



## Discrete Fourier Transform Analysis in a Complex Vector Space

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Alternative computational strategies for the Discrete Fourier Transform (DFT) have been developed using analysis of geometric manifolds. This approach provides a general framework for performing DFT calculations, and suggests a more efficient implementation of the DFT for applications using iterative transform methods, particularly phase retrieval. The DFT can thus be implemented using fewer operations when compared to the usual DFT counterpart.

The software decreases the run time of the DFT in certain applications such as phase retrieval that iteratively call the DFT function. The algorithm exploits a special computational approach based on analysis of the DFT as a transformation in a complex vector space. As such, this approach has the potential to realize a DFT computation that approaches  $N$  operations versus  $\log(N)$  operations for the equivalent Fast Fourier Transform (FFT) calculation.

*This work was done by Bruce H. Dean of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810.*

*This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center, (301) 286-7351. Refer to GSC-15684-1.*

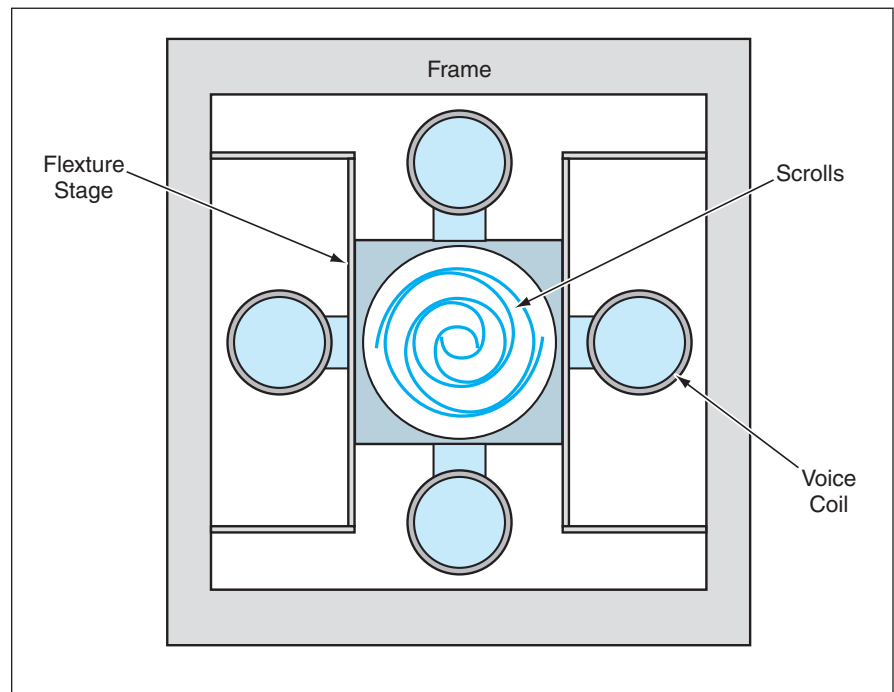
## Miniature Scroll Pumps Fabricated by LIGA

These would serve as roughing pumps for vacuum systems of miniature instruments.

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Miniature scroll pumps have been proposed as roughing pumps (low-vacuum pumps) for miniature scientific instruments (e.g., portable mass spectrometers and gas analyzers) that depend on vacuum. The larger scroll pumps used as roughing pumps in some older vacuum systems are fabricated by conventional machining. Typically, such an older scroll pump includes (1) an electric motor with an eccentric shaft to generate orbital motion of a scroll and (2) conventional bearings to restrict the orbital motion to a circle.

The proposed miniature scroll pumps would differ from the prior, larger ones in both design and fabrication. A miniature scroll pump would include two scrolls: one mounted on a stationary baseplate and one on a flexure stage (see figure). An electromagnetic actuator in the form of two pairs of voice coils in a push-pull configuration would make the flexure stage move in the desired circular orbit. The capacitance between the scrolls would be monitored to provide position (gap) feedback to a control system that would adjust the drive signals applied to the voice coils to maintain the circular orbit as needed for precise sealing of the scrolls. To minimize



A **Miniature Scroll Pump** includes a scroll mounted on a flexure stage and a scroll mounted on a stationary baseplate. The voice coils drive the flexure stage in a circular orbit to effect pumping.

power consumption and maximize precision of control, the flexure stage would be driven at the frequency of its mechanical resonance.

The miniaturization of these pumps would entail both operational and manufacturing tolerances of  $<1 \mu\text{m}$ . Such tight tolerances cannot be achieved eas-