TEAM 3
CAMERA STABILIZER

TOM MIZELL

ALEX PENNOCK

AHMED SALIH

INTRODUCTION

- Project sponsored by professor Michael Young of George Mason University, PE with experience in wireless data communication and radar systems
- Professor Young is a 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 up to $500 towards to budget
- The design team has the opportunity to test the camera stabilizer while riding in Professor Young's personal aircraft
- Gaining valuable experience in designing, testing and building electrical systems

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

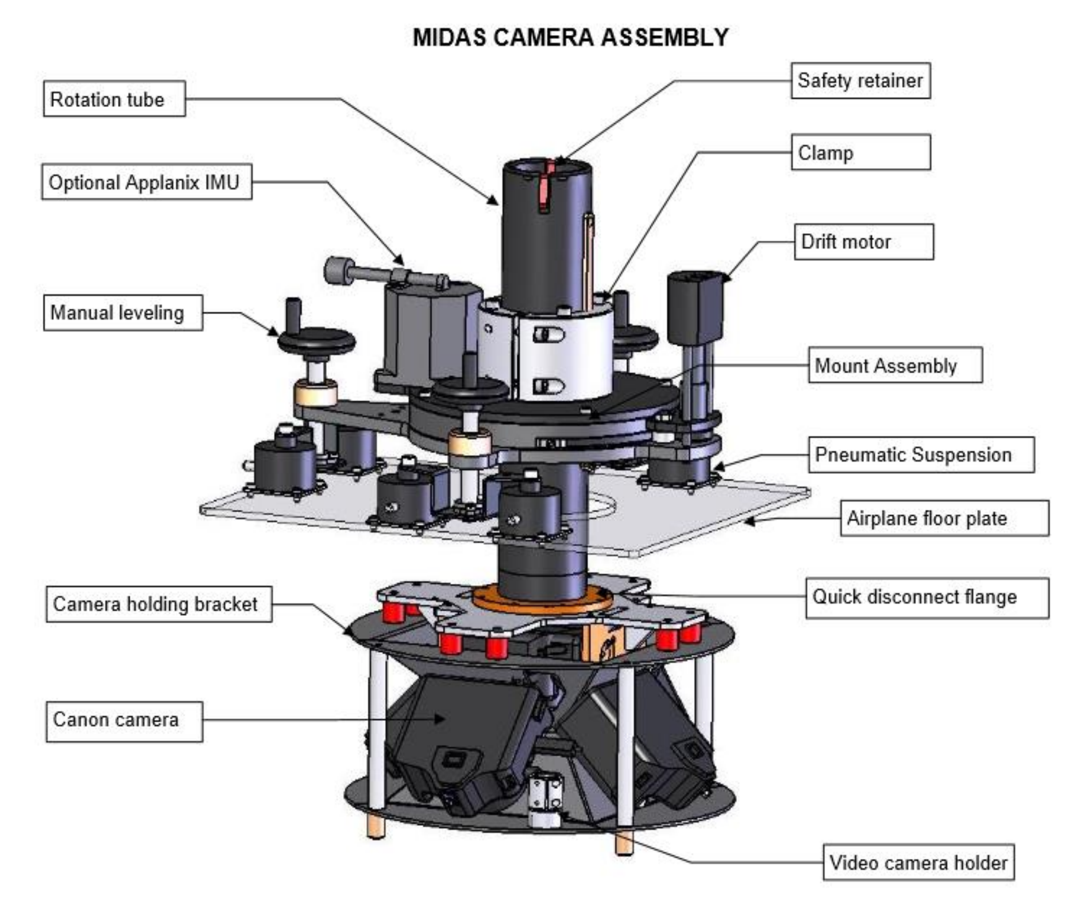
OBJECTIVES FOR DESIGN

- 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: 4” x 1.5”
- Maximum handle profile: 6” length x 1.5” 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 Mount

