

# Shrini's Crew

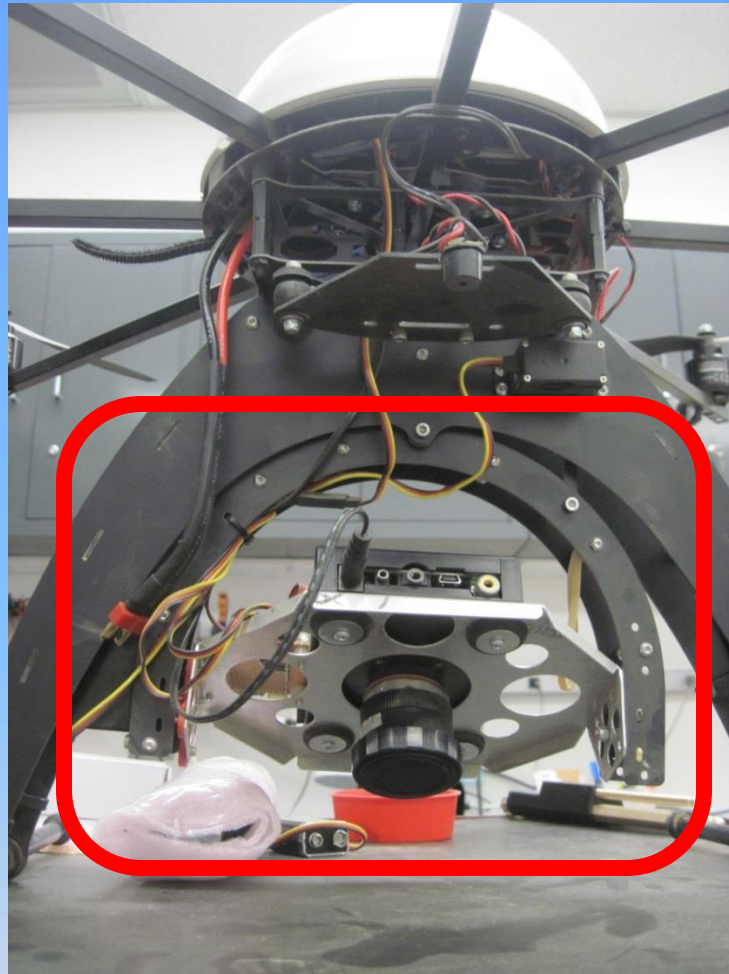
Camera platform stability for use in  
UAV remote sensing

