

AE3-422
High-Performance Computing
Assignment

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Description

The developed application calculates the static and dynamic response of a beam subjected to distributed and point force loads. The application can perform all the task if provided with appropriate command-line arguments. In the development of the application BLAS, LAPACK and SCALAPACK libraries were used whenever possible. In addition due to the symmetry and the sparse band of the matrices, symmetric banded storage was used to increase efficiency by decreasing storage size. Appropriate functions for populating the matrices and vectors as well as printing them were developed. Each of these functions were put in separate files for better code readability and manageability.

Task 1

Task one calculates the static deflection of the beam due to a distributed and a point force load. Appropriate LAPACK function (dpbsv) was used to solve the system of equations. After successful solution the tasks saves the solution to a file and displays it. Figure 1 shows the solution.

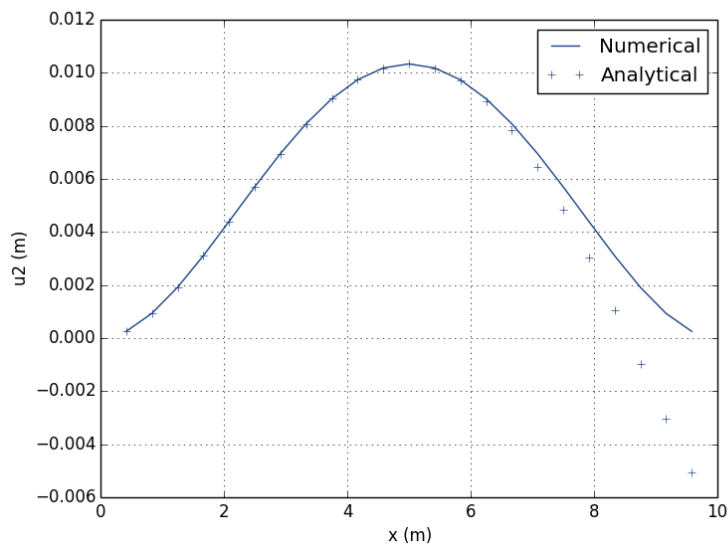


Figure 1. Comparison of numerical solution to analytical solution (analytical solution valid in the range $0 < x < L/2$)

Task 2

Task two solves the dynamic deflection of the beam due to a distributed and a point force load with an explicit scheme. The load increases from 0 to a specified value over a specified loading interval. During each time step the deflection at middle of the beam is saved to a file. Appropriate BLAS functions (cblas_dsbmv, cblas_dcopy) were used for matrix multiplication and vector copying. After completing the specified number of time steps the task saves the solution to a file and displays it. Figure 2 shows the implicit solution for different loading times and figure 3 shows the amplitude of oscillations for different loading times.

