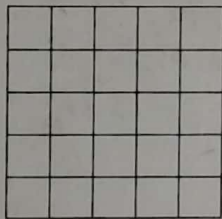


Graph Composition

Nelson Raphael
Senior Design Notebook



5 x 5 RULED

- 100 Sheets
- 200 Pages
- 9 ³/₄ x 7 ¹/₂ in.
- 24.7 x 19.0 cm



Tools for the Future

My contact info

Nelson Raphael

Phone #: 678-595-3833

E-mail: raphael7@gatech.edu

Team Members' Contact Info

Stephanie Chan

Phone #: 678-972-0273

E-mail: schan40@gatech.edu

Elizabeth Fuller

Phone #: 478-919-4407

Email: efuller3@gatech.edu

Adrian Munoz

Phone #: 478-478-1989

E-mail: am262601@gatech.edu

Lemek Robinson

Phone #: 678-808-9046

E-mail: lrobinson61@gatech.edu

Raphael

Senior Design Meeting

Underground Vault Inspection

10/11/18

Team

Lemck
Adrian
Elizabeth
Stephanie

Grabber's Role

- ↳ advice for decisions
- ↳ advice for team organization
- ↳ email is best!

Weekly Meeting 10/11/18

Thursdays @ 11am

↳ Wednesdays
@ 11am - 12pm

Technical Paper

Project Proposal

- ↳ Lit Review / Background Research
- ↳ Introduction
- ↳ Statement of Purpose
- ↳ other sections

Historical Context

- ↳ sponsored by NEETRAC @ GT
- ↳ hazardous environments for transformer vaults
 - poorly lit
 - dangerous equipment
 - gases, fumes (gas samples taken)

What do we do instead?

- 1st inspection done by a vehicle
- No wait / Faster Response Time
- No people @ risk

Quad Copter

- ↳ lack of payload
- ↳ poorly lit / resolution doesn't matter
- ↳ stability was an issue

Team Quad

- ↳ stability issue due to c.o.g.
- ↳ reduced flight time to 5 min
- ↳ FLIR cameras
- ↳ Reading Gauges was hard

* Meeting @ Burger-Henry Vault
&
w/ GA Power

AR

TravisBot (proposed focus)

- ↳ very dense (very negatively buoyant)
- ↳ diff control for motors
- ↳ low c.o.g. allows for easy build on surface
- ↳ platform robot
- ↳ RC control used
- ↳ fully controlled / autonomous

Team Auto Sol

- GUI
- Ethernet Cable

PVZ Bot

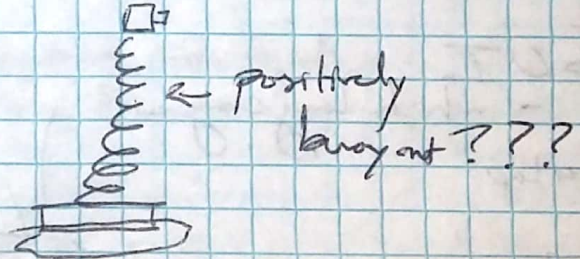
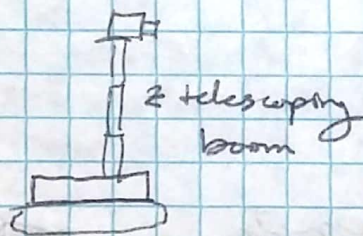
- gas sensors CO
- Worked on the control interface

* VR Experience *

Look over individual reports

- #1 Pick your vehicle (either pre-existing or create a new one)
- #2 Pick a working location (possibly the new maker space)
- #3 Establish a meeting date w/ Burger - Henry Vault & GA Power

- Vehicle Control
- Human Vehicle Interface
- Sensory (Gas, Infrared / FLIR, Mic (Sound))
- Control Systems
- Power Generation for Vehicle
 - ↳ more efficient motors
- Mechanical Design / Boom to get to gauge



To-do

- Designate roles for TRP (Technical Research Paper)
Done 10/15/18 ✓
- Decide on which robot body to use
Done 10/15/18 ✓

NB
2

Technical Group Topics

- ↳ Sensors
- ↳ Communications
 - Bluetooth / Wi-Fi / depends dependent on GUI
- ↳ Control System (Power) / (Controlling it)
- ↳ GUI
- ↳ VR

Sensors / Processors

- Gas } (Stephane)
- Infrared }
- Lighting } (Adrian)
- Noise }

Communications (Lemke)

- Human Interaction

Control System

- actual controlling via PID or other systems: Nelson
- currently speed controllers are there
- mechanics

GUI

- which language?
- Overlap

VR

- HUD?
- How to create movement

(Elizabeth)

Lemke

To do

- ~~Done~~
- Meet w/ Advisor
Done 10/17/18
- Set topics for proposal
Done 10/17/18
- Meet @ the GTR II Lab
Done 10/27/18

3 # Use Double Tread Robot body

Advisor Meeting

10/17/18

Research Technical Paper

due next Monday

- reasonable at this moment
- meant to get you started
- not binding or restricting

Send it for critique from Graber

- send it in Friday / Sat Saturday &

Create One Drive Folder to get access to the remaining information

- currently have access to Z
- 10MB size
- give Graber access

Team Organization

- Leads
 - Website
 - Communication
 - Topics
- ↳ may split via the papers

Successful Teams

- great mgmt
- clear roles
- work ethic
- organized

Start w/ Weekly Updates

- have slides prepared for Graber each week
- Gantt Chart (Timeline P)
- subject to change

Workshop Space ??

- VL 373?, Senior Design Lab, Current Lab
- Check out maker space for availability of space
- Meet next week in Lab where robot is located
- His office space is a possible option (additional key)

Meeting Space

- remain flexible

10th St.
ABeyel

Topics

- Sensors pt. 1 (Adrian)
- Sensors pt. 2 (Stephanie)
- VR (Elizabeth)
- Communications / GUI (Lemke)
- Control System (Nelson)

Possible Ones to consider outside the paper

- Mechanical
 - scissor lifts, etc.

Proposal

- Financials
- Gantt / Schedule
- Overall plan

★ To do

- Write technical paper draft on control system

10/29/18

Meeting @ the GTRI Lab

Can use the google Tango tablet for 3D modeling
↳ this uses Kinect & OSLe-AM

Previous sensor tower has cameras & sensors that are working

We are able to work on the robot in the lab if we need to

Make sure they don't empty sensor design locker over Christmas break

Let Dr. West know which sensors we need, since he might have them for us to use

To - do

- Start working on Assignment #3

Done 10/30/18 ✓

- Develop CPM / PERT Charts for assign. #5

Done 10/31/18 ✓

- Meet w/ team to discuss answers

Done 10/31/18 ✓

5

Group Meeting

10/31/18

Senior Design Locker 51

Combination

0-0-9-0

← may change

Writing Down Tasks to complete

Assigning times

Then creating our CPM chart

Then creating our PERT chart

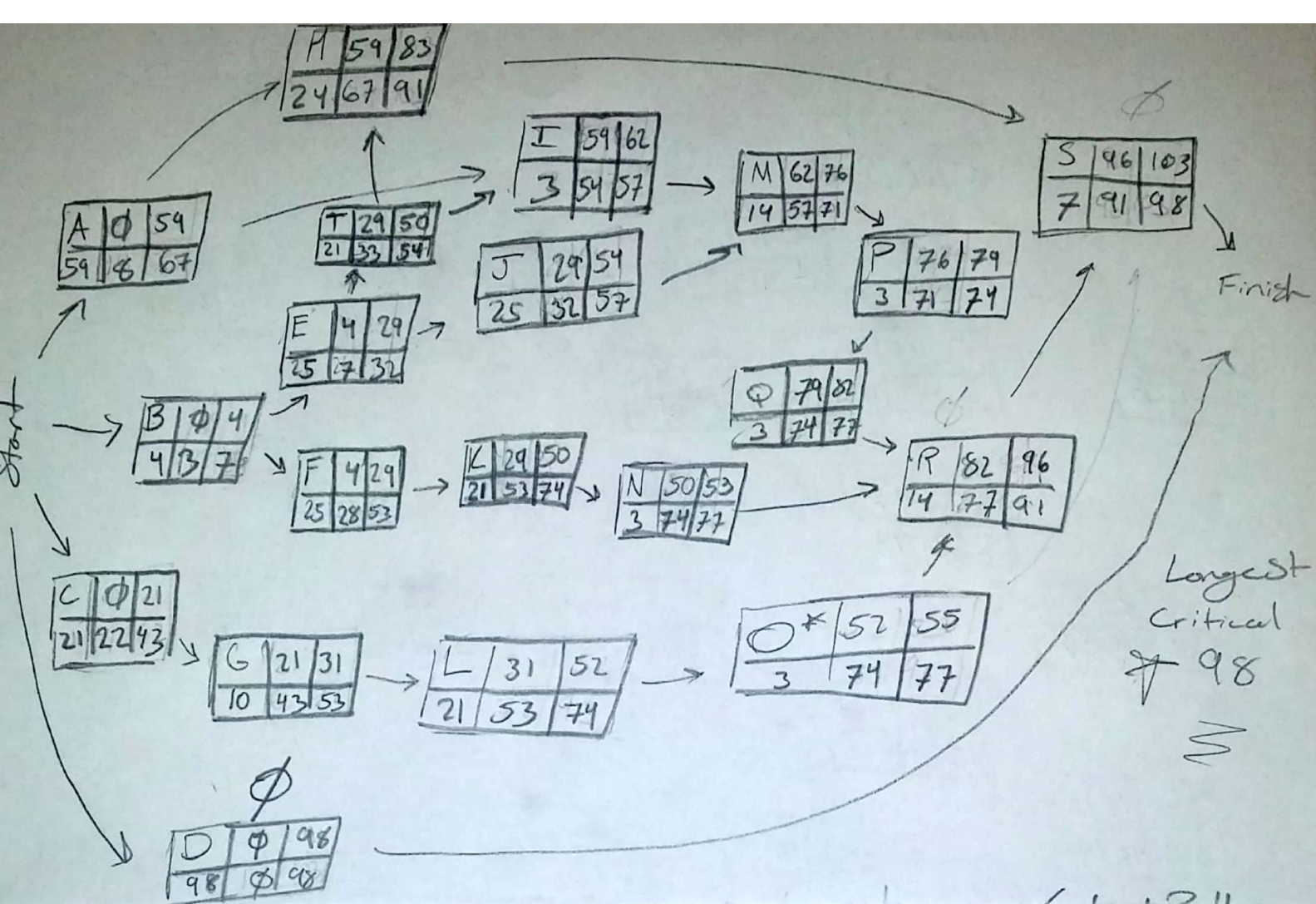
Tasks to be completed

~~Design Mechanical System for Camera~~

- > GUI Design
- > Scrapping robot / testing parts for usability
- > Mechanical Arm CAD design
- > Deliverables
- > Sensor Package Schematic
- > Control System Design
- > 3D prototype of mechanical arm
- > Testing communications w/ GUI
- > Testing sensor parts
- > PCB design for sensor parts package
- > Order motors/controllers for control system
- > Order materials for mechanical arm
- > Print PCB
- > Integrating control system into robot shell
- > Assemble mechanical arm onto robot
- > Soldering PCB
- > Mounting PCB to robot
- > VR Integration
- > Final Testing
- > Order sensors