Kellen Crawford

Matt Klein

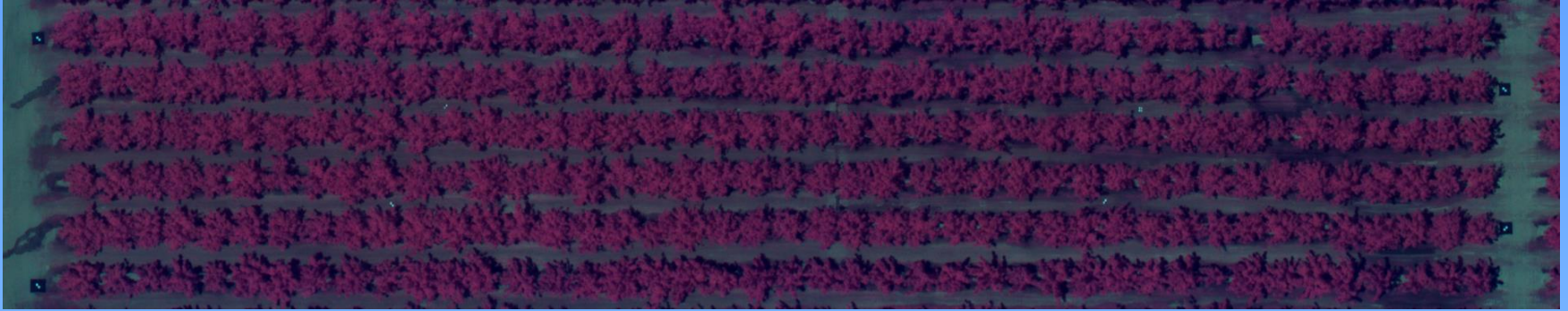
Kevin Brouwers

# Camera Platform

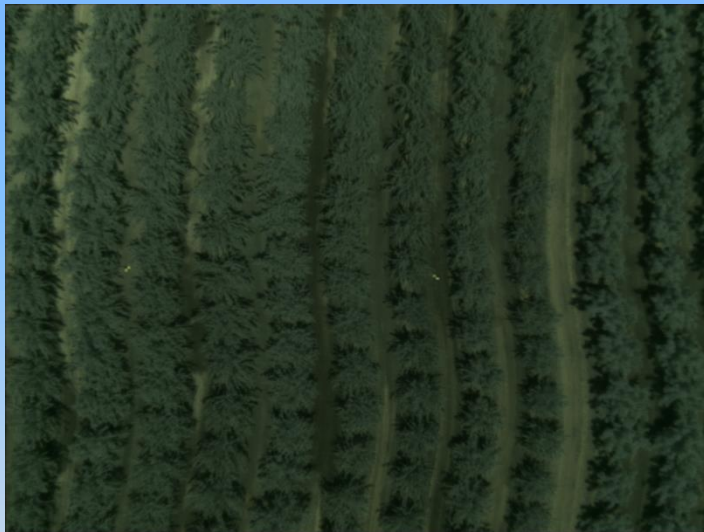


Primary goal of this project is to determine what is causing the distortion in image data that is captured during flight.

# Automated Image Processing Agricultural Data Acquisition



Mosaic image using image processing software.  
Microsoft Research Image Composite Editor (ICE)



Distorted image



Normal image

# Approach



Analyze hardware and software

Model the system dynamics

**Identify possible root causes of problems**

Acquire data to verify and quantify problems

Develop tests procedures

For real-time data

**Develop and implement system solutions**

Evaluate results

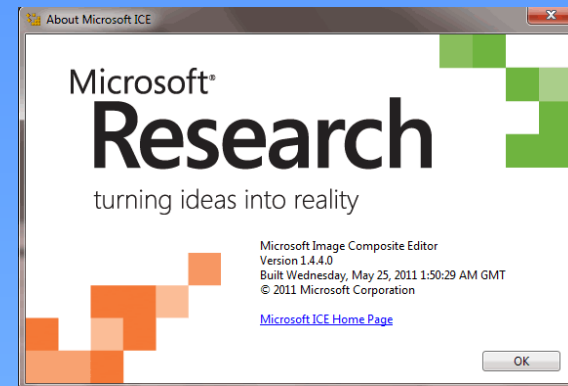
# Imaging/Camera Systems

Analysis of Problems and Possible Root Causes

## Agricultural Digital Camera User's Guide



Tetracam Inc  
21601 Devonshire Street  
Suite 310  
Chatsworth, CA 91311 USA



Mon Oct 19, 11:39 PM Live System User

DSC\_4602-DSC\_4607.pto - Hugin - Panorama Tools Frontend

File View Help

Images Camera and Lens Crop Control Points Optimizer Exposure Stitcher

name	width	height	yaw (y)	pitch (p)	roll (r)	Anchor	# Ctrl Pnts
_4602.JPG	2000	3008	109.4	26.7	66.4	AC	22
_4603.JPG	2000	3008	120	-3.2	52.3	--	32
_4604.JPG	2000	3008	-146.4	-74	-15.5	--	36
_4605.JPG	2000	3008	-97	-11.1	-48.1	--	23
_4606.JPG	2000	3008	-82.5	26.8	-54.8	--	24
_4607.JPG	2000	3008	15.7	25.7	10.7	--	40

