TEAM 3
CAMERA STABILIZER

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INTRODUCTION

- Project sponsored by professor Michael Young of George Mason University, PE with experience in wireless data communication and radar systems
- Professor Young is an amateur pilot that enjoys aerial videography during his flights
- These videos are often distorted due to unsteady motion conditions

MOTIVATION

- Taking up the project would allow for the opportunity to work with Professor Young and thus having a mentor throughout the design process
- Professor Young would cover the budget up to $500
- The design team has the opportunity to test the camera stabilizer while riding in Professor Young’s personal aircraft

SOLUTION

In order to prevent any type of distortions to the video image, the camera's movement must be stabilized.

Based on customer requests, multiple designs were approached by the members of the team:

- After video editing program (iMovie)
- Mechanically based optical image stabilization (Lens Control)
- Software based digital image stabilization (Digital Filtering)
- Electromechanical compensation

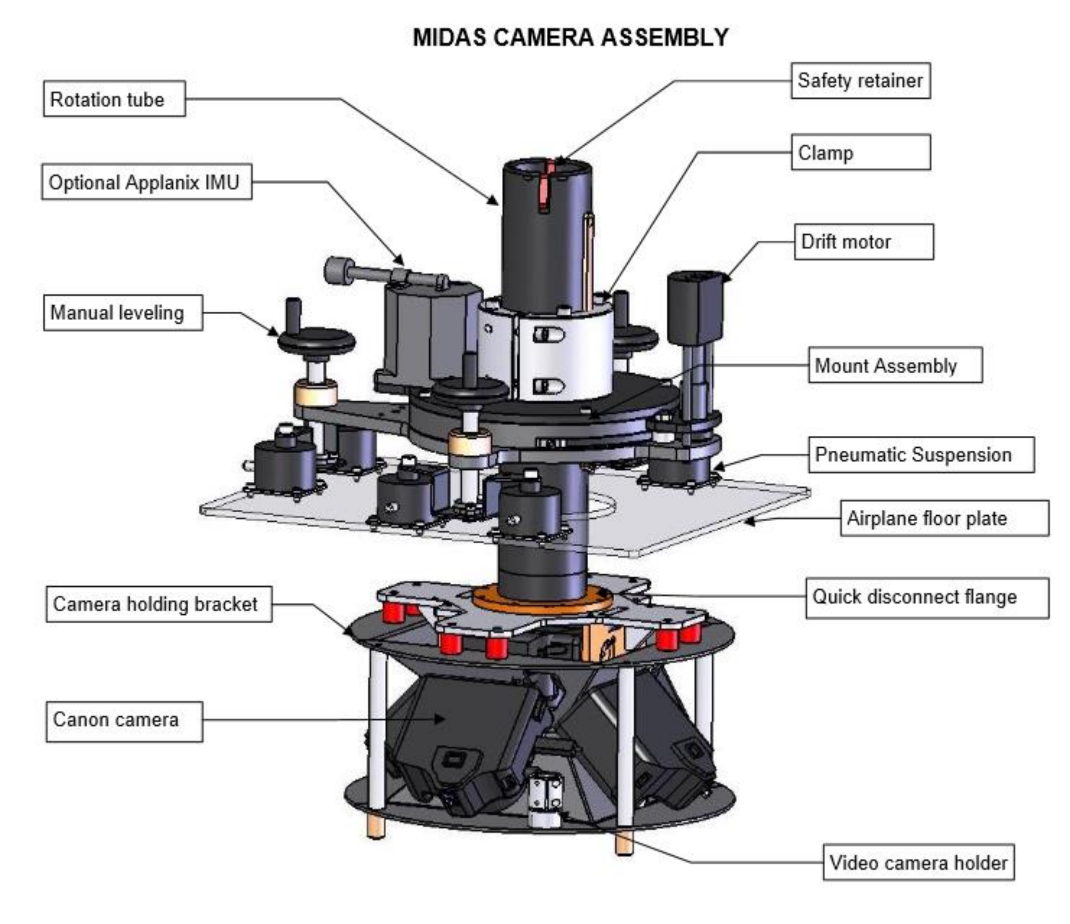
OBJECTIVES FOR DESIGN

- Must be a single hand-held device
- Fast response time to eliminate movements seen by the camera
- Support Nikon 1 or other comparable cameras.
- Efficient power consumption
- LIGHTWEIGHT!!!

SPECIFICATIONS

- Maximum arm profile: 10” x 4”
- Maximum handle profile: 6” length x 3” diameter
- 120° rotational movement within 500 milliseconds
- 4.4” x 3” x 1.7” adjustable camera mounting
- Will operate for a minimum of 30-minutes on a single charge
- Device will weigh 2lbs without mounting the camera

DESIGN INFLUENCES



MIDAS Camera

- Mounts to Airplane flooring
- Dampening system to isolate mechanical vibrations
- Uses multiple solenoid leveling
- Large dimensions (19” x 13” x 15”)

Drone Stabilizer

- Uses heavy counter weights
- Weight ranges between between 3 to 8lb
- Causes user fatigue

