PROJECT PERISCOPE

Final Presentation

December 8th 2015

Team #11

ECE 445 - Fall 2015



ECE ILLINOIS

ILLINOIS

Team Members



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Presentation Agenda

1. • Introduction to the project
2. • Modular Design
3. • Requirements, Verifications and Results
4. • Future Work

Introduction

What is Project Periscope?

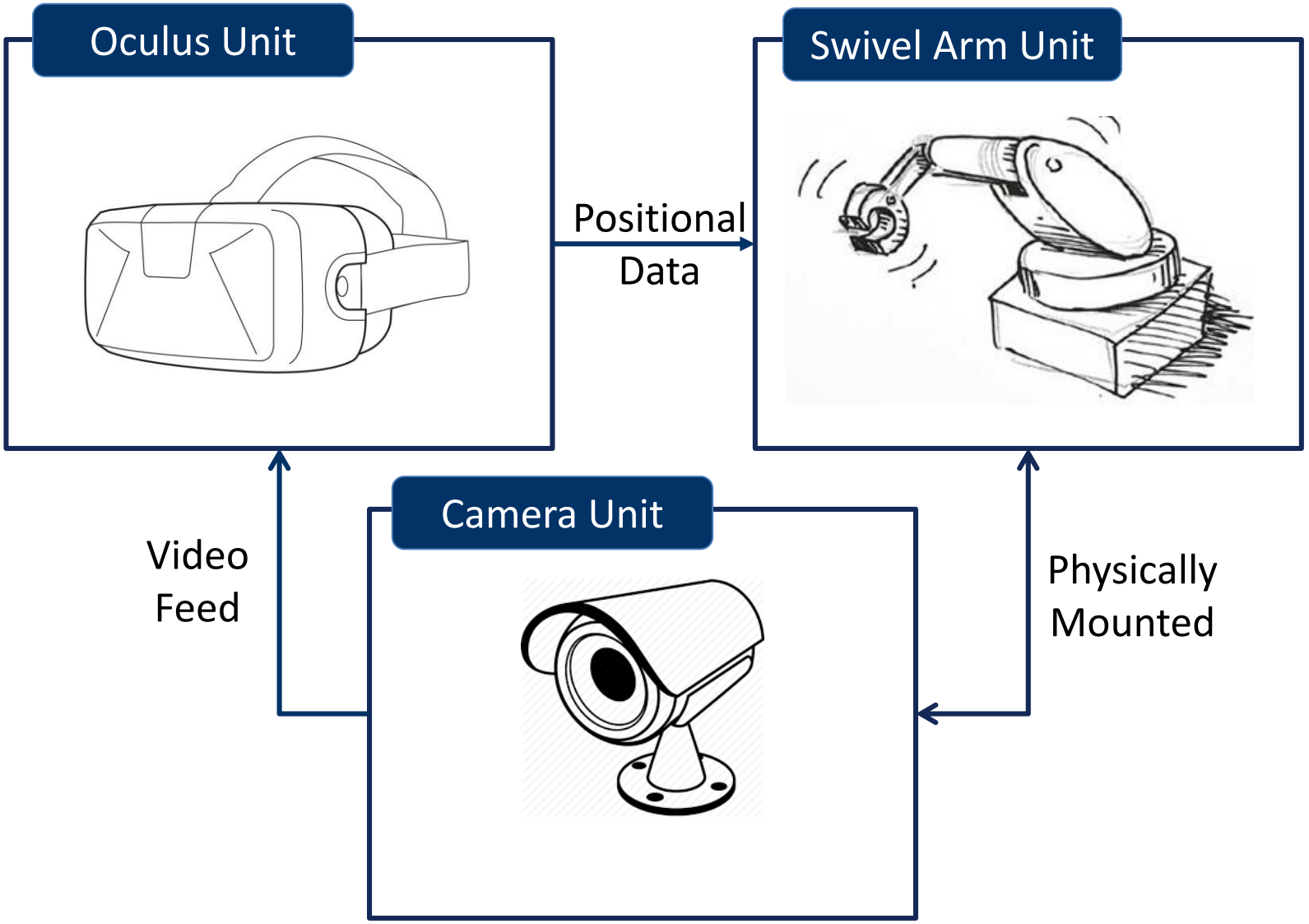
The Idea

- Scaling the idea of a Periscope to modern day dimensions
- To create an immersive VR experience
- have eyes in a very different part of the world

Utilities

- Explore the world
- Bridge telepresence with live media events
- Remote surveillance system
- Many more!