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

Steadicam Stabilizer

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

Glidecam HD Pro

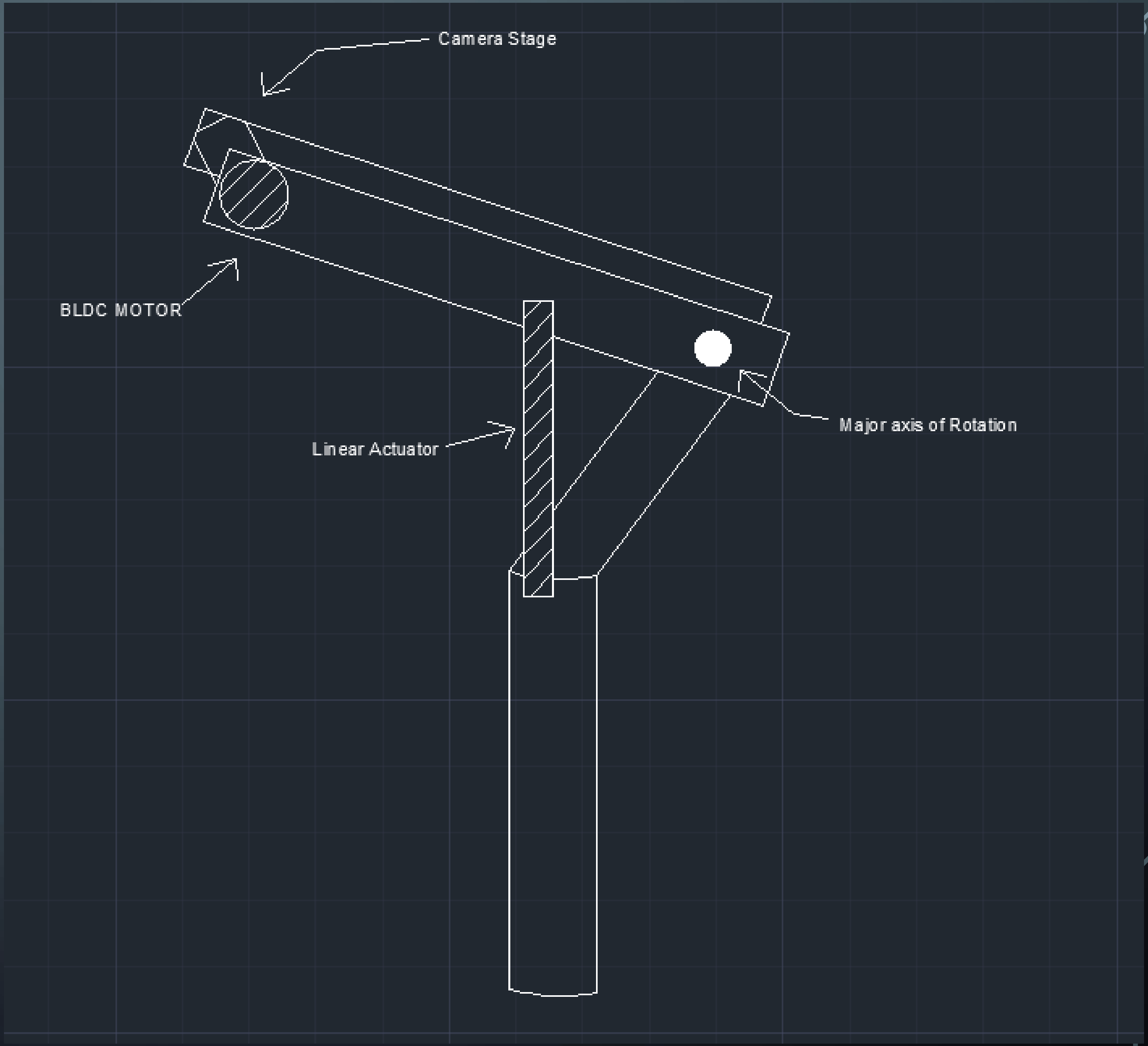
- Uses complex mechanical spring arm action
- Requires full body harness
- HEAVY!!!