Steadicam

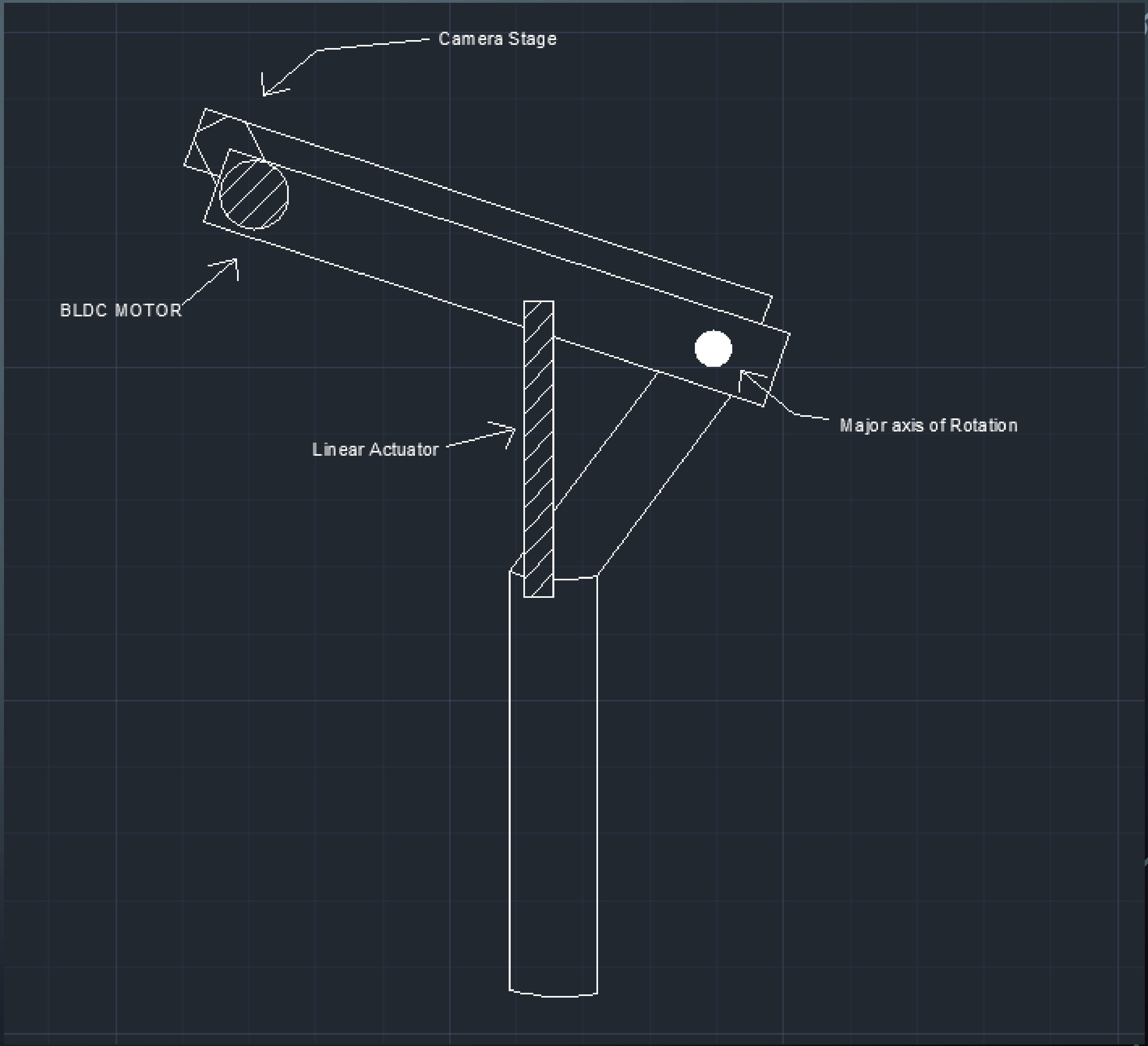
- Uses complex mechanical spring arm action
- Requires full body harness
- HEAVY!!!

DESIGN INFLUENCES

Easy Gimbal

- Single-handed camera stabilizer
- Light weight
- Overhand camera mounting
- Able to stabilize images with aggressive movement