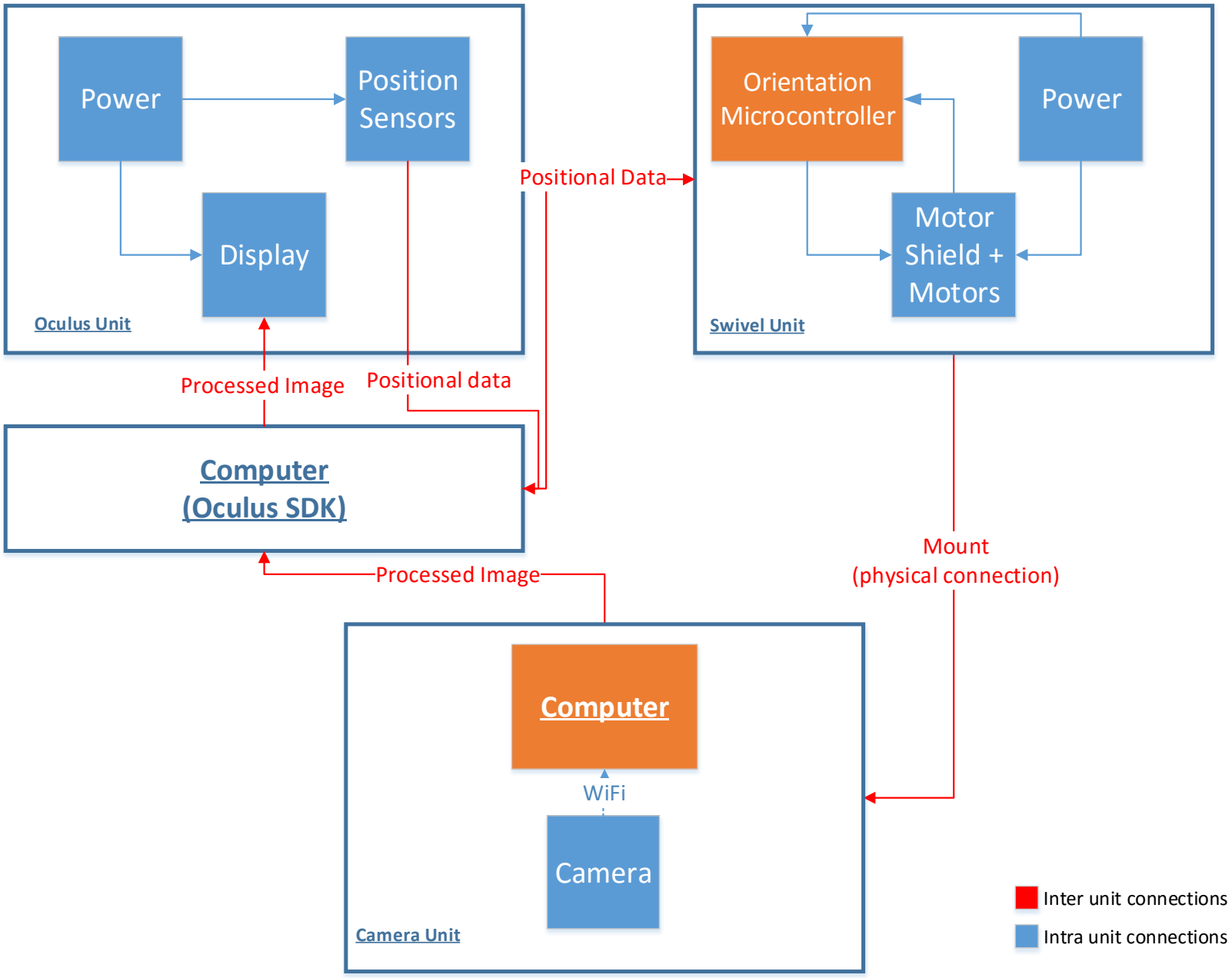
Modular Overview*



*Disclaimer – Images are just for visual explanation

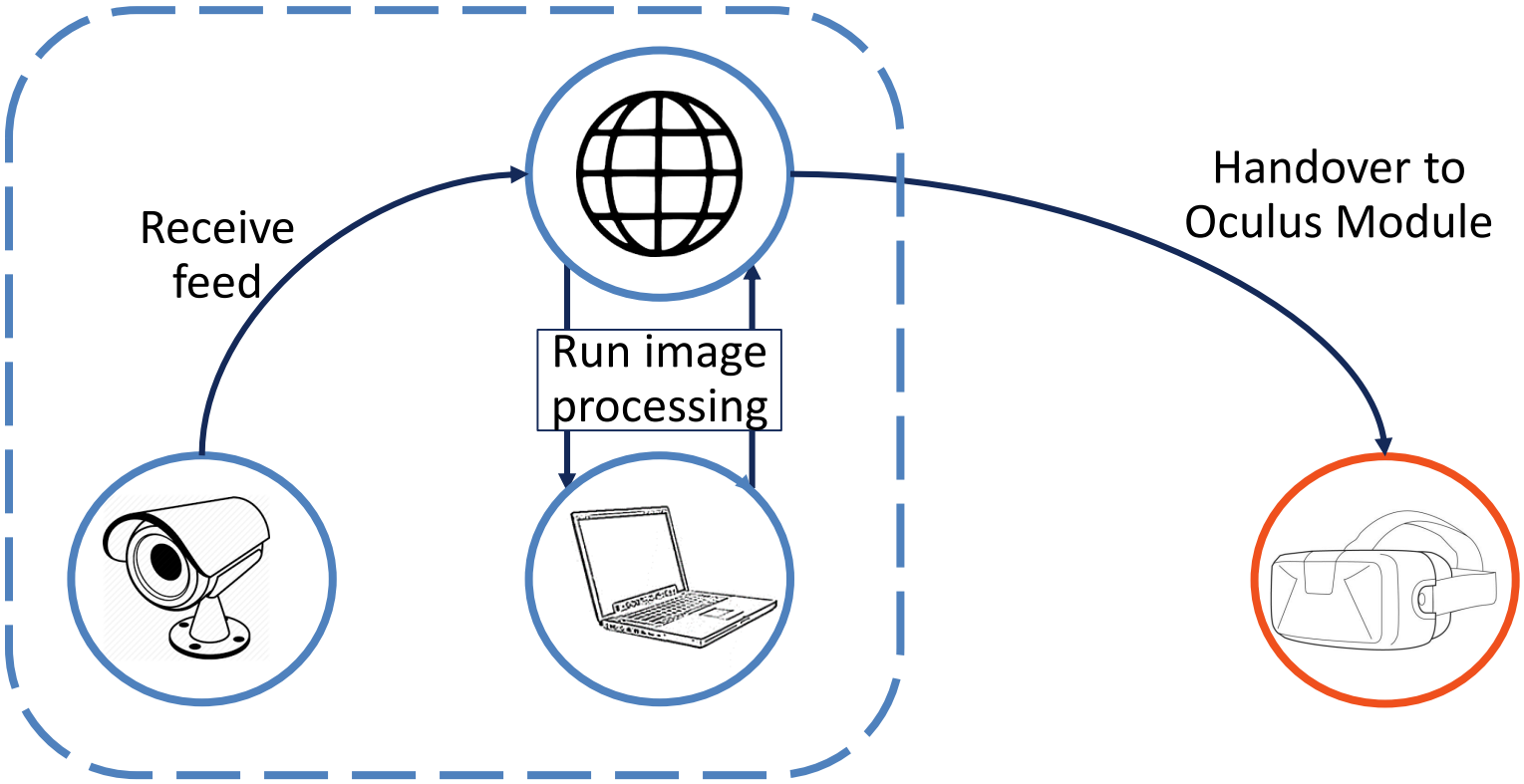
Image Source – Google Images

Block Diagram



Modular Design

Camera Module – High Level

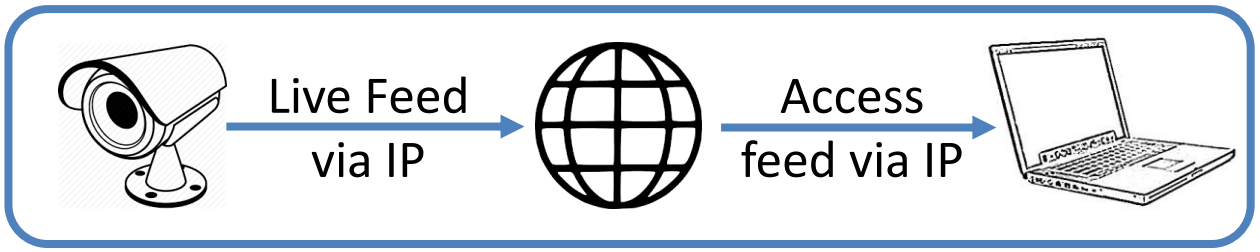


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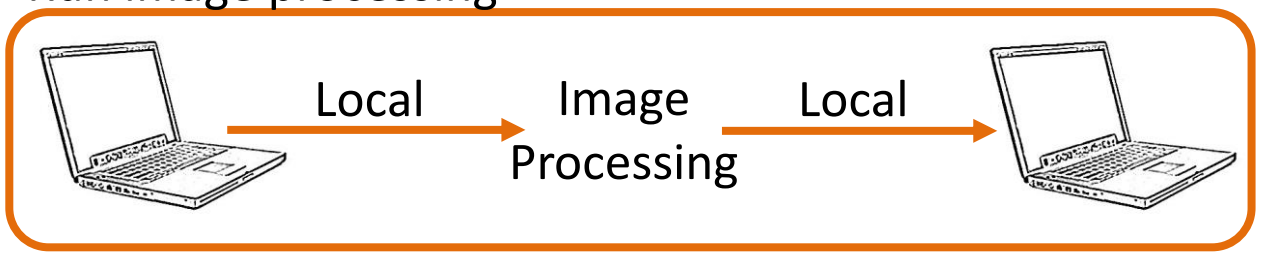
Image Source – Google Images

Camera Module

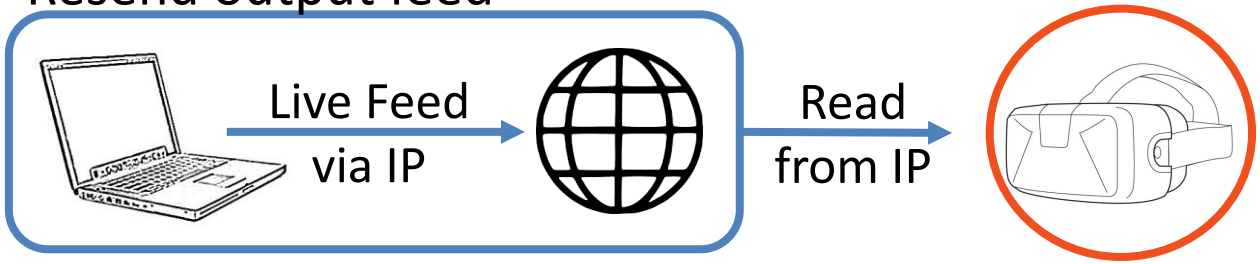
Receive feed



Run image processing



Resend output feed



*Disclaimer – Images are just for visual explanation

Image Source – Google Images

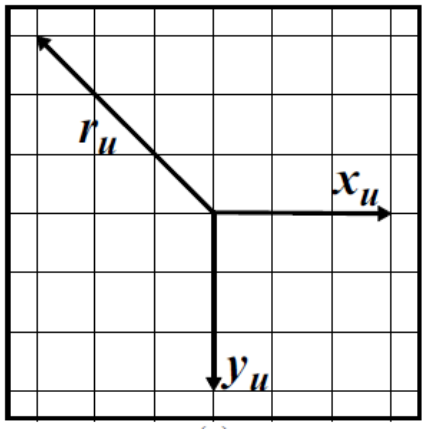
Camera Module - Image Processing

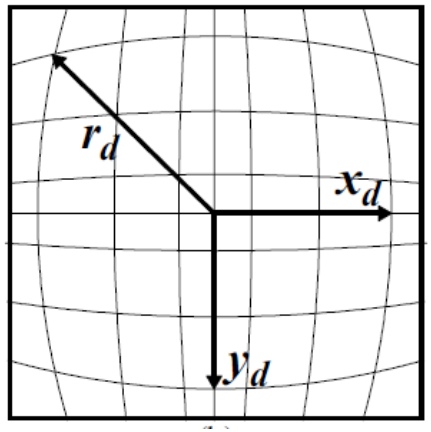
Core Challenge

- Live video feed provides flat images
- Oculus Rift requires a depth factor as well
- Solution – Barrel Distortion

Barrel Distortion Algorithm

- Maps each point of a 2D image, with respect to a central focal point
- Redistributes the coordinates
    - Farther coordinates pushed further out
- Result – a 2D image with a depth perception

