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Bond-Graphs + Genetic Programming = Automated Synthesis of Mechatronic or Multi Domain Dynamic Systems

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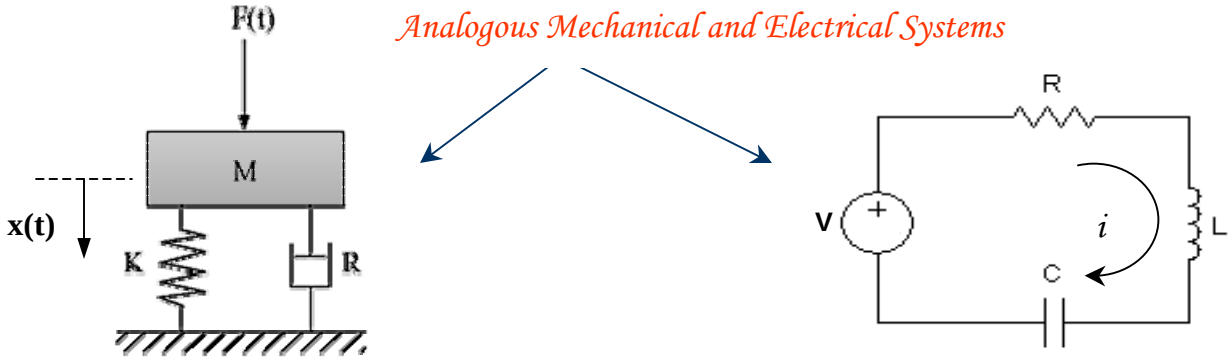
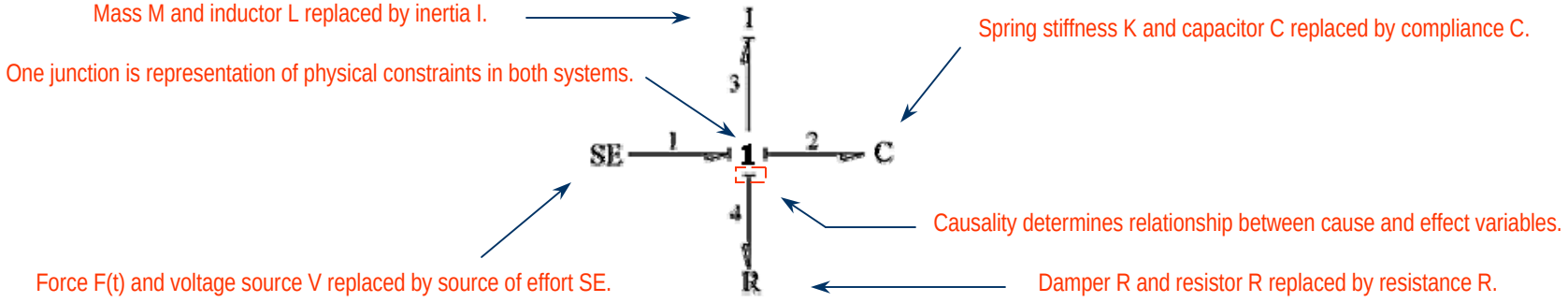
Bond-Graph Modeling of Analogous Physical Systems