DESIGN INFLUENCES

Easy Gimbal

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

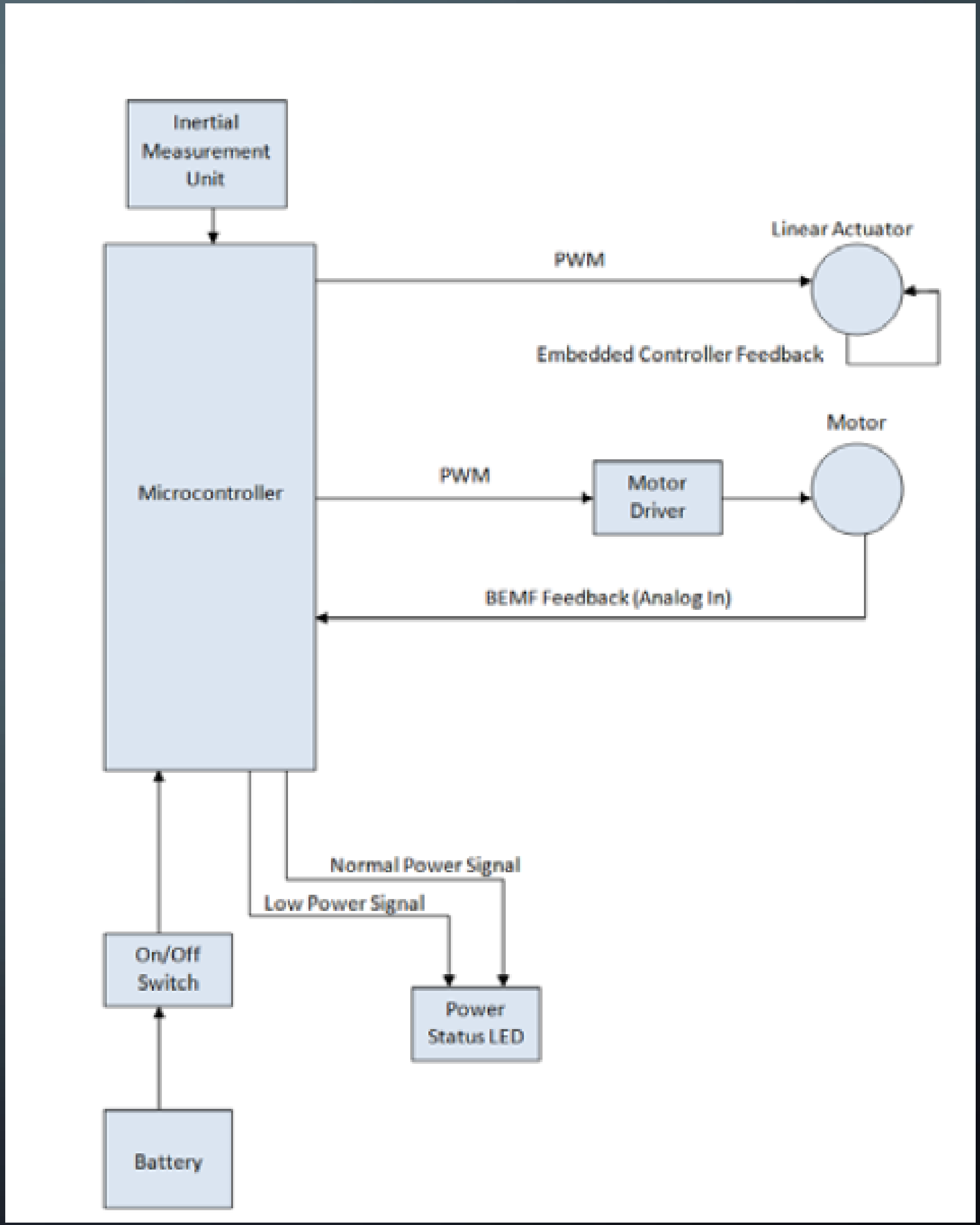
Design A Frame



BLOCK DIAGRAM

Design A

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

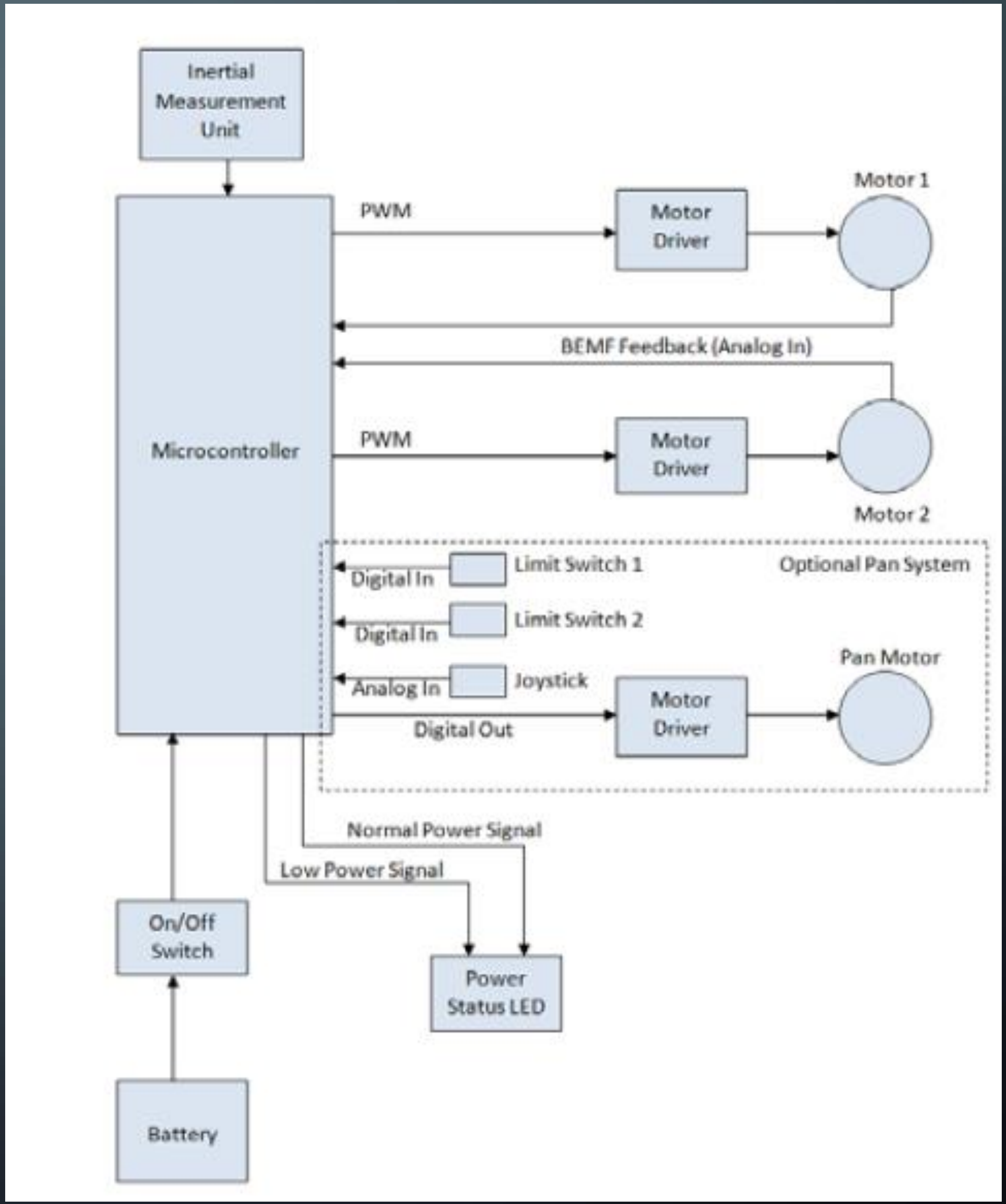


Design B

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

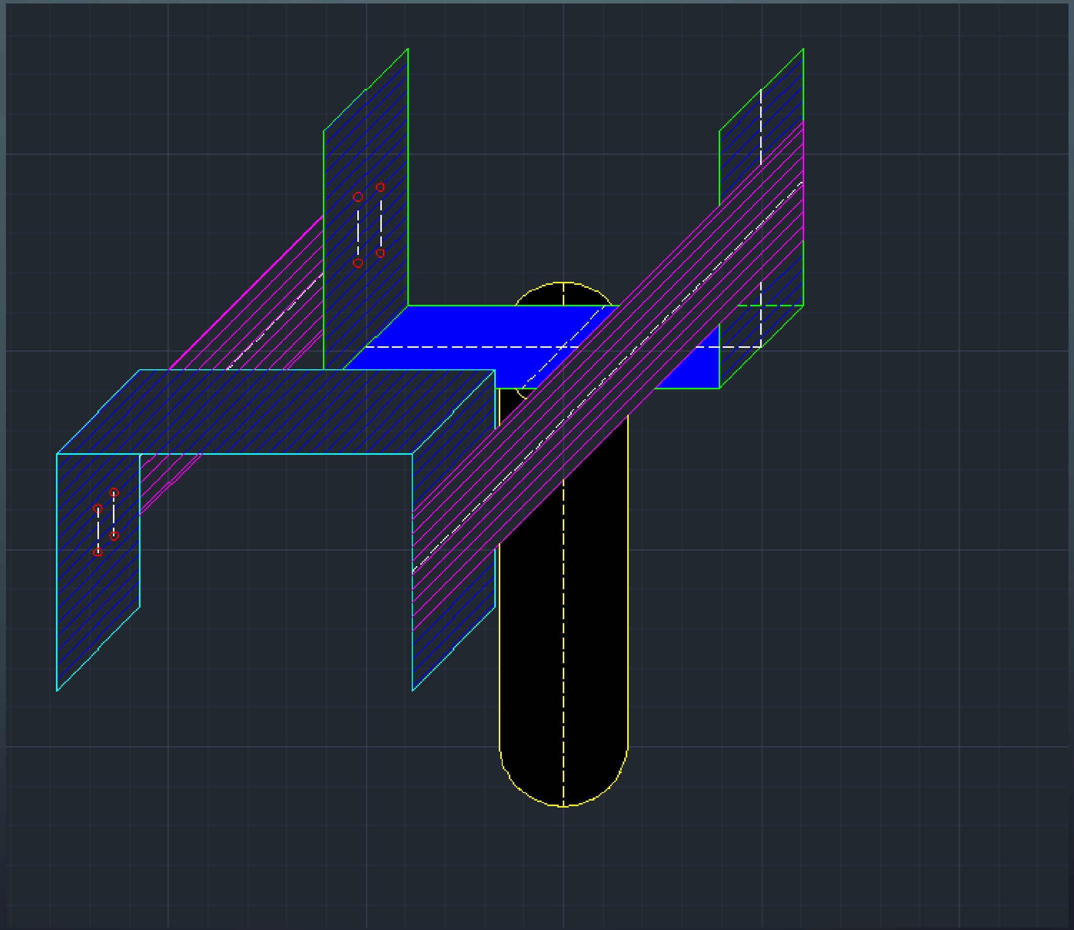
Design A

- 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

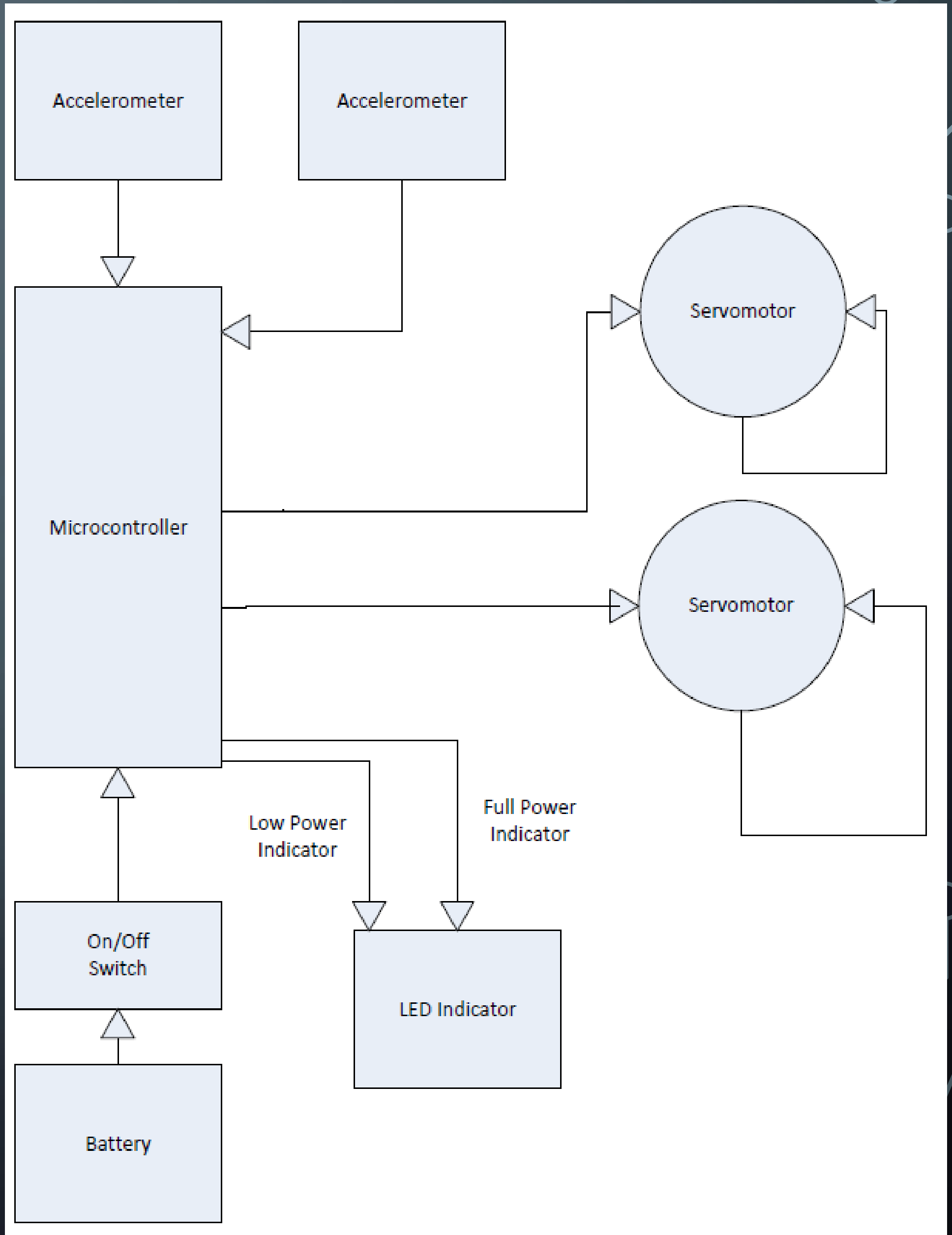
FINAL DESIGN



BLOCK DIAGRAM

Final Design

