LAIPE V1.0

1. Introduction

The letters LAIPE(TM) stands for "Link and In Parallel Execute". LAIPE is a collection of high performance subroutines for intensively-computing numerical analysis. LAIPE provides Fortran and C native calling syntax. All the functions in LAIPE are parallelable in nature. Link your applications with LAIPE, and then your application not only can be run on a uniprocessor computer but also can be speeded up on a multiprocessor computer. For the first example in file PERF.WRI, that solves a system of linear equations $[A]\{X\}=\{B\}$ of order 10000X10000, the timing results on a 90MHZ dual-Pentium computer are as follows.

Number of Processors	1 CPU	2 CPUs
Elapsed Time (seconds)	215.63	107.98

For the 23rd example in file PERF.WRI, that solves a system of linear equations $[A]\{X\}=\{B\}$ of order 40000X40000, with a narrow bandwidth, by a multiple-entry solver, the timing results on a 90MHZ dual-Pentium computer are as follows.

Number of Processors	1 CPU	2 CPUs
Elapsed Time (seconds)	6.63	3.30

LAIPE speeds up a solution procedure on a multiprocessor computer, and is most well suitable for large-scaled problems. Certainly, applications with LAIPE functions can be executed on an uniprocessor computer. For timing results of more LAIPE functions, please see file PERF.WRI.

This release consists of several useful direct solvers, such as Cholesky decomposition, sky-line solvers, Crout decomposition, multiple-entry solvers, and other popular techniques based on Gaussian elimination. The LAIPE direct solvers deal with the following categories:

dense systems
sparse systems (constant bandwidth, variable bandwidth --- sky line)
positive-definite systems
indefinite systems
symmetric systems
asymmetric systems
solvers with partial pivoting
solvers with full pivoting

LAIPE is written in Mtask that is a parallel programming language, and is INITIALLY for Windows NT and Microsoft Fortran/C compatible compilers on x86-based processors. All trademarks and registered trademarks are the property of their respective holders.

2.   User-Friendly Interface

As mentioned previously, LAIPE provides Fortran and C native calling syntax. The LAIPE interface is as simple as an ordinarily-calling statement of serial programs. Just link an application with a LAIPE solver, and then LAIPE takes care of the whole solution procedure. For an example of a sky-line solver that implements Cholesky decomposition, the Fortran statement is as
          CALL Decompose_VSP_S(A, N, LLA, Zero, NoGood)
where "VSP" means a variably-banded, symmetric, and positive definite system. There are no special statements or compiler directives for parallel computing. In a C program, the statement is as simple as
          Decompose_VSP_S(&A, &N, &LLA, &Zero, &NoGood);
For the definition of each argument/parameter passed to LAIPE, please see the user's guide entitled "*LAIPE: Parallel Direct Solvers for Linear System Equations*"

3.   Files Included

The files with this demo are introduced in the following.
1. README.WRI briefly introduces LAIPE and describes the included files. For more detailed descriptions on LAIPE, a user's guide is necessary.
2. PERF.WRI contains parallel performance of some LAIPE functions on a dual-Pentium computer. The best performance of some LAIPE solvers on a dual-Pentium computer can reach up to almost 200% faster; while other performances are around 180%. The dual-Pentium computer that tested the performance uses an Intel Neptune chipset, based on which both CPUs share with a L2 cache, cheap but not efficient. It would be better if each processor has an individual L2 cache. Efficiency also depends on problem size. Larger-scaled problems may have a higher efficiency. For a small problem, a single processor is sufficient for the speed. LAIPE also provides functions that may limit a single processor (or a portion of processors) for a small problem.
3. FBANDED.EXE is an executable file that solves a constantly-banded, symmetric, and positive definite system. If this program is executed on a SMP environment (i.e., Windows NT) with multiprocessors, the program reports the elapsed time spent in LAIPE solvers on one processor, on two processors, ,,, and so on. The improvements on speedup can be seen from the timing results. When running this program, keep the computer standing alone because elapsed time varies with the system loads. Due to block-based distributions, a speed improvement is impossible if the bandwidth is less than 30 (That may be improved by a multiple-entry solver).
4. FMENTRY.EXE is an executable file that solves a symmetric system with a small bandwidth by a multiple-entry procedure. Similar to program FBANDED.EXE, if this program is run on a multiprocessor computer, the program reports the elapsed time with respect to different number of processors. The improved speed can be seen from the timing results.

