Actively Stabilized Gimbal Sensor Platform

Scott Torborg, Kyle Vogt, Mike Scharfstein

- DARPA Grand Challenge 2005
- Improves sensor data quality
- Leverages power of configurable logic with low-latency control loops
Sensors and Motors

• Maxon brushless motors with 74:1 gearing
• Maxon controller/amplifier
• Analog Devices ADXL accelerometers and ADXRS gyroscopes
• 12-bit Serial ADCs, DACs
Overall Block Diagram

FPGA

One system per axis

Configuration, trigger, and diagnostic lines not shown.
Control Interfaces

- Controller Area Network
- SJA1000 CAN core
- RS232 Backup Interface
- 16550 UART core
- Open-source modules
- MAX232 and SN65HVD251 transceivers
Command Interpreter

- Allows host to modify operation of system
- Stores and parses commands from CAN and RS232 interfaces
- Used for setup, configuration and debugging
- Directly reads and writes to a bank of registers
Input Blocks

- Serial ADCs
  - ADXL accelerometers
  - ADXRS rate gyroscopes
  - Buffered to allow variable sampling rate
- Motor encoder
  - Gives us motor position
  - Compare to desired position
- Data also fed back to register file
Motor Control Output

- DAC outputs voltage to Maxon controller
  - Value calculated from filter and absolute offset
  - Controls current or velocity
Config Register File

- Collection of registers
- Allows dynamic reconfiguration:
  - Sensors/ADCs in use
  - FSM timing frequencies
  - Generic parameters
- Diagnostic feedback:
  - Motor position, sensor values
Convolution Filter

- Like Lab 3, but parallelized and high-resolution
- Parameterized for arbitrary bus width, arbitrary number of multipliers

Diagram:

- Coefficient SRAM
- Sensor Data SRAM Buffer
- Dedicated multipliers
- Convolution Filter
Absolute Control

- Provides ability to override stabilization with high-level position control

Diagram:
- Desired position (from regfile)
- Actual position (from encoders)
- Filter
- Gain
- DAC output
Timeline

• 4/29 - UART, basic commands, ADC input
• 5/2 - hardware, CAN, basic filter, motor control, encoder feedback
• 5/7 - absolute control, command interpreter
• 5/10 - debugging finished!