Created our CPM diagram using Draw.IO
in google drive

Created Gantt Chart using a template online



Critical Paths
Pessimistic

Slack

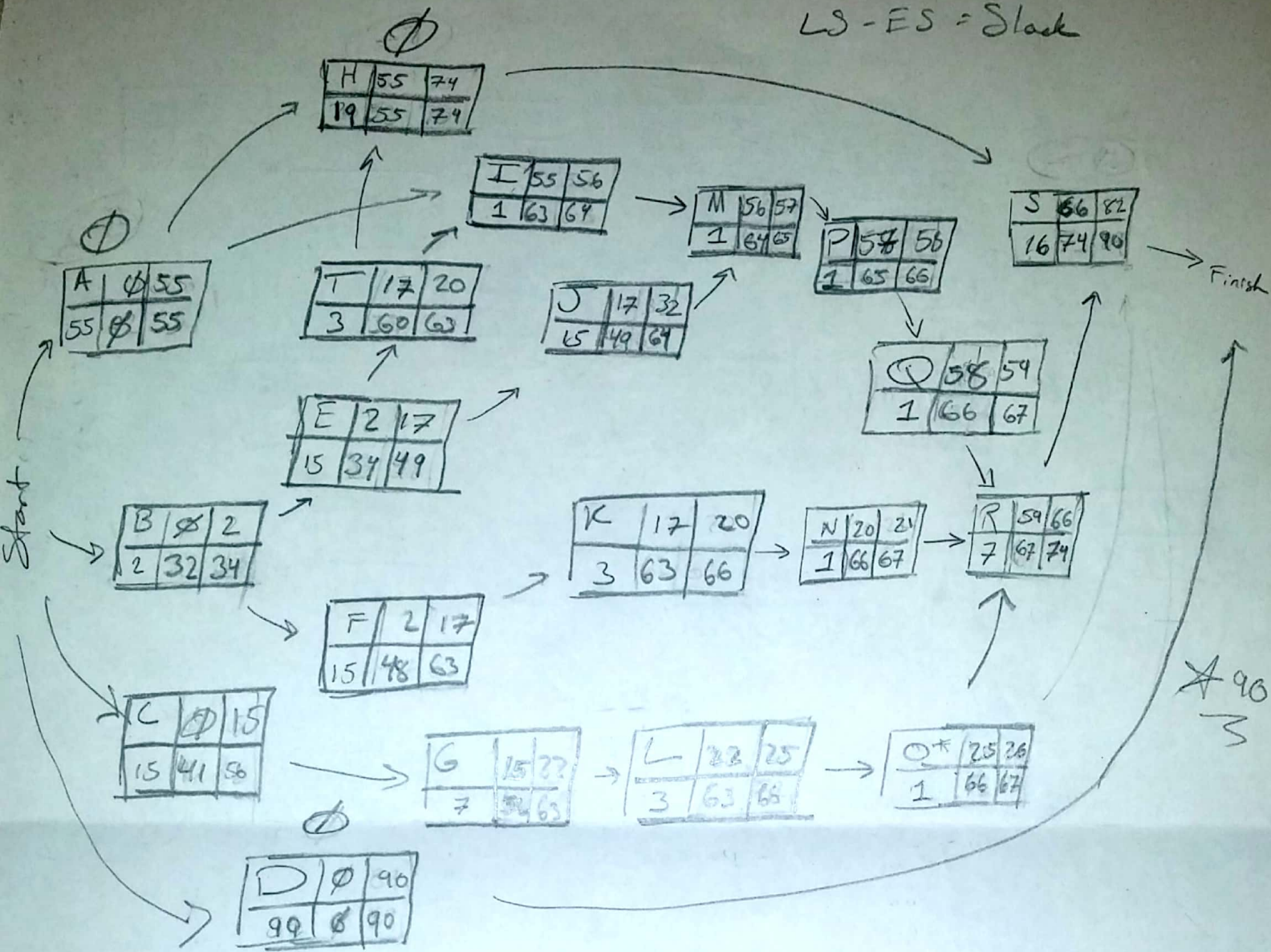
A 8
B 3
C 22
D 0
E 3
F 24
G 22
H 8
I 5
J 3
K 24
L 22
M 5
N 24
O 22

P 5
Q 5
R 5
S 5
T 4

No Critical Path
D

Handwritten signature
(Typed in Ntkk)
Page 7

LS - ES = Slack



Slack

A 0
B 32
C 41
D 0
E 32
F 46
G 41
H 0
I 8
J 32
K 46
L 41
M 8
N 46
O 41
P 8

Q 8
R 8
S 8
T 43

90 is greatest Critical Paths

Optimistic

D < only

Activity?

NR

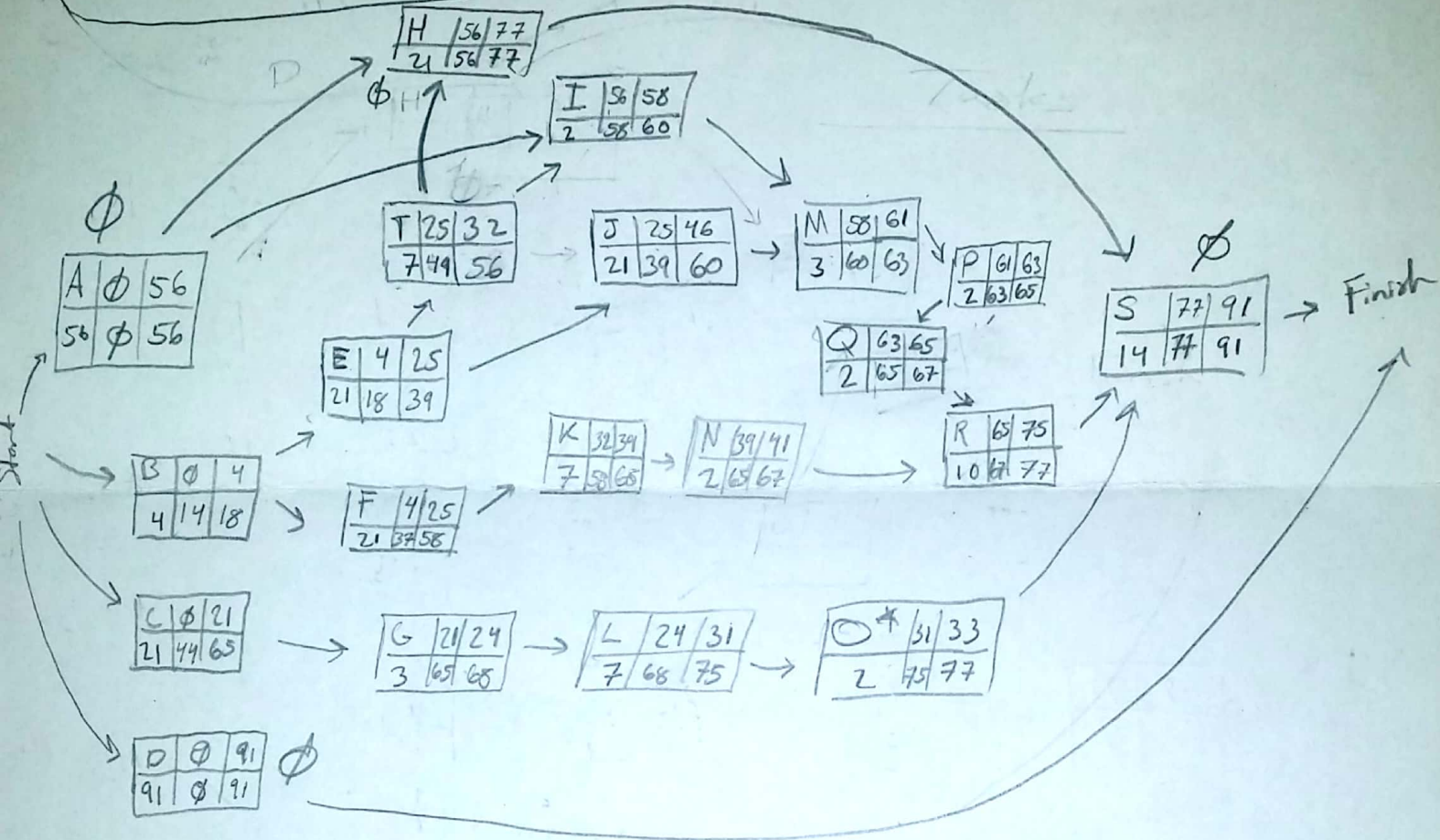
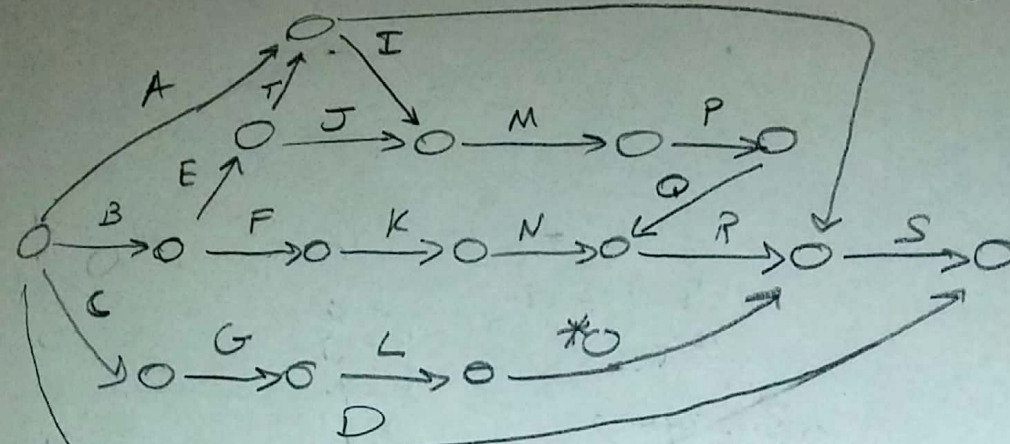
Taped in Ntbbk

