Week 9 Subsystem Design Review

MSD P14045 10/29/13

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Agenda

- Major Tasks Since Week 6
- Subsystem Progress
- Analysis
- Next Steps

Major Tasks

1.
1. Develop a single system (kit) for both the red and blue stander
    a. Wheel System
    b. Tray System

1. Develop legacy code to work on the new Stellaris Launchpad

1. Assure Bluetooth connection functionality

*image from blog.mindjet.com

Wheel System

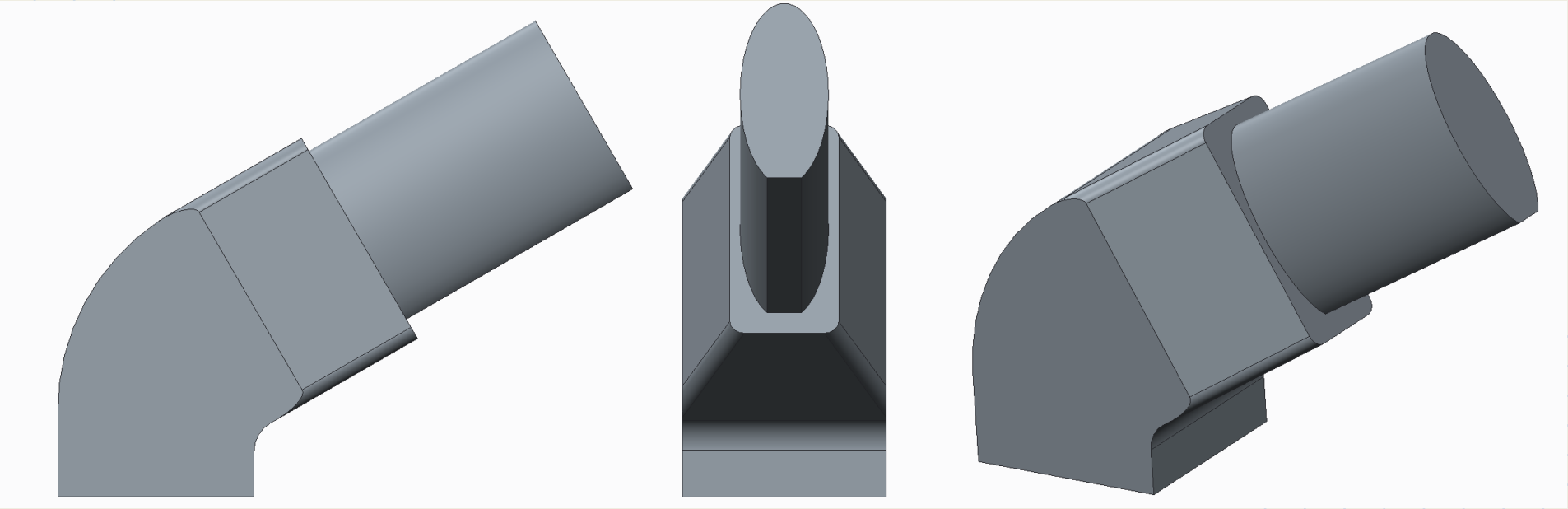
Goal:

- Replace the ugly, roughly machined plastic adapter on the stander with a new part.
- Design this new part in such a way that is an easy bolt-on replacement.

Changes/Updates:

- More accurate shapes and dimensions based on measurements of the blue stander.
- Essentially mimics the existing bracket in its attachment to the stander and wheel assembly.

Wheel System

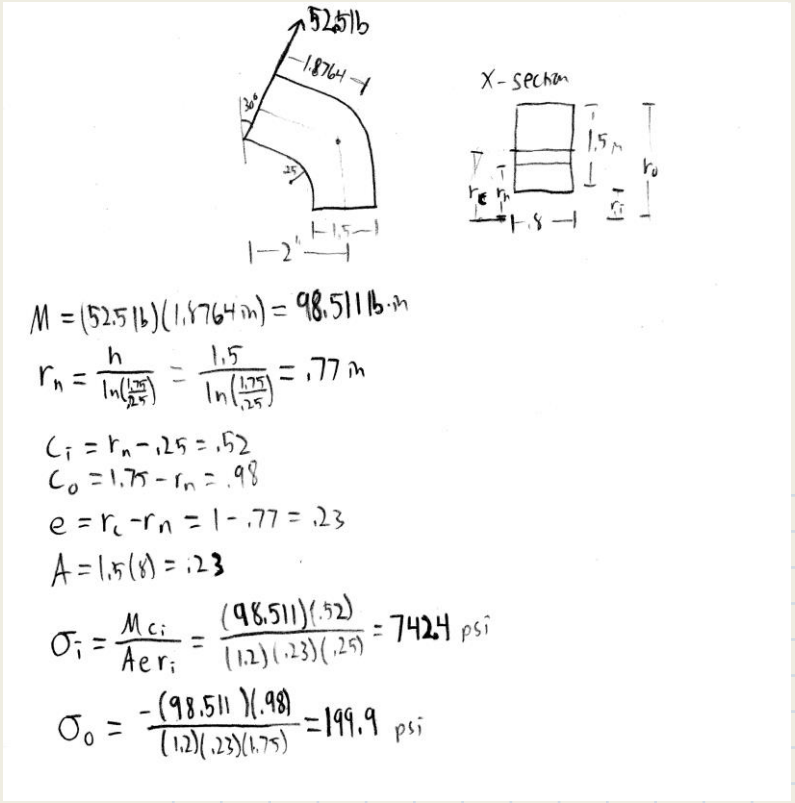


Preliminary Engineering Analysis

Assumptions:

- Treated bracket as curved beam
- Constant, rectangular cross-section with minimum dimensions
- Force value is max rated capacity plus weight of stander itself.

Max Stress of 742.2psi is located on the inside of the curved section.



$M = (52.5\,lb)(1.8764\,in) = 98.511\,lb\cdot in$

$r_n = \frac{h}{\ln(\frac{r_o}{r_i})} = \frac{1.5}{\ln(\frac{1.75}{.25})} = .77\,in$

$c_i = r_n - .25 = .52$

$c_o = 1.75 - r_n = .98$

$e = r_c - r_n = 1 - .77 = .23$

$A = 1.5(8) = .23$

$\sigma_i = \frac{M c_i}{A e r_i} = \frac{(98.511)(.52)}{(1.2)(.23)(.25)} = 742.4\ psi$

$\sigma_o = \frac{-(98.511)(.98)}{(1.2)(.23)(1.75)} = 199.9\ psi$

Preliminary Engineering Analysis - Impact

Assumptions:

- Same beam analysis as before
- Force is based off of dropping the empty stander from a height of 2ft.

