Jeffrey Alexander Cool

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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.
- Comparison of classical PID tuning methods.
- Frequency measurement using a magnetic pickup I made.
- Successful implementation of a tracking controller for a nonlinear plant.

Control of Inverted Pendulum with Fan Actuation: Spring 2015
State Space modeling and Design of 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 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.

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 resettable integrator and window comparator
- Bilinear PWM open loop speed control.

Personal Projects

Analog Capacitive Touch Sensors: Summer 2015

I designed and built a device comprised of 16 analog capacitive touch sensors with individual adjustable parameters for use in a piece of interactive art.

- Design based on a relaxation oscillator which exploits op amp slewing to obtain a signal whose amplitude depends strongly on a capacitance.
- Various user accessible controls allow for a wide range of inputs.

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 extracting schematic from PCB using minimal measurements.
- Problem identified as failure of lower output stage transistors of a 7404 quad nor gate.
- 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.
- 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.

Autonomous landing controller for a RC paraglider: March 2017

Designed for the CSULB USLI 2017 Aerospace team.

- Nonlinear digital controller implemented in C controls payload weight distribution using fed back GPS data in a simplified coordinate system.
- Design of novel pulse-width comparator circuit for manual override subsystem.
- Excercise in robust control system design for minimally modeled plant.

Entrepreneurial Endeavors

Design and Manufacture of Custom Ribbon Microphones: 2006-2010

I designed and built a series of velocity ribbon microphones for two audio engineers in Long Beach, CA.

- Original transducer designs, fabricated from various materials.
- Trade off studies with various commercial and hand-made transformer designs.
- All by-hand metal and wood work.

Analog Circuit Design for Musical Signal Processors: April 2017

A friend and I have been designing various guitar pedals and noisemakers with the goal of releasing a product in the near future.

- Analog and mixed signal design using mainly LTSpice and physical prototyping.
- Nonlinear designs include multipliers, VCOs, PLLs.

Embedded Programming and PCB Layout for ARM SoCs: May 2017

I was brought on by a startup to assist with the development of Bluetooth enabled consumer electronic devices.

- Embedded programming of state machines in C for ARM Cortex M0 MCU.
- Design of peripheral circuitry for illumination and audio processing.
- PCB layout including integrated antenna design.

Relevant Software Tools

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