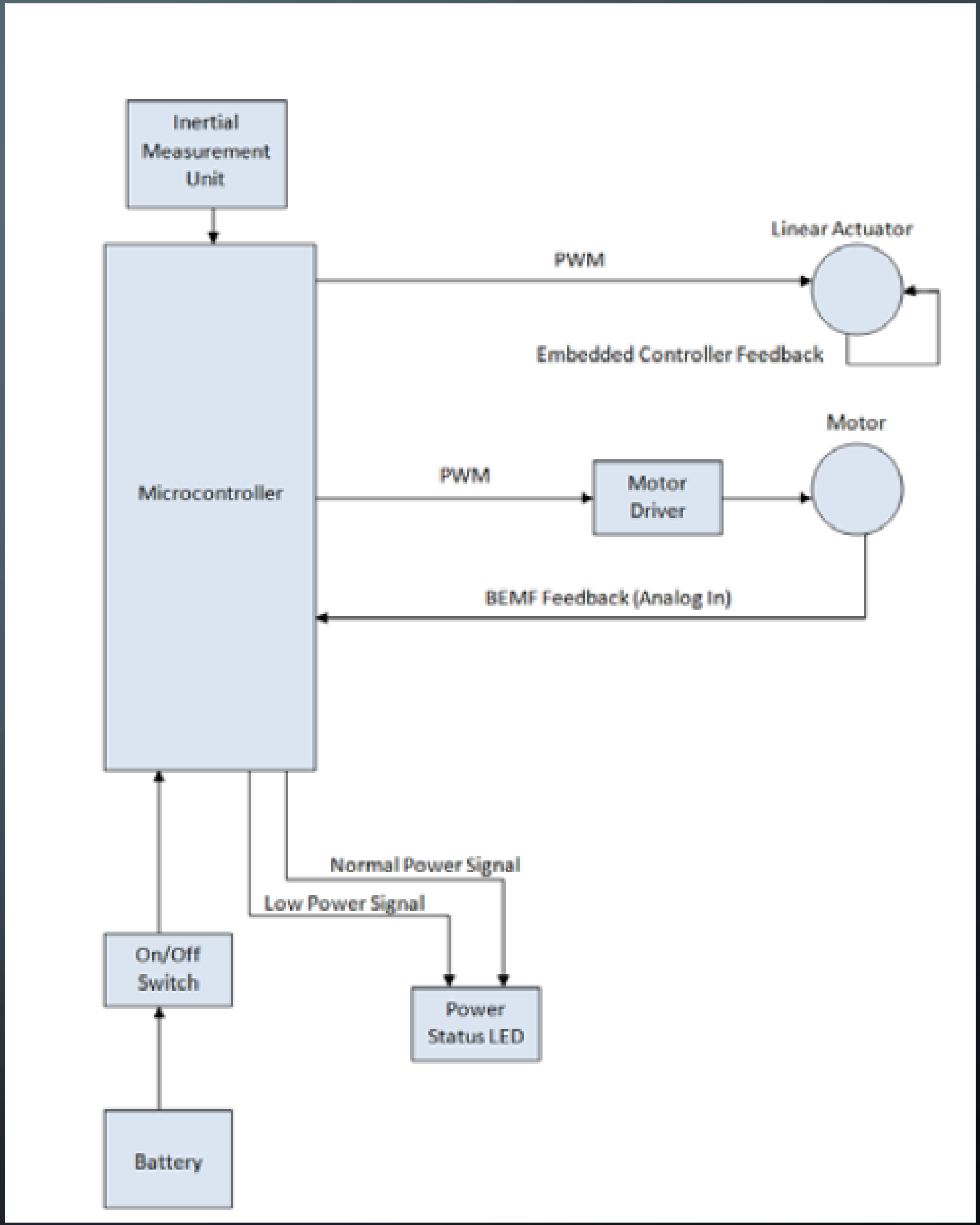
Design A Frame



BLOCK DIAGRAM

Design A

Primarily designed for stabilizing vertical movement of the camera via motion arm.

