Organization(s): Coyote Systems Inc.

Title: Portable Coupled Field CAD

Duration of Effort: July 1996 –September 1999

Principal Investigator(s): Per Ljung
Phone: (415) 346-4223 x12 / Email: pbljung@coyotesystems.com
Web: www.coyotesystems.com

MTO **Composite CAD**

Objective

This program developed software that simulates MEMS devices by solving coupled 3D electrostatic and elastostatic fields using the fast boundary element method (BEM). This approach emphasizes accurate and computationally efficient physics-based PDE analysis of large, realistic MEMS devices. These algorithms allow for robust automated analysis, eliminating the need for a "simulation expert".

Progress/Results

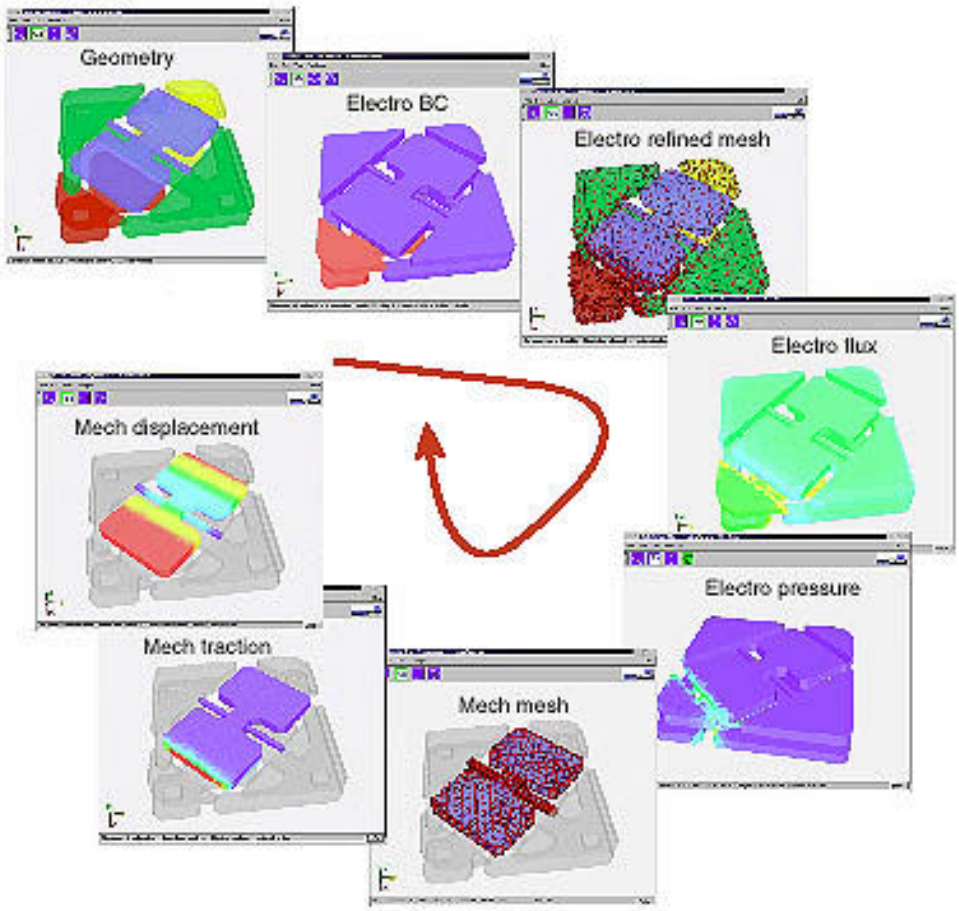
- Demonstrated automatic 3D model generation from layout (CIF, GDSII) of large, complex MEMS devices.
- Demonstrated electrostatic analysis of large, complex MEMS devices (e.g. ADXL76 simulated in 5 minutes).
- Demonstrated coupled electro-mechanical analysis of large, complex MEMS devices (e.g. TI micromirror).
- Demonstrated automatic adaptive refinement (h & p) of large, complex MEMS devices.
- Demonstrated generation of table-based macromodels of cross-capacitances and forces.
- Developed "tunnel acceleration" to reduce geometric complexity with no accuracy loss.
- Investigated optimal electro-mechanical coupling algorithms.
- Developed portable, human-readable API.
- Developed portable, easy-to-use GUI.
- Developed portable C++ based multi-physics fast multipole accelerated boundary element.
- Developed "wizards" to assist users in generating generic coupling simulations.
- Demonstrated capability to handle multiple arbitrary materials and multiple arbitrary boundary conditions.
- Largest model simulated exceeds 2 million BEM elements.
- (typical MEMS electrostatic models are 10k-50k elements).
- Fastest speed observed exceeds 1.25 million BEM elements/hour.

Status

- Conceived, developed and delivered a high-speed high-accuracy 3D coupled-PDE simulator for large, complex MEMS devices.
- Fulfilled all milestones on-time.
- Delivered a "push-button tool with power-user options".
- Tool delivered to Beta Partners.
- Commercial customers currently using tool.

Coyote Systems

Coupled Electro-Mechanical Simulation of TI Micromirror



Setup	1. Import Layout/Geometry	Automatic/Manual
	2. Define Electro Boundary Conditions	Manual
	3. Define Mechanical Boundary Conditions	Manual
Automatic Iteration	4. Refine Electro mesh	Automatic
	5. Solve Electro flux	Automatic
	6. Calculate Electro pressure	Automatic
	7. Refine Mech mesh	Automatic
	8. Apply Mech traction	Automatic
	9. Solve Mech displacement	Automatic
Convergence	10. Done!	Automatic