None Photometrics Drag Crop Identify

SC\_4603.JPG  
KON CORPORATION  
KON D100  
19 Sep 2008 02:01:20 PM EDT  
320 s

Preview Options  
projection (f): Stereographic Blend mode: normal EV: 0

Click to create or edit control points here. 199.0 x 110.0

DSC\_4602-DSC\_4607... Fast Panorama preview

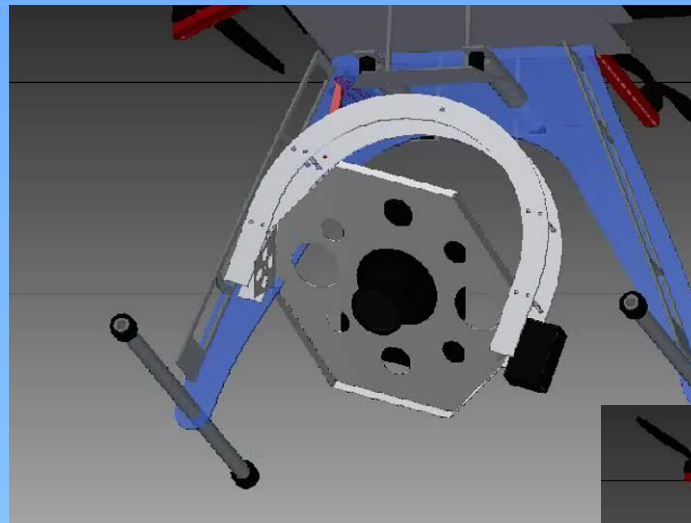
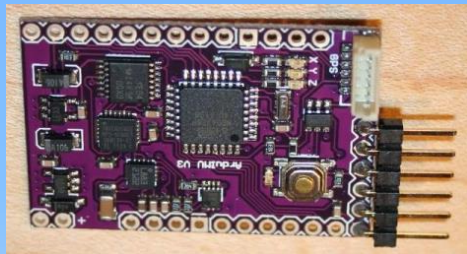
## Hardware

## System Dynamics

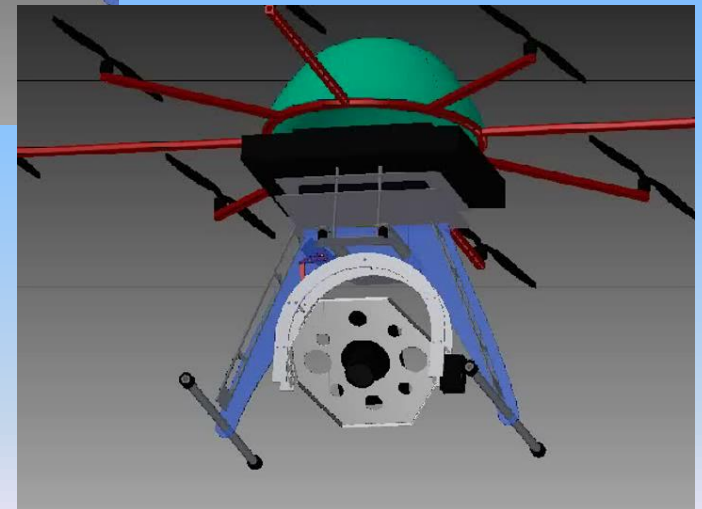
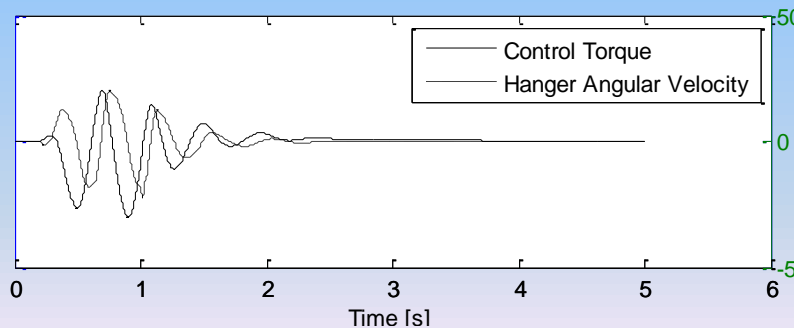
## Software