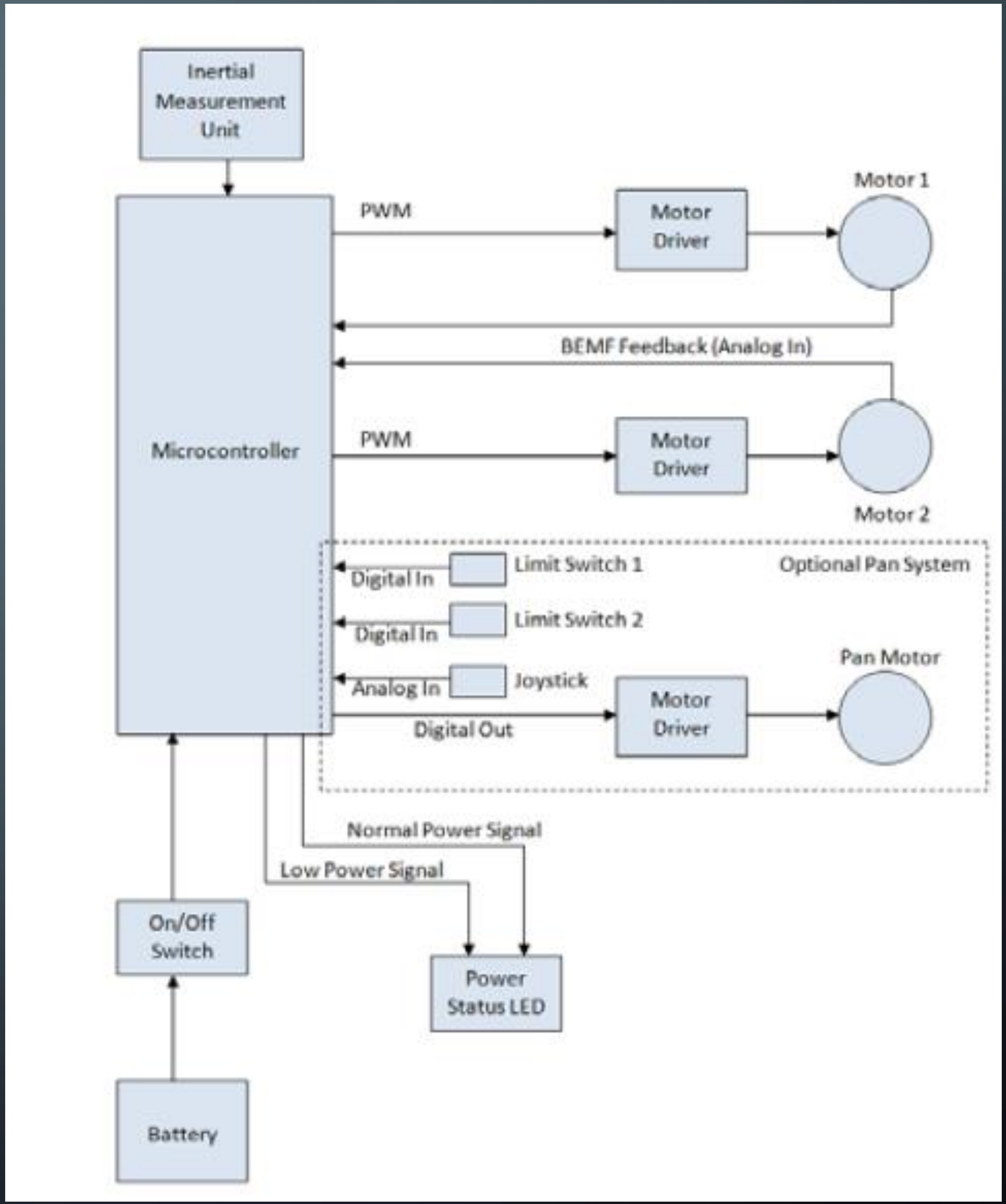


Design B

BLOCK DIAGRAM

Design B

Primarily designed for stabilizing unnatural movements of the camera caused by the operator with respect to roll, tilt and pan (optional).



DIFFERENCE BETWEEN THE TWO DESIGNS

Design A

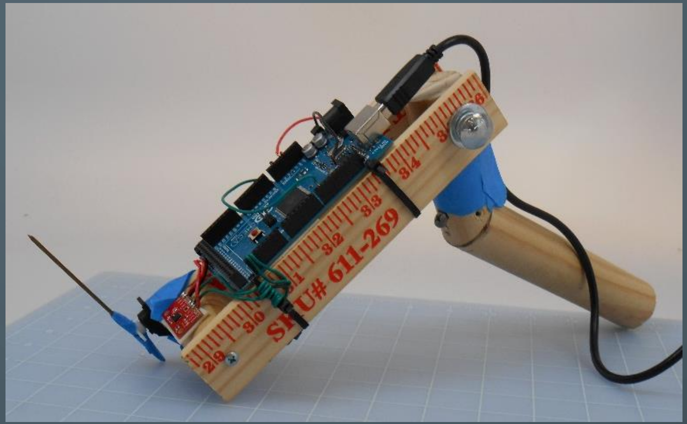
- More mechanically involved
- Uses original mechanical design
- Less control complexity
- High torque requirement
- Closer to customer specs

Design B

- Very little mechanical movement
- Uses developed mechanical design
- Increased control complexity
- Minimal torque requirement
- More optional functionality

HARDWARE

FRAME



- Aluminum frame construct
- U-channel to act as a camera mount
- L-channel arm to connect camera mount to handle
- All electrical components will be housed within the handle
- Battery housed in handle, below grip

CAMERA

Camera that Customer will be using on the device that.

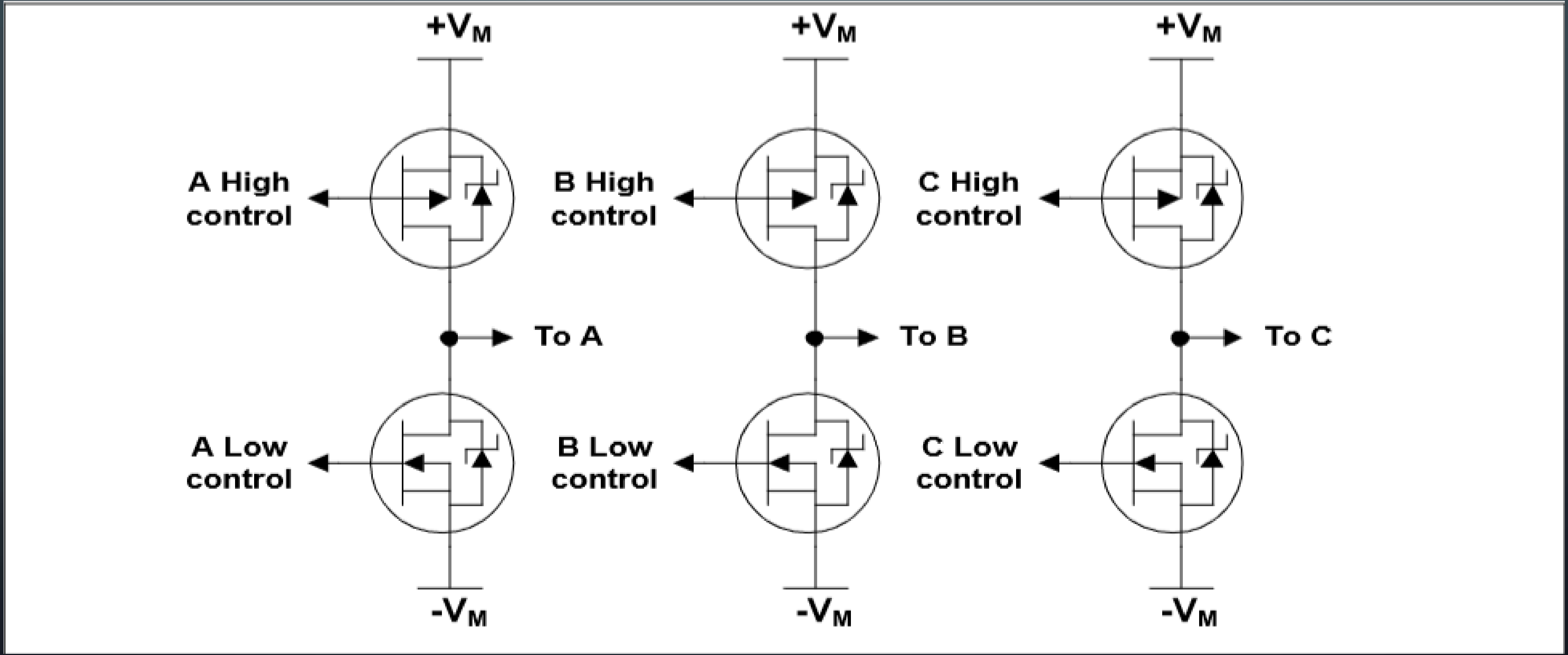
- Dimensions are 4.17” x 2.4” x 1.18”
- Weight 0.61 lb with normal lens
- Uses standard camera mount

