Microelectromechanical Systems

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2. A Complete MEMS Analysis System and Implementation

Sponsors
Computer Microvision for Microelectromechanical Systems (MEMS)
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The testing and analysis of MEMS (micro electromechanical systems) devices are two of the main steps in designing MEMS devices. These tasks must be implemented in a way which allows them to be done remotely and by multiple users to form the whole distributed environment to a cooperative work environment. There have been programs that control different hardware, such as stage, pifoc, strobe, etc., but the implementation has been only local. Tasks addressed include: improvement of the efficiency of integration of hardware controls to our Java-based MEMS client/server analysis system; solution of remote operation problems (e.g. slowness in focusing, lack of synchrony in the user interface and process at the server side); transfering our client server to the popular web server, Apache, which gained more efficiency. In this project, we strove for seamless integration and inter-operation in order to implement methods to increase the performance of remote hardware control.

3. A Remotely Automated Microscope for Characterizing Micro Electromechanical Systems (MEMS)

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Designers of Micro Electromechanical Systems need tools to test the electrical as well as mechanical properties of the devices they fabricate. Computer Microvision acts as a good analysis tool during the testing and development stages of the design process. Computer Microvision involves the use of light microscopy and video imaging to acquire 3-dimensional images at multiple phases of motion. In this research, a Computer Microvision system is defined and implemented. The Computer Microvision system includes a PC, an automated X-Y-Z stage, a camera, and a piezo electric device. Custom hardware includes the design of a module for a PCI interface that acts as a central controller for stimulus and stroboscopic illumination.

There are benefits in being able to run the system remotely and support a multi-client environment. The Computer Microvision system uses an Apache web server to provide remote access and all communication is done via "messages". Java servlets form an integral part of the server side software in overcoming HTTP's inability to handle state. A client connects to the server's URL via a Web-browser and is presented with a Graphical User Interface (GUI) that acts as medium to access all aspects of the Computer Microvision system. The GUI, written in Java, also supports remote focusing which can be done either manually or automatically. The various hardware settings can be configured, an experiment or analysis can be launched, and the results can then be viewed.

4. A Complete MEMS Analysis System and Implementation

Sponsors

Defense Advanced Research Projects Agency
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Micro Electro-Mechanical Systems (MEMS) design is often done using circuit design rules for layout and complex synthesis or mechanical simulation for actual device structure. The problem with this approach is that devices that work well in simulation often have high sensitivity to process variation and therefore can have properties that differ substantially from projected values. These effects lead to both poor performance and lower yields.

Figure 1 shows a picture as well as a diagram of a comb-drive resonator. This device is ideal for process sensitivity analysis because its resonant frequency is a key system parameter that can be easily computed in simulation and is directly affected by the process and underlying geometries.