(Page 7)

Project Planning

Critical Path Map

Senior Design 4011



LS-ES

Slack

A	0
B	14
C	44
D	0
E	14
F	33
G	44
H	0
I	2
J	14
K	26
L	44
M	2
N	26
O	44
P	2
Q	2
R	2
S	0
T	24

Critical Paths

Most Likely

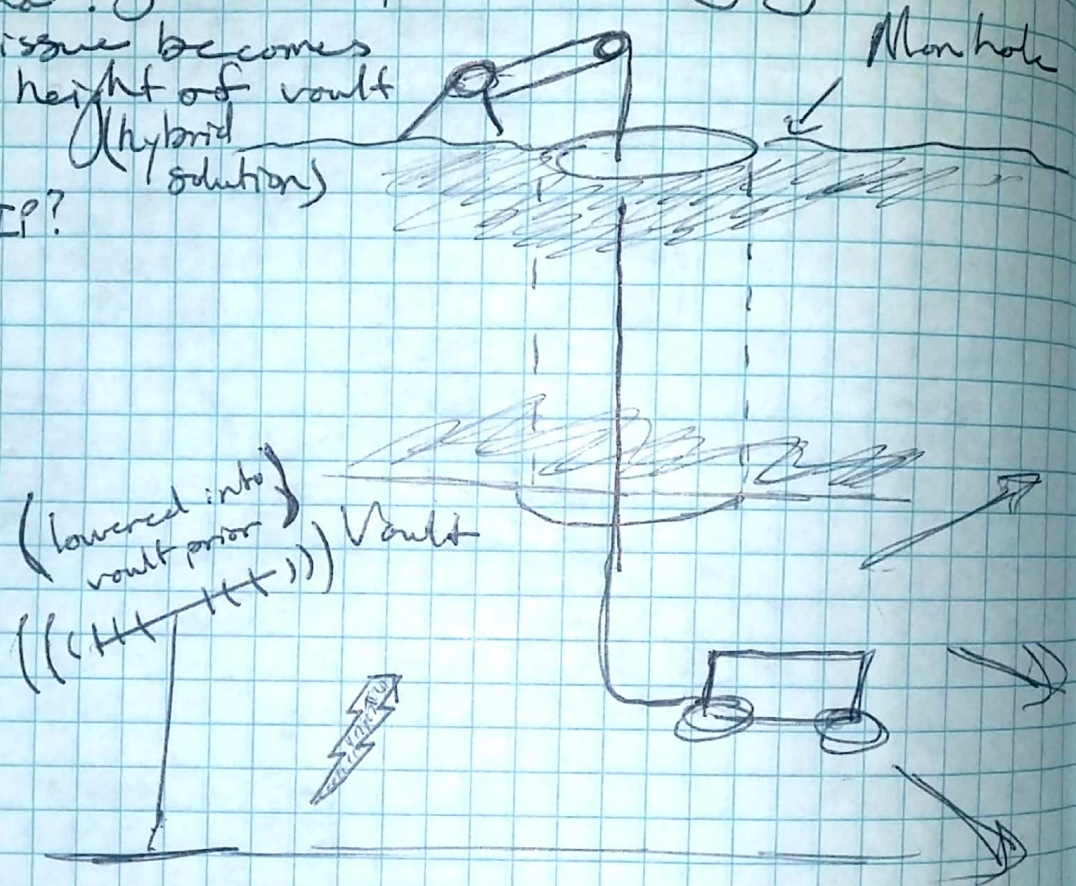
→ A H S
→ D

Handwritten signature and text: Taped in Notebook (Page 85)

Tethered vs. Ethernet

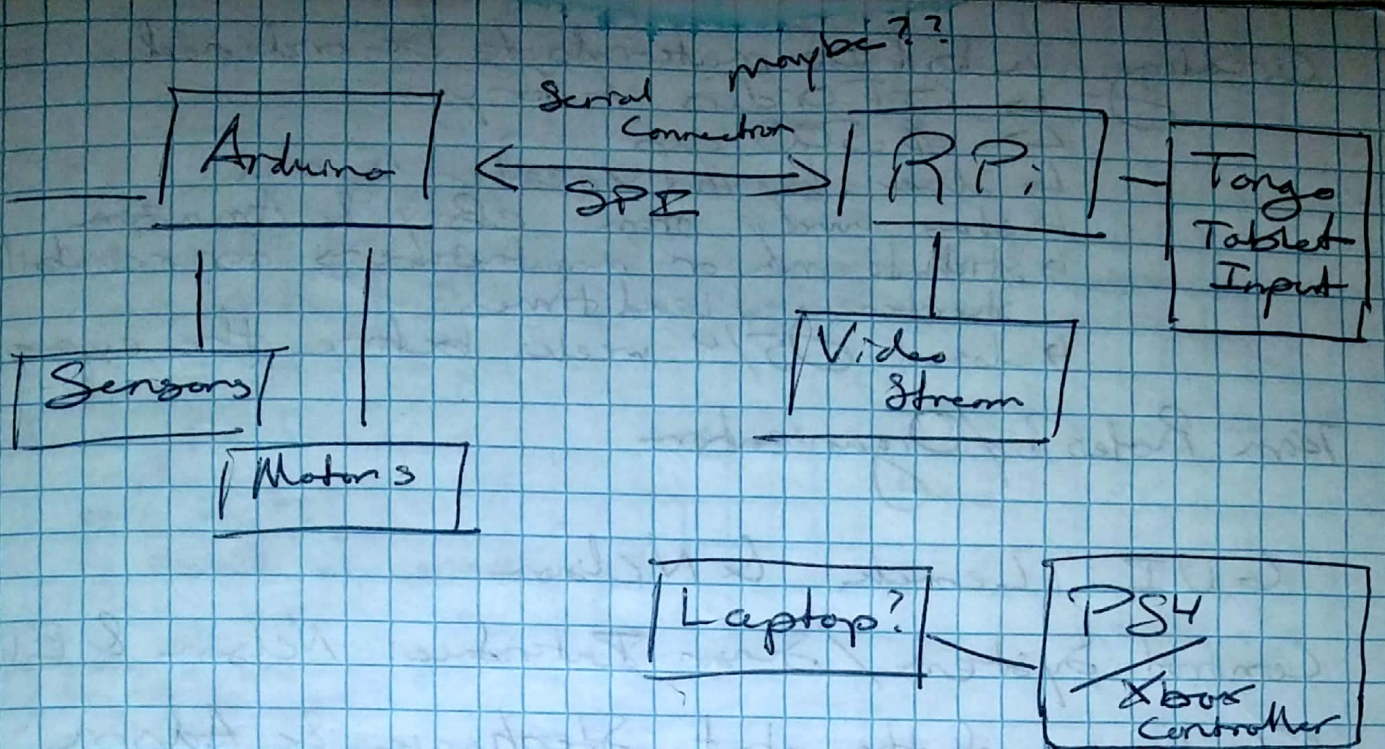
Tether

- > how long the tether needs to be to lower it
- > managing the the tether so it isn't tangled up on objects
- > navigating in the dark
- > electrical hazards pose on risk to operator
 - ↳ exploring fiber optic as an alternative
- > mgmt. programs to prevent tangling the cord
- > antenna?
 - ↳ issue becomes height of vault (hybrid solution)
- > TCP/IP?



Ethernet

- > not as reliable in this vault situation
- > sending at a lower frequency
 - ↳ data rate drops
- > standards to consider
 - ↳ bluetooth
 - ↳ zigbee
 - ↳ SMS (text msg)
- > high bandwidth & reliable protocol needed for video



Control: Having modular code to communicate w/ both!

GUI

↳ Kivy (Python-based)

Control Hardware (Interfaces)

Send info over ethernet (UDP)

↑
Arduino

Tango Tablet?

↳ which one will it communicate w/ ?

↳ RPi or Arduino

Robot has?

↳ Speed controllers

↳ Uses R/C at the moment

* Batteries
need to
be replaced *

Texas Instruments

↳ Processors...

↳ High clock Frequencies

RPi

↳ controls hardware as well & we expand the # of ports

↳ plug sensors into a USB hub

Creating a bill of materials to be ordered
↳ GT orders it for you
↳ \$500 cap
↳ due by this semester 's end
↳ stay away from eBay & Amazon
↳ stick to major manufacturers for reliability & shortening lead times
↳ closed 3/4 weeks before the expo

Team Roles? / Organization

GUI: Lemek & Nelson

Control System / Sensor Interface: Nelson & Elizabeth

Electronics of the robot: Stephanie & Adrian

Mechanical Arm:

To do List

- > Sort out capabilities of Arduino & Raspberry Pi components Done 11/12/18 ✓
- > Create basic block diagrams indicating hardware setup Done 11/14/18 ✓
- > Begin + slot cad drawing for mechanical arm Done 11/26/18 ✓

RPI

- ↳ has GPIO
- ↳ only 2 one for PWM (use these for servo movement)
- ↳ simulating the rest of the PWM