MOTOR

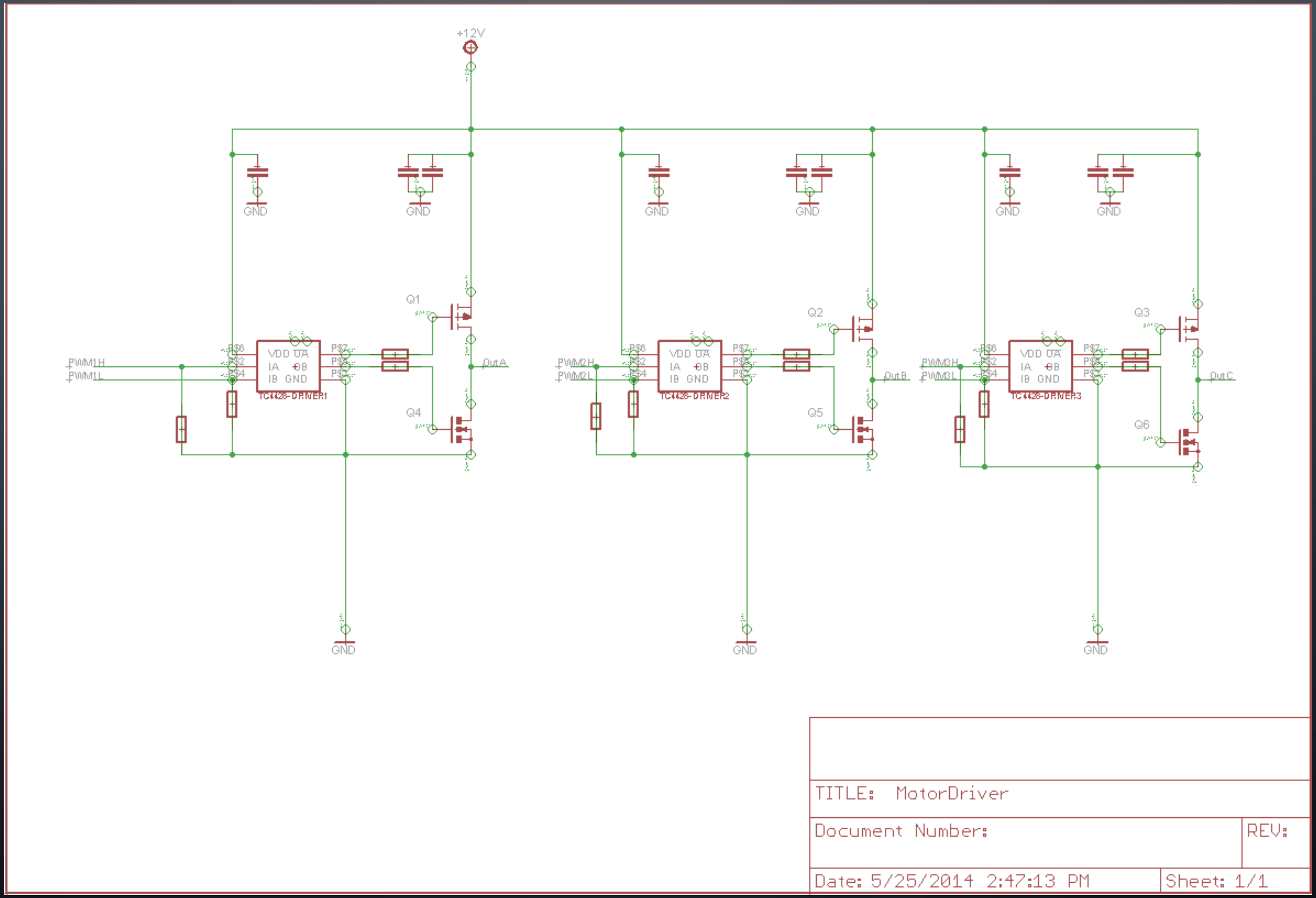
Turnigy GBM4006-150T BLDC

- 0.18 lbs
- 40 mm Diameter
- 35 rpm/v
- 22 poles
- Potential 2.7° motion resolution
- Expected max current to be 45A
- Expected max voltage to be 7.4 to 14.8V

