Haptic Display of Interaction Forces in MEMS Assembly Processes

ABSTRACT: In recent years, the world economy has seen expansive market growth in the area of Micro-Electro Mechanical Systems (MEMS). It is predicted that the MEMS market could reach more than $34 billion by the year 2002. Today, commercially available MEMS products include accelerometers for airbags and inkjet printer heads. These products require little or no assembly because a monolithic integrated circuit process is used to develop the devices. However, future MEMS will be more elaborate. Monolithic integration is not feasible when incompatible processes, complex geometry, or different materials are involved.

For these cases, new and extremely precise micro-manipulation capabilities will be required for successful product realization. This paper outlines the design and implementation of a computer aided simulation of Micro Electro Mechanical Systems (MEMS) assembly utilizing force feedback devices for display of forces of interaction. The system described in this paper solves boundary element equations for electrostatic forces between MEMS components and then displays this solution in near real time with the help of the PHANToM force feedback device. Issues discussed in this paper include: boundary element solutions of electrostatic forces, interpolation of a six degree of freedom solution grid, scaling up of electrostatic forces to human scale, and use of the PHANToM device for haptic display of electrostatic and contact forces.