Arduino Uno

- ↳ Analog In
- ↳ Analog Out
- ↳ PWM 6 pins

Biggest Issue

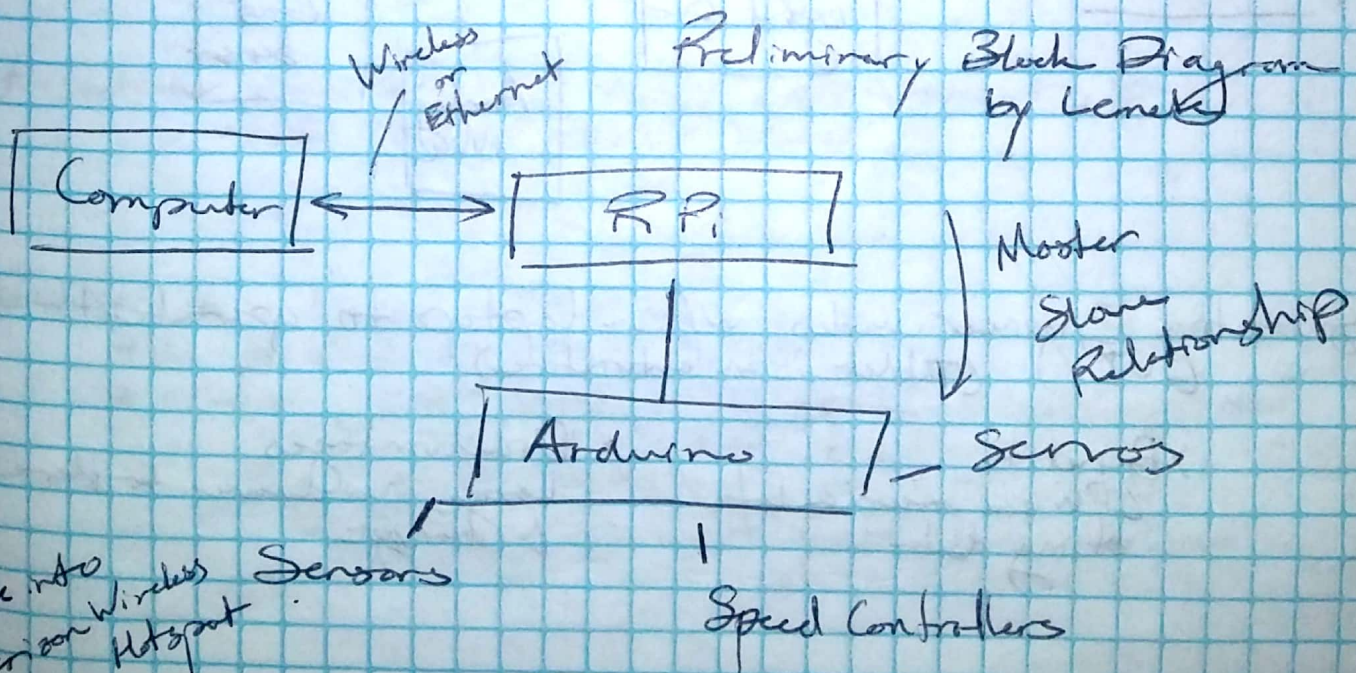
- ↳ Outsource
 - Analog
 - ADC/DAC Converter
 - PWM
- ↳ Processing

Block Program to be made for operation

- ↳ Bring to Graber

Camera on Lift

- ↳ plastic bubble (for water proofing)
 - issues w/ resolution
 - issues w/ dust



To-do List

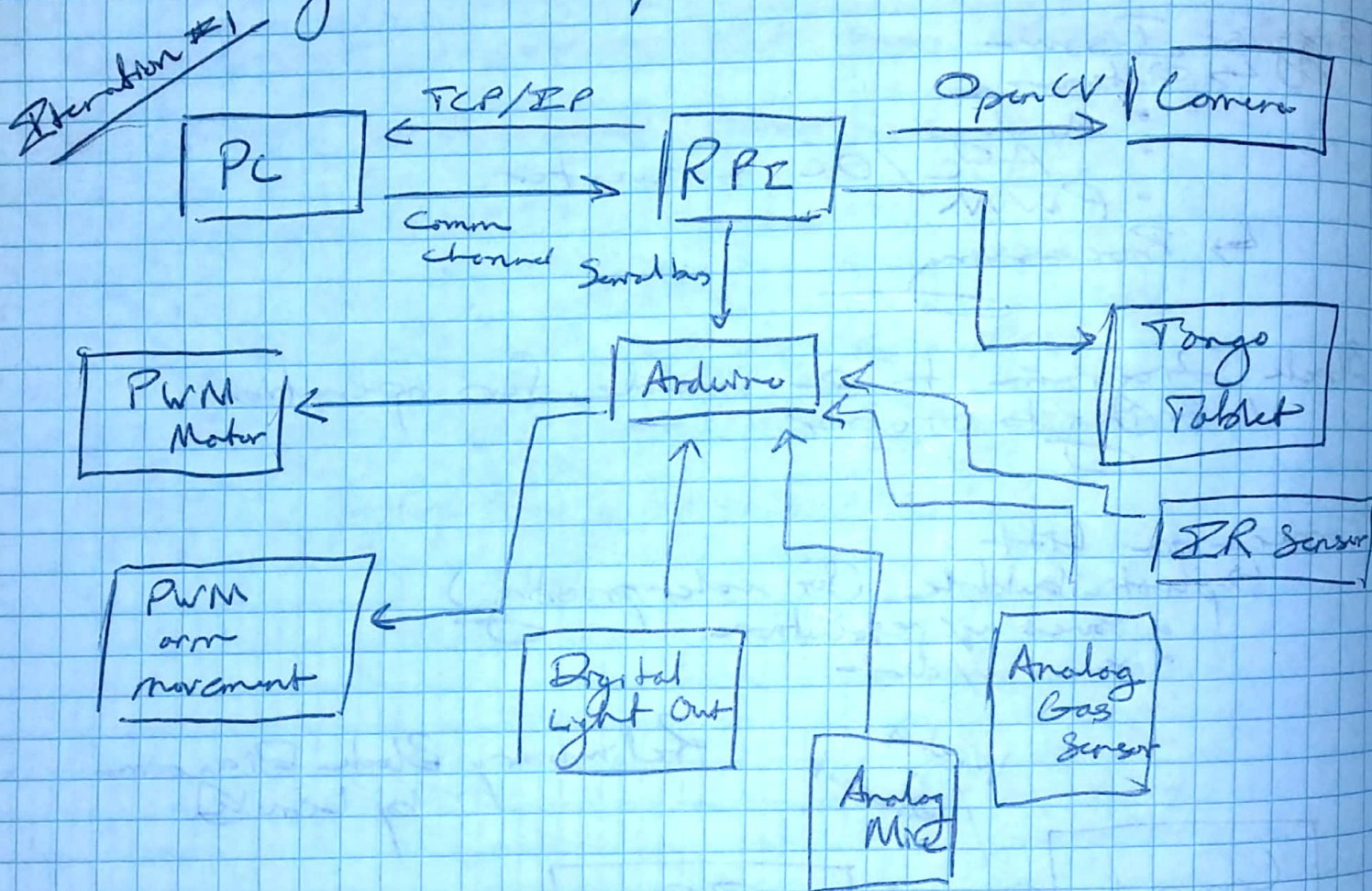
11/12/18

- Bill of Materials (End of semester) Done
- Block Diagram due Wed 11/14 ✓
- • hardware
- • communication
- Bring web templates due Wed 11/14 ✓

Team Meeting w/ Advisor

11/14/18

Hardware Diagram made by Lerick & Adrian



Substation Engineer works w/ a laptop to operate the GUI (Tablet is an alternative)

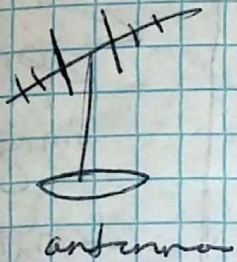
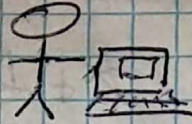
> Benefits

GPU can process a lot of data

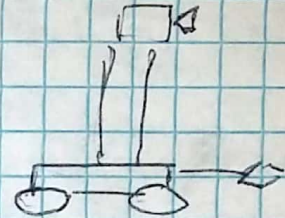
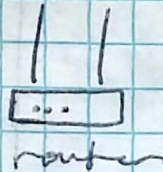
> Disadvantages

Large hardware to store & manage

All Antenna uses wifi to communicate w/
the robot in the vault possibly



or



* we may fit a router inside the robot to protect it *

* Considering other output devices &
- i.e. phone, tablet, laptop

* VNC Viewer
- communicating w/ RPI through wifi on
IP/Mac address

* Caution against too many components &
- work division possible issue

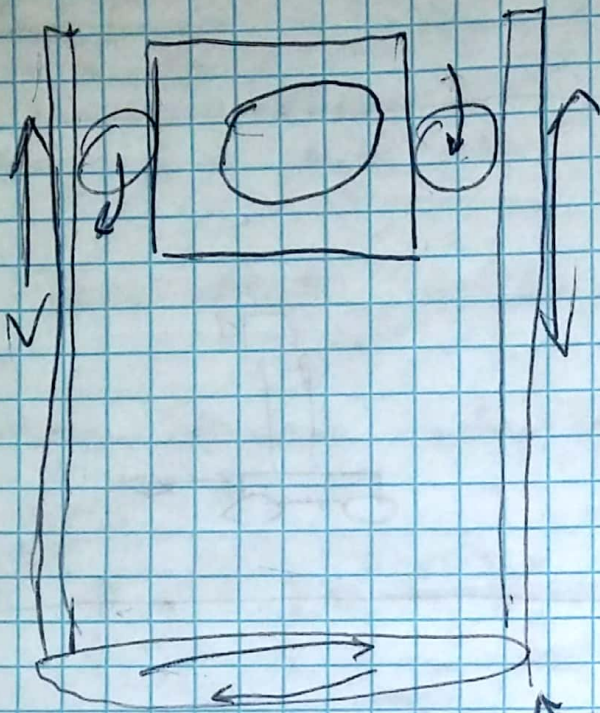
Decide on 2 more iterations

↳ do pro/con for all 3 iterations

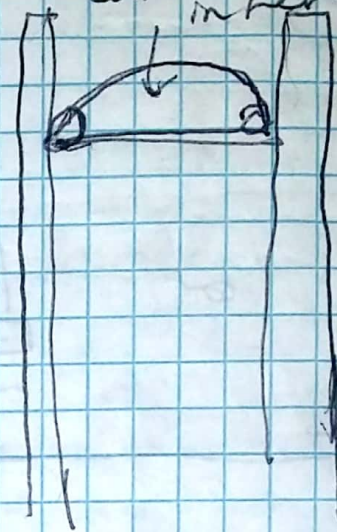
↳ choose best iteration to guide design approach
↳ will guide bill of materials
↳ will guide writing proposal as well

Handwritten signature or initials.