MOTOR CONTROL THEORY



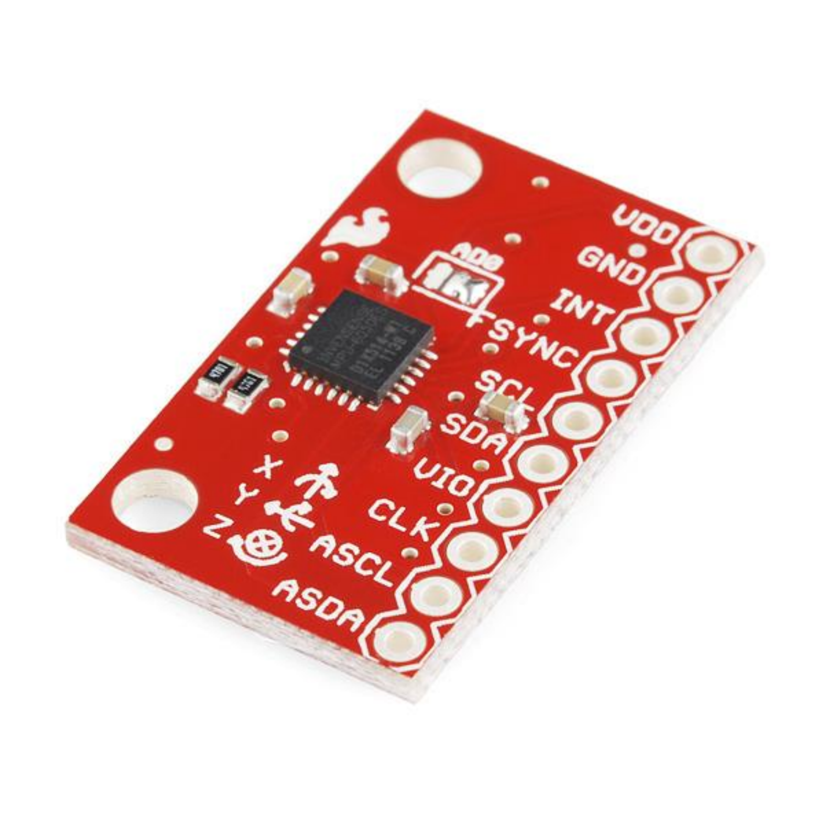
MOTOR DRIVER



INERTIAL MEASUREMENT UNIT

MPU6050

Sensor Specs	3-Axis Accelerometer 3-Axis Gyroscope Thermometer Magnetometer
VLOGIC	1.71 TO 3.6
Serial Interfaces Supported	I^2C
G-Rating	+/- 4g
Architecture	16-bit
Max. Clock	3.4 MHz
Small Footprint	6 x 6 mm

