SYSTEM*: HIGH-LEVEL SYNTHESIS OF PHYSICAL SIMULATIONS FOR FPGA-BASED REAL-TIME EXECUTION

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HARDWARE-IN-THE-LOOP TEST AND ELECTRIC MOTOR EMULATION

Electrified vehicular powertrains undergo exhaustive test procedures during development. In order to test an electric motor controller, motor and vehicle mechanics are replaced by a virtual device - the electric motor emulator (EME). An EME computes motor currents and rotor position from repeated voltage measurements and recreates these currents with a power stage. An EME involves a built-in real-time model requiring a challenging reaction time of approximately 1 µs. This is achieved by executing the model on an FPGA.

THE PROBLEM

- Mapping such models to FPGAs requires tremendous engineering efforts.
- Can automation simplify the engineering task?

TOOL COMPARISON

<table>
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<tr>
<th>Tool</th>
<th>Input languages</th>
<th>Interf microarchitecture?</th>
<th>Arbitrary-width fixed point arithmetic?</th>
<th>Supports floating point arithmetic?</th>
<th>Open source?</th>
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</tbody>
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* Matlab/Simulink with HDL Coder

THE SOLUTION: SYSTEM*

CASE STUDY: SQUIRREL-CAGE INDUCTION MACHINE

TUNING PARAMETERS

- Arithmetic: 32bit fixed point, IEEE single/double
- Scheduling: Force-directed scheduling with various schedule lengths
- Xilinx IP cores with various latency settings

CONCLUSIONS

- Broad range of performance/area tradeoff is achievable.
- Quality of hand-coded design was attained.
- Floating-point arithmetic is affordable.

REFERENCES