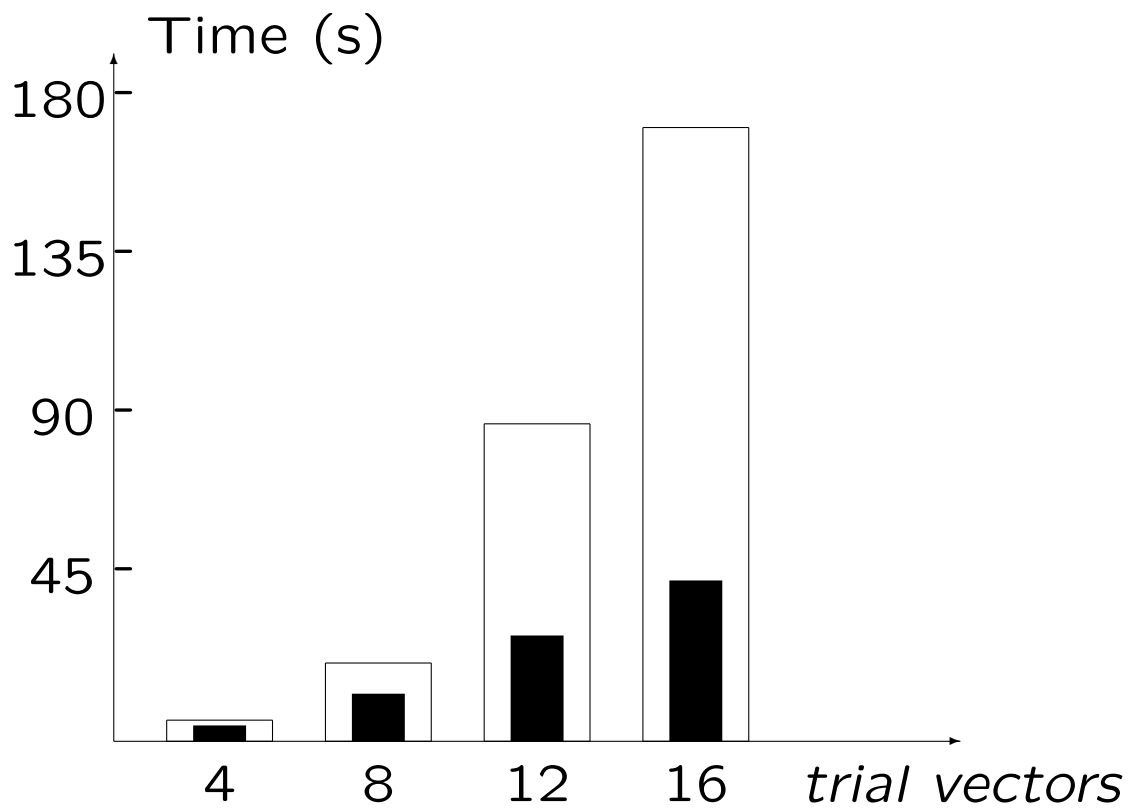(Convergence for 3 eigenvectors out of 4 trial vectors)

Comparative Results in Sequential Computation

(Convergence for 6 eigenvectors out of 8 trial vectors)

Comparative Results in Sequential Computation

(25 % of Guard Vectors)

Power System Parallel Eigensolutions

- Hybrid algorithm, a simple but definite evolution

- A revolutionary method will soon be published

Location of System Eigenvalues