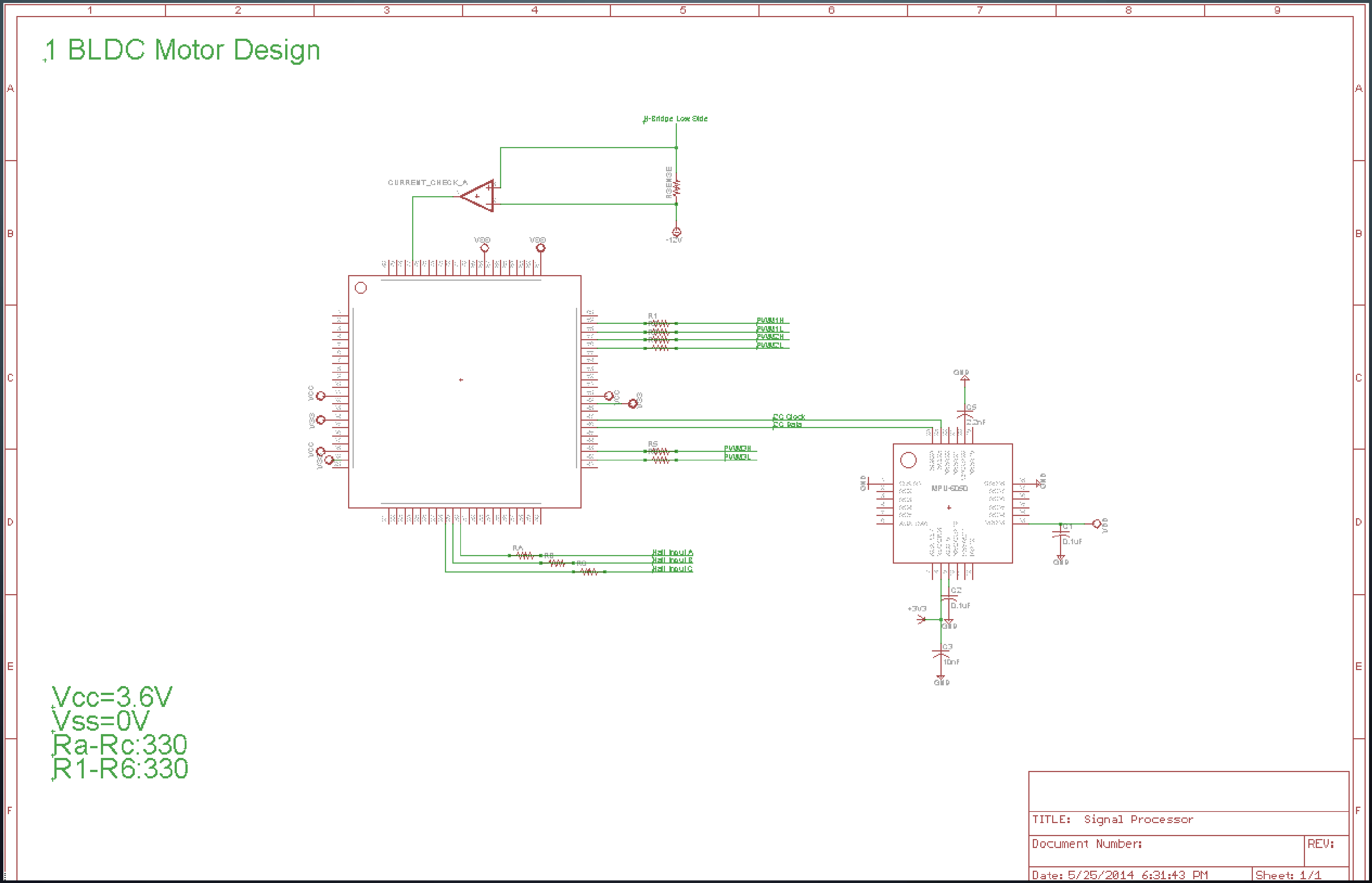


MICROCONTROLLER

- MSP430F5529

Max Voltage (V)	1.8 - 3.6
Max Current (A)	0.0425
I/O Pins	63
I^2C Interfaces	2
Analog to Digital Converter	12-bit
Timers	6
Comparators	Yes
Clock Frequency	25MHz

SIGNAL PROCESSING



POWER

- Compact Lithium Ion Polymer battery
- Minimum Battery Supply: 14.8V
- Ideal Battery Supply: 2Ah
- External charging capabilities

SOFTWARE

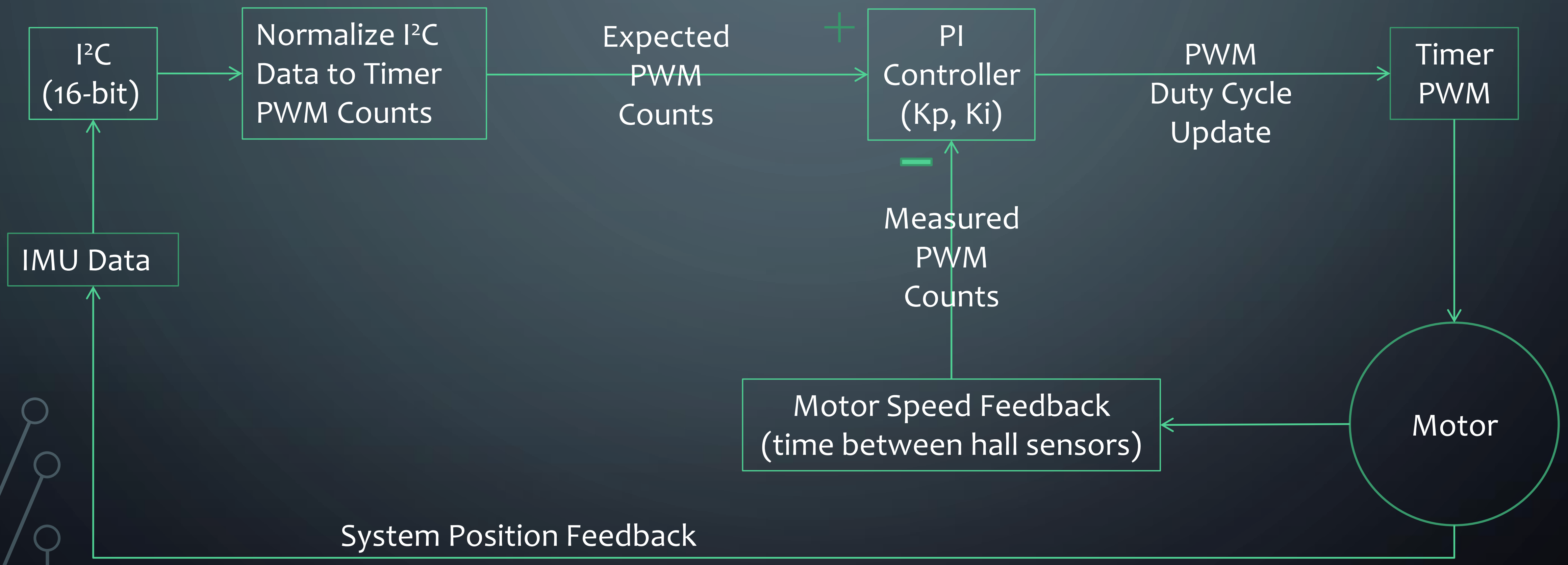
CONTROL OVERVIEW

- Closed Loop Feedback System
- Proportional Integral Controller (PI)
- C-Based Programming
- Code Composer Environment

WHY PI CONTROLLER?