Camera Build Ideas by Lemek & Stephanie



* take into account center of gravity *
camera in here



split the image
design a better one
in CAD

may not need the bottom rotation because the robot can turn in place

Aluminum T-slot profiles (google it)

Fasteners
Rigid
Tubing

Build the structure & add the fasteners
↳ quick prototyping

- 2 iterations of this design

1 w/ T-slots & dome

Another w/ the other method

- How do we bring robot into the vault?

To-do List by next meeting

- > Draft Proposal by next Tuesday (Everyone) Done ✓
- > Meet Monday ~~1/19/18~~ Done 11/19/18 ✓
- > CAP visualization using slots Done 12/3/18 ✓
 - ↳ visual for team
 - ↳ foldable design?
- > Define objectives Done 11/28/18 ✓
- > Develop 2 iterations of hardware layout w/ Lemke Done 11/19/18 ✓
- > Assignment #6 & Nelson Done 11/19/18 ✓
 - Thursday before 3
 - Friday before 2

Team Meeting (no Advisor) 11/19/18

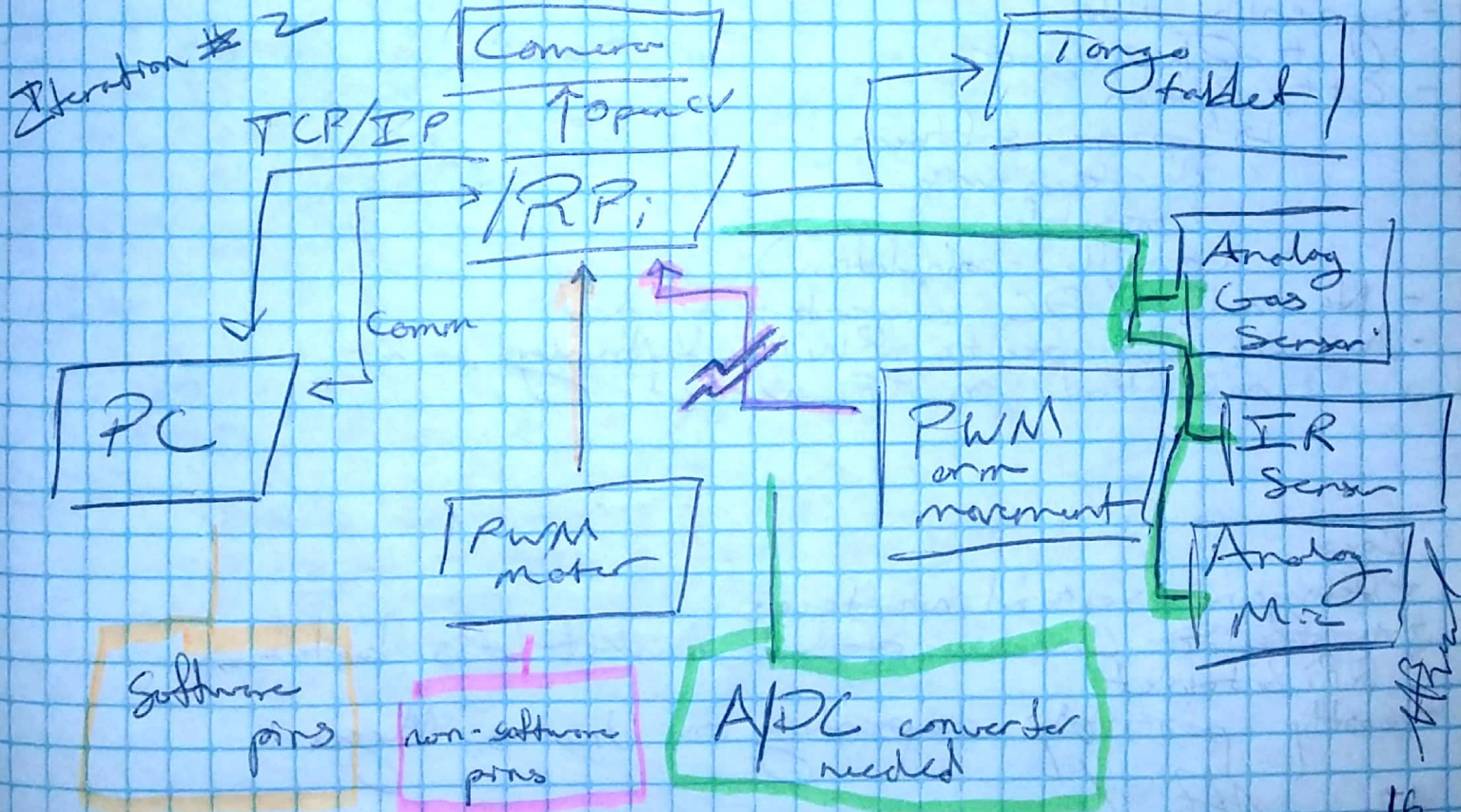
Final Proposal due next Wednesday 11/28/18

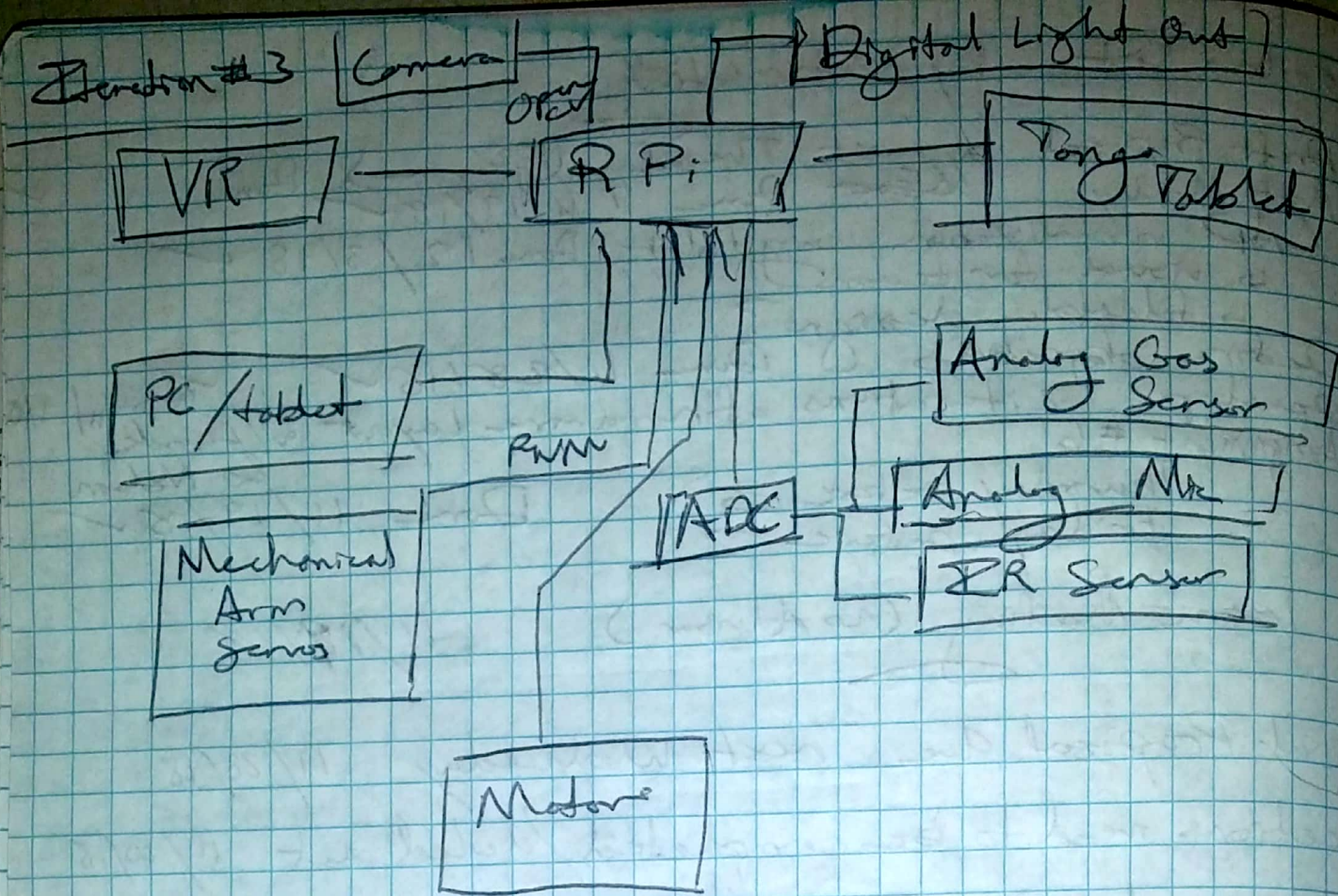
Sectors need to be completed/detected out 11/20/18

NTBles due on 12/3

Assignment #7 due 12/3

Lemke & Hardware Iterations





Iteration #1

Pros

- segmenting data to each processor
- C++ / Python
 - ↳ some software dev team-wise possible (parallel-completion)
- No analog / DC converter needed
- Arduino has specific RWM & Analog so no simulator on RPi needed

Cons

- Delaying several interfaces
- ~~more~~ Chance of data packet loss between RPi & Tablet
- Costly possibly depending on Uno vs. Mega

Iteration #2

Pros

- One programming language for everything
- No worries about communication across w/ the hardware

Cons

- > ADC needed
- > PWM has to be simulated
- > Lack of parallel of completion
Prioritizing tasks on the RR (threading would be of the processes)
- > All in python, less people know it