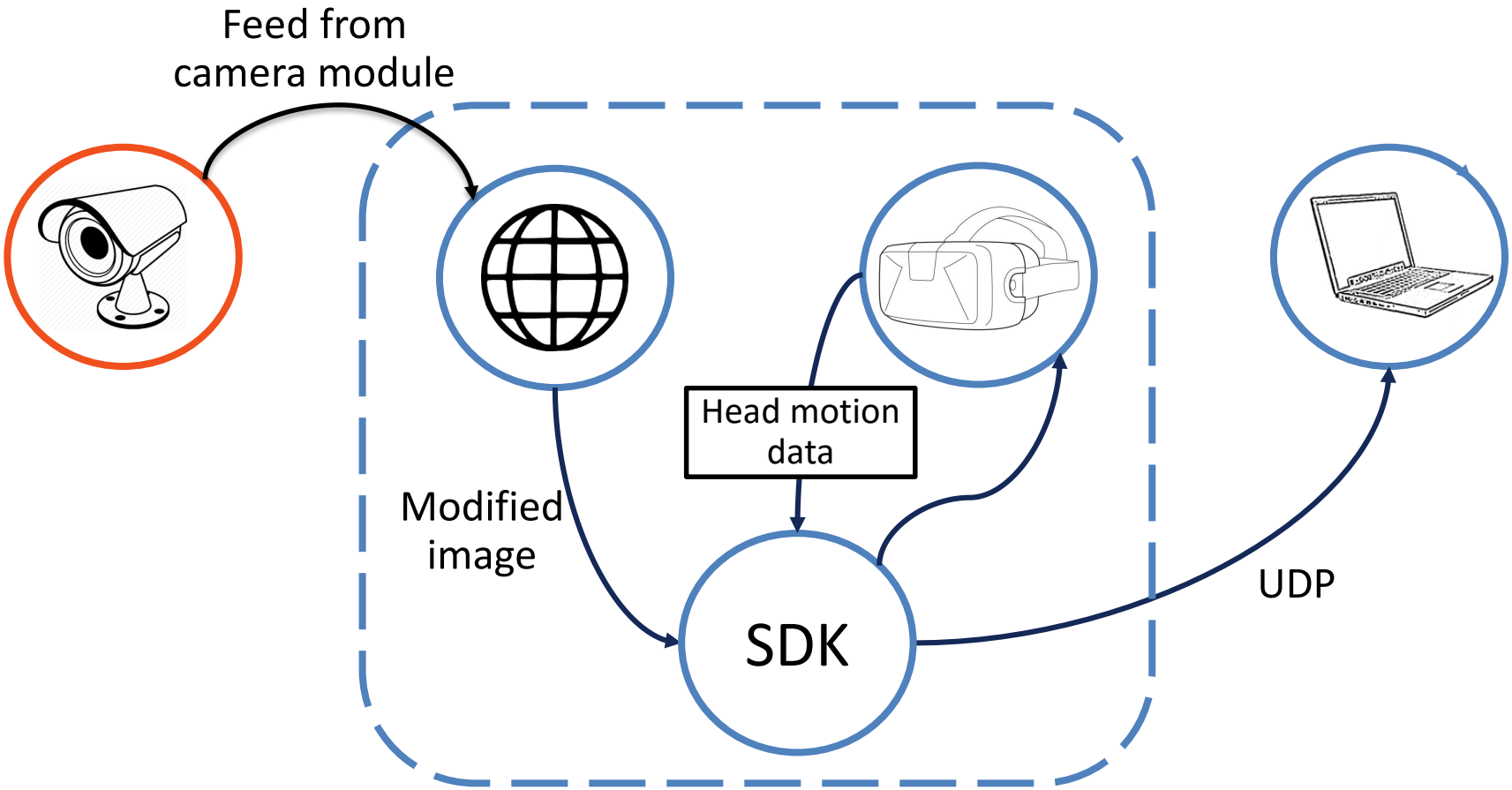




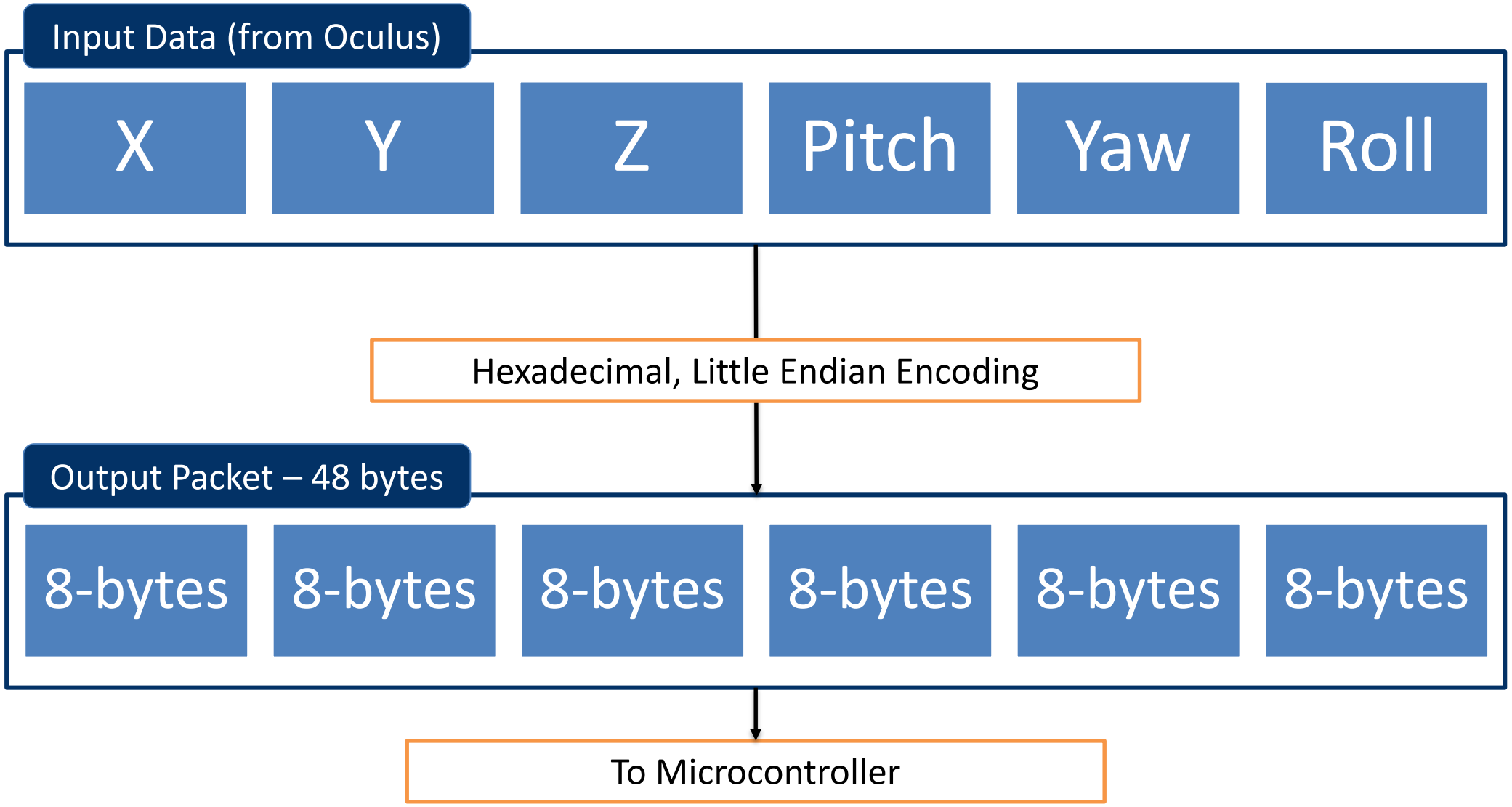
$$new_r = (0.24r^4 + 0.22r^2 + 2)$$ [1]

1 Bailey, D.G. "*Barrel Distortion Correction Algorithm.*" Massey University, Web.

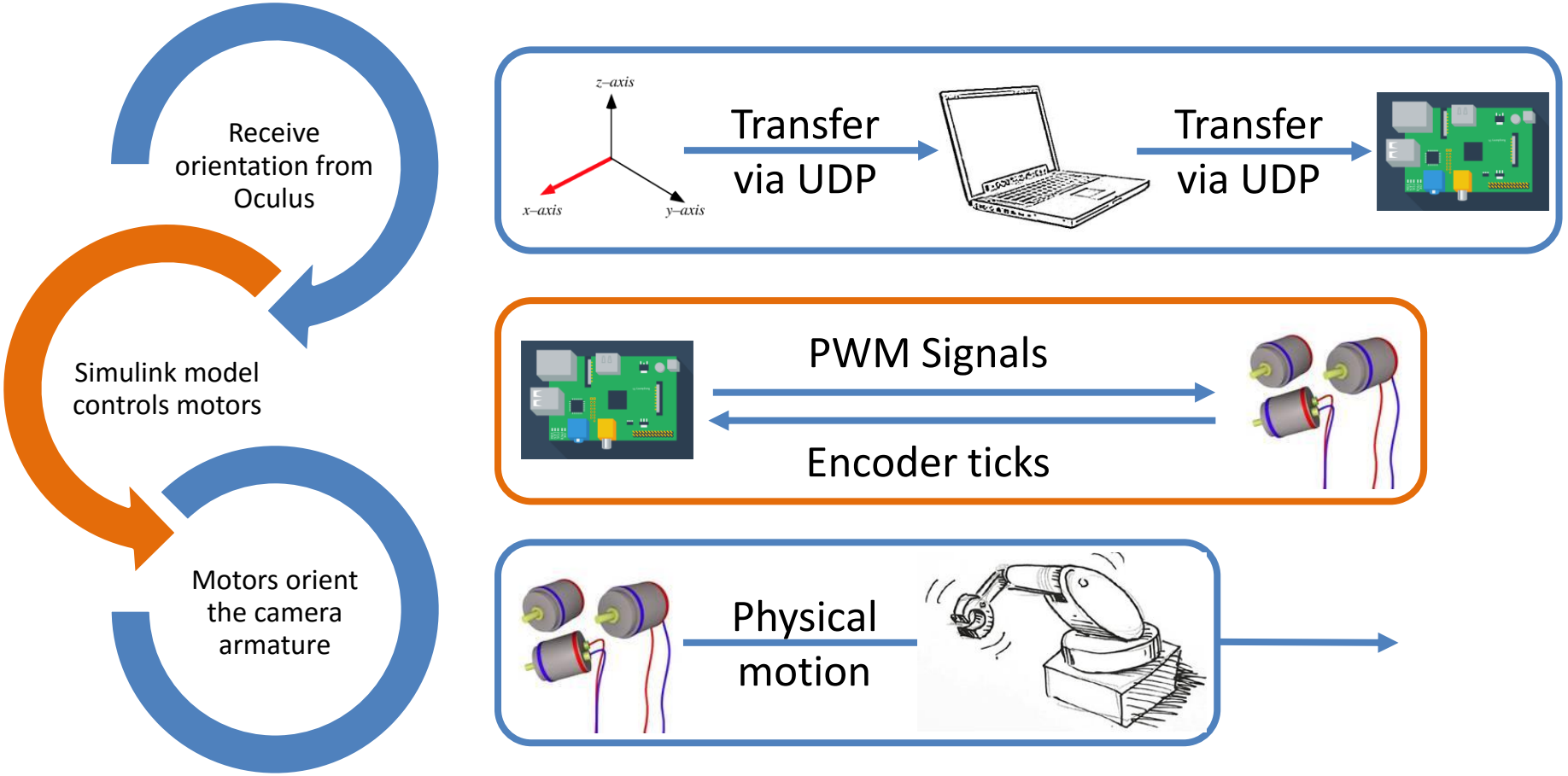
Oculus Module



Oculus Unit – Data Transfer



Swivel Arm Unit



Swivel Arm Unit – Motor Movement

Core Challenge

- Motors need to be able to realistically follow user's head movements
- Cameras are heavy, human muscles are strong and fast
- Solution – Powerful motors controlled by Simulink model running on a Raspberry Pi

Torque Calculations

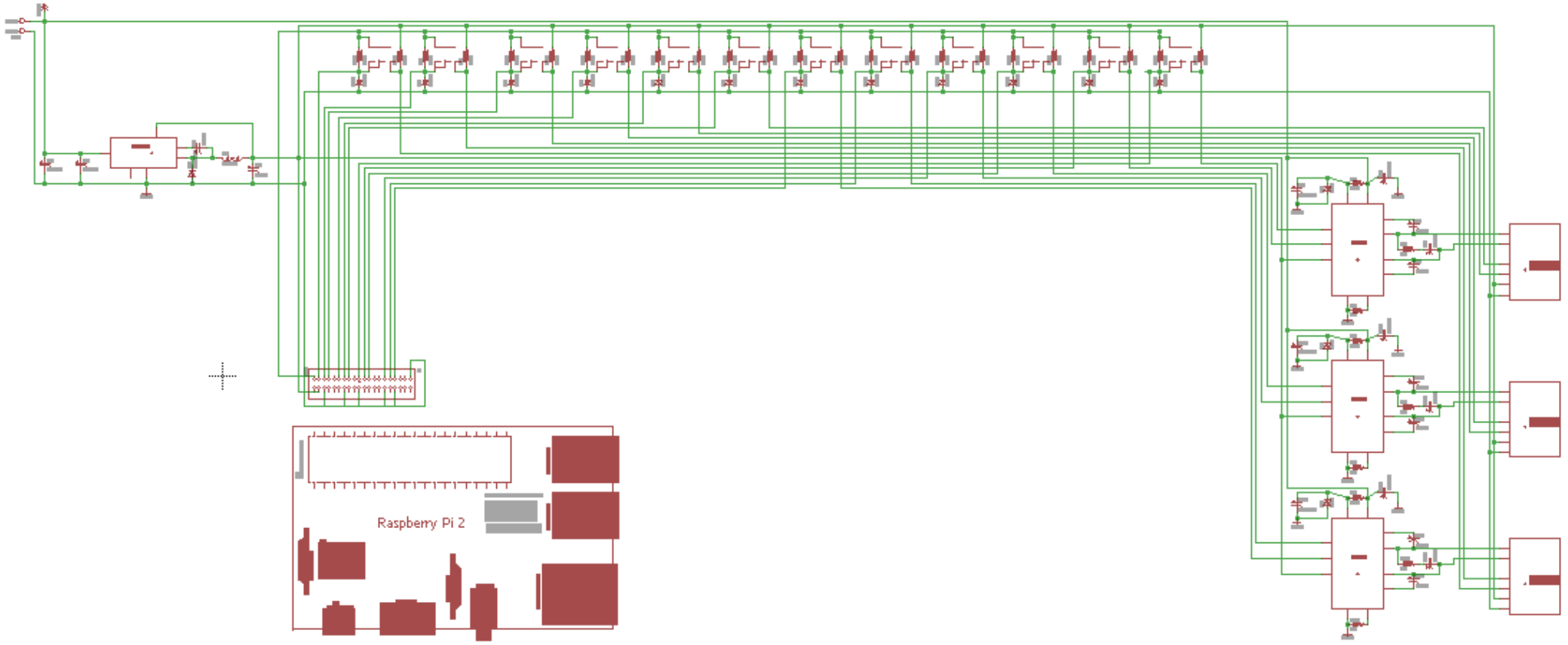
$$I = I_{rod} + I_{motor} + I_{camera} = 0.01097959 \frac{kg}{m^2}$$