- The integral parameter (Ki) eliminates steady-state error
- The proportional parameter (Kp) provides fast response to sudden load changes, affecting rise time
- The derivative parameter (Kd) provides extremely fast response to changes in motor speed
- Often Kd has little positive effect in simple controllers and introduces more error than compensation
- Therefore to minimize complexity and allow easier manual tuning, PI controller will be implemented

CLOSED LOOP CONTROL IMPLEMENTATION



ADMINISTRATIVE

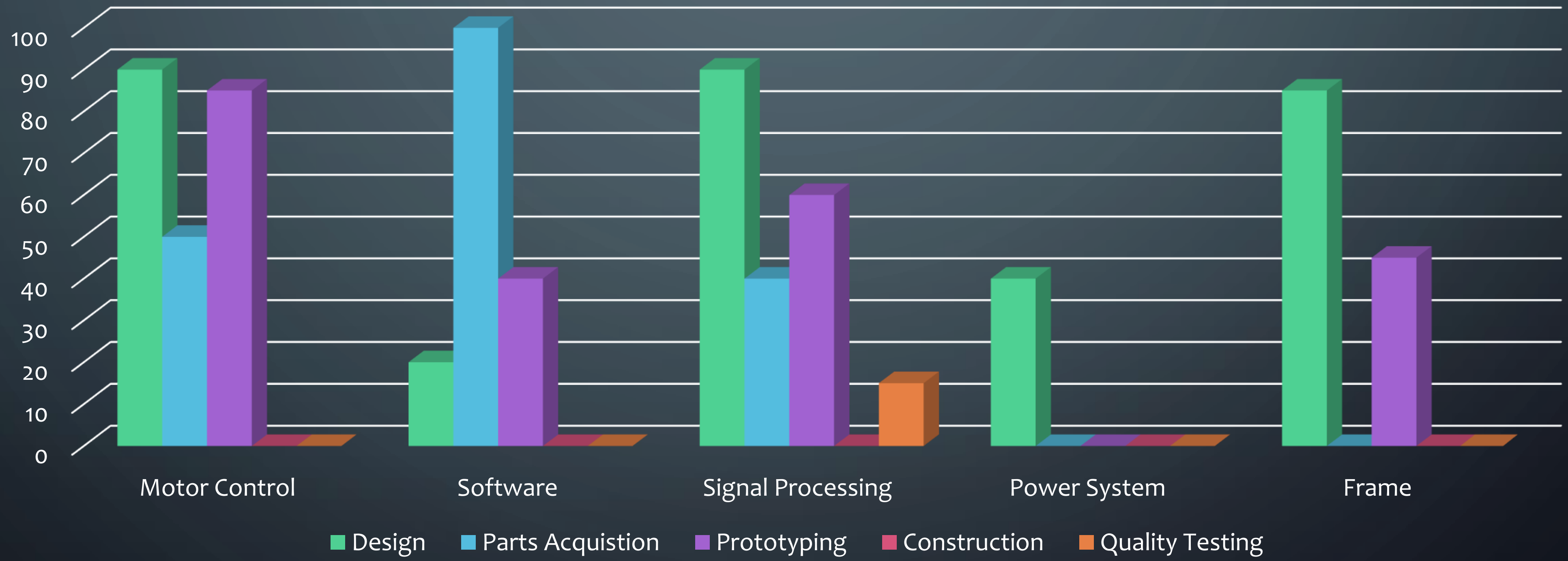
WORK DISTRIBUTION

	Tom	Alex	Ahmed
Motor Control	X	X	
Frame	X		X
Software	X	X	X
Power		X	X
Signal Processing	X	X	

BUDGET

Current Expenses				
Items:	Price:	Date:	Member:	Where:
6-axis Dev Board	$43.96	2/19/14	Tom Mizell	sparkfun.com
Soldering Iron	$15.13	3/14/14	Tom Mizell	Skycraft
Soldering Stand	$5.25	3/14/14	Tom Mizell	Skycraft
Wires	$3.07	3/14/14	Tom Mizell	Skycraft
3X Engineering Notebook	$40.20	1/20/14	Tom Mizell	Amazon.com
Battery Pack	$4.56	3/12/14	Alex Pennock	RadioShack
Voltage Regulator	$11.14	3/12/14	Alex Pennock	RadioShack
Battery Clips	$2.21	3/12/14	Alex Pennock	RadioShack
Turning Motor	$17.74	2/28/14	Ahmed Salih	ebay.com
GWS Motor	$14.99	2/28/14	Ahmed Salih	ebay.com
Breadboard	$13.76	3/11/14	Ahmed Salih	RadioShack
Turnigy GBM4006 BLDC	$40.15	5/11/14	Tom Mizell	Hobbyking.com
NDP6020P Motor Driver	$16.31	5/18/14	Alex Pennock	Fairchild.com
FDD6770A Motor Driver	$17.40	3/11/14	Alex Pennock	Fairchild.com
Total	$245.87			

PROGRESS OF PROJECT



CHALLENGES & SETBACKS

- Slow start due to lack of similar designs during research
- Team not settled on a frame design
- In testing found Microchip PIC difficult to debug
- Design is be very motor specific (not enough specs on selected motor)
- Currently can’t account for complete power consumption
- Final power supply not decided

QUESTIONS
&
COMMENTS