Max Stress of 5983.32psi is located on the inside of the curved section.

I am currently unsure of the accuracy or feasibility of this analysis.

Drop from 2ft

$V_f^2 = 2gx$

$V_f^2 = 2(32.17)(2)$

$V_f^2 = 128.68$

$V_f = 11.343 \text{ ft/sec}$

$a = \frac{11.343 \text{ ft/sec}}{.05 \text{ sec}} = 226.87 \text{ ft/sec}^2$

$F = Ma = (1.865 \text{ slug})(226.87 \text{ ft/sec}^2)$

$F = 423.12 \text{ lbf}$

$M = (423.12)(1.8764) = 793.94 \text{ lb-in}$

$\sigma_i = \frac{Mc_i}{Aer_i} = 5983.32 \text{ psi}$

$\sigma_o = \frac{-Mc_o}{Aer_o} = -1610.89 \text{ psi}$

(using same values for c, A, e, r)

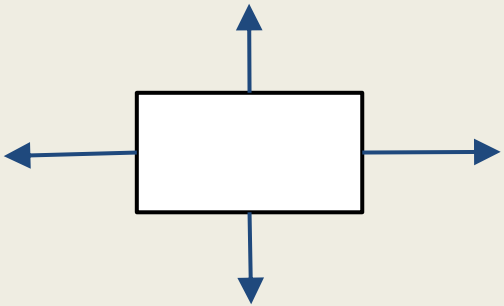
Wheel System - Next Steps

- Get manufacturability consultation
- Analyze the sleeve section
- FEA of the part
- Finalize drawings
- Select material and manufacturing process

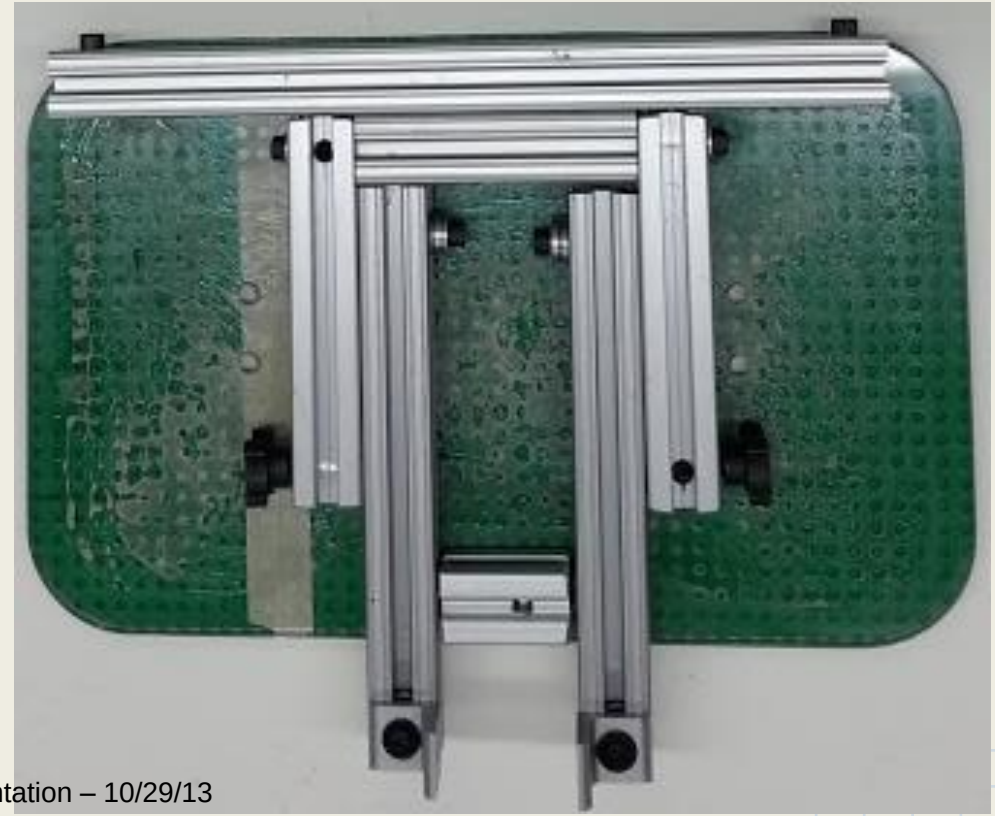
Tray System

Requirements:

- Movement left, right, forward, and backwards
- Dimensions: 8 x 14 inches
  - Ability to be seen over
- Easy Adjustment
- Streamlined Design



Tray System - Demo



Tray System

Assumptions:

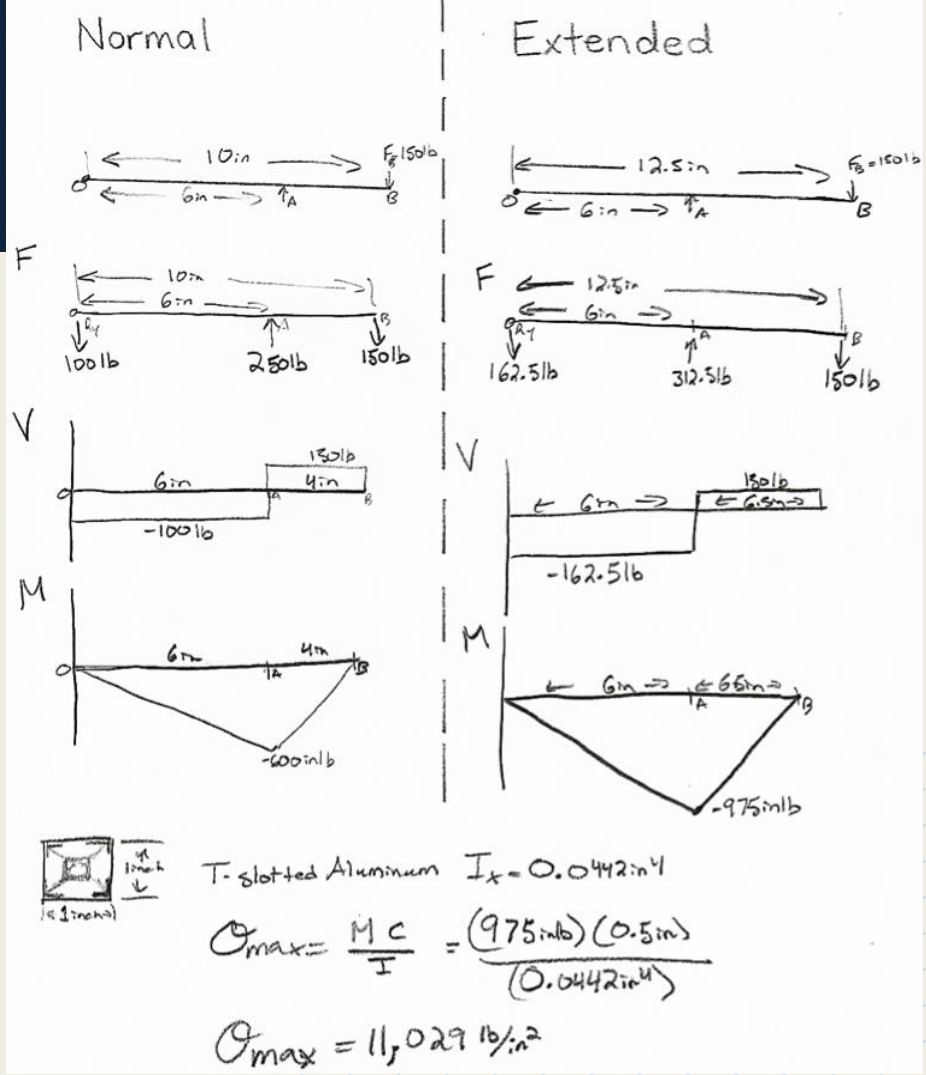
-Simple Cantilevered Beam

-Single Solid Component

-Equilibrium

Ultimate Tensile Strength of Aluminum: 39,900 lb/in^2

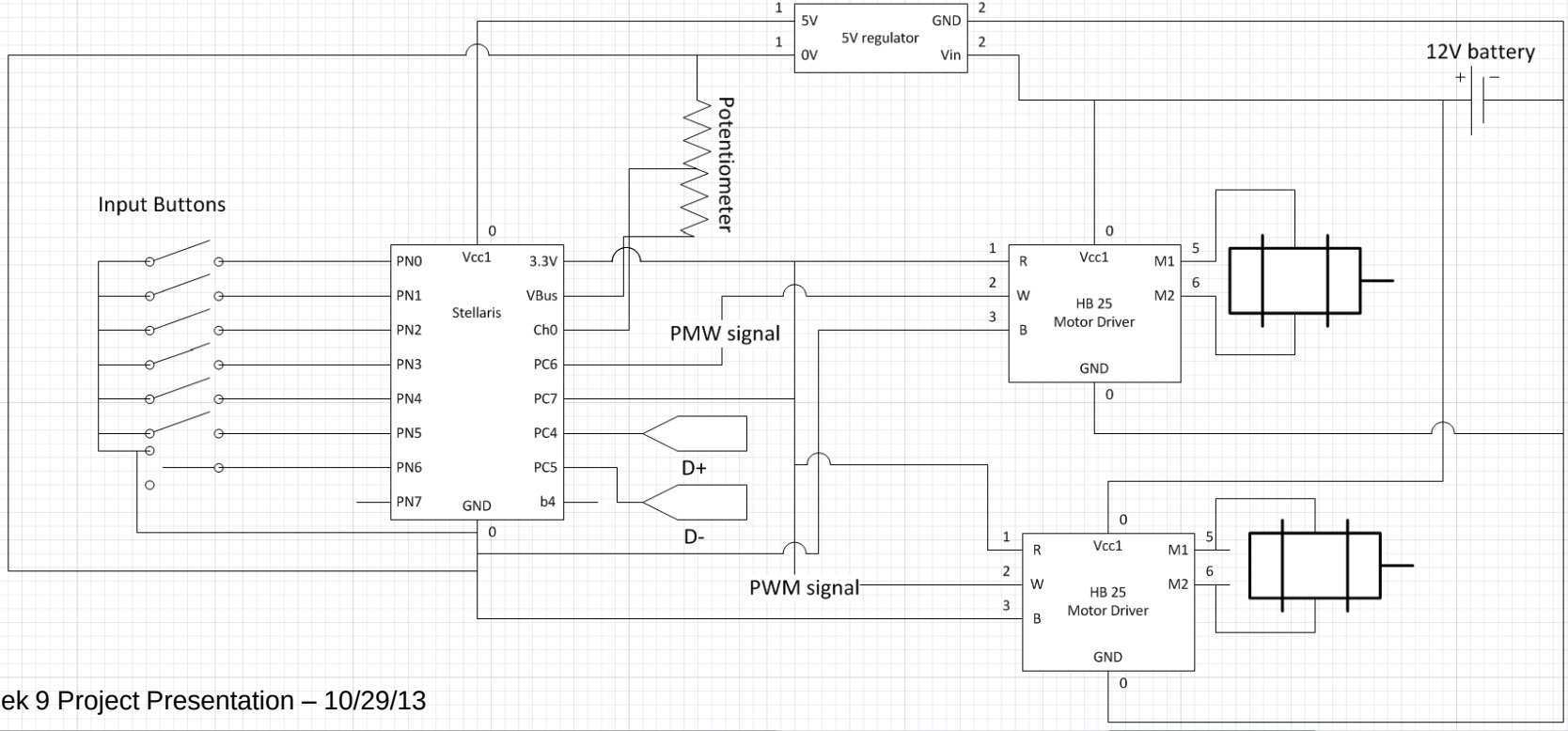
(Source: Brunner Enterprises, Inc.)



Tray System - Next Steps

- Developing/Selecting Actuator
- Hinge System
- Transition to Overall Electronics Packaging

Electrical System Schematic



Software Risks

Straight Travel
-built in libraries for using quadrature encoders for velocity capture