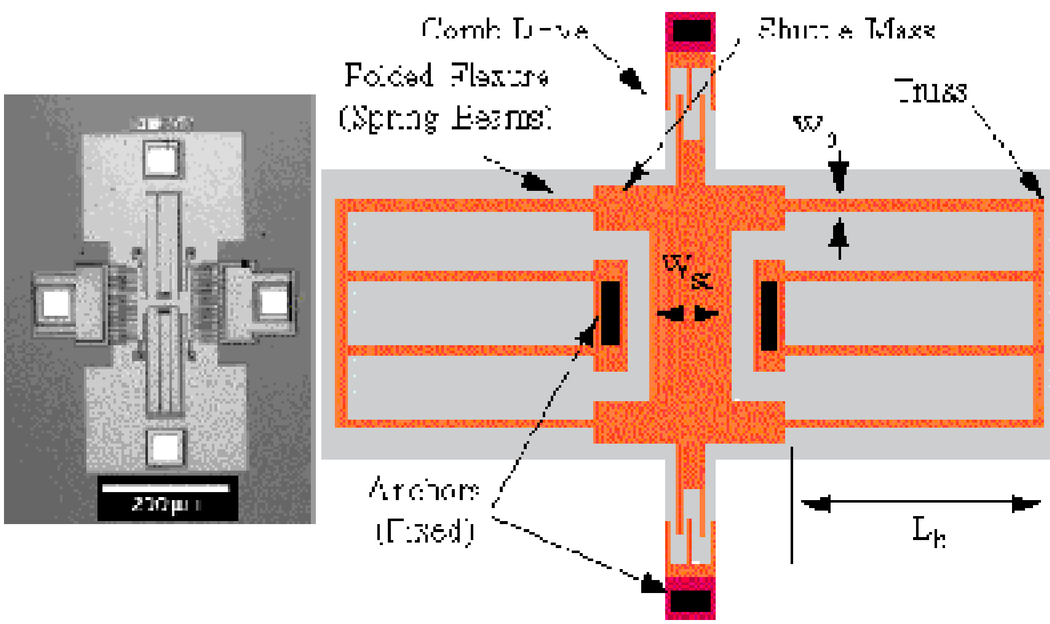

Figure 1. Comb-Drive Resonator

As an example of the importance of process variation to device performance, Figure 2 compares a 50Khz resonator based on a 2 mm folded beam flexture to a 50Khz resonator using a 4 mm beam. The graph shows that for a 1 s manufacturing variation in beam width (taken from actual MEMS fabrication data), the 4 mm system experienced a 4.2% frequency variation compared to the 10% one for the 2 mm system. This reduction in system variation (for frequency) would lead to higher yield and tighter system specifications.