- Modeling

- Controller
- Sensors
- Servos
- Camera
- Mechanical Systems

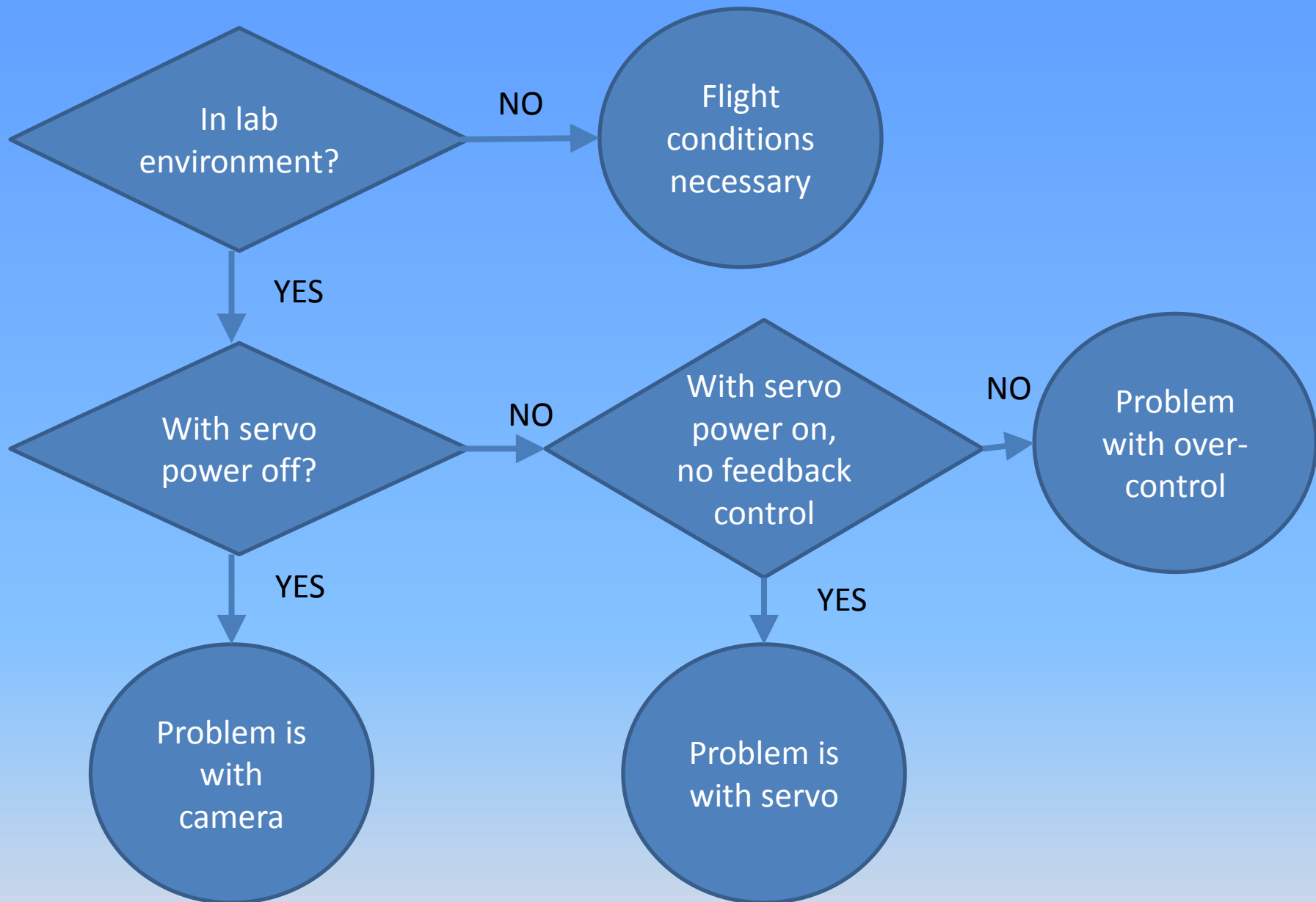


- Controller Code
- Camera Configuration
- Composite Imaging



# Possible sources of distortion

- Camera
- Flight conditions too dynamic
- Feedback control
  - Mechanical
    - Soft bushings
    - Long moment arm for roll servo
    - servo twitch
  - Software
    - Control code is faulty (can't keep up, wrong parameters, need derivative term, etc.)