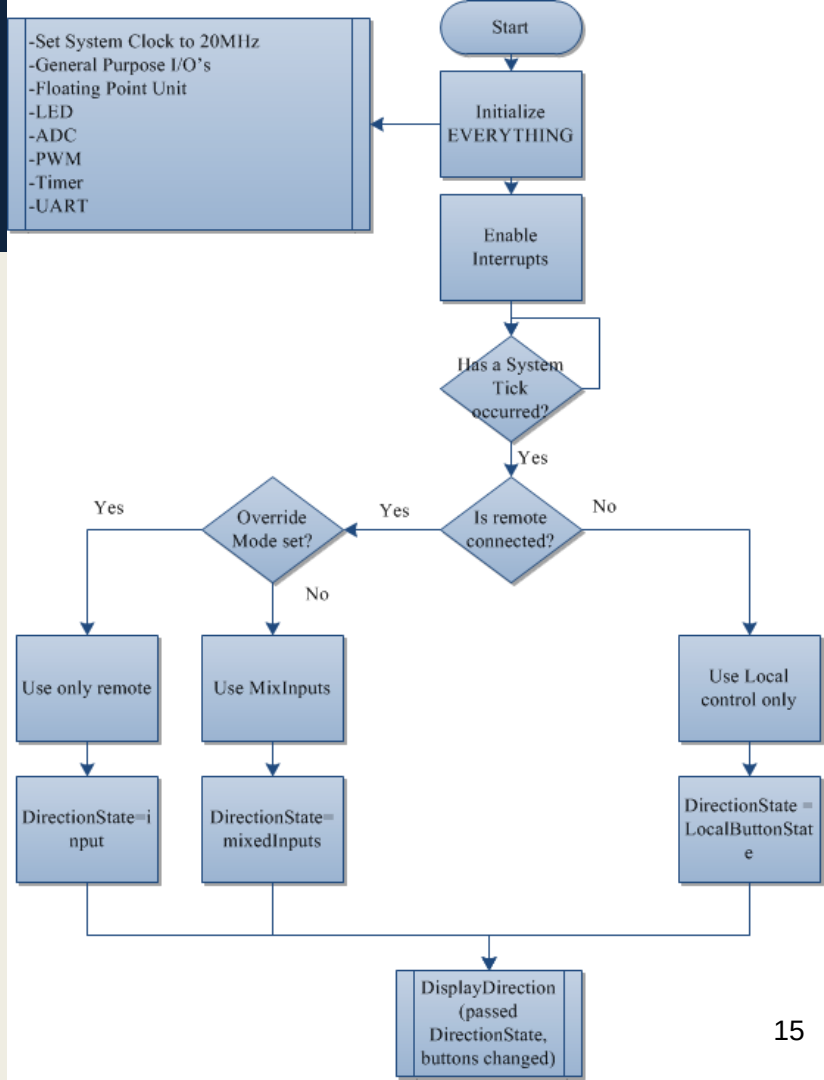
Processor Change
-taken care of by Launchpad/Stellaris
-more time consuming will be cleaning legacy code

Bluetooth Connection
-need a dummy system, or a prototype part, preferably the wt12

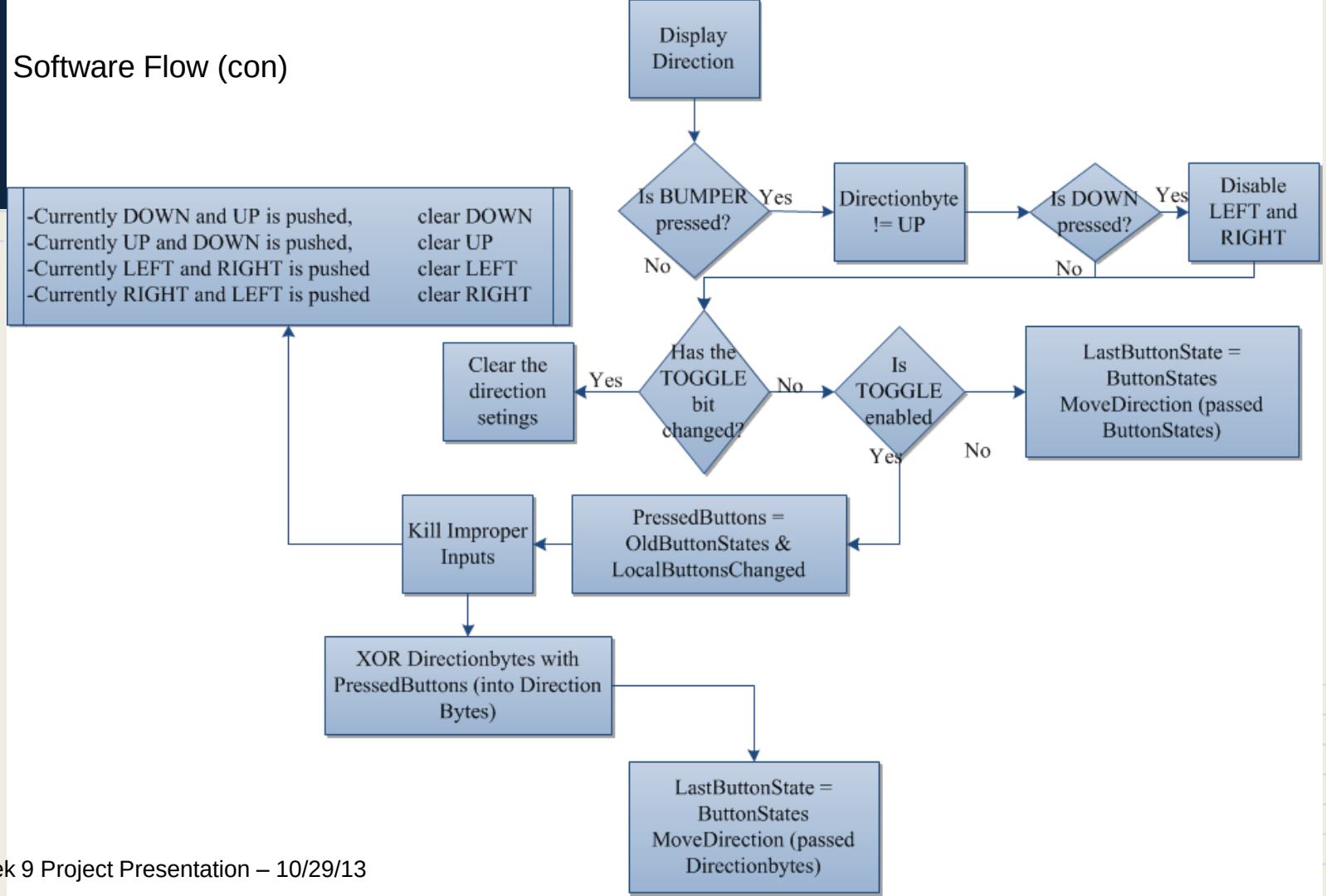
UART connection to stander controls
-can also use USB mini-b connection on the launchpad

