Author(s) : K.S. Kölbig, H.-H. Umstätter **Library:** MATHLIB
Submitter : **Submitted:** 22.04.1996
Language : Fortran **Revised:**

Complex Fast Fourier Transform

Subroutine CFSTFT calculates the finite Fourier transform of a complex periodic sequence $a_0, a_1, \ldots, a_{n-1}$, whose period n must be a power of two. Either the direct transform

$$A_j = \sum_{k=0}^{n-1} a_k \exp\left(\frac{-i2\pi jk}{n}\right), \qquad (j = 0, 1, \ldots, n-1), \tag{1}$$

or the unscaled inverse transform

$$\alpha_k = \sum_{j=0}^{n-1} A_j \exp\left(\frac{i2\pi jk}{n}\right), \qquad (k = 0, 1, \ldots, n-1), \tag{2}$$

where a_k, α_k and A_j are complex numbers, may be calculated.
If the A_j in (2) have the values defined by (1), then $a_k = \alpha_k/n$, $(k = 0, 1, \ldots, n-1)$. To ensure optimum use of storage, the same array is used for input and output, and all intermediate calculations are carried out in this array.

Structure:

SUBROUTINE subprogram
User Entry Names: CFSTFT

Usage:

```
CALL CFSTFT(M,A)
```

M (INTEGER) On entry, n is determined by the absolute value of M via $n = 2^{|\mathtt{M}|}$.
M $<$ 0 : The direct transform (1) is calculated.
M $\geq$ 0 : The inverse transform (2) is calculated.
Unchanged on exit.

A (COMPLEX) One dimensional array of dimension (0:d), where d $\geq$ n $-$ 1.
M $<$ 0 :
On entry, A$(k) = a_k$, $(k = 0, 1, \ldots, n-1)$.
On exit, A$(j) = A_j$, $(j = 0, 1, \ldots, n-1)$, as defined by (1).
M $\geq$ 0 :
On entry, A$(j) = A_j$, $(j = 0, 1, \ldots, n-1)$.
On exit, A$(k) = a_k$, $(k = 0, 1, \ldots, n-1)$, as defined by (2).

Method:

The method is based on an algorithm of Cooley, Lewis and Welch (see **References**), with the following modifications which increase speed for small values of M: multiplications by $\exp(ip\pi)$ are replaced by addition or subtraction, and terms of the form $\exp(i2\pi/q)$, $(q = 2, 4, \ldots, n)$ are calculated recursively using only square roots and divisions.

References:

1. G. Dahlquist and Å. Björck, Numerical methods (Prentice-Hall, Englewood Cliffs, 1974) 416.
2. L.R. Rabiner and B. Gold, Theory and application of digital signal processing (Prentice-Hall, Englewood Cliffs, 1975) 332.

•