IMPLEMENTATION OF GEMACS 3.3 ON PERSONAL COMPUTERS

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Abstract

GEMACS 3.3* is a powerful MM/GTD hybrid package which can model a wide range of antenna and scattering problems. It is intended for use on large mainframe computers but an implementation on a personal computer has advantages in the possibilities of interactive use and graphical output. An approach to this implementation is presented, together with benchmark test results from typical PCs, a mainframe and a supercomputer.

1. Introduction

GEMACS is a very powerful and flexible code for electromagnetic modeling, not only because it allows flexible hydridization of different approaches, but also because it incorporates powerful geometry pre- and post-processors and other features which aid execution of large problems [1]. The code is very large and is normally intended to be run on a large mainframe computer or vector processor. However, there are attractions in being able to use it on a personal copmputer since the possibility of interactive dialogue and graphics compensates for the reduced processing power in many applications. The latest version of the code (Version 4.0) includes a finite-difference (FD) module which adds substantially to its length [2]: the running of this on larger personal computers (based on the Intel 80286 or 80386 microprocessor) has recently been reported [3]. For many applications, however, FD is not needed and a more compact code can be realized which will run on smaller PCs. In the work reported here, the earlier Version 3.3 of GEMACS was modified for implementation on a standard IBM-type PC, originally based around the Intel 8086 microprocessor. This version of the code contains only Moment-Method and GTD modeling modules. The personal computer used was fitted with an Intel 8087 co-processor but, more significantly, the 8086 processor was replaced by an NEC (i.e. Nippon Electrical Corporation) V30 accelerated-architecture microprocessor that is pin-compatible with the 8086. The use of this processor in standard IBM-type PCs has been found to give a great improvement in performance [4].

GEMACS 3.3 consists of five modules which are executed sequentially:

1. Input module (geometry processor and command language interpreter)
2. GTD module, which also supports a hybrid MM-plus-GTD solution
3. MM module, using wire grids and/or surface patches
4. Solution module, exploiting banded matrix iteration
5. Output module

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*This version has now been superseded by version 4.0 and is no longer supported. There is, however, not a great deal of difference between these versions apart from the addition of the finite-difference module to the latter.

In operation, the code is strongly file-oriented. The starting point whenever running any module is a check point file which is updated whenever there is an exit from the module. The user is able to designate a certain run time and, if the execution is unfinished at the end of this time, the check point file is updated and the current values of the internal variables are saved, thus permitting execution to be recommenced at a later time. The flexible hybridization of GTD and MM techniques makes the code particularly powerful and useful for handling objects that are too large to be analyzed by MM alone.

2. A PC Version of GEMACS 3.3

GEMACS 3.3 was written in Fortran 4 and hence, as a preliminary, statements which contained obsolete features of Fortran 4 were modified so that they conformed to the current Fortran-77 standard. The code was then transferred to a PC where non-standard modifications had necessarily to be made in order to make optimum use of the limited power available. To simplify this, all the DIMENSION and COMMON statements of the routines were taken out of the program and an INCLUDE statement used which makes the compiler read the DIMENSION and COMMON statements from a specified file. In order to compile each module with a limited DOS memory the modules were divided into groups of routines which were compiled separately and subsequently linked.

2.1 Hardware and PC Configuration

An IBM PC/XT or PC/AT or compatible computer is required, with the following specifications and extensions:

1. 640Kb of RAM memory
2. Mathematical co-processor (8087 or 80287)
3. 10Mb (or larger) hard disk
4. Printer with either wide (132 characters/line) paper or normal paper if compressed mode is available.

A large and fast hard disk is recommended if very large structures are to be analyzed. Table 1 shows the size of each module in Fortran lines, RAM bytes and compressed disk bytes.

Table 1 Sizes of GEMACS 3.3 PC Modules

Module	Source Code Lines*	Minimum memory required bytes (in RAM)	EXE file size on hard disk (bytes)
INPUT	14109	343879	254679
GTD	17356	577187	407843
MOM	12135	319539	234739
SOLN	9143	260683	179931
OUTPUT	7037	216773	136245

*excluding comment lines

2.2 Choice of Fortran Compiler

An attempt was made to compile the code using RM Professional Fortran 1.0 but unfortunately this failed due to the size of the common block data segments. Another attempt was made using Microsoft Fortran Version 3.31 but this gave difficulties due to the restricted subset of Fortran-77 implemented. Finally, an optimized Microsoft Fortran Version 4.0 was used. This was successful and it has the additional advantage of options for optimization to achieve maximum speed or minimum size: speed optimization was used for the present work.

Problems arose in implementing the GTD module with the maximum number of plates (51) permitted in the mainframe version. For this, 720Kb would be required which is clearly outside the ability of DOS on a PC/XT-type system. The use of overlay was tried but this had a severe effect on run-time performance. As a compromise, the maximum permitted number of plates was reduced to 14 (as in GEMACS 3.1 [1]), which permits the program to run without overlay. Some other problems were encountered due to the optimization option in the compiler: these were tackled by disabling the optimization in a small number of routines. The executable files were stored in compressed format in order to reduce hard disk space requirements.

2.3 Code Operation

GEMACS uses unformatted indirect access files to store the check point data file and all of the data sets produced, including the interaction matrix. The minimum number of files needed for a MM/GTD problem is 16, however it is very likely that additional files will be required, e.g. for structure loads, additional excitations or additional field patterns. It is therefore advisable to specify that at least 20 files will be used when loading DOS: this is done in the CONFIG.SYS file.