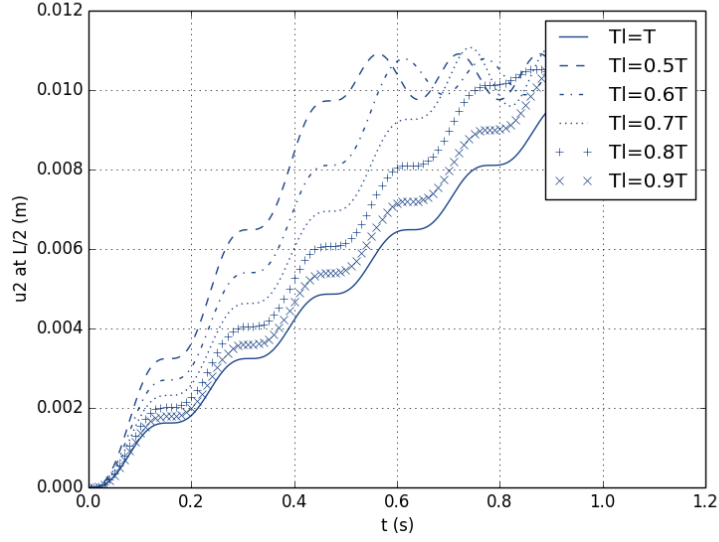


Figure 2. Explicit solution for different loading times

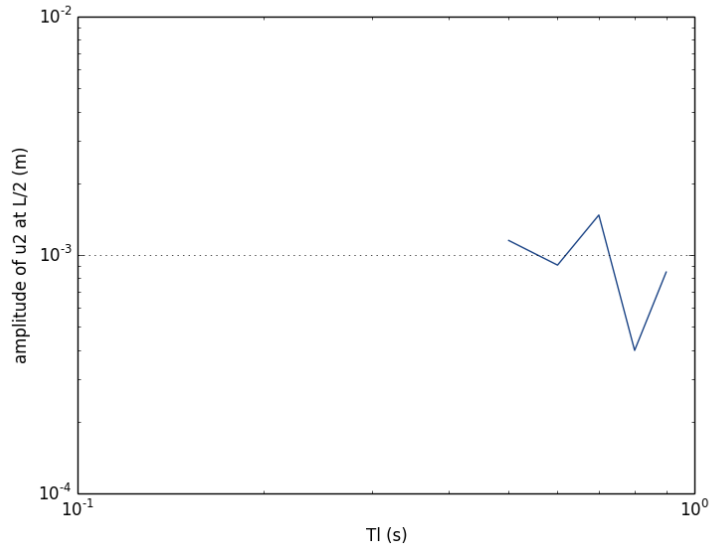


Figure 3. Oscillation amplitude versus loading time

Task 3

Task two solves the dynamic deflection of the beam due to a distributed and a point force load with an implicit scheme on one process. The load increases from 0 to a specified value over a specified loading interval. During each time step the deflection at middle of the beam is saved to a file. Appropriate BLAS functions (cblas_dsbmv, cblas_dcopy) and LAPACK functions (dpbsv) were used for matrix multiplication, vector copying and solution of system of equations. After completing the specified number of time steps the task saves the solution to a file and displays it. Figure 4 shows the implicit solution for different loading times and figure 5 shows the amplitude of oscillations for different loading times.