# Experimental Findings

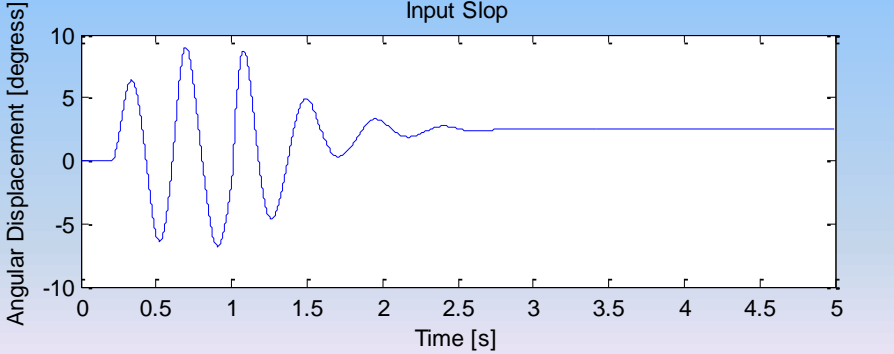
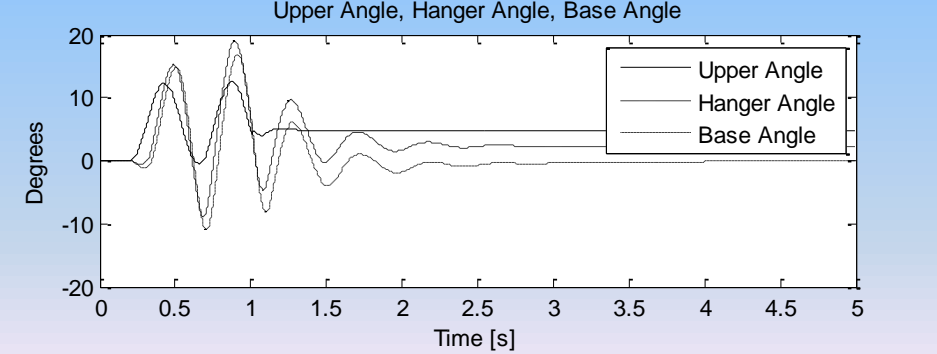
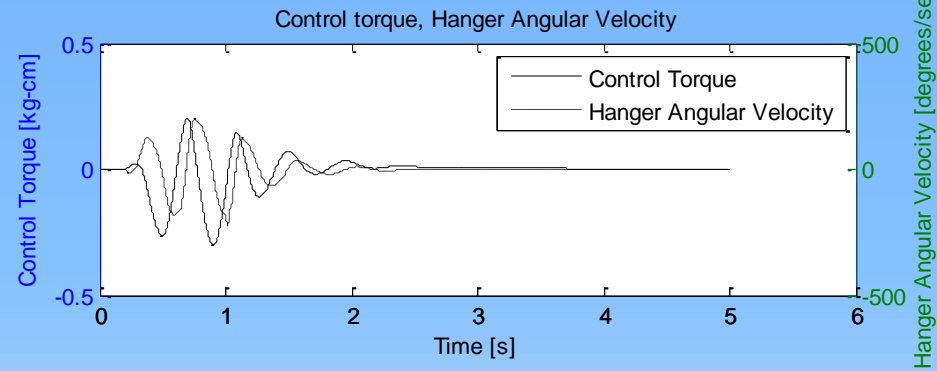
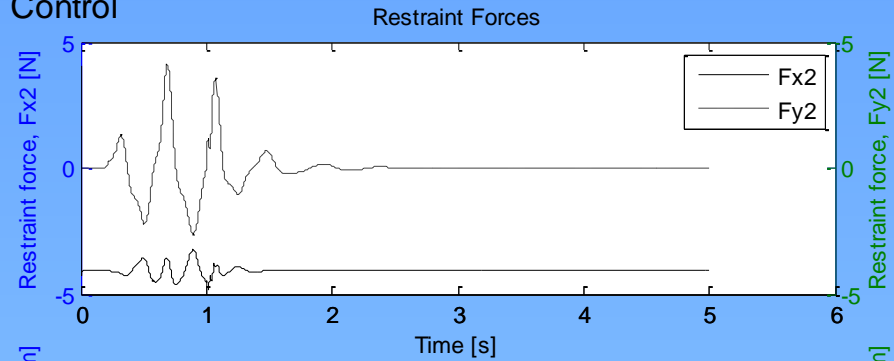
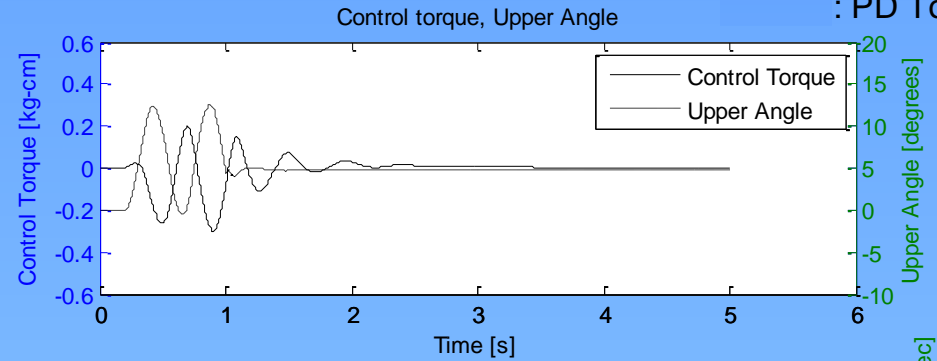
- Control loop timing
- Camera capture command placed inside loop
  - Hardware Cable Constructed to Trigger Camera
  - Developed software to coordinate acceleration data with picture numbers for ICE analysis
  - No longer have distorted images!
  - Not sure why yet, investigation of possible root causes is necessary.
    - The command signal now sequential in time relative to the stabilization control.