Electromechanical system design that is now able to stabilize vertical movements

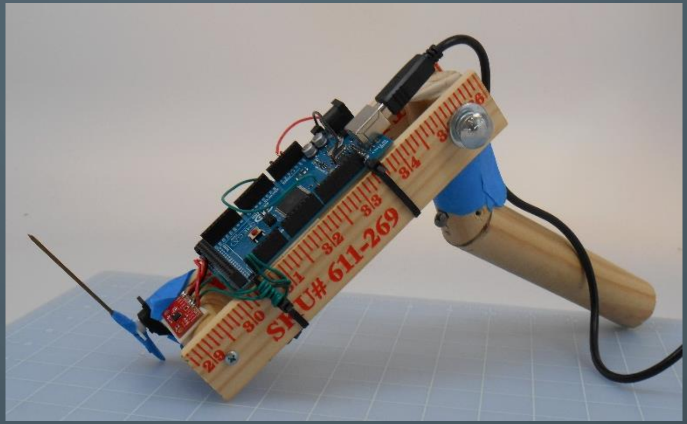


MAIN CHANGES TO DESIGN

- Switched from MSP430 to Atmega328
- Switched from Brushless DC Gimbal Motors to Servomotors
- Relocated positon of motors on frame
- Changed positioning of Smaller U channel

HARDWARE

FRAME



- Aluminum frame construct
- U-channel to act as a camera mount
- U-channel connected directly to handle
- Two parallel arms connecting both U channels
- Handle which will house PCP and Battery