Analogous Mechanical and Electrical Systems



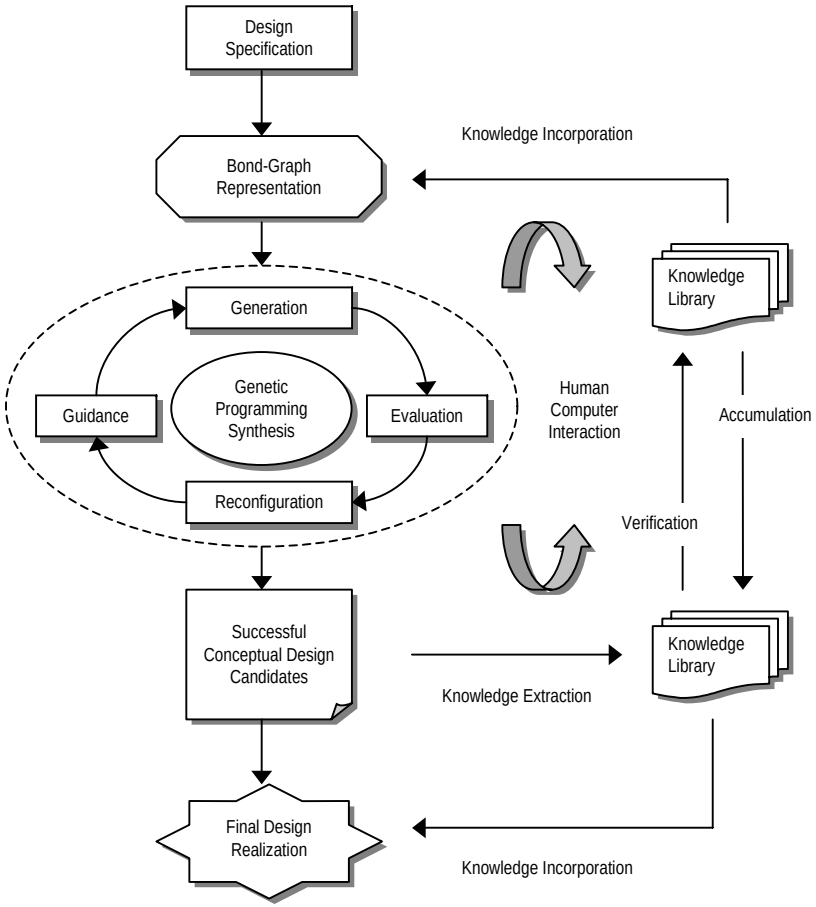
Schematic Representation of a Spring-Mass-Damper System

Schematic Representation of a Resistor-Inductor-Capacitor System



Intuitive Bond-Graph Model of the Analogous Mechanical and Electrical Systems

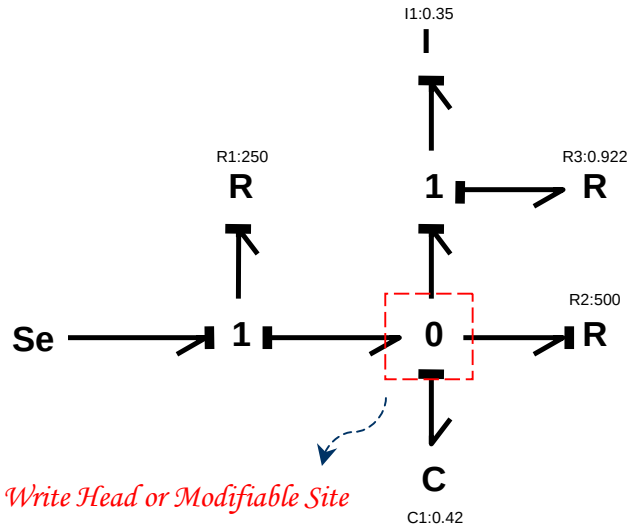
Methodology for Combining BGs with GP



Evolving Bond-Graph Models

- Employing the outlined methodology a simulated experiment has been devised to combine Bond-Graphs with genetic programming for automated synthesis/design of a simple physical system.
- The evolved Bond-Graph model of the physical system and numerical values of all evolved parameters along with target performance are included in next slide.