$$\alpha = 50 \frac{rad}{s^2}$$

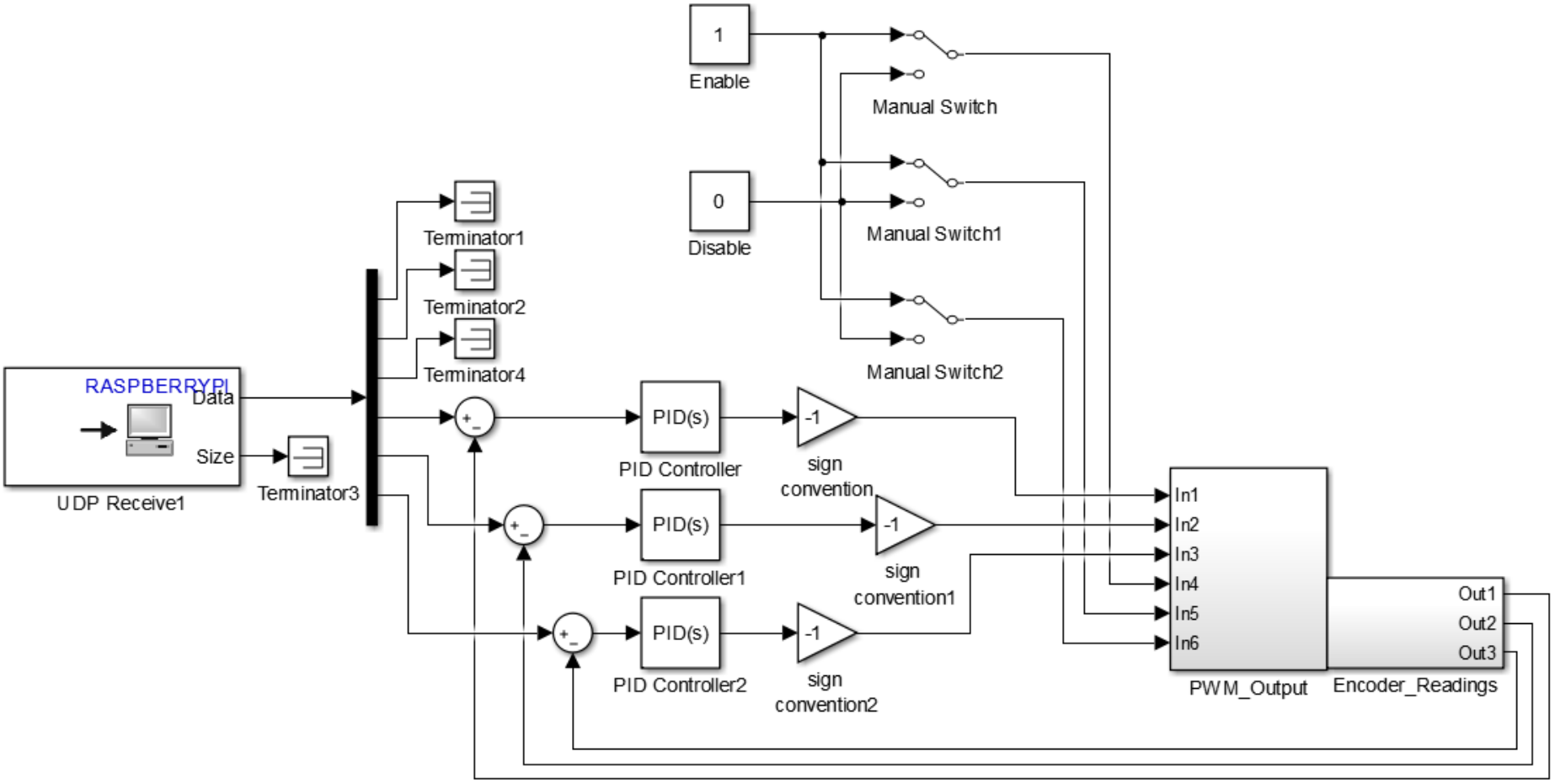
$$\tau = \tau_{movement} + \tau_{gravity} = 0.55 + 0.742 = 1.3\ Nm$$

*Various assumptions made about head motion in order to calculate required torque

Circuit Diagram



Simulink Model



Requirements, Verifications and Results

Requirements, Verifications and Results

Camera Module

Requirements	Verifications	Results	Final Status
The camera to PC image transition latency must be within 1.2s ± 50ms	• Connect the video feed over IP to the VLC Media Player • Use a stopwatch to monitor object appearance	Returned in 1.1533 seconds (average)	
The image processing algorithm must return output **within** an additional 0.5s ± 50ms		Returned in 0.0337 seconds (average)	
Overall handover time from camera module to Oculus module must be **within** 1.3s ± 50ms	• View final feed on Oculus SDK • Use a stopwatch to monitor object appearance	Returned in 1.209 seconds (average)	

Requirements, Verifications and Results

Oculus Module

Requirements	Verifications	Results	Final Status
The Oculus position data must correspond 1:1 with User's movements with a tolerance of ~10 degrees	Compare SDK Pitch, Yaw and Roll values with the received Matlab Pitch, Yaw and Roll values	Matlab graphs accurately mimic SDK values	
Achieve a maximum latency of 3s ± 500ms	When User movement degree and 3D Vector degree are exactly equal, timestamps should not differ by more than 3s with tolerance of ± 500ms	Timestamps differed by 2.09s (average)	

Requirements, Verifications and Results

Swivel Arm Module

Requirements	Verifications	Results	Final Status
Simulink can read encoder counts and output PWM signals to control the motors in the arm	Set up dummy models to read encoder counts and output simple PWM signals to motors	Able to read encoder counts with an accuracy of 0.08039 degrees per tick	
Motors are able to produce 1.5 Nm of torque to within 10%	With load attached, motors should be able to actuate through all ranges of motion	Motors produce approx. 1.74 Nm of torque	
System works within a 5m range of wireless separation	Step input response should not exceed 7% overshoot	Overshoot is approximately 5% with a 0.1 second settling time	

Requirements, Verifications and Results

System Range Testing

Requirements	Verifications	Final Status
System works within a 5ft range of wireless separation	Test with Oculus unit and Swivel-Camera unit is the same room (~7ft)	
System works within a 15ft range of wireless separation	Test with Oculus unit and Swivel-Camera unit in opposite ends of the apartment room (~20m)	
System works within a 90ft range of wireless separation	Test with Oculus unit and Swivel-Camera unit on different levels within the ECEB (~150ft)	

Safety Warnings

1. • Epilepsy Hazard
2. • Electrical Hazards
3. • Physical Injury Hazards

Future Work

Future Work

Remote Presence

- Enhance quality of experience
- Change the way people view live events
- Military (bomb squad, UAV, etc)

Size rescaling

- Can be scaled down to the micro levels
- Integrated design – applications in medicine, security surveillance, and advanced robotics

Material Capability

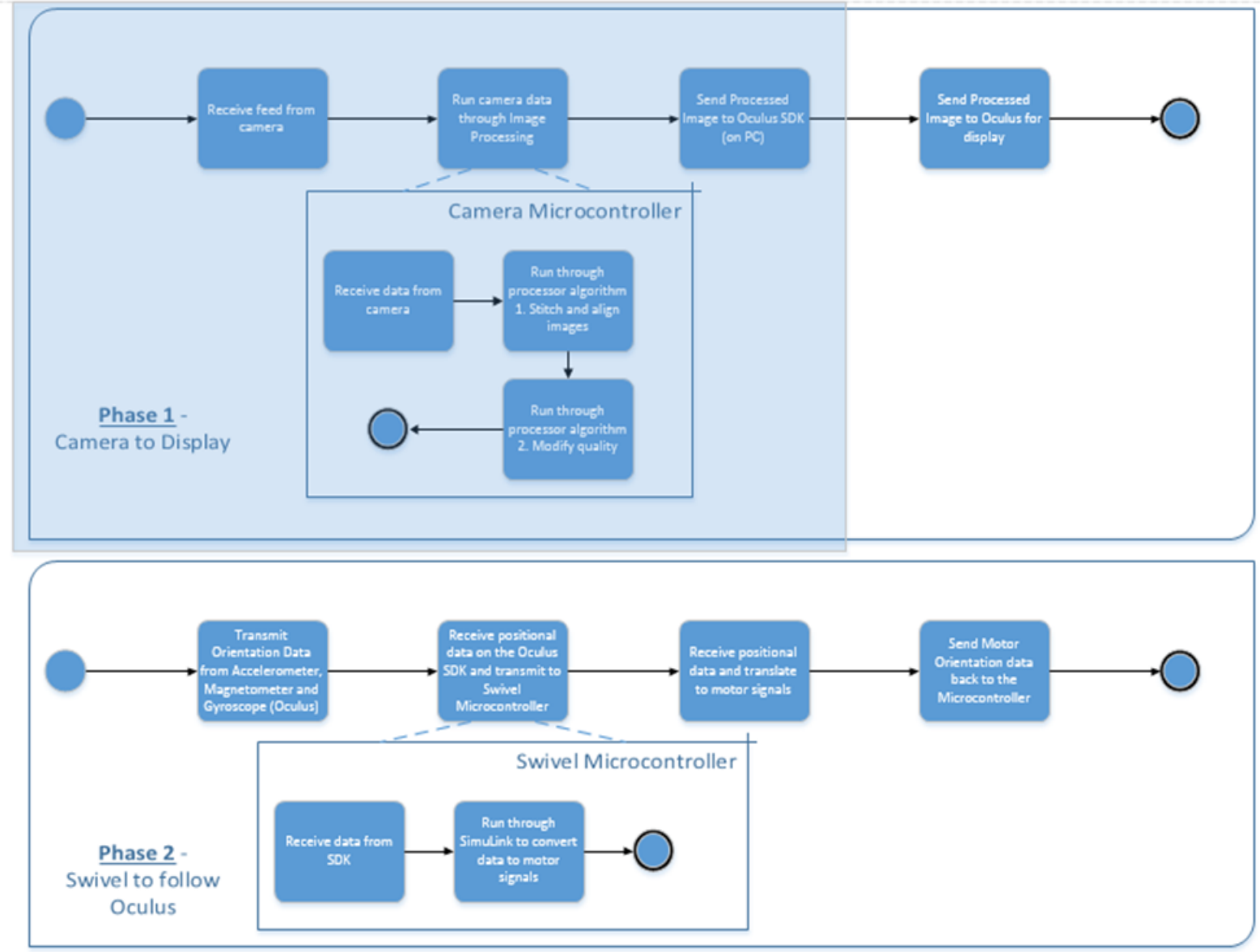
- Water and pressure resistance
- Could have applications in underwater and space exploration

Questions? Comments?