Software Flow

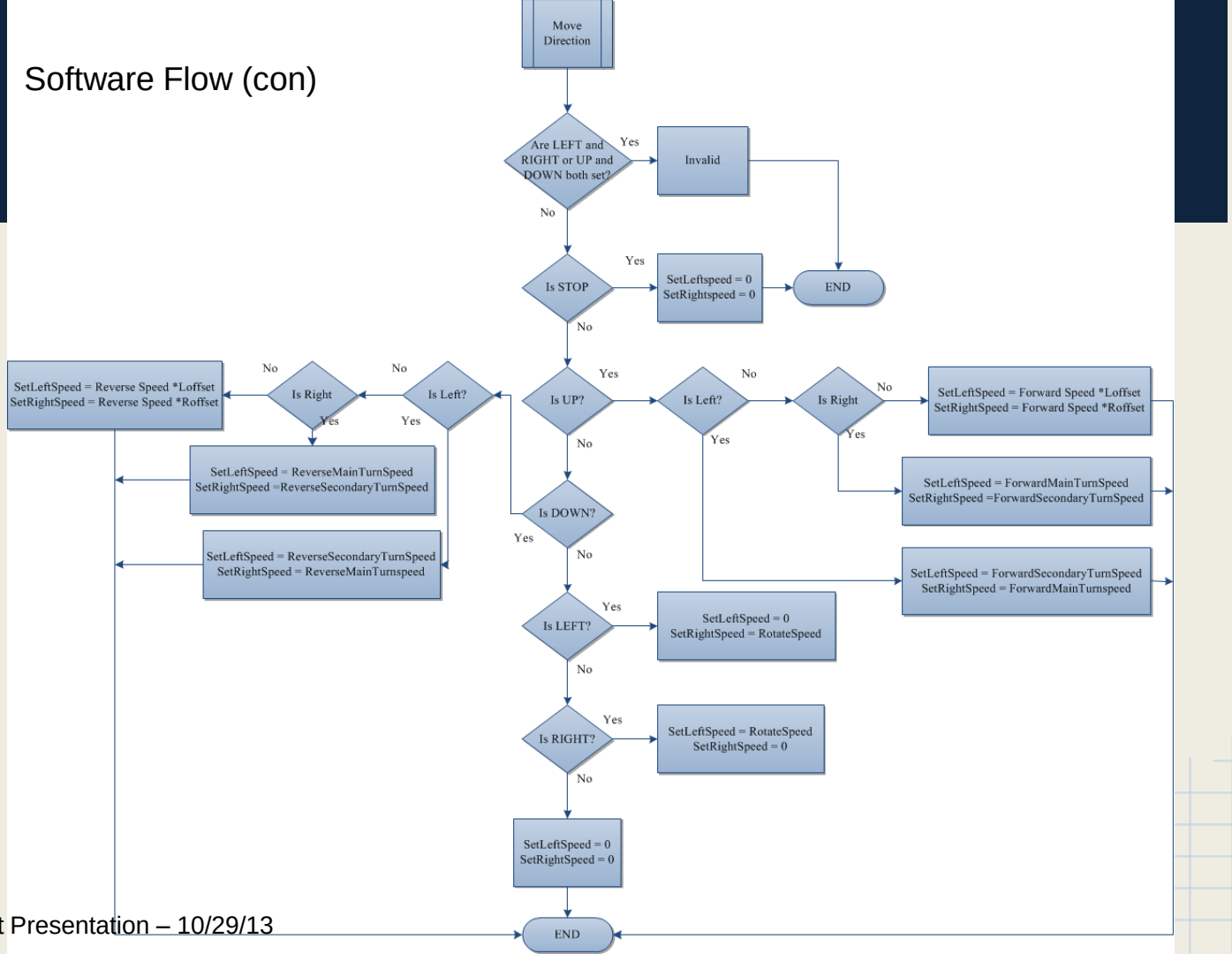
One Loop, that is interrupted periodically to debounce the input buttons and triggers a refresh of the speed settings

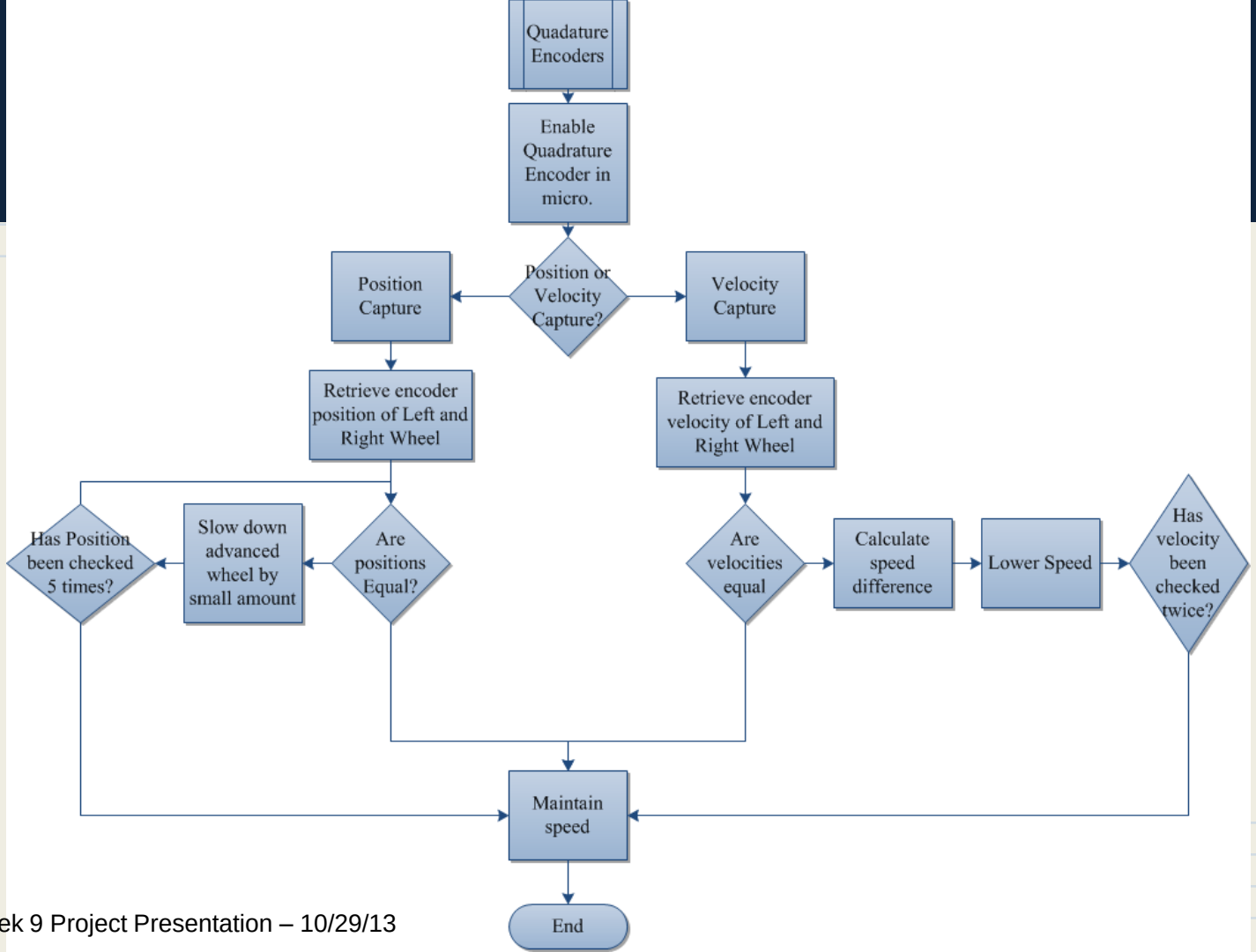


Software Flow (con)