Iteration #4

★ ← This is the one we went with →

Pros

Same as iteration #1
+ novelty in operation

Cons

Same as iteration #1
+ VR Cost
+ Interfacing VR w/ Pi
+ 2 person use

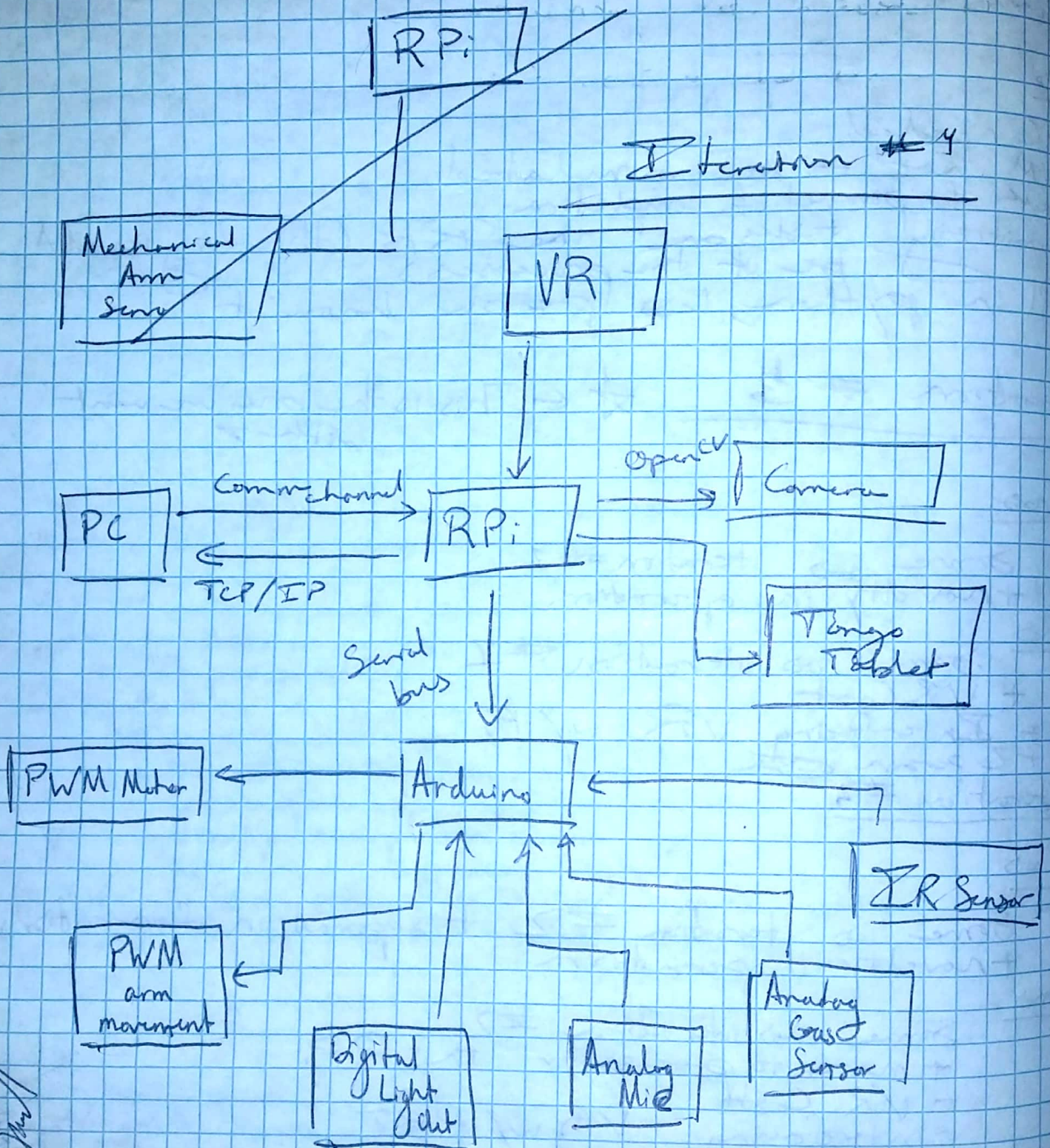
Iteration #3

Pros

Same as iteration #2 + separation of operations
+ novelty in operation

Cons

Same as iteration #2
+ more to process for the RPi
+ VR Cost
+ Interfacing VR w/ RPi
+ 2 people person use



To Do List

- Print out completed drawing of T-slot component
Done 12/21/18 ✓
- Visit Power Vault next week
Done 11/28/18 ✓
- Complete Problem #2 for Assignment #7
Done 12/1/18 ✓
- Complete final computer generated block diagrams for proposal
Done 11/28/18 ✓

AB

Advisor Meeting @ Burger Henry Power Vault

11/28/15

In the vault

Cases that would be present in the vault bonus to test for: Subur



This may decompose for pipe

Ideal Vehicle: One that is operated by a remote control

* Preferred 2-man operation *

↳ Using the VR controller

↳ Another actually observing the values & readings

Light: We may need to put it on the side of the sensor arm or control it to reduce glare on the windows of the gauges

Here are some possible problems we may run into outside of the vault:

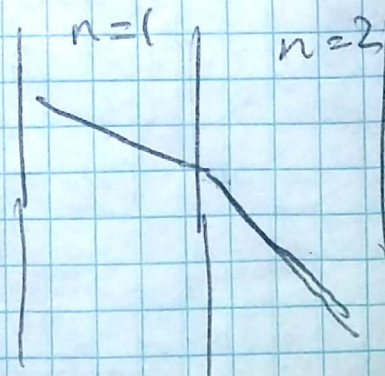
- cables that run everywhere, so it impedes that navigation of the robot

- Outcasts

- vaults may need to be pumped out so submerging the robot won't do well for gauge observation

(Refraction index issues)

- Getting our antenna down in the vault would be challenging



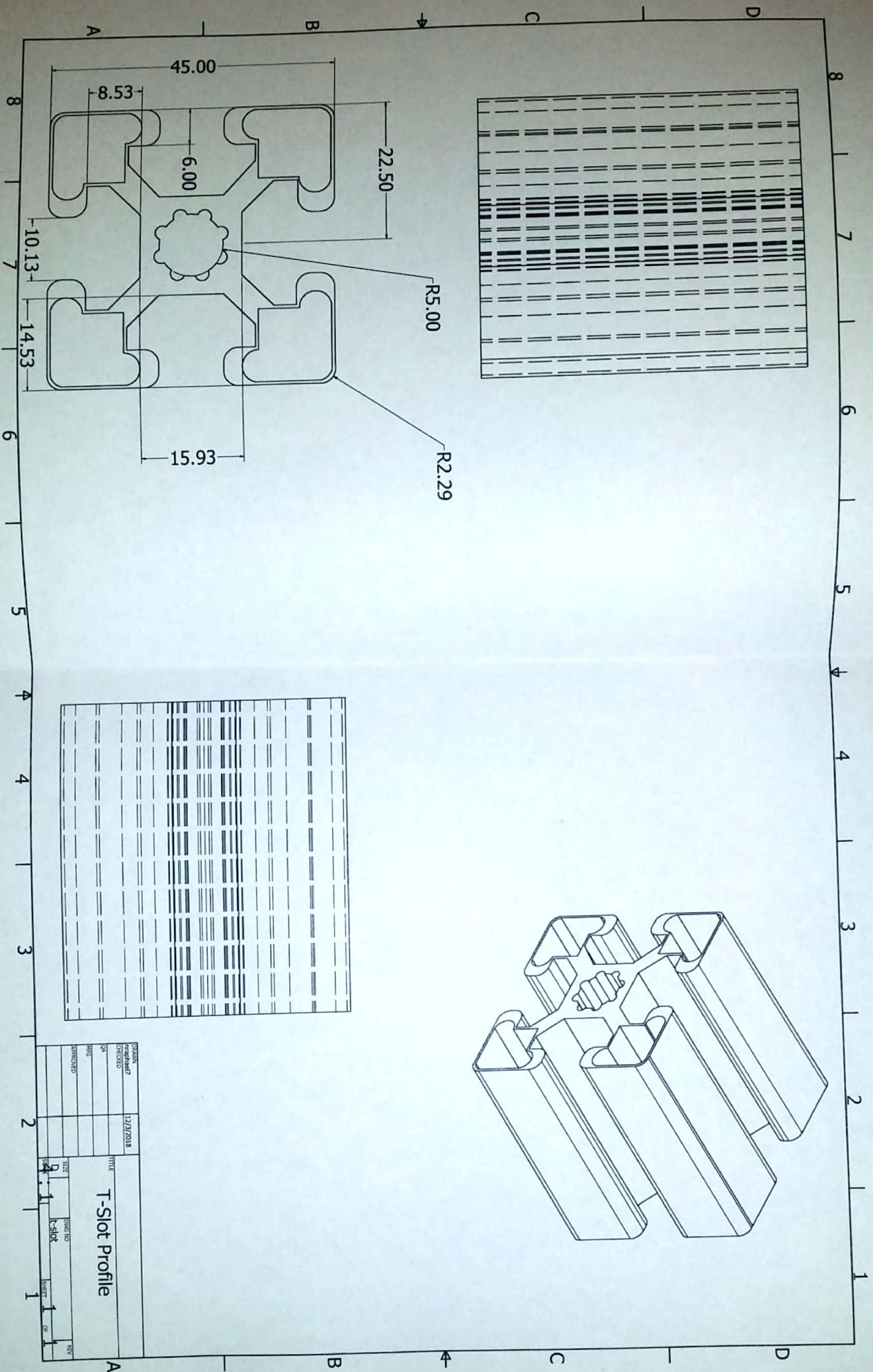
- Contact for the Burger
- Henry Vault (Tony)
↳ Graber is sending info

- Prepare for about an ankle high water level when building the robot
- We will need sensors to keep it from crashing into obstacles

To Do

- Post CAD drawing of t-slot & add it to Ntbk
Done 12/3/18 ✓
- Finish Assignment #7
Done 12/3/18 ✓
- Discuss pros & cons after visiting vault & design modifications
Done 11/28/18 ✓

APR 1



(Copied in Ntbb)

Meeting w/ Advisor

1/8/19

★ All team members present ★

Scheduling

- weekly schedule proposed (Tuesdays @ 4pm)
- NewTime (Tuesdays @ 4:30 - 5:30pm)

Updated Proposal C93 out of 100 on the current proposal

- emphasis on the block diagrams
- ★ showing how the communication works ★
- clearly design

Presentation

- give proposal presentation next week Tuesday (1/15)

+Revisions+

Mechanical Arm Design (eye-height)

- ↳ t-slots w/ fasteners, saw & screw driver
- ↳ pre-designed arm for 75\$, minimal non-hd size

Tango Tablet

- ↳ replaced w/ a Kinect camera
- ★ a tablet w/ a Kinect in it ...

Dealing w/ more than 1 PC CPU

- ↳ PC to RPi to Arduino to Tango Tablet
- ↳ possible ways to reduce complexity

Demonstration @ Capstone

- ↳ mock setup
- ↳ gauges on the poster board to be read by the robot
- ↳ adjust lights
- ↳ A few words about scenario

Expand Project Demonstration to 2-3 pgs.