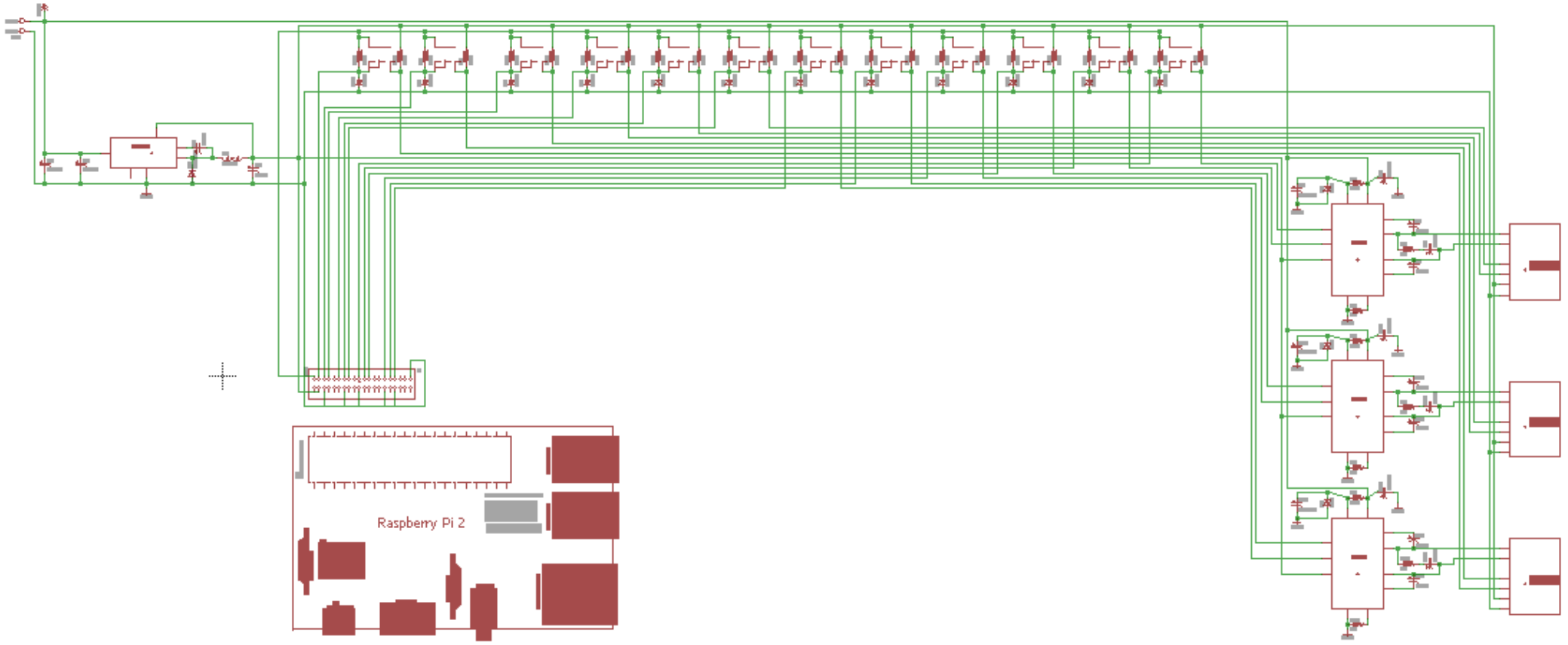
All right, let's discuss patent rights

Appendix

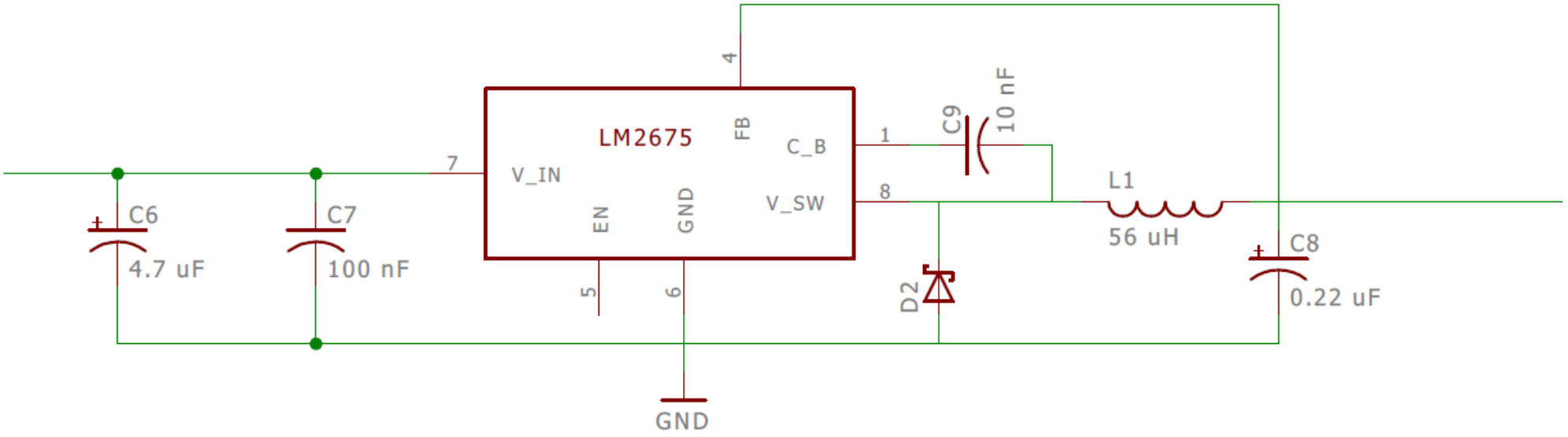
Software Flowchart



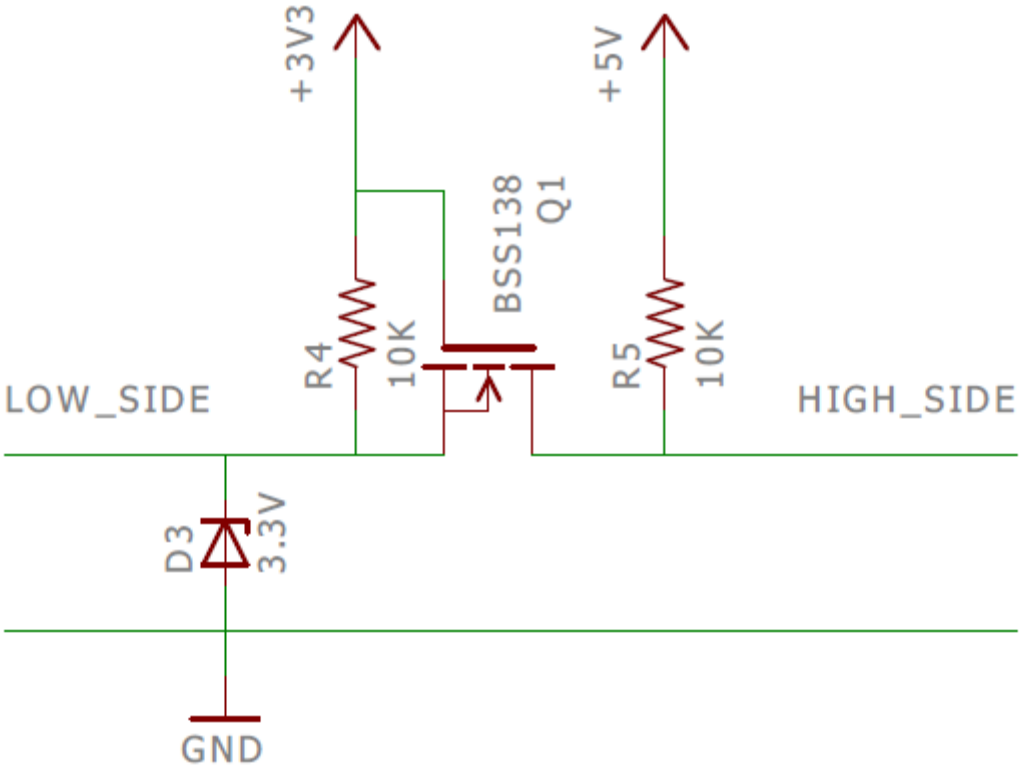
Circuit Diagram



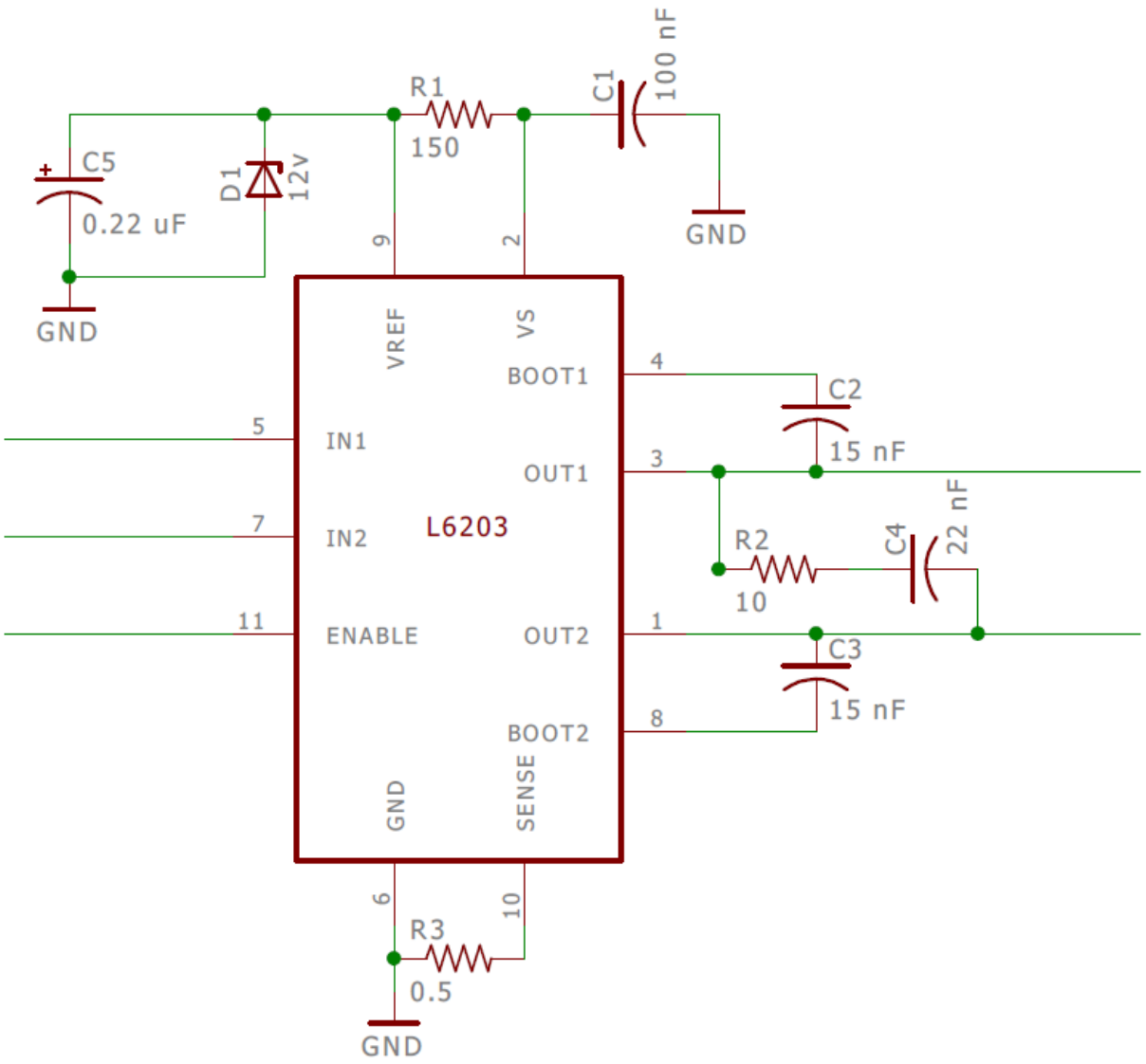
Buck Converter



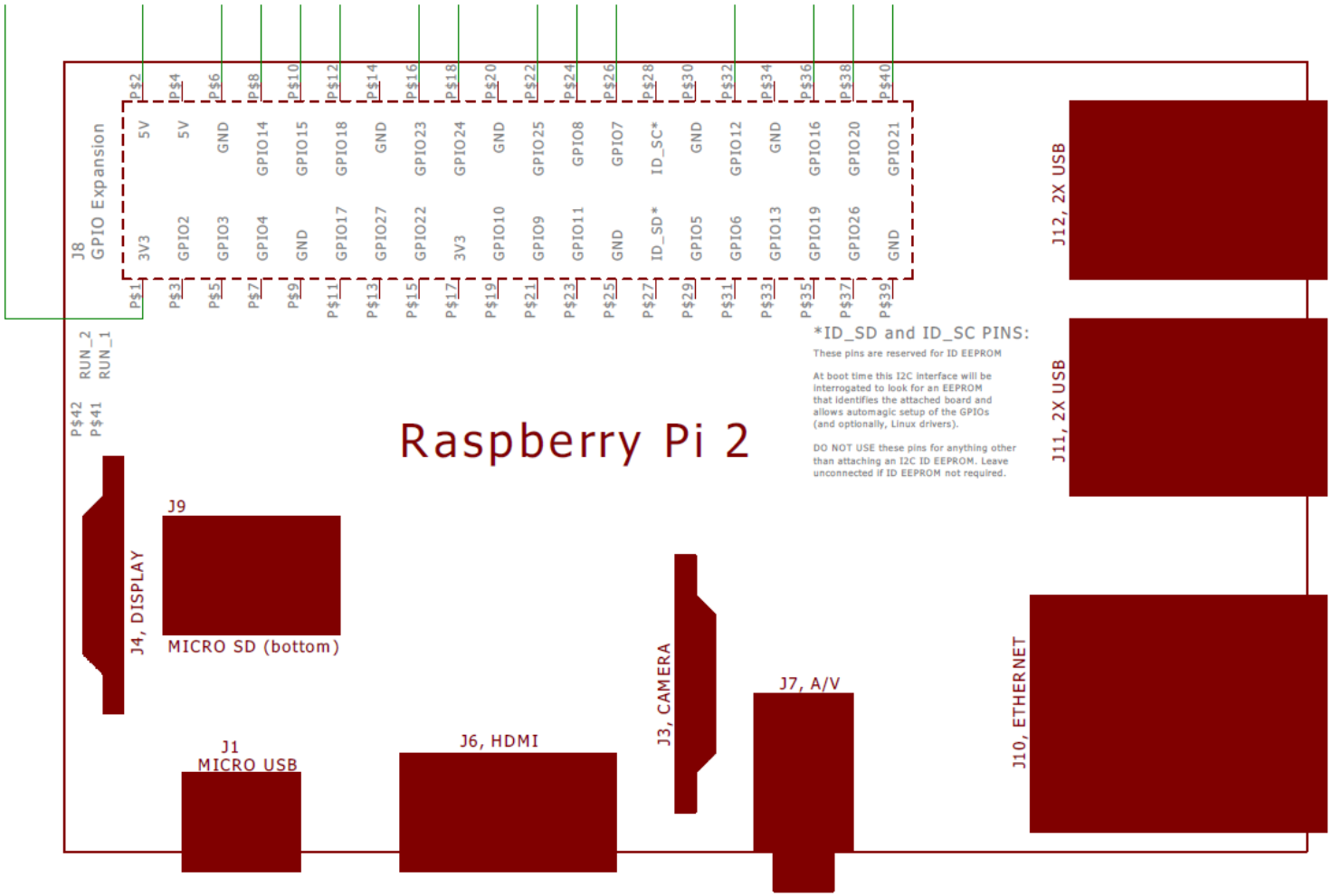
Logic Level Converter (x1)