CAMERA

Camera that Customer will be using on the device that.

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

MOTOR

Hitec HS-5645MG Servomotor

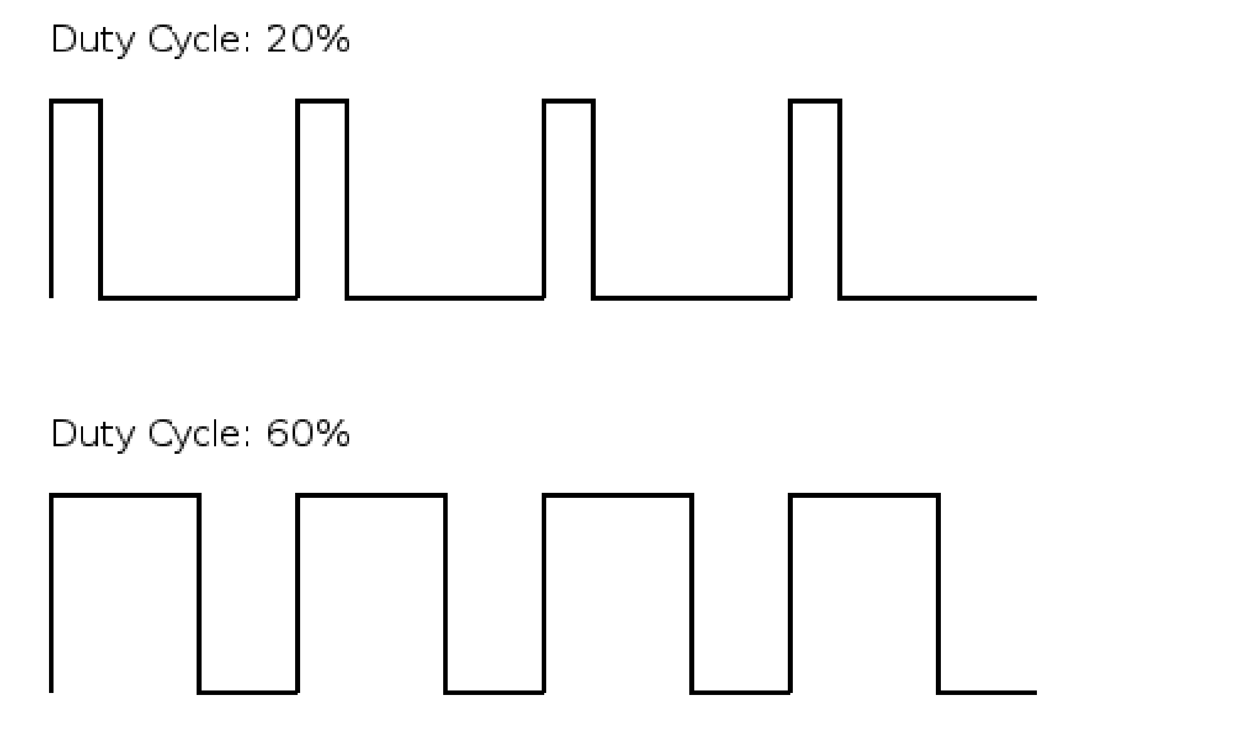
- 2.21 oz
- Dimensions: 1.59” x 0.77” x 1.48”
- 168 oz-in Torque
- Max speed of 0.18 sec/60°
- Max current draw is 1.3 A
- Max voltage 6 V

MOTOR

- Hitec HS-5685MG Servomotor
- 2.10 oz
- Dimensions: 1.59" x 0.80" x 1.50"
- 179 oz-in Torque
- Max speed of 0.17 sec/60°
- Max current draw is 3 A
- Max voltage 7.4 V