- ↳ add different scenarios
- ↳ methods of testing
- ↳ what can & can't be verified

Replace Screenshots

- ↳ changes to vector graphic
- ↳ EMF EPS

Expand Schedule, Tasks, & Milestones

- ↳ state everyone's role in the project
- ↳ implement it in a chart format
- ↳ reword the list (Appendix C) reword
- ↳ add columns for names (for responsibilities)

To-Do List

- Make the presentation
- Rewrite the proposal
 - 2 sections
 - > Project Demonstration
 - > Schedule, Tasks, & Milestones
- Ask Tony for the Inspection Guidelines

✓ ✓ 4/15/19 4/15/19

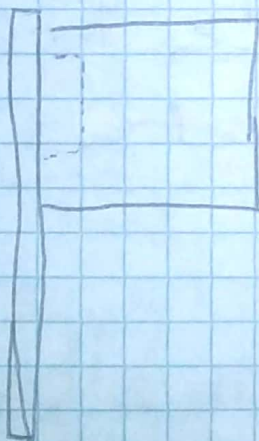
Proposal Revisions

* All team members present *

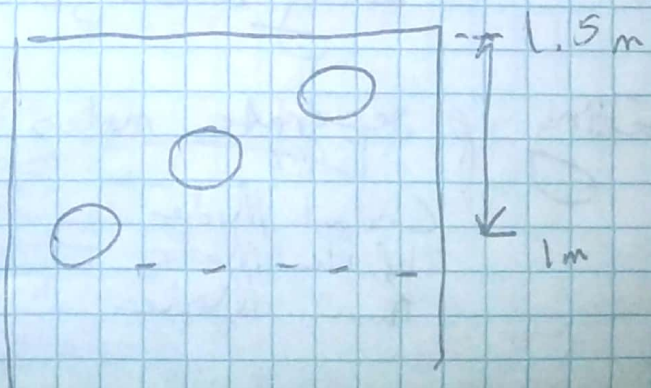
1/9/19

Project Demonstration

- Conditions we can test
 - Reading the gauge
 - Mobility of the manipulator
 - Movement response / Connectivity
 - Temperature
 - Humidity, Air Quality
 - Efficiency of the control system
- Conditions we can't test
 - Gas content (unless harmless gas)
 - Air flow / Sound



model foam board



Handwritten signature or initials.

Intentionally

Left

Blank

Meeting w/ Advisor

1/15/19

Giving proposal presentation

* All team members present *

Adjust the Gantt Chart

- ↳ possibly
- ↳ Expo
- ↳ Report + Edit

Re-do Presentation

↳ bigger font

↳ better images/figures for slides

Speed Controllers inside of the robot

↳ may be on an old standard

• PWM signal

↳ check Arduino for code examples

↳ ~~DC Brush~~

~~Speed Controllers~~

Making a new speed controller

↳ creating a new one may be trickier

↳ adding diodes, snubber ckt, etc.

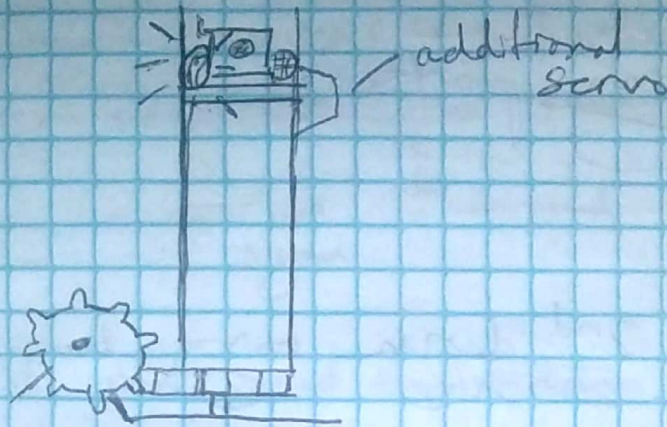
Setting up separate modes for speed

Crawl Mode

Walk Mode

Run Mode

Adding holding torque to the motor



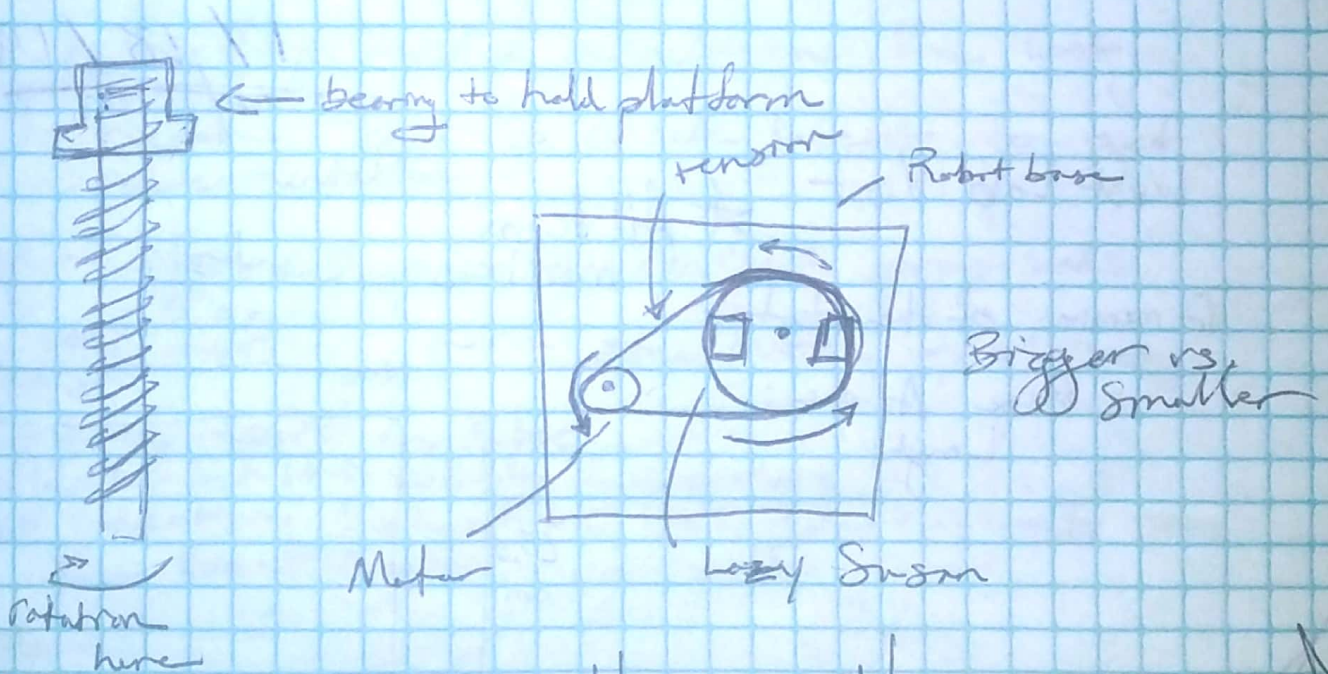
Stepper Motors? Consider these?

→ Threaded Rod? [Pre-sized]

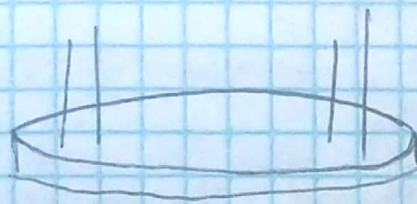
Lead Screws & Rails & Coupler

w/ Linear Bearings

Brush motors



Power Supply?
charging Method?



28

Stepper Motors 1.2 Amps

* Reprap.me
↳ ordering parts *

To-do list

- Begin / Finish 2nd design using lazy Susan in Inventor ✓
- Sensor Pkg Schematic 1/22 ✓
- Control System Design 1/22 ✓
- Testing the Sensors / Motors / Speed Controllers 1/23 ✓
- Updated proposals 1/18 ✓
- Talk w/ Lemke about Socket ✓

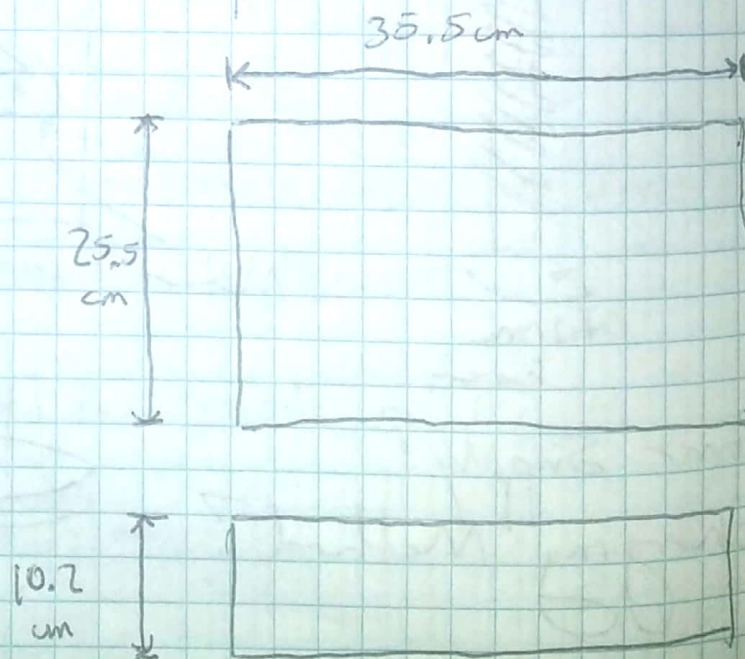
1/18/19
~~1/18/19~~

West Lab Visit

* All team members present *

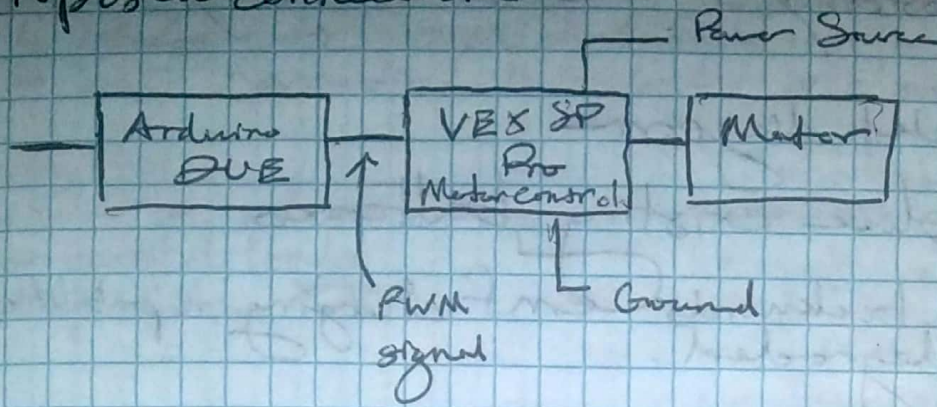
Dimensions of the robot

Base Alone:
Length



1/18/19
29

Proposed connection



Successfully manipulated the Arduino DUE within robot
Connected the speed controller