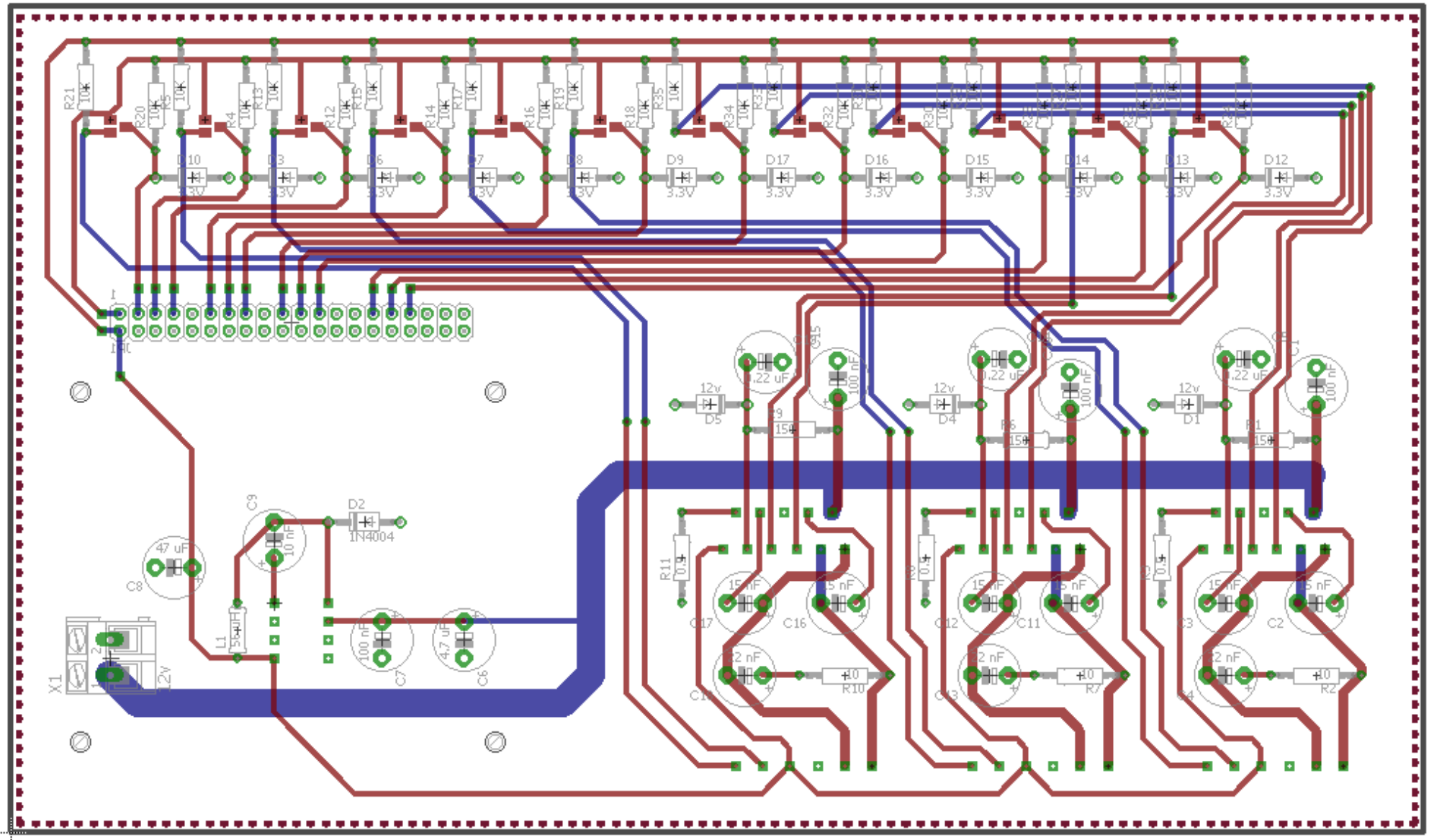
Motor Driver



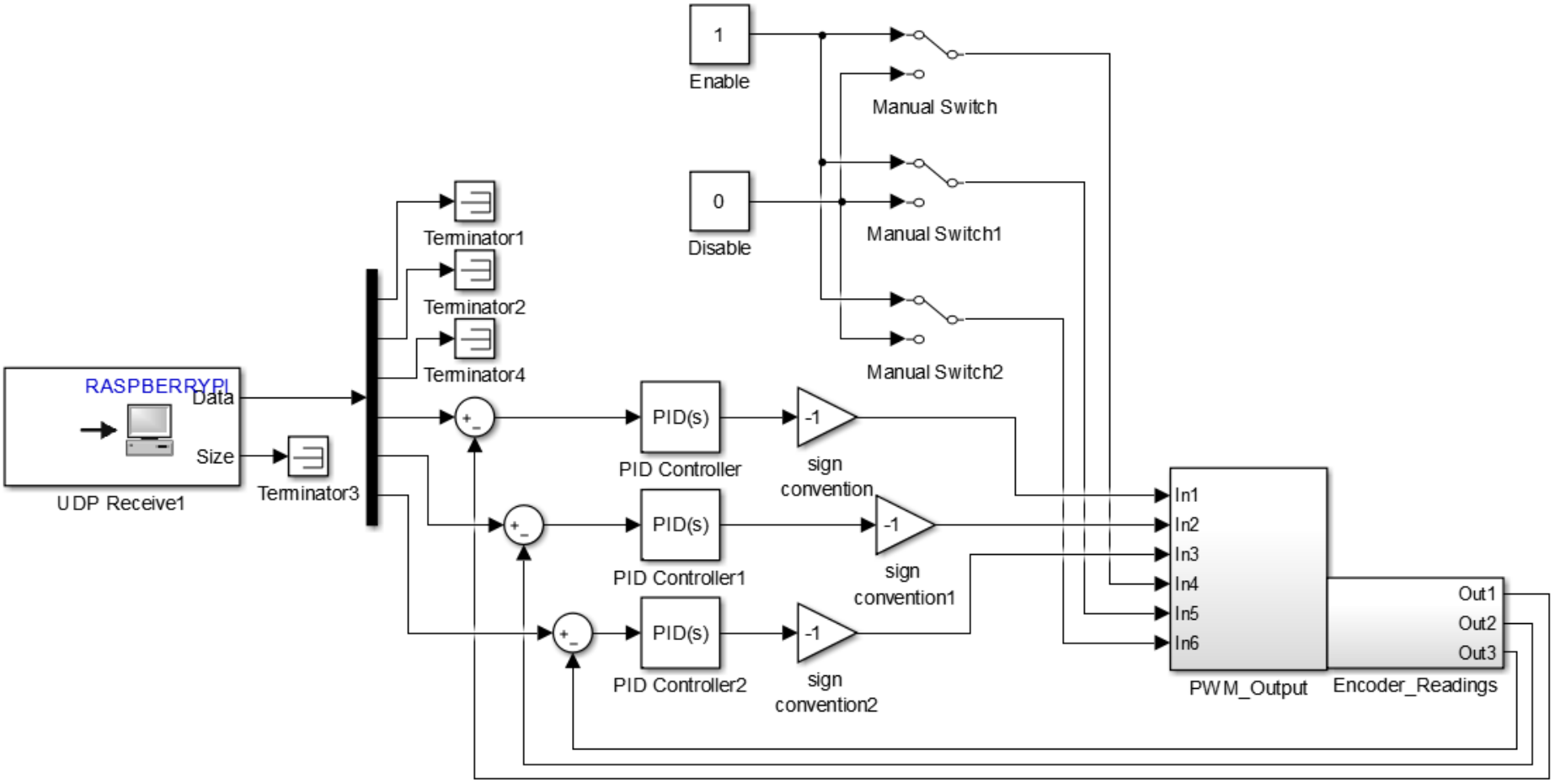
Raspberry Pi Connection Diagram



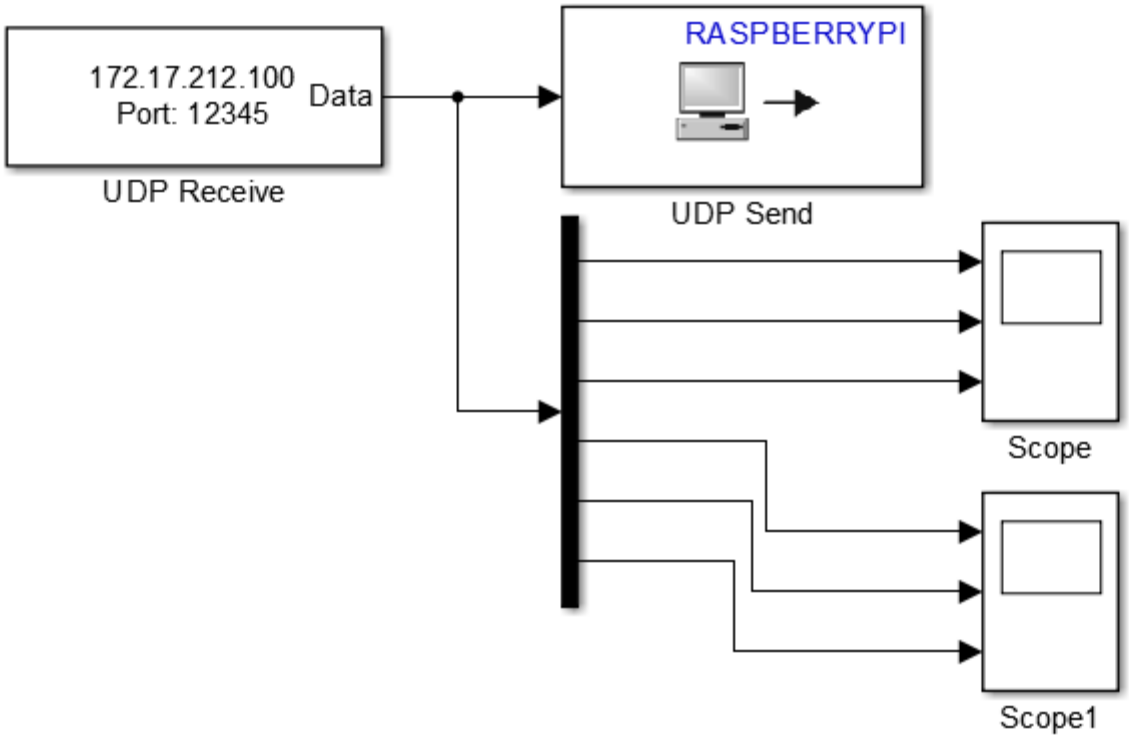
PCB Layout


D10
D3
D6
D7
D8
D9
D17
D16
D15
D14
D13
D12
3.3V
J1