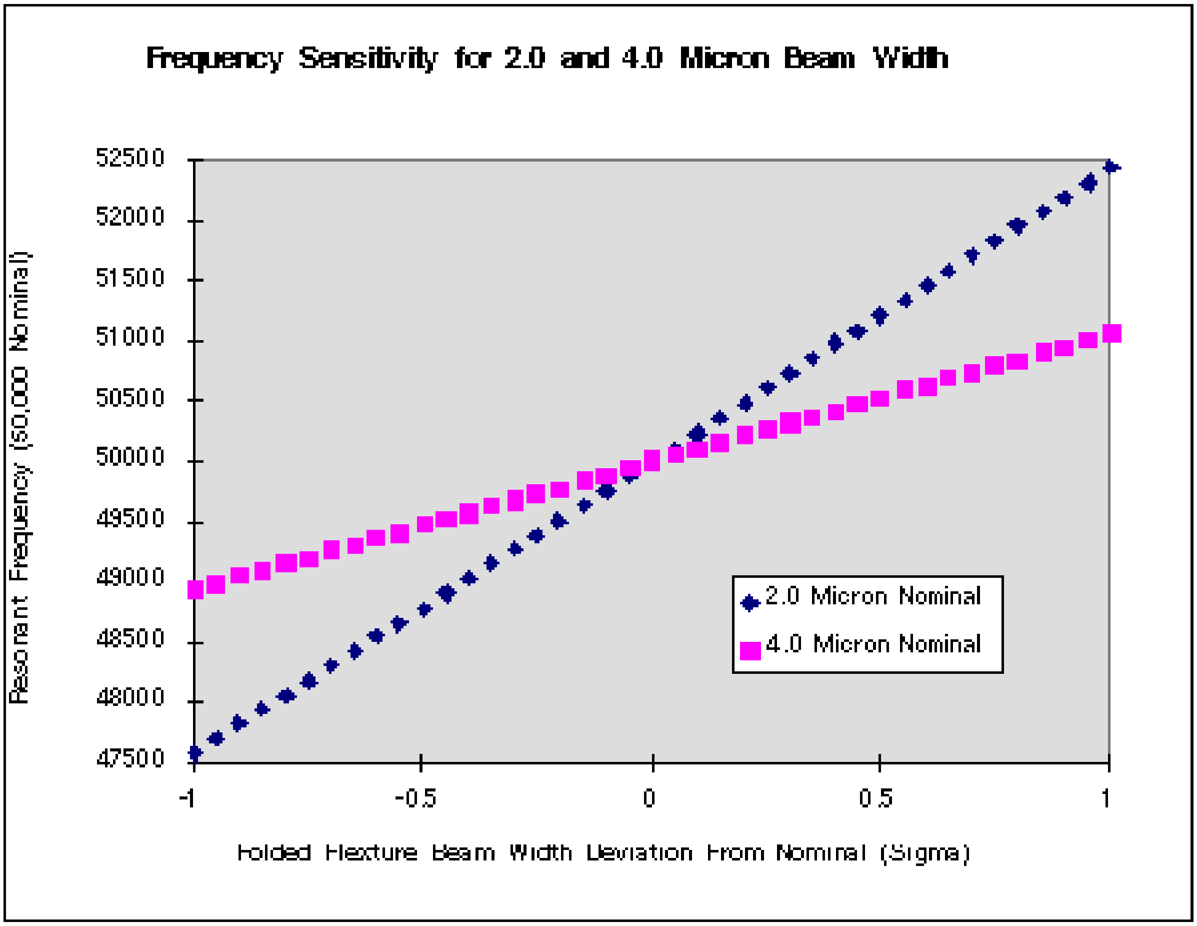

Figure 2. **2.0mm vs. 4.0mm Folded Beam Resonator**

A methodology for enhancing MEMS designs was developed using the property shown in figure 2. The comb-drive resonator was used as an example device. A tool for synthesizing resonators that are more robust to process variation was developed. Figure 3 shows the results of synthesizing three resonators using the tool. Figure 3.A shows a 50KHz resonator synthesized for area alone. Typical fabrication process variation would cause this device over 10% frequency variation. Figure 3.B shows the same resonator optimized for less than 9% frequency variation. Figure 3.C shows the same resonator with under 5% variation. Using this tool, a designer can trade device size for process robustness.

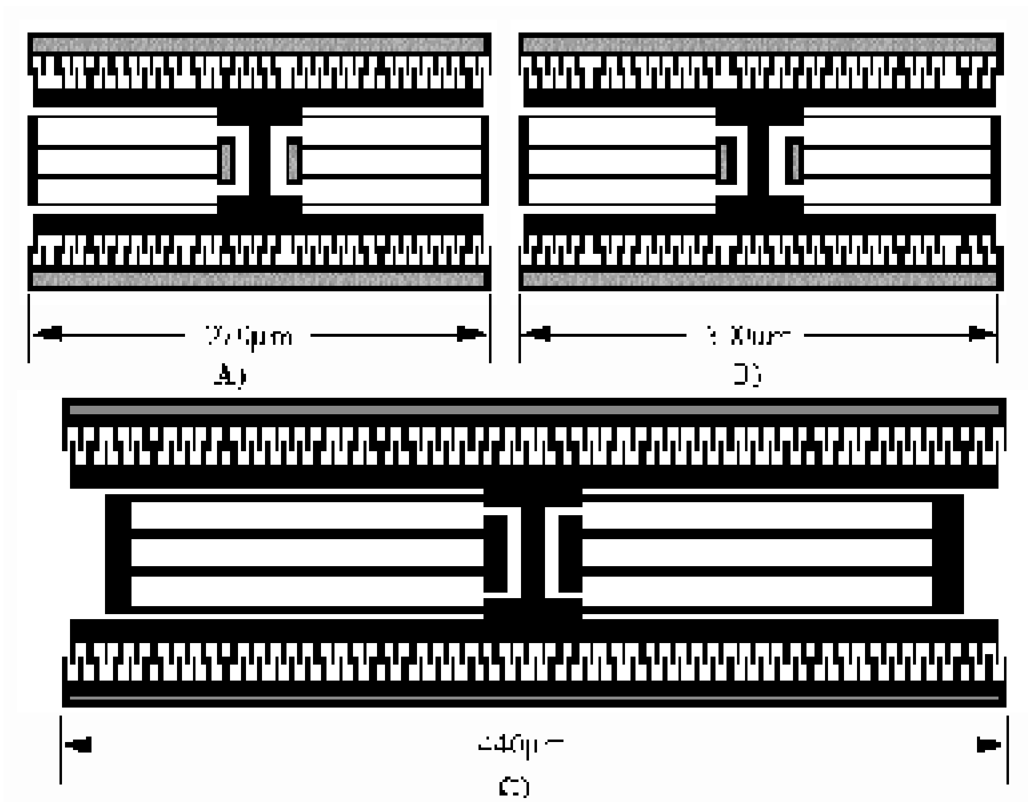

Figure 3. Synthesized Resonators: a) 10.22% Frequency Variation, b) 9% c) 5%

Publications

Theses

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