- ↳ powered it on (connected to DC power supply)
- ↳ Just need to provide a PWN signal
- ↳ PWN supplied but can not be sustained
(issue due to current draw being too great)

Meeting w/ Advisor

All team members present

1/22/19

Possible team that existed in between the last
Graber team & us

- ↳ Reach out to Nick West to get documentation

> Graber approved of our revised proposals

> Give the meeting more structure w/ slides

- title
- progress report / updates
- tasks for this week (upcoming)
- indication for where we are currently on the Gantt Chart

To do

- ↳ Prepare slides for the next meeting

1/29/19

> Develop a workaround for the I2C dilemma

- can technically be connected all together (all 3 sensors)
- can expand a different port & only do sensors necessary for the I2C on the I2C

1/29/19

30

Explore the possibility of the snubber circuit / free-wheeling diode circuit

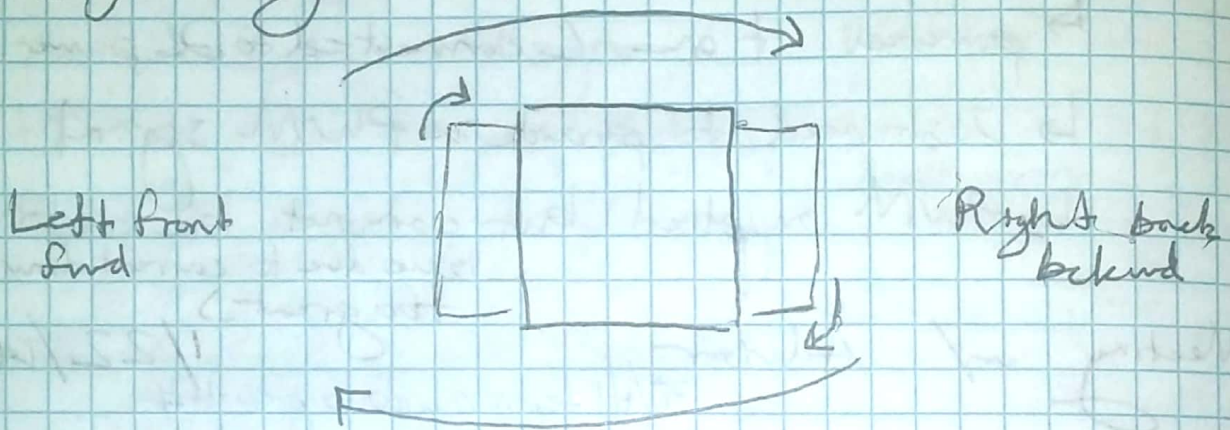
↳ need circuit diagram

May need to replace existing batteries

↳ due to backwards CapF charging capabilities were degraded.

Turn-in Place mode being designed by Elizabeth

- controlling left & right motor individually
- using the analog motors but toggle buttons for just singular motor control

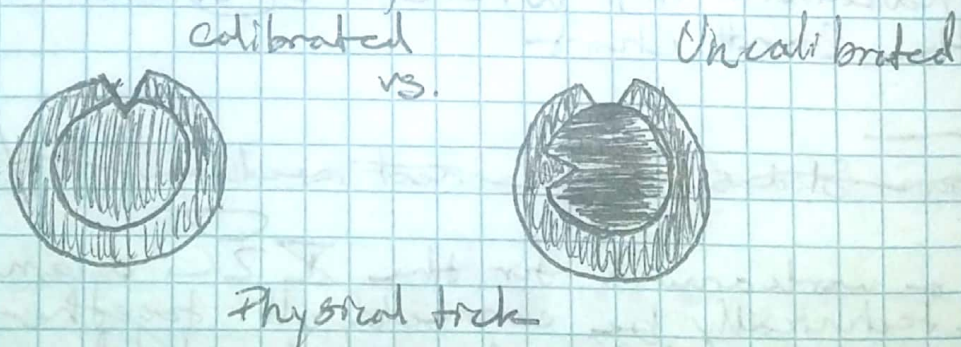


How do we know where to stop on the extension?

- using microstepping
- knowing how many turns it will be until it reaches the end

Rotating the robot & the camera (how does it know which way it is facing?)

- Physical tick to calibrate the arm before it is turned on
- An inner calibration protocol



Sensor design is a pretty good suggestion (Adrian)

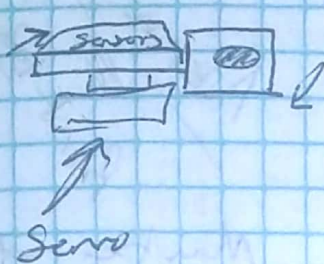
- ↳ Premature implementation
- ↳ only have time to implement one solution

Strengths

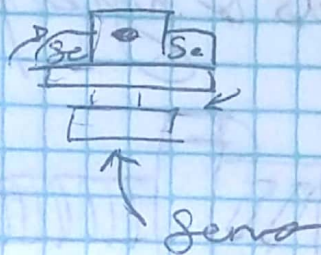
- built to be robust for vertical loads
- collapsible ***

Weaknesses

- issues w/ side loads
- not very modular in design
- imperfections cause massive disaster



vs.



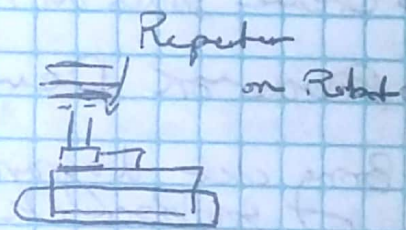
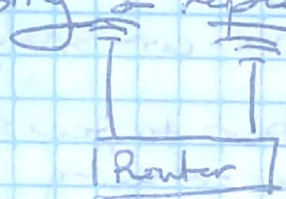
Se = Sensors

Are we trying to tilt it?

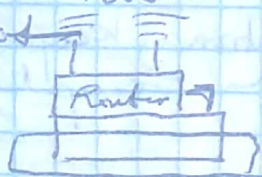
Buy another Arduino DUE

Approach for communication

Either using a repeater



Attaching the router to the robot



• ethernet connection between RPi & repeater

* ethernet is connected to the RPi on top

• possible issue is space on top of the robot for mounting the router & having the lazy susan on top

Streaming issues

• using pickle currently

(compresses images/frames, sends them over & uncompresses them)

• about to try implementing

gstreamer
↳ additional library in OpenCV

32

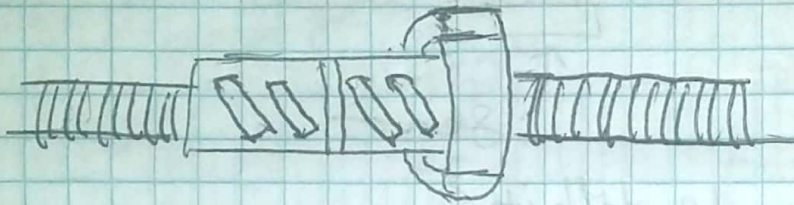
Night Vision?

- using an infrared led & implementing illuminating the whole room due to the sensitivity
- Night vision camera module for RPi 3

Lead Screws vs. Ball Screws

Ball

- higher loads & higher precision

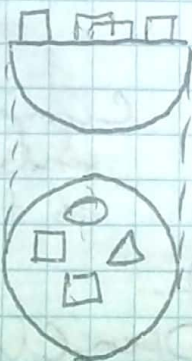


~~Nema 1.8~~
~~Print Bad~~

Telescoping Platform?

To-do List

- > Create slides for next meeting
- > ~~Revised~~ Develop a pre-con analysis for arm designs 1/29/19
- > Bring ckt diagram to Graber to see if a snubber ckt or free-wheeling diode ckt is needed 2/7/19 ✓
- > Begin on website documentation, keep it as a local hosted entity so it can be uploaded to web space 1/30/19 ✓
- > Finish Lazy - swim lead screw design on Inventor 2/5/19 ✓
- > Coming for sensor design 2/19/19 ✓



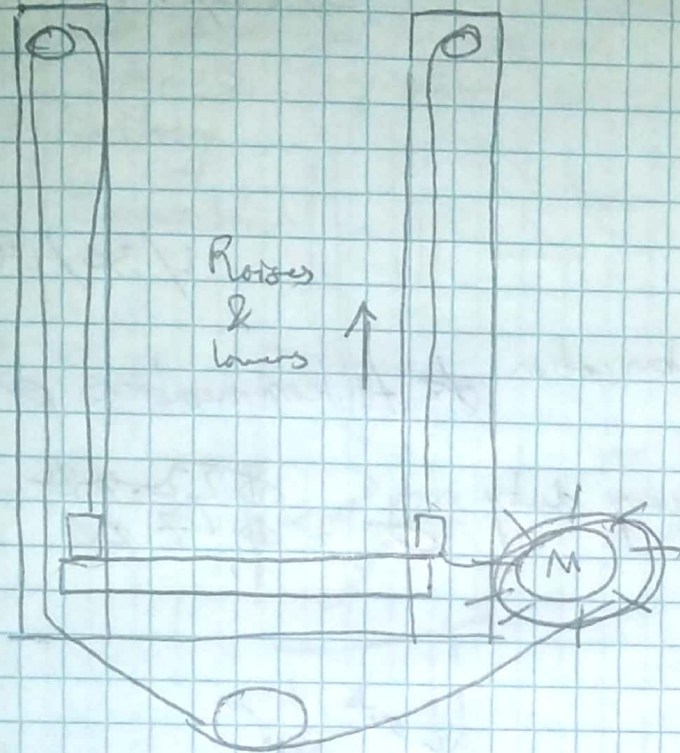
1/19/19
33

1/28/19