# System Modeling

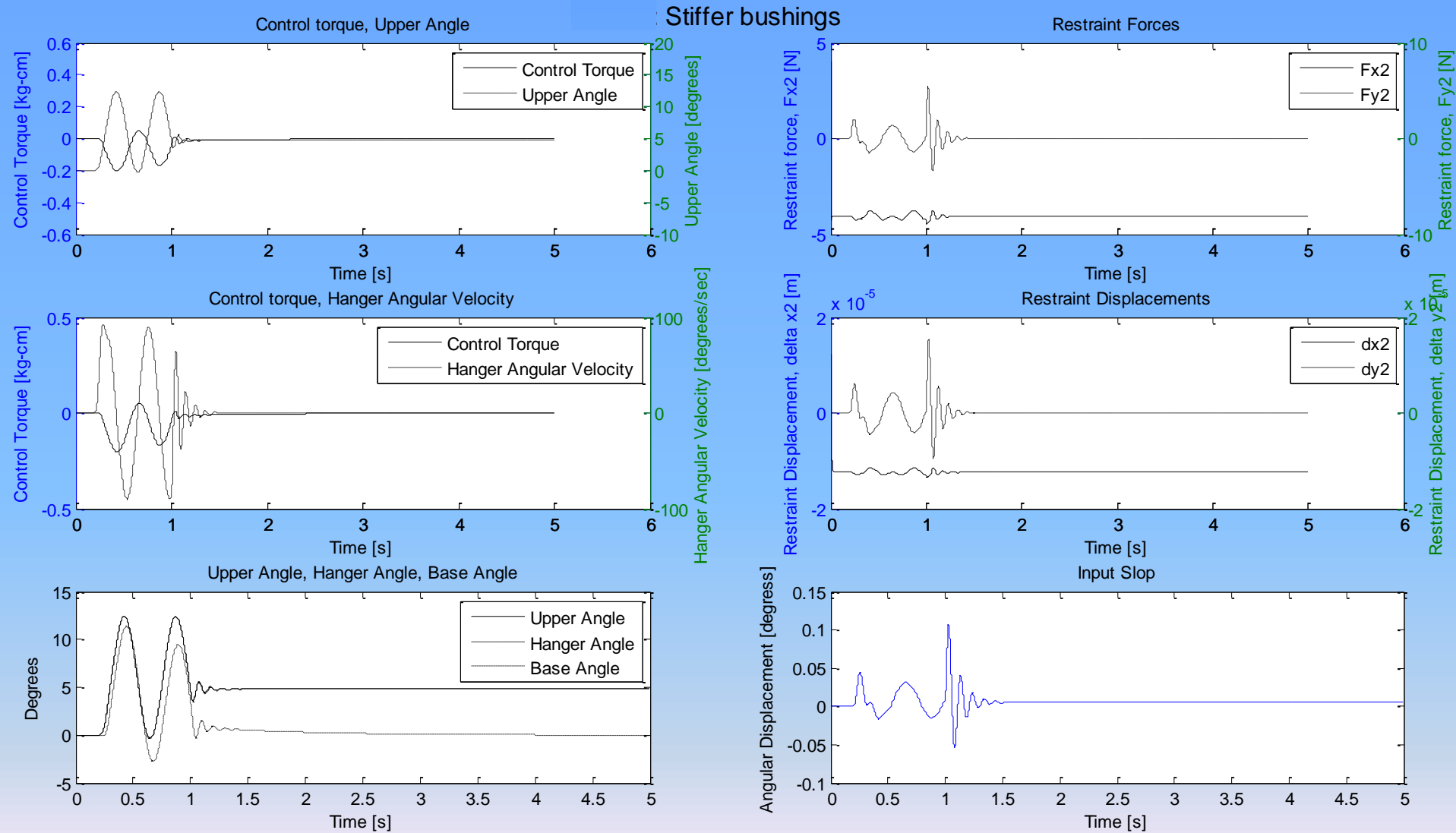
- Model the system to aid in understanding the effects of tuning system design parameters on the quality of the camera stabilization control.

# System Modeling

: PD Torque Control



# System Modeling



# Conclusions thus far...

- Control algorithm directly impacts the image quality
  - Code iteration rate
  - Camera acquisition control
- System optimization - bushings
  - ~ 3 times faster
    - 1.5s down to 0.5s
- Overall project objective has evolved based on results



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Questions?