D5
D4
D1
12v
C15
C14
C13
0.22 uF
100 nF
15 nF
2 nF
R11
R10
R7
R2
C9
D2
IN4004
C8
47 uF
10 nF
L1
C7
C6
100 nF
4.7 uF
X1
12V

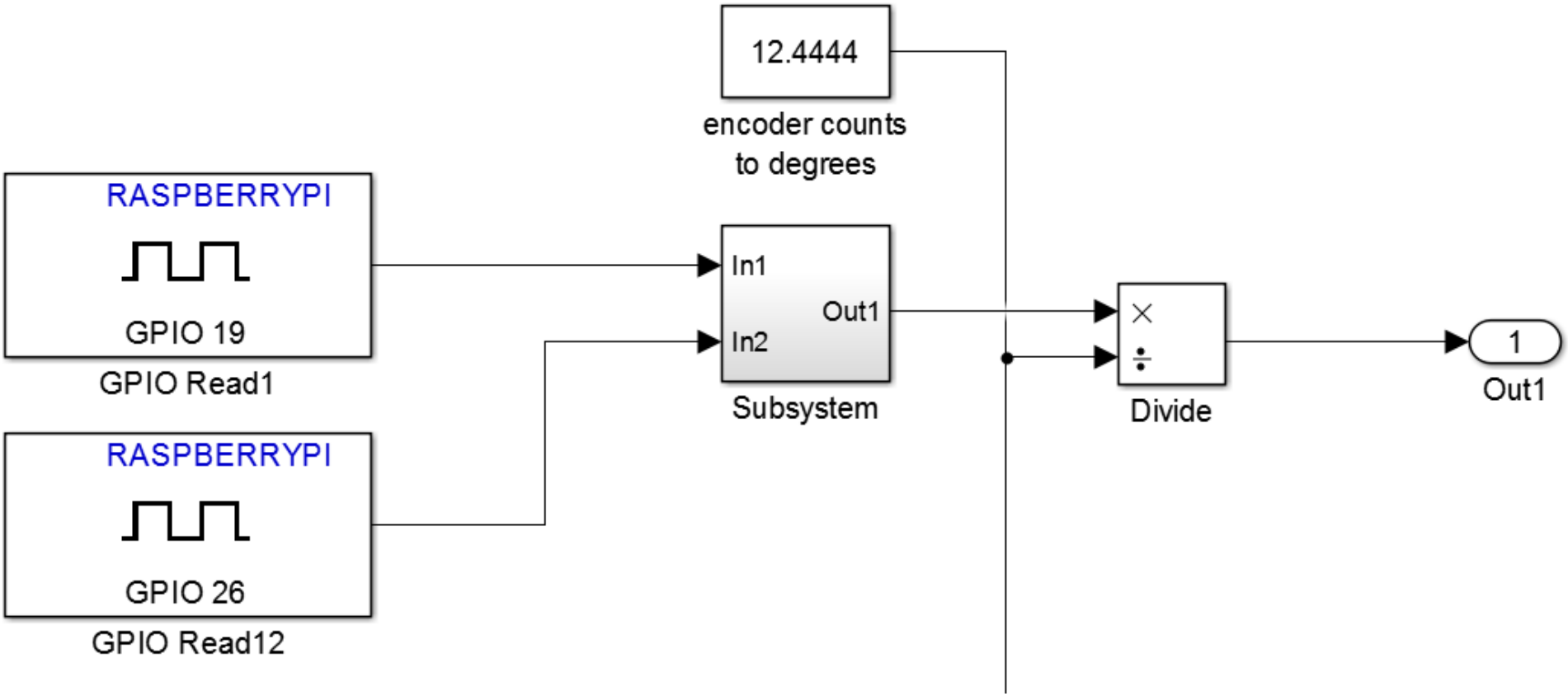
Simulink Model



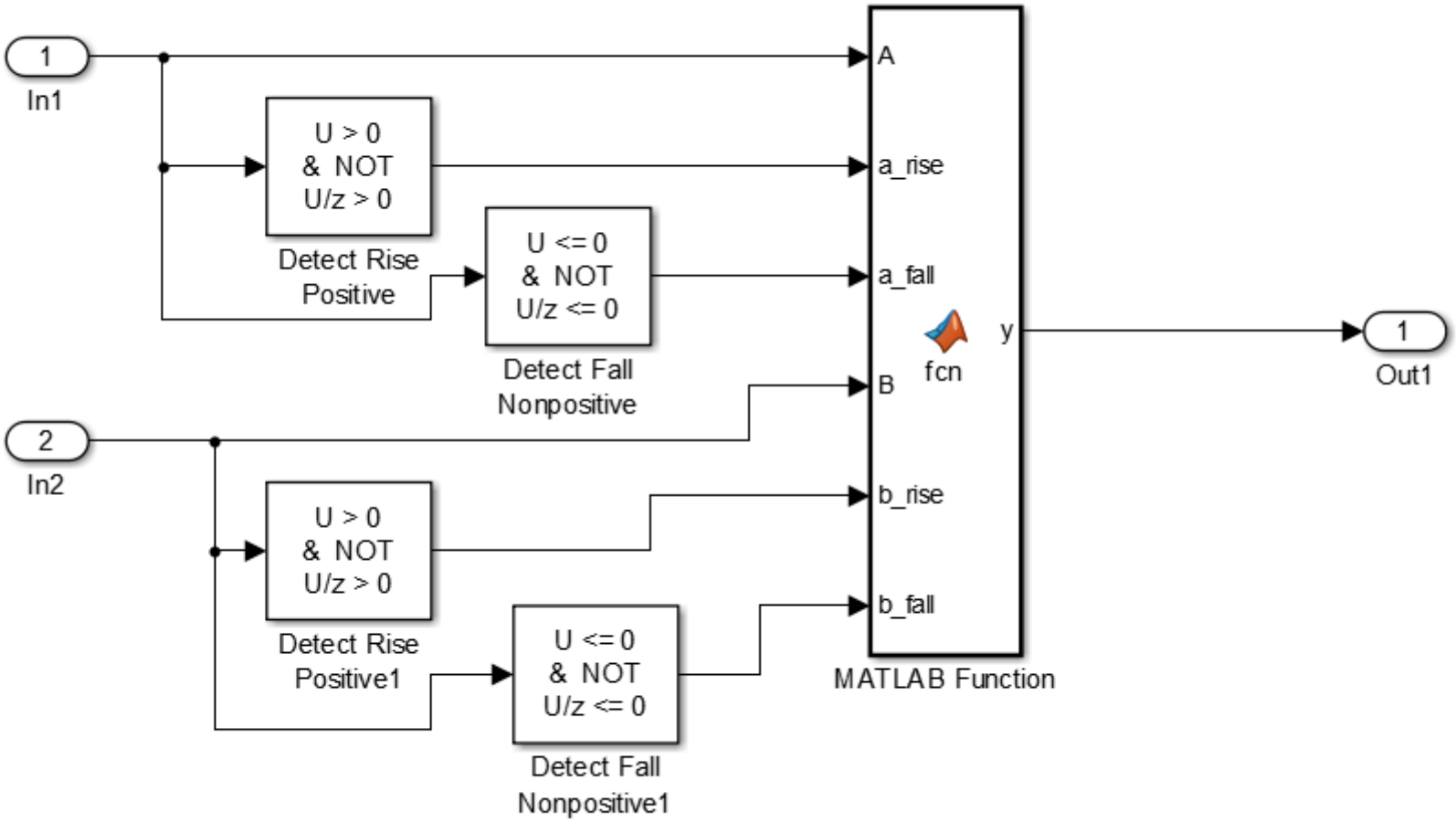
UDP “Bouncer”


