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A FORTRAN source library for quaternion algebra. Application to multicomponent seismic data

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The quaternions, named also hypercomplex numbers, constituted of a real part and three imaginary parts, allow a representation of multi-component physical signals in geophysics. In FORTRAN, the need for programming new applications and extend programs to quaternions requires to enhance capabilities of this language. In this study, we develop, in FORTRAN 95, a source library which provides functions and subroutines making development and maintenance of programs devoted to quaternions, equivalent to those developed for the complex plane. The systematic use of generic functions and generic operators: 1/ allows using FORTRAN statements and operators extended to quaternions without renaming them and 2/ makes use of this statements transparent to the specificity of quaternions. The portability of this library is insured by the standard FORTRAN 95 strict norm which is independent of operating systems (OS). The execution time of quaternion applications, sometimes crucial for huge data sets, depends, generally, of compilers optimizations by the use of in lining and parallelisation.
To show the use of the library, Fourier transform of a real one dimensional quaternionic seismic signal is presented. Furthermore, a FORTRAN code, which computes the quaternionic singular values decomposition (QSVD), is developed using the proposed library and applied to wave separation in multicomponent vertical seismic profile (VSP) synthetic and real data. The extracted wavefields have been highly enhanced, compared to those obtained with median filter, due to QSVD which takes into account the correlation between the different components of the seismic signal.
Taken in total, these results demonstrate that use of quaternions can bring a significant improvement for some processing on three or four components seismic data.

Keywords: Quaternion - FORTRAN - Vectorial processing - Multicomponent signal - VSP - Fourier transform.