2.4 Code Limitation

As mentioned above, the number of plates permitted in the GTD module was limited to 14 (c.f. 51 in the mainframe version). The maximum number of corners that each plate may have was also reduced to 6 in the PC version (as in GEMACS 3.1, c.f. 16 in the standard version 3.3). All of the other limitations are the same as those in the mainframe version [1].

2.5 Benchmark Testing

The test example cited in the GEMACS manual [1] was used for comparative tests. This consists of a 0.25m monopole located over a square conducting plate of side length 1.5m and driven at 500MHz. A hybrid solution was used, the plate being modeled as a single GTD plate and the monopole being modeled as a wire with six segments using the Method of Moments. The published test solves for the current distribution on the monopole and calculates the far field and input parameters.

Test results and timings were available* for a Honeywell 6180 mainframe (this was actually running GEMACS Version 3.1). Two personal computers were used to test the present code and, for comparison, results from a Cray X-MP/48 were also obtained. The personal computers used were as follows:

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*Provided by K R Siarkiewicz, USAF Rome Air Development Center

1. A standard IBM PC/AT (6MHz clock) with the enhancements specified in Section 2.1.
2. An Amstrad PC1512 with the same enhancements.

The Amstrad PC1512 is compatible with the IBM PC/XT but it has an 8MHz clock and, for the present tests, the 8086 microprocessor was replaced by a V30 as discussed in Section 1. Comparative results are given in Table 2 and the corresponding timings are given in Table 3.

Table 2 Comparative Results for Benchmark Test

Result	IBM PC/XT	Amstrad PC 1512 with V30	Honeywell 6180*	Cray X-MP/48
Input Impedance (ohms)	300.876	300.876	300.877	300.877
Input phase (deg)	17.676	17.676	17.676	17.676
Input power (W)	0.158E-02	0.158E-02	0.158E-02	0.158E-02

*running GEMACS 3.1

Table 3 Comparative Timings (sec) for Benchmark Test

Module	IBM PC/XT	Amstrad PC 1512 with V30	Honeywell 6180	Cray X-MP/48
INPUT	4.8	7.9*	1.91	0.03
GTD	503	273	133.26	1.60
MOM	4.3	4.8*	8.44†	0.04
SOLN	3.2	3.7*	(inc. in MOM)	0.03
OUTPUT	2.6	3.0*	1.02	0.09
Total time	518	292	145	1.79

*Dominated by slow hard disk
†Time for MOM and SOLN

It is seen that the GTD module dominates the processing time on all of the computers: Fig. 1 shows comparative timings for the routines within this module, excluding routines involving disk access (results for the Cray are not shown).

It is seen that the results produced by the personal computers are almost identical to those from the mainframes (detailed results for the far fields are not shown, but were also identical within the range of the printed output (four significant figures)) and the timings are of a similar order of magnitude to those achieved by the Honeywell mainframe: the Cray is, of course, very much faster. The performance of the V30 microprocessor is particularly remarkable since it achieves almost twice the speed of an 80286-architecture machine when it is not hindered by disk access times. Allowing for the faster clock rate in the Amstrad PC1512, the speed improvement with the V30 is less (1.4 times faster) but still substantial.

References

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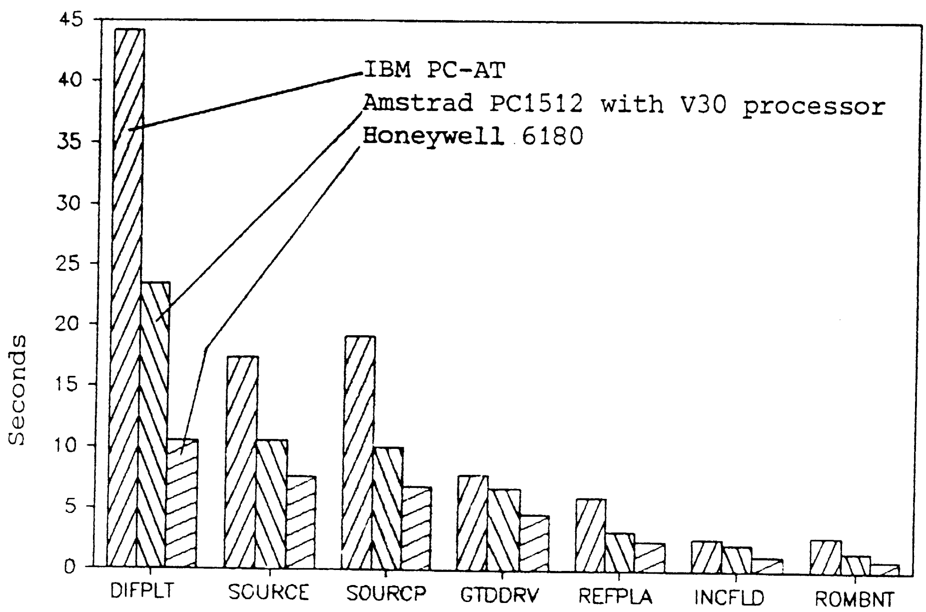

Fig. 1 Comparative timings for routines within the GTD module. (The times for DIFPLT have been divided by 10)