172.17.212.100
Port: 12345
Data
UDP Receive
RASPBERRYPI
UDP Send
Scope
Scope1

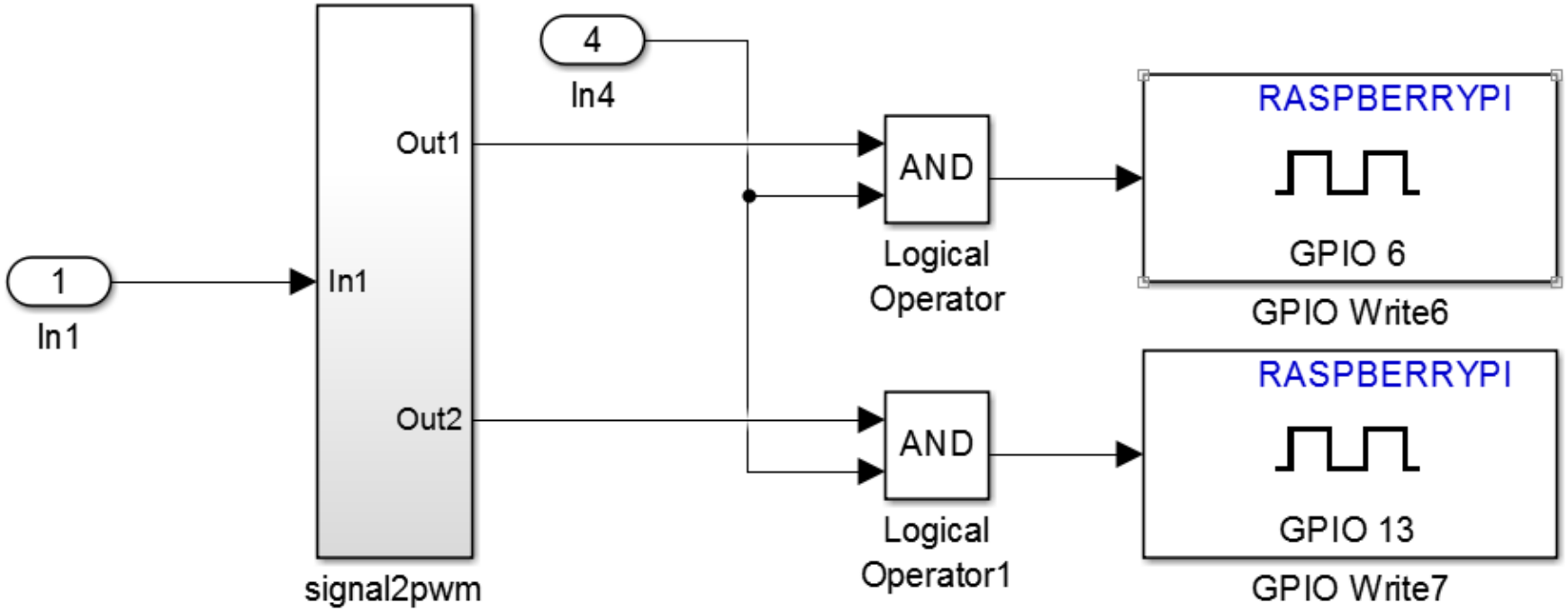
Encoder Reader



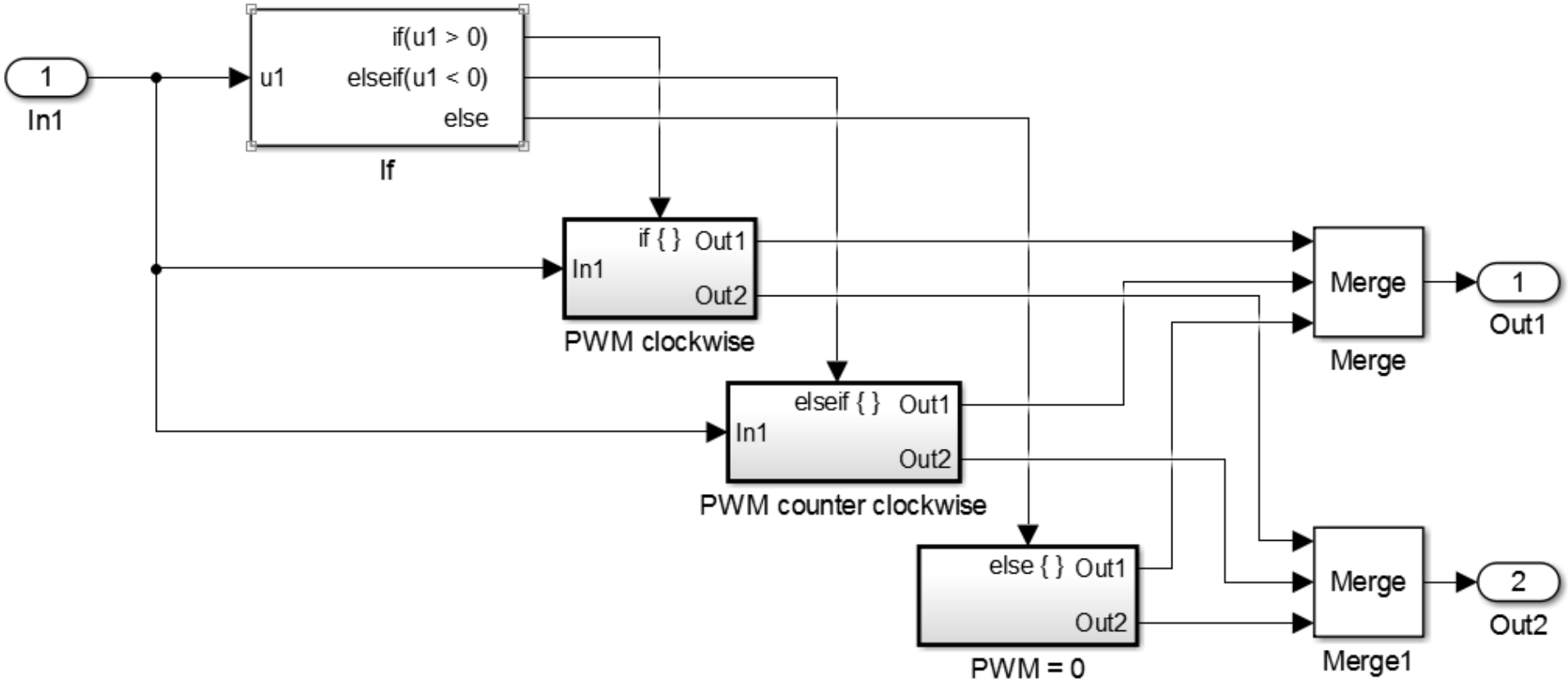
Direction Selector and Position Updater



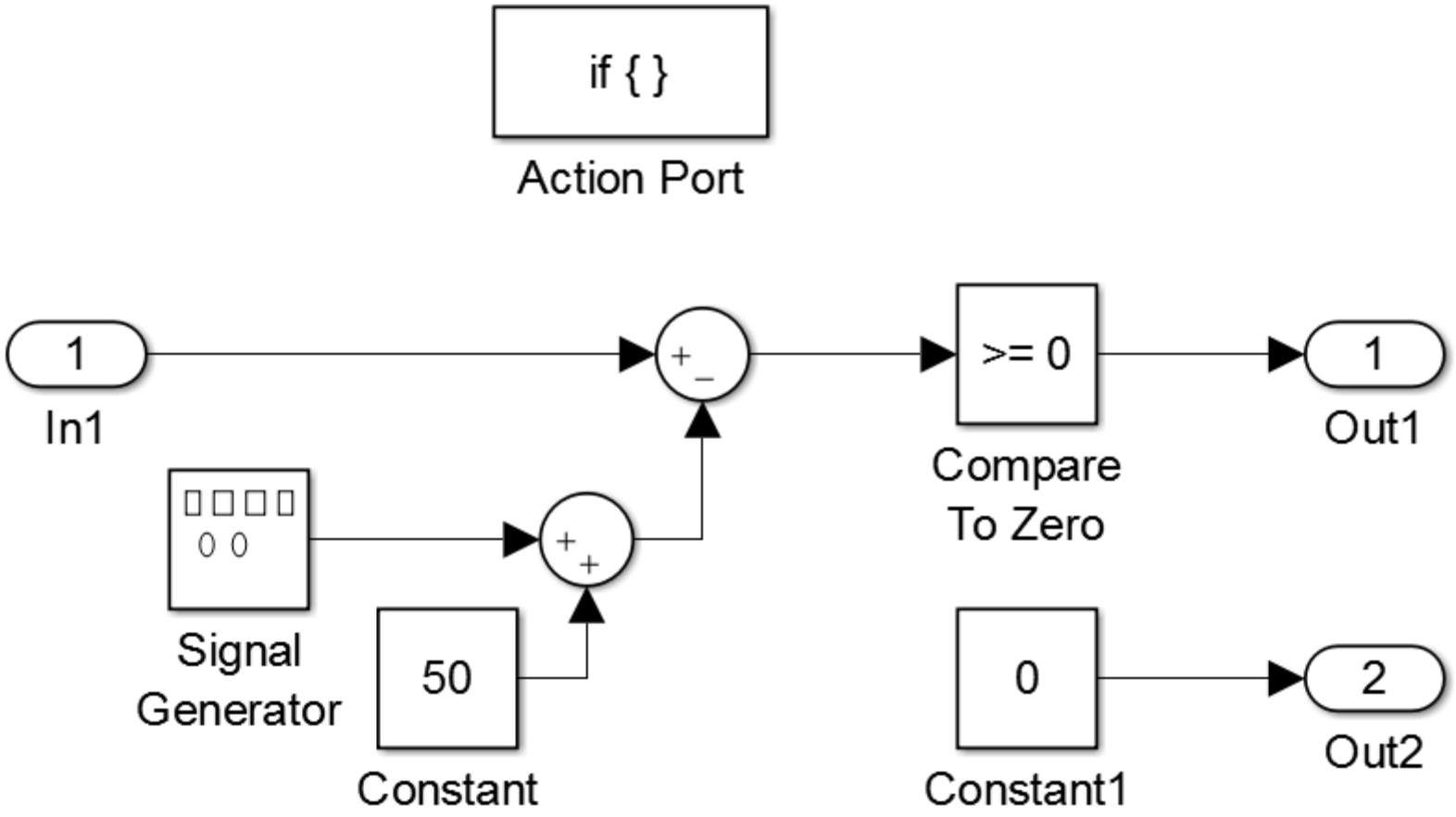
PWM Output


4
In4
Out1
1
In1
In1
Out2
signal2pwm
AND
Logical
Operator
AND
Logical
Operator1
RASPBERRYPI
GPIO 6
GPIO Write6
RASPBERRYPI
GPIO 13
GPIO Write7

Direction Selector



PWM Signal Generator



Future Work

Tele Presence

- Enhance quality for improved tele presence
- Could potentially change the way people currently view live events

Size rescaling

- Can be scaled down to the micro levels
- Applications could include the fields of medicine, security surveillance as well as advanced robotics and machinery

Material Capability

- Can be made pressure and water resistant
- Direct applications could include underwater surface exploration as well as outer space imaging and exploration