ABSTRACT

A complete redesign of muMATH is nearing completion, and this paper previews some of the new capabilities, which include the following:

1. Rational arithmetic can be either exact or automatically rounded to any precision, thus providing a unified alternative to the usual combination of exact rational plus arbitrary-precision floating-point arithmetic.

2. There is function plot graphics.

3. Two-dimensional output of expressions is provided, including raised exponents and built-up fractions.

4. The algebraic capabilities are substantially improved:
   a) Simplification is more automatic and thorough, with options that are easier to use.
   b) The default normal form tends to preserve factors at all levels while automatically achieving significant simplification of rational expressions, radicals and elementary transcendental expressions.
   c) There are polynomial expansion, gcd and factoring algorithms with speeds that compare favorably with those of systems running on mainframes or Lisp machines.
1. INTRODUCTION

The intent of muMATH has always been to provide computer algebra on the most popular and inexpensive feasible personal computers using the most popular operating system. Thus, muMATH was originally designed for the Intel 8080 chip together with the CP/M-80 operating system, followed by the Apple II family. Subtracting memory space used by the operating system, these two families typically left at most 60 kilobytes of read-write random-access memory for muMATH together with the muSIMP interpreter in which muMATH is implemented.

When the larger address space microprocessors first appeared, it was unclear which if any would predominate and thus be most appropriate for the intended muMATH audience. An inexpensive S-100 dual processor board made the Intel 8088 processor family particularly attractive for development, so we implemented our software (including the separate muLISP) for that family. IBM's subsequent choice of that family turned out to make it the most popular one -- at least in the USA.

Subtracting space used by the operating system, the IBM-PC family and its many imitators typically provide a maximum amount of read-write random access memory ranging from 200 to 500 kilobytes. This is enough to accommodate many desirable capabilities that could not fit in 60 kilobytes. Also, experience implementing and using the original muMATH has suggested ideas for a much better system. Thus, I have been engaged in a complete redesign that should be ready for distribution late this year by the time this proceedings appears. Consequently, this paper previews some of the novel features of the new design rather than reviewing the currently distributed version.

2. FLOATING SLASH ARITHMETIC

muSIMP has always had exceptionally fast infinite precision integer arithmetic. Empirically, the seconds required to multiply two numbers each having d decimal digits is about \(0.9 \times 10^{-6} d^2\) asymptotically, and the time to divide their product by either of them is about 25% slower. As examples entailing a sequence of multiplications, interpreted factorial and "^" functions use 0.4 seconds to compute 300! and 0.5 seconds to compute 9999^300. These and all other muSIMP/muMATH times in this article are for the IBM-AT. Times for the IBM-PC and XT are slower by a factor of about 2.5.