Multiple-entry solvers are for a system with a small bandwidth.
5. FBANDED.FOR is a Fortran program for FANDED.EXE.
6. FMENTRY.FOR is a Fortran program for FMENTRY.EXE.
7. CBANDED.C is a C program that may be linked to CBANDED.EXE. Both CBANDED.EXE and FBANDED.EXE deal with the same problem.
8. CMENTRY.C is a C program that may be linked to CMENTRY.EXE. Both CMENTRY.EXE and FMENTRY.EXE deal with the same problem.
9. LAIPEF.LIB is a LAIPE V1.0 Fortran library for Pentium (or higher) processors. Libraries for 386 or 486 processors are also available, but not in this demo.
10. LAIPEC.LIB is a LAIPE V1.0 C library for Pentium (or higher) processors. Libraries for 386 or 486 processors are also available, but not in this demo.
11. MTASKF5A.LIB is Mtask V1.1 Fortran library for ASCII data representation and Pentium (or higher) processors. It is a library of parallel programming language, based on which LAIPE develops. Libraries for 386 or 486 processors, or for Unicode data representation, are also available, but in this demo.
12. MTASKC5A.LIB is Mtask V1.1 C library for ASCII data representation and Pentium (or higher) processors. It is a library of parallel programming language, based upon which LAIPE develops. Libraries for 386 or 486 processors, or for Unicode data representation, are also available, but in this demo.
13. MAKEFILE is a makefile to generate the executable programs. Modify this file according to the compilers you use. Then,
    nmake fortran ------> .for.exe
    nmake c   ------> .c.exe
    nmake all   ------> .for.exe & .c.exe

All the libraries introduced are for Microsoft Fortran/C compatible compilers. Only two kinds of LAIPE solvers are demonstrated here. The complete library has more LAIPE solvers for all kinds of applications.

4.   User's Guide

The user's guide entitled "*LAIPE: Parallel Direct Solvers for Linear System Equations*" consists of 15 chapters in 364 pages. ISBN # is 0-9644361-0-6. The contents are as:

Chapter 1. Introduction
Chapter 2.   Constantly Banded, Symmetric, and Positive Definite Systems
Chapter 3.   Variably Banded, Symmetric, and Positive Definite Systems
Chapter 4.   Dense, Symmetric, and Positive Definite Systems
Chapter 5.   Constantly Banded and Symmetric Systems
Chapter 6.   Variably Banded and Symmetric Systems
Chapter 7.   Dense and Symmetric Systems
Chapter 8.   Constantly Banded And Asymmetric Systems
Chapter 9.   Variably Banded And Asymmetric Systems
Chapter 10. Dense And Asymmetric Systems
Chapter 11. Constantly Banded and Asymmetric Solvers with Partial Pivoting
Chapter 12. Constantly Banded, Symmetric, and Positive Definite Solvers with Partial Pivoting
Chapter 13. Constantly Banded and Symmetric Solvers with Partial

Each chapter, in detailed, discusses the calling syntax, profile with data storage scheme, and Fortran/C examples. Technique support may be unnecessary.

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6. Ordering Information

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And, mail the ordering information with a check payable to Parallel Integrated Research, and send your order to

   Attn: Mr. Jenn-Ching Luo
   Parallel Integrated Research
   P.O. Box 787
   Baldwin, NY 11510

Price:

1. LAIPE V1.0 Library without user's guide, royalty free,

   [Please specify compiler: _____],

   $320.00 single workstation   QTY[__] $[__]

2. Mtask V1.1 Library without user's guide, royalty free,

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3. User's Guide for LAIPE entitled "*LAIPE:Parallel Direct Solvers for Linear System Equations*", 364 pages,

   ISBN 0-9644361-0-6, $23.50 each   QTY[__] $[__]

4. User's Guide for Mtask entitled "*Parallel Computations on Windows NT*", 281 pages,

   ISBN 0-9644361-0-8, $14.50 each   QTY[__] $[__]

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