Results of Simulated Experiment



The Final Simplified Bond-Graph Model

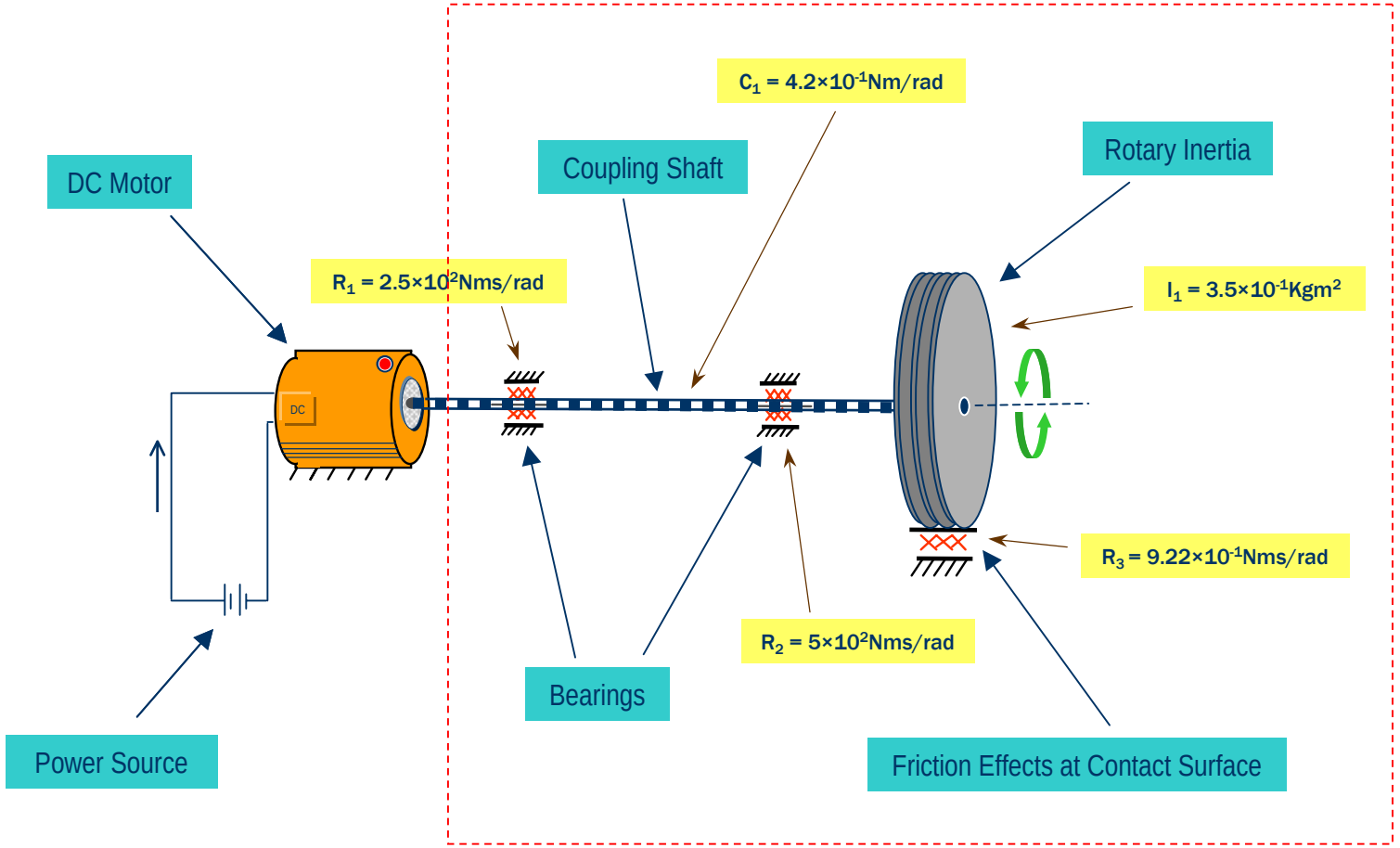
Target Eigen Values	
-1±2*j*	
Solution Eigen Values	
-0.78±1.063*j*	
Average Distance Error	
0.961	
Evolved Structure on Write Head	
R Elements	1
C Elements	1
I Elements	1
Junctions	1
Bonds	4
Bond-Graph Element Values	
R Element	0.922
C Element	0.42
I Element	0.35

Summary of the Results

Physical Design Realization

- Using the final simplified evolved Bond-Graph model of the synthesized system physical design realization of a simple rotary mechanical system has been carried out appearing in next slide.
- A complete dynamic analysis has been performed to cover the stability and controllability aspects of this synthesized physical system.

Synthesized Rotary Mechanical System



Conclusion

- The novel methodology followed for combining Bond-Graphs with genetic programming offers a powerful tool for automated design/synthesis of multi energy domain dynamic or mechatronic systems.
- The dynamic analysis (of the system in previous slide) reveals that a stable, controllable and human compatible physical system can be evolved by using the open ended design/synthesis paradigm offered by the outlined methodology.

Thank you for your attention.