Jeffrey Alexander Cool

Contact

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Engineering Interests

Mixed signal IC design and CMOS layout, Modern and Classical control systems design, Analog and TTL circuit troubleshooting and repair, Nonlinear analog circuits, Digital filters, Digital system design with VHDL/Verilog.

Education

B.S in Electrical Engineering from CSU Long Beach
Graduated Magna Cum Laude in June 2016
Emphasis in Control and Microelectronics

Relevant Coursework

Electronics: Mixed Signal IC design, Solid State Devices, Analog Circuits I & II, Power Electronics and Motor Control
Control: Classical Control, Digital Control, Modern Control Systems Design
Computation and Mathematics: Digital System Design, Microprocessor Principals and Applications, C++ Programming, Linear Algebra, Differential Equations, Probability and Stochastic Modeling, Electromagnetic fields

Academic Projects

Control System for Tuning a Vibrating String: Fall 2014
Tuning a vibrating string by varying its length with a motorized slide – a nonlinear SISO system, controlled with linear feedback.

- Digital PID compensator implemented in PBASIC on a BS2 based MCU.
- Ziegler-Nichols and CHR PID tuning and comparison.
- Frequency measurement using homemade magnetic pickup.
- Demonstrated linearizing effect of feedback.

Control of Inverted Pendulum with Fan Actuation: Spring 2015
State Space modeling and Design of optimal LQR controller for a modification of the standard inverted pendulum problem – a single input, double output situation.

- Analytical system modeling and linearization in time domain.
- Design of LQR state feedback controller for simplified 2nd order model.
- System modeling in Matlab and Simulink.
- Implementation of SF controller and IIR filters on Atmel 32u4 MCU in C.
- Design of electronic interface and packaging.

4 bit Charge Redistribution DAC: Design, Layout and Simulation: Fall 2015
Demonstration of CMOS layout techniques for a simple serial DAC. Layout designed in Microwind in a 0.12μm CMOS process.

- Completely manual layout.
- Use of pass transistor logic and dynamic D-latches to minimize layout area.
- Characterization of linearity, gain error, and transient response including crosstalk.
- Interdigitized MOS capacitors for improved matching.

4 bit flash CMOS ADC Design, Layout and Simulation: Fall 2015
A standard project to which I added some useful features. Layout designed in Microwind and DSCH in a 0.12μm CMOS process.

- Hybrid manual (for analog front end) and automatic (for priority encoder) layout.
- Transient simulation with level 3 Spice model and BSIM4.
- Minimum delay output buffer – cascade of inverters with progressively wider channels.
- ESD protection clamps on the inputs, constructed from parasitic diode structures.
- Linearity and signal integrity characterization: DNL, INL, gain error.

Investigation for FPGA based BLDC controller: Fall 2015
Design inspired by commercial BLDC controller. Commutation sequence determined using measurements of the time integral of the back EMF in the un-driven coils.

- Digital Logic System implemented on a Spartan3E FPGA in VHDL.
- Analog measurement/processing circuit comprised of integrators, comparators and transmission gates.
- Bilinear PWM open loop speed control.

Personal Projects

Analog Capacitive Touch Sensors: Summer 2015

I designed and built a device comprised of 16 capacitive touch sensors with individual adjustable parameters for an MFA candidate. The circuit is essentially a cascade of textbook circuits which takes as an input, a continuously variable capacitance, and outputs a logical on/off signal.

- Each module consists of the following nonlinear circuits: a relaxation oscillator, a peak detector, and a Schmitt trigger with common emitter inverting output stage.
- Exploits op amp slew rate limiting, so that the amplitude of the oscillator output is frequency dependent, and thus dependent on the input capacitance.
- Adjustments for base frequency and switching threshold allow various input impedance ranges, including inputs that are not purely capacitive.

Troubleshooting and Repair of Automotive Engine Control Module: Summer 2016

Diagnosed the source of a problem that was causing four injectors to remain in the on position using minimal tools and no circuit diagram.

- Exercise in deducing the nature of circuitry between nodes on a PCB by measuring resistances and diode drops.
- Problem identified as failure of all lower transistors in totem pole output stage of a 7404 quad nor gate.
- Replaced a surface mount component with a DIP chip.
- Revived a non-op automobile, allowing it to pass CA emissions tests.

Control of "Flexible" Inverted Pendulum: July 2016

Investigated a variation on an inverted pendulum of n-segments in which actuation is applied at the union of the segments via servomotors.

- Modeling via Euler-Lagrange Equations of motion with Lagrangian derived from physical diagram.
- Complete system modeling for n=2 case using hybrid approach involving signal flow graphs, transfer functions and state space representations.
- Verified Controlability, Observability for various measurement schemes.

Relevant Software Tools

- **Languages**
  C/C++, PBASIC, AVR Assembly, VHDL, VHDL-AMS, Verilog, SPICE
- **Analytical Tools**
  Matlab/Octave, Mathematica, Minitab
- **Design, Layout and Simulation**
  Microwind, DSCH, LTSpice, Simulink, Xilinx, hAMSter
- **Documentation**
  Excel, Word, LaTeX, html