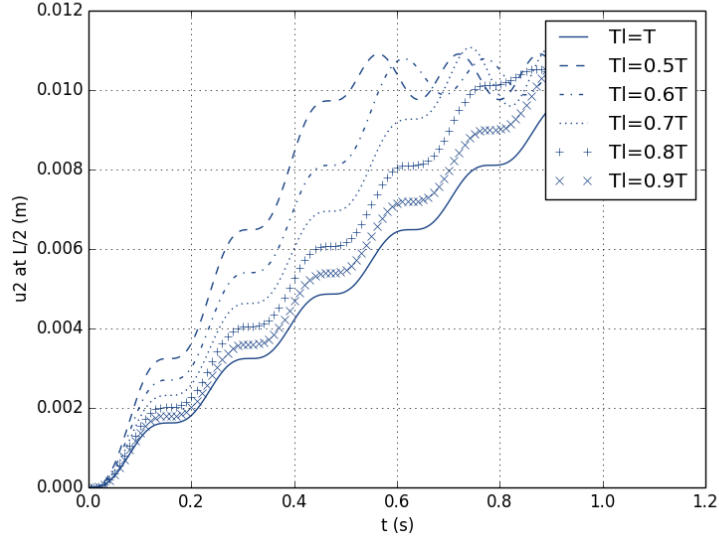


Figure 4. Implicit solution for different loading times

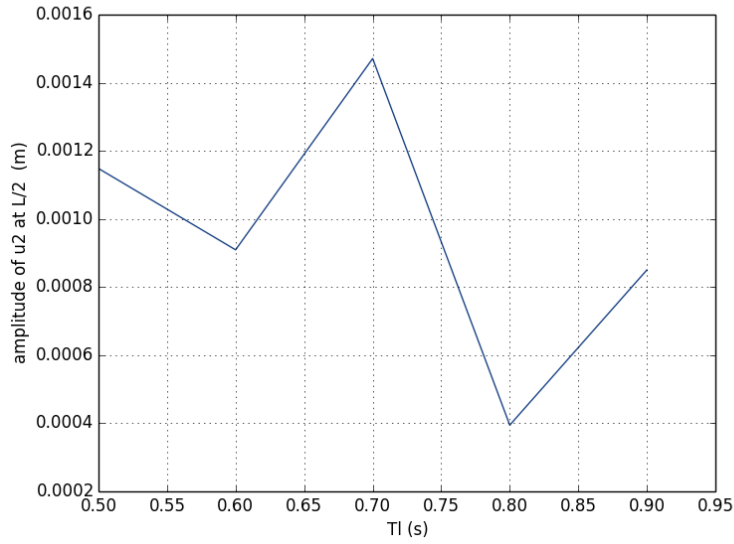


Figure 5. Oscillation amplitude versus loading time

Task 4

Task two solves the dynamic deflection of the beam due to a distributed and a point force load with an explicit scheme on two processes. Every process computes the deflection of the middle of the beam. Appropriate MPI functions (MPI_Send, MPI_Recv) were used so the two processes can exchange data. Figure 6 shows that the explicit solution on two processes matches the solution on one process.

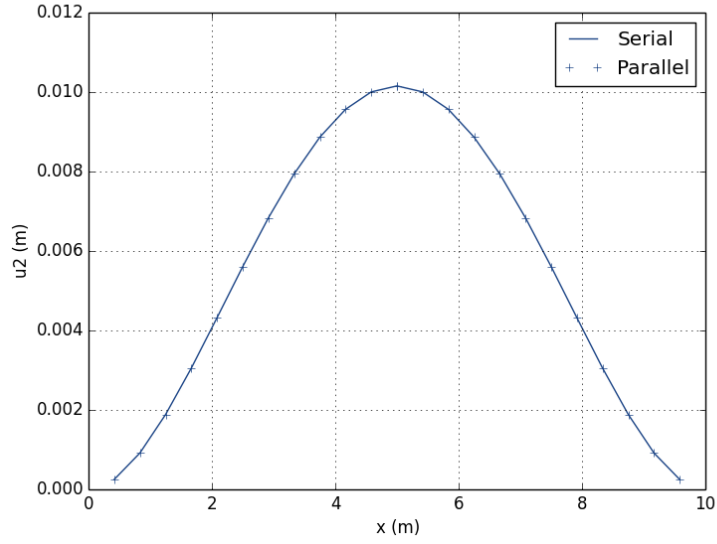


Figure 6. Serial and parallel explicit solution

Task 5

Task two solves the dynamic deflection of the beam due to a distributed and a point force load with an implicit scheme on two processes. The first process computed the deflections up to the middle of the beam. The second process computed the remaining deflections. SCALAPACK functions (pdpbsv) were used. Figure 7 shows that the implicit solution on two processes matches the solution on one process.

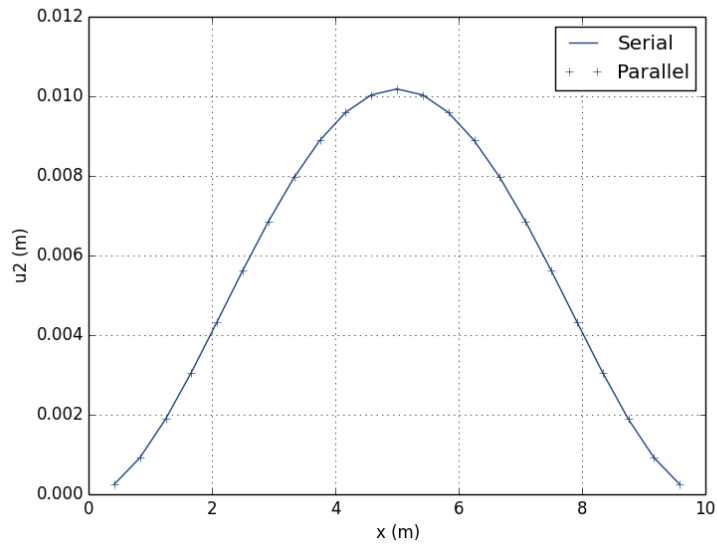


Figure 7. Serial and parallel implicit solution