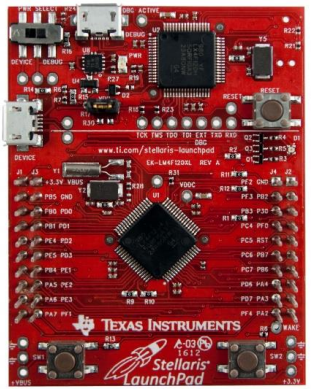


Software Flow (con)




Quadature Encoders
Enable Quadrature Encoder in micro.
Position or Velocity Capture?
Position Capture
Velocity Capture
Retrieve encoder position of Left and Right Wheel
Retrieve encoder velocity of Left and Right Wheel
Has Position been checked 5 times?
Slow down advanced wheel by small amount
Are positions Equal?
Are velocities equal
Calculate speed difference
Lower Speed
Has velocity been checked twice?
Maintain speed
End

Launchpad

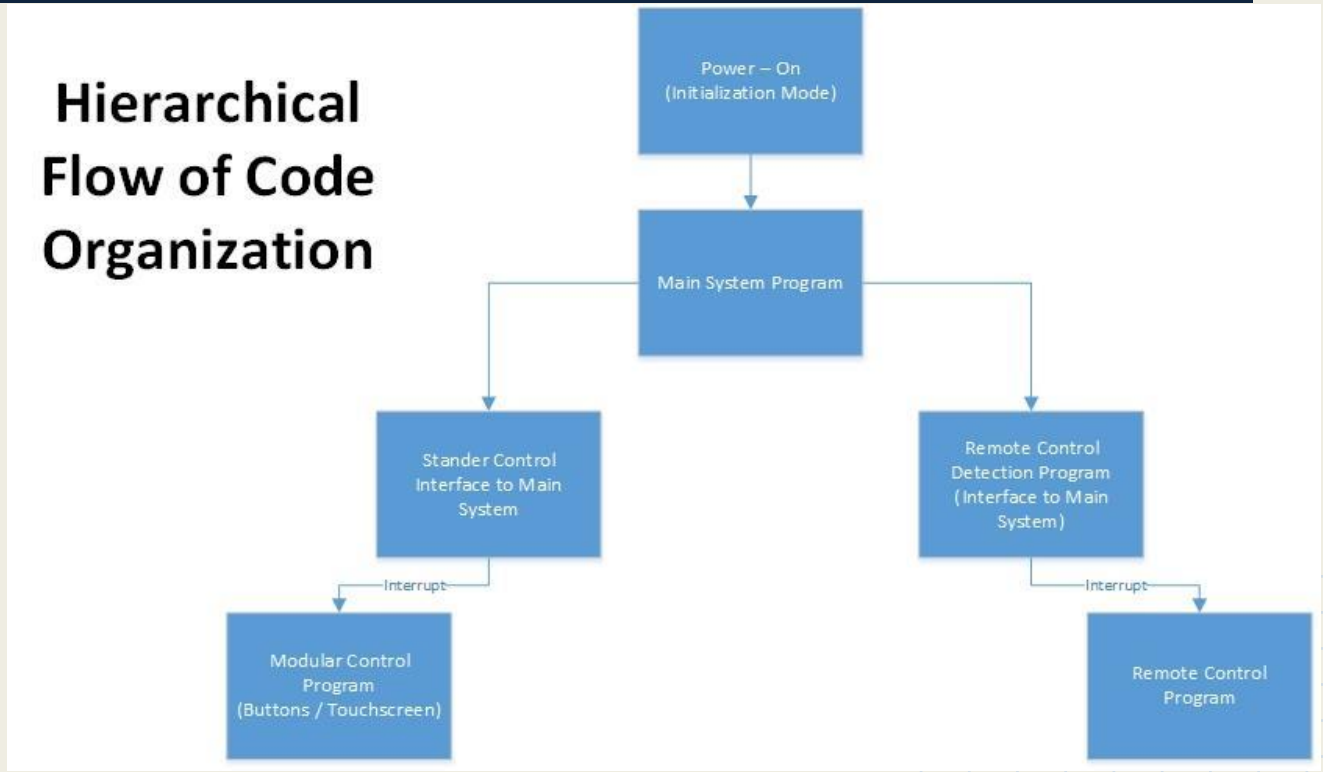


LMF4-232-H5QD vs. LMF4-120-H5QR
Both have 32k SRAM and 256k Flash

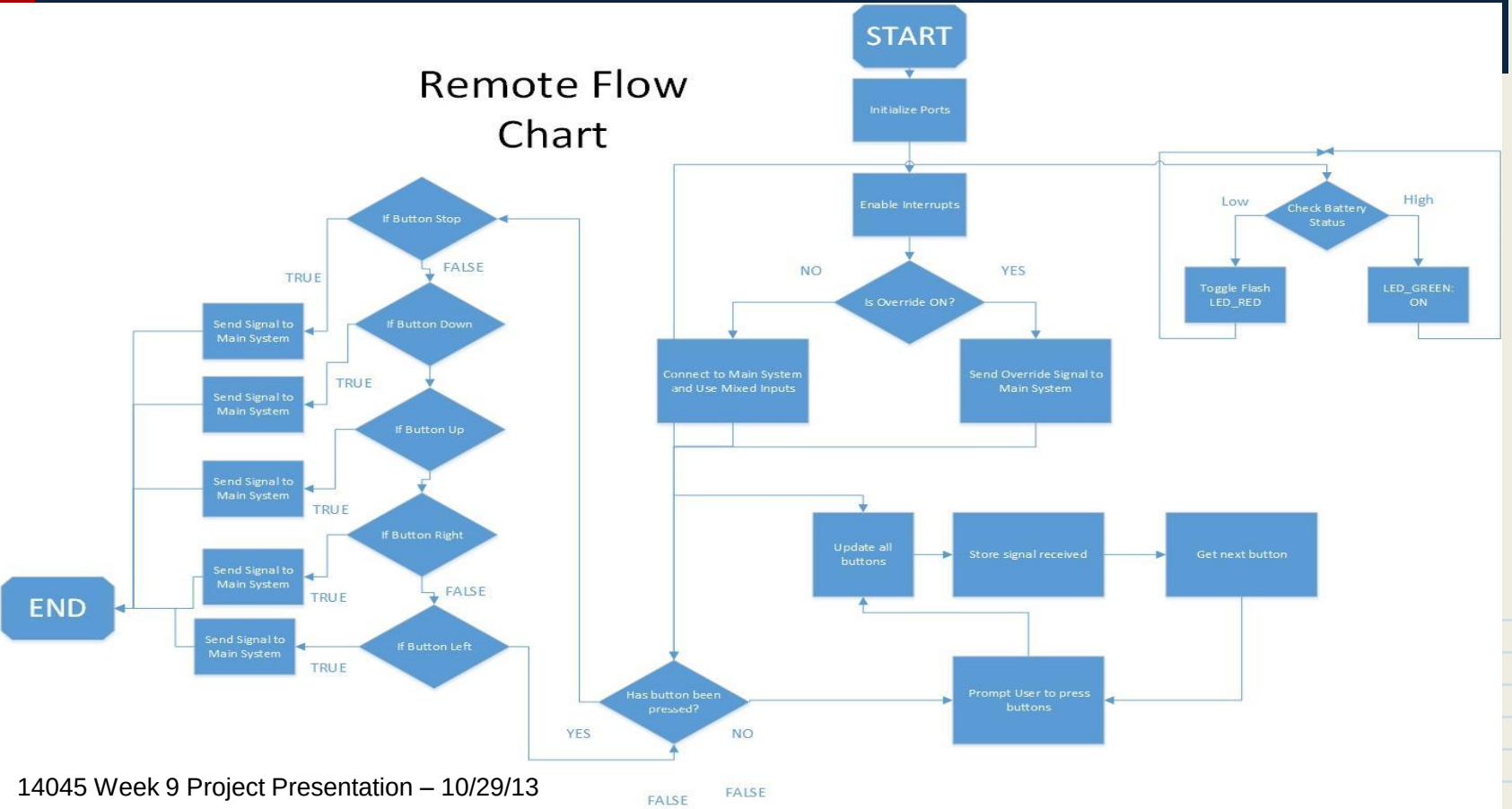
Same architecture,
-the supporting libraries are sound

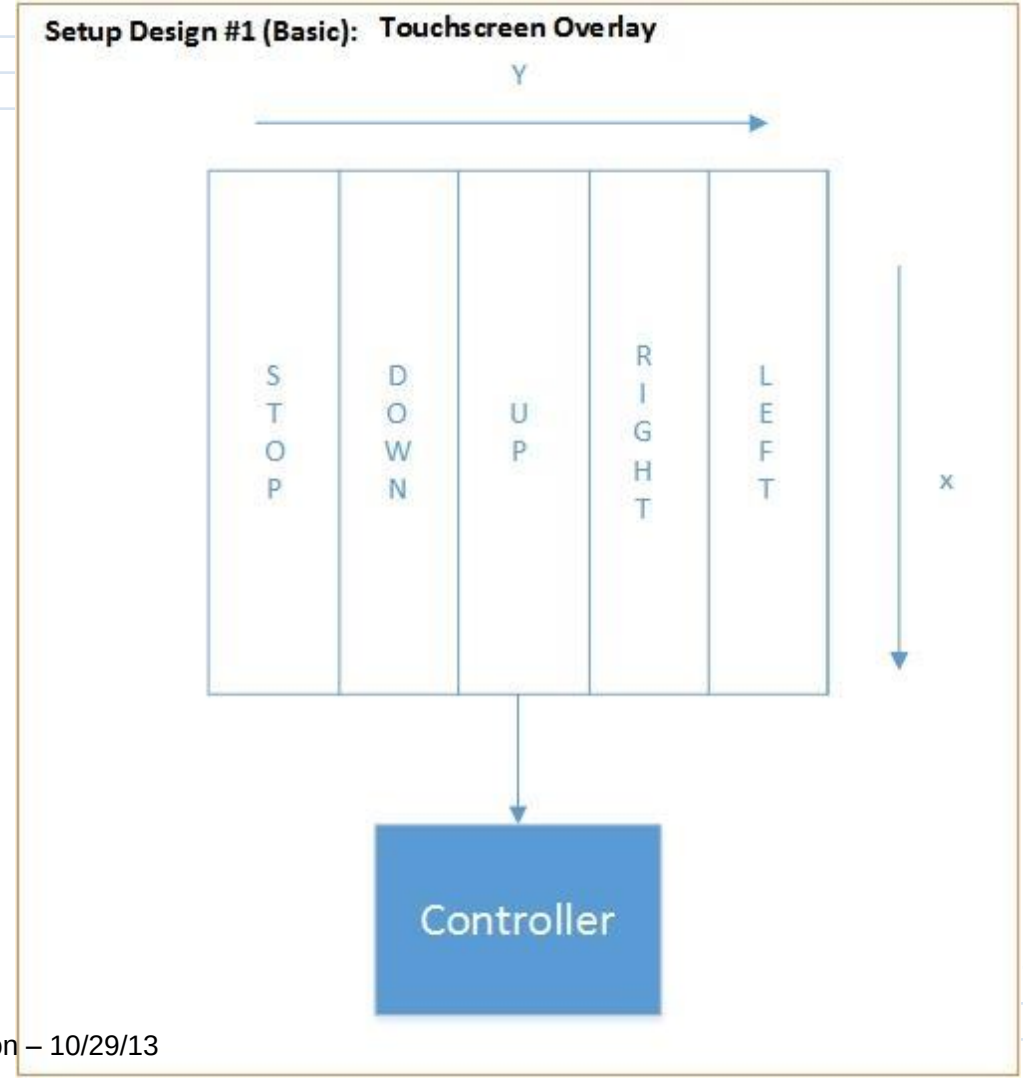
Code is compatible
-needs cleaning for references to peripherals that don’t exist