MOTOR CONTROL

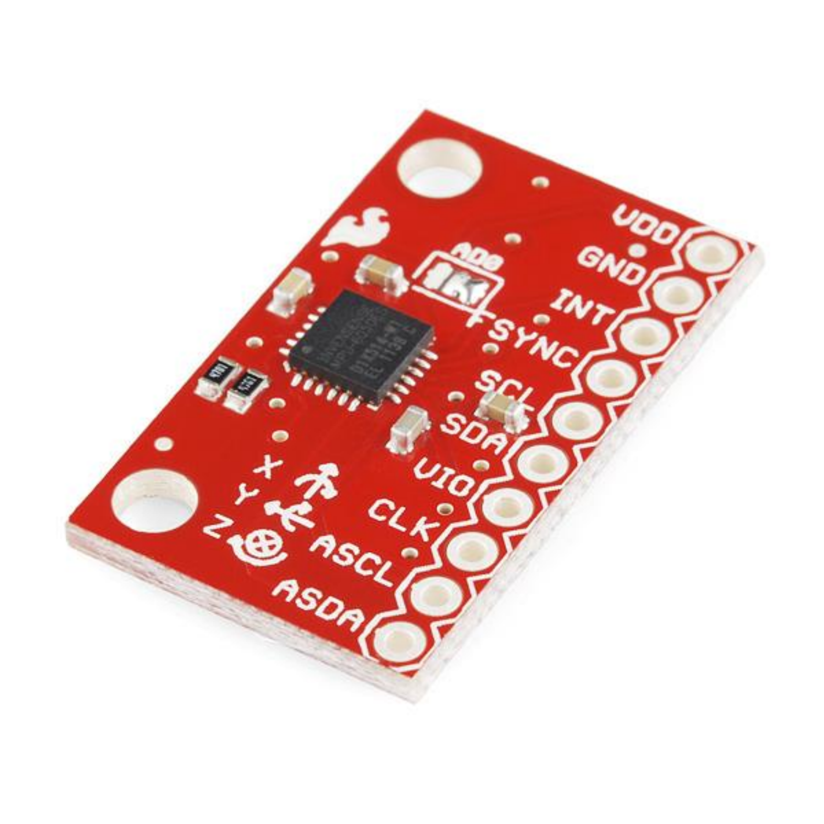
- ATmega328p provides PWM input signal to servomotors
- Internal feedback of servo to insure that motor stays in position assigned by PWM signal.



INERTIAL MEASUREMENT UNIT

MPU-6050

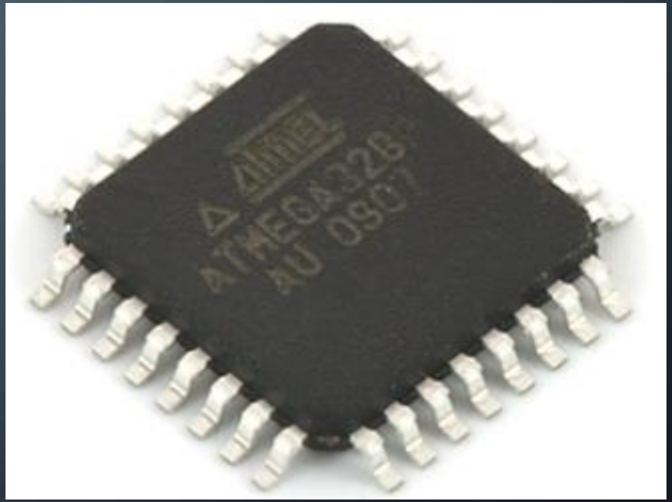
Sensor Specs	3-Axis Accelerometer 3-Axis Gyroscope Thermometer Magnetometer
VLOGIC	1.71 TO 3.6
Serial Interfaces Supported	I2C
G-Rating	+/- 4g
Architecture	16-bit
Max. Clock	3.4 MHz
Small Footprint	6 x 6 mm

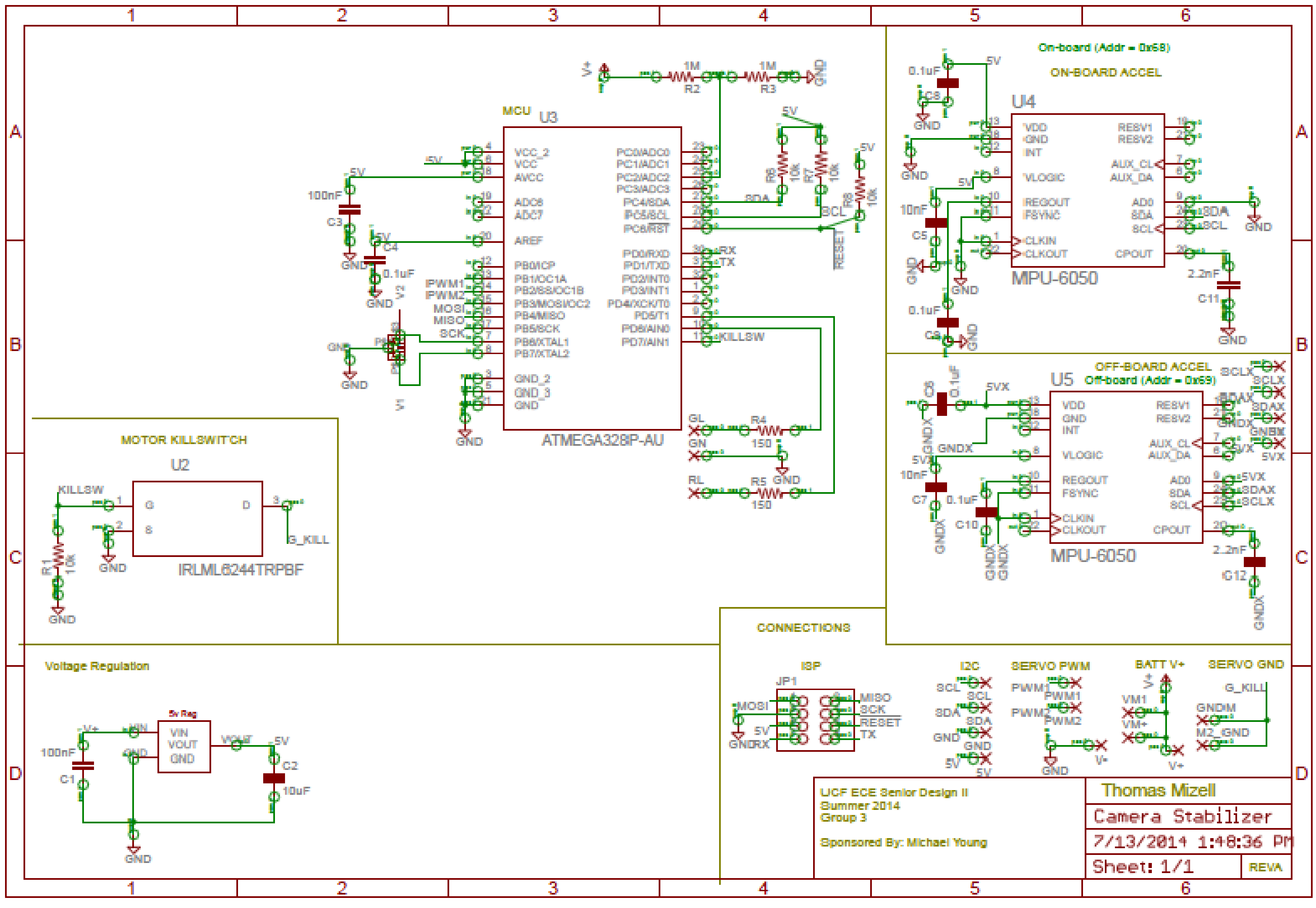


MICROCONTROLLER

- ATmega328p

Max Voltage (V)	5
Max Current (mA)	20
I/O Pins	23
I2C Interface	Yes
Analog to Digital Converter	10-bit
Timers	3
Comparators	1
Clock Frequency	16 MHz




MCU
U3
ATMEGA328P-AU
ON-BOARD ACCEL
On-board (Addr = 0x68)
U4
MPU-6050
OFF-BOARD ACCEL
Off-board (Addr = 0x69)
U5
MPU-6050
MOTOR KILLSWITCH
U2
IRLML6244TRPBF
Voltage Regulation
5v Reg
CONNECTIONS
ISP
JP1
I2C
SERVO PWM
BATT V+
SERVO GND
UCF ECE Senior Design II
Summer 2014
Group 3
Sponsored By: Michael Young
Thomas Mizell
Camera Stabilizer
7/13/2014 1:48:36 PM
Sheet: 1/1
REVA

POWER

- Tenergy Li-Ion 18650
- Compact Lithium Ion Polymer battery
- Battery Supply Voltage: 7.4 V
- Battery Supply current: 5200 mAh
- Internal protection circuit

POWER

Tenergy TLP-2000 Smart Charger

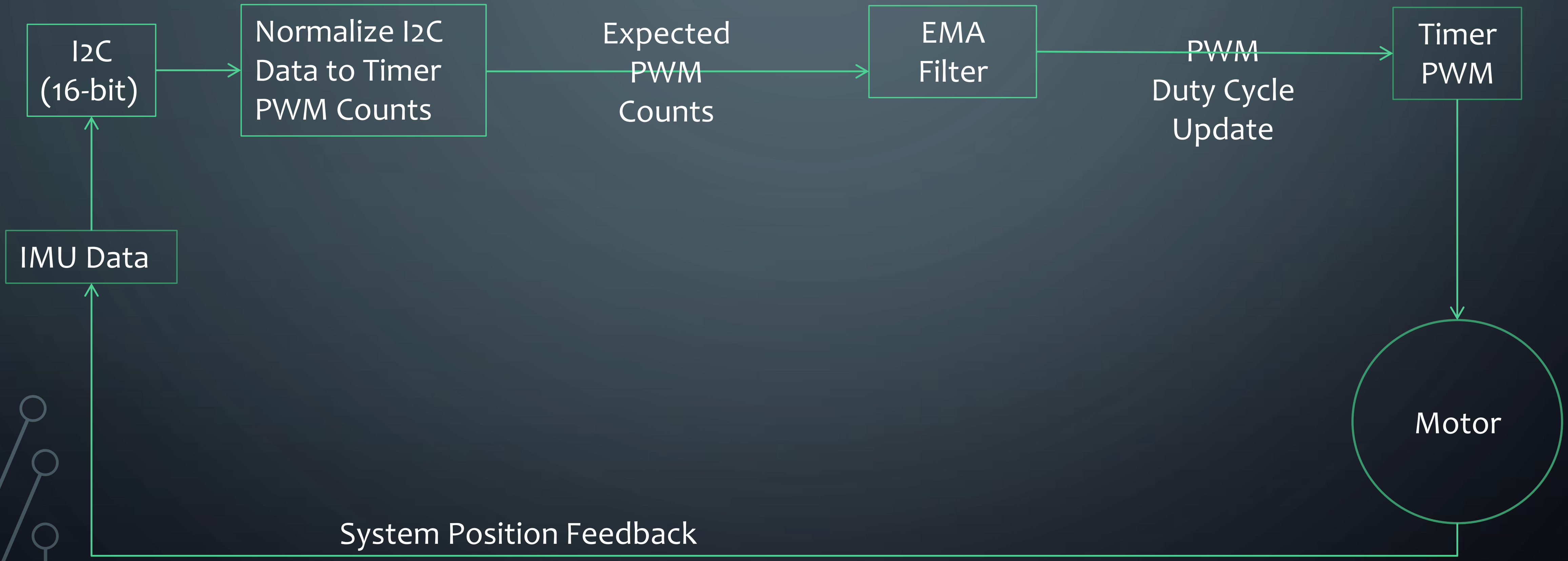
- Charges batteries ratted between 3.7 V – 14.8 V
- Universal 100 V – 240 V AC input
- Automatic charging stop when battery is fully charged
- LED indication

SOFTWARE

CONTROL OVERVIEW

- Closed Loop Feedback System
- Exponential Moving Average (EMA) filter
- C-Based Programming
- Arduino Open Source IDE

CLOSED LOOP CONTROL IMPLEMENTATION



ADMINISTRATIVE

WORK DISTRIBUTION

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

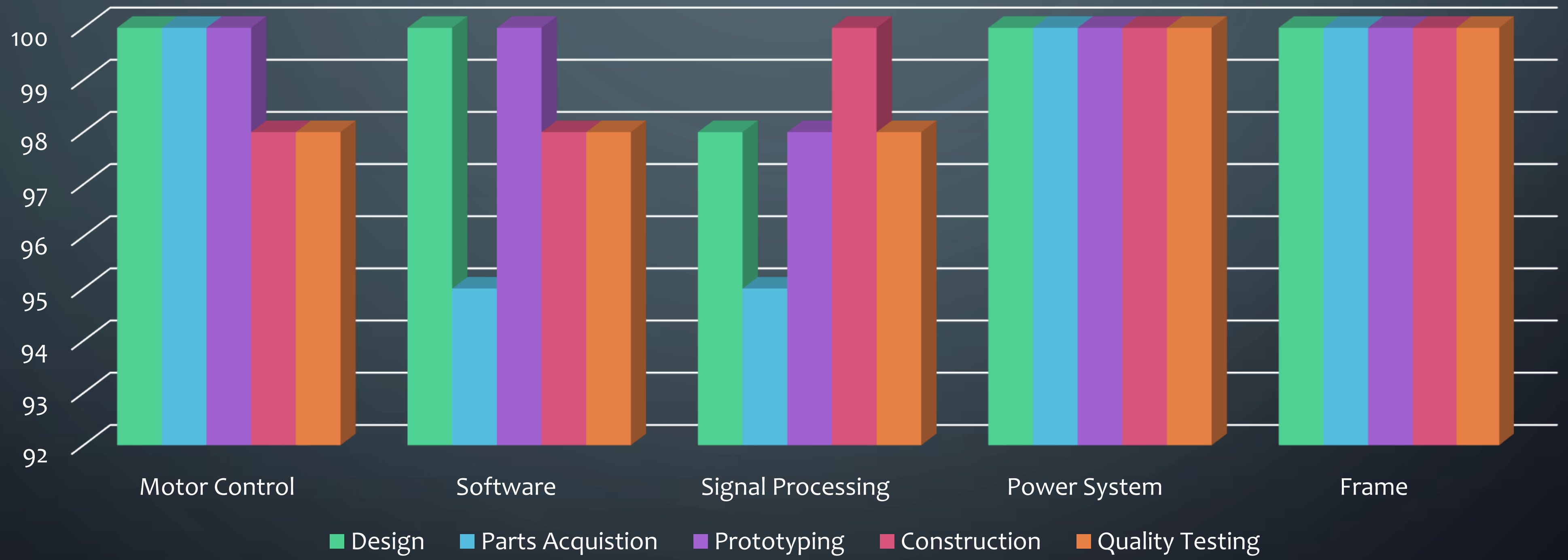
RESEARCH BUDGET

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		

IMPLEMENTATION BUDGET

Current Expenses				
Items:	Price:	Date:	Member:	Where:
Tenergy	$52.99	6/18/2014	Ahmed Salih	Allbattery.com
Tenergy	$21.95	6/18/2014	Ahmed Salih	Allbattery.com
Hitec -5645	$46.99	7/9/2014	Alex Pennock	Skycraft
Hitec -5805	$69.99	7/10/2014	Alex Pennock	Skycraft
ATmega328p	$3.61	7/10/2014	Tom Mizell	digikey.com
Hitec -5790	$174.99	7/17/2014	Ahmed/Alex/Tom	Skycraft
Aluminum Hardware	$42.61	7/15/2014	Alex Pennock	servocity.com
PCB	$50.00	7/15/2014	Tom	4pcb.com
Miscellaneous Hardware fasteners	$15.00	7/22/2014	Alex Pennock	Home depot
Hitec -5685	$39.99	7/23/2014	Alex Pennock	Skycraft
Total	$518.12			

PROGRESS OF PROJECT



CHALLENGES & SETBACKS

- Slow start due to lack of similar designs during research
- In testing found Microchip PIC difficult to debug
- Insufficient torque output from BLDC motors caused complete change of system design
- Swapped out MCU due to difficulty in usage and footprint size
- Damaged three servomotors during testing and system development
- On July 23rd, Atmel processor locked-out while mounted on PCB. Caused total rebuild of system.

LESSONS LEARNED

- Ensure components are readily available
- Proper Research of components is needed
- Clear group communication is ALWAYS needed
- Setting milestones and proper deadlines

QUESTIONS
&
COMMENTS