Controls

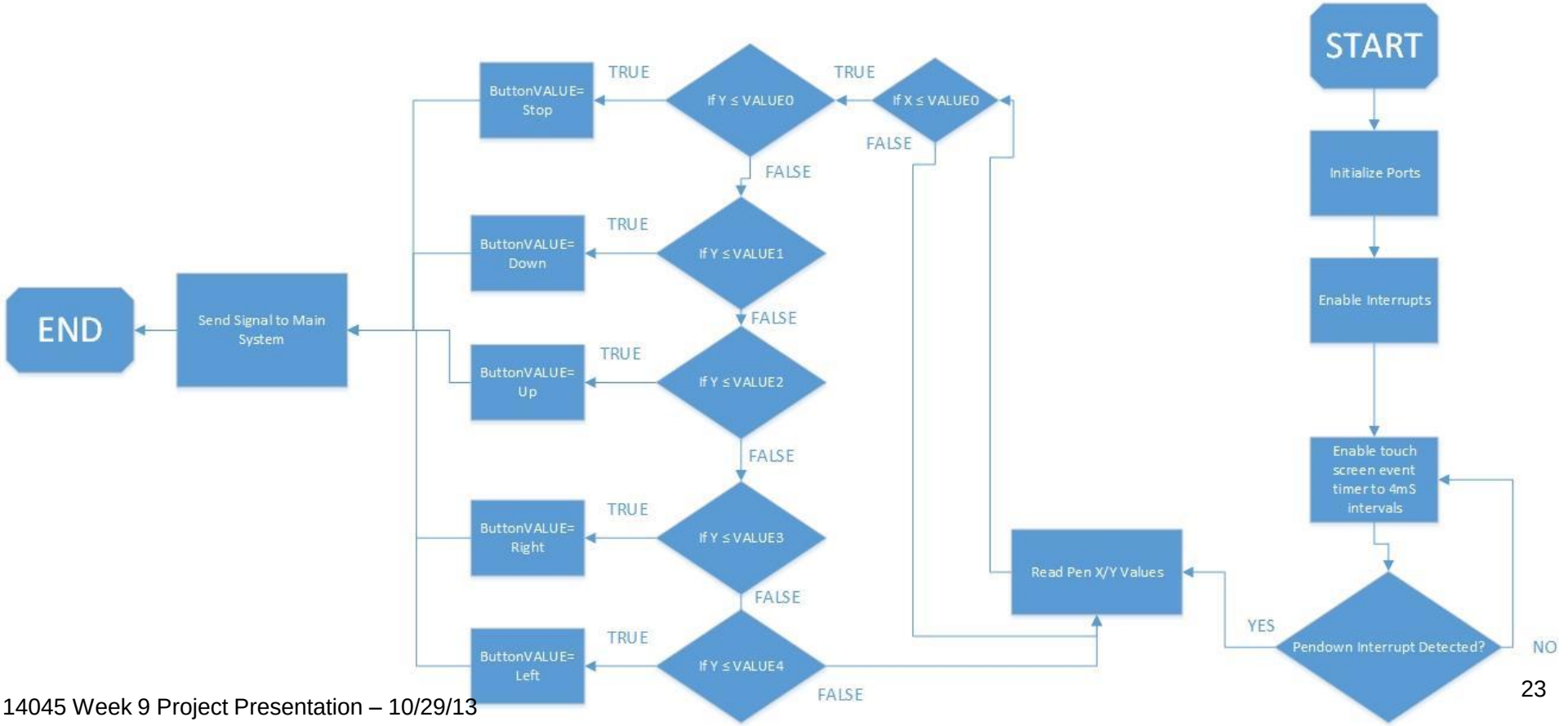

Hierarchical Flow of Code Organization
Power – On (Initialization Mode)
Main System Program
Stander Control Interface to Main System
Remote Control Detection Program (Interface to Main System)
Interrupt
Interrupt
Modular Control Program (Buttons / Touchscreen)
Remote Control Program

Controls


Remote Flow Chart
START
Initialize Ports
Enable Interrupts
Check Battery Status
Low
High
Toggle Flash LED_RED
LED_GREEN: ON
NO
YES
is Override ON?
Connect to Main System and Use Mixed Inputs
Send Override Signal to Main System
If Button Stop
TRUE
FALSE
If Button Down
Send Signal to Main System
TRUE
If Button Up
Send Signal to Main System
TRUE
If Button Right
Send Signal to Main System
TRUE
FALSE
If Button Left
Send Signal to Main System
TRUE
END
Update all buttons
Store signal received
Get next button
Prompt User to press buttons
Has button been pressed?
YES
NO
FALSE
FALSE


Setup Design #1 (Basic): Touchscreen Overlay
Y
STOP
DOWN
UP
RIGHT
LEFT
x
Controller

Touch Screen Flowchart



Controls

Next Steps:

- Review Electrical System breakdown with experts in field (Professors)
- Use Texas Instrument’s Code Composer for preliminary code development
- Test code on current (Blue stander) button set-up.
- Combine different subsystems.

Preliminary Bill of Materials

Description	Price	Qty.	Total Cost
Tactile Switch; 0.05A 12V (Remote)	$0.38	4	$1.52
Tactile Switch; 0.025A 50V (Remote: STOP)	$1.63	1	$1.63
Stellaris Launchpad	$7.99	3	$23.97
Slide Switch 0.1A; 12V	$0.40	2	$0.80
Touchscreen Overlay	$81.51	1	$81.51
Controller for Touchscreen Overlay	$78.66	1	$78.66
36-Position Quadrature Encoder Set	$39.95	1	$39.95
HB-25 Motor Controller	$49.95	2	$99.90
Wheel Mount Kit	$299.00	1	$299.00
12V 20AH Lithium Ion Battery	$70.00	1	$70.00
Bluetooth Module: Bluegiga WT12	$34.48	1	$34.48
Temperature Switch	$1.00	1	$1.00
Voltage Regulators	$2.00	1	$2.00
Keypad Membrane Switches (Stander)	$41.00	0	$0.00
Small Whiteboard	$7.00	1	$7.00
Magnets	$1.20	20	$24.00
Magnetic Sign Holder (Touchscreen Display)	$9.96	1	$9.96
6105 T5 Aluminum Sliders (44in)	$0.00	1	$0.00
Sliders	$0.00	10	$0.00
Thumb Screw - 1.5in	$0.00	3	$0.00
1/4 - 20 sockethead screw (1in)	$0.00	2	$0.00
1/4 - 20 sockethead screw (1.5in)	$0.00	4	$0.00
Button Head - 0.5in	$0.00	6	$0.00
1/4in Washer	$0.00	10	$0.00
Spacing stud	$0.00	1	$0.00
Electric Linear Actuator	$200	1	$200.00
		Total:	$975.38

Accomplished vs Planned

Accomplished:

- Basic tray system design for both standers.
- Preliminary analysis of wheel mount adapter.
- Define previous groups electrical system.
- Establish that the Launchpad will be a suitable replacement uC.
- Designed basic modular control systems' code flow.
- Created a preliminary B.O.M.

Planned:

- Packaging Solutions
- Bluetooth
- Touch Screen Overlay development (code organization, analysis of compatibility between ucontrollers and initial testing)

Remaining Questions:

1. How to guarantee straight travel?
2. How will we make sure the stander runs smoothly?
3. How will the Automated tray work?
4. Maintain max allowable weight?
5. How long will the response time of the controls (stander/remote) take?
6. How will we test touchscreen overlay?
7. How can we improve the current bump sensor?
8. Begin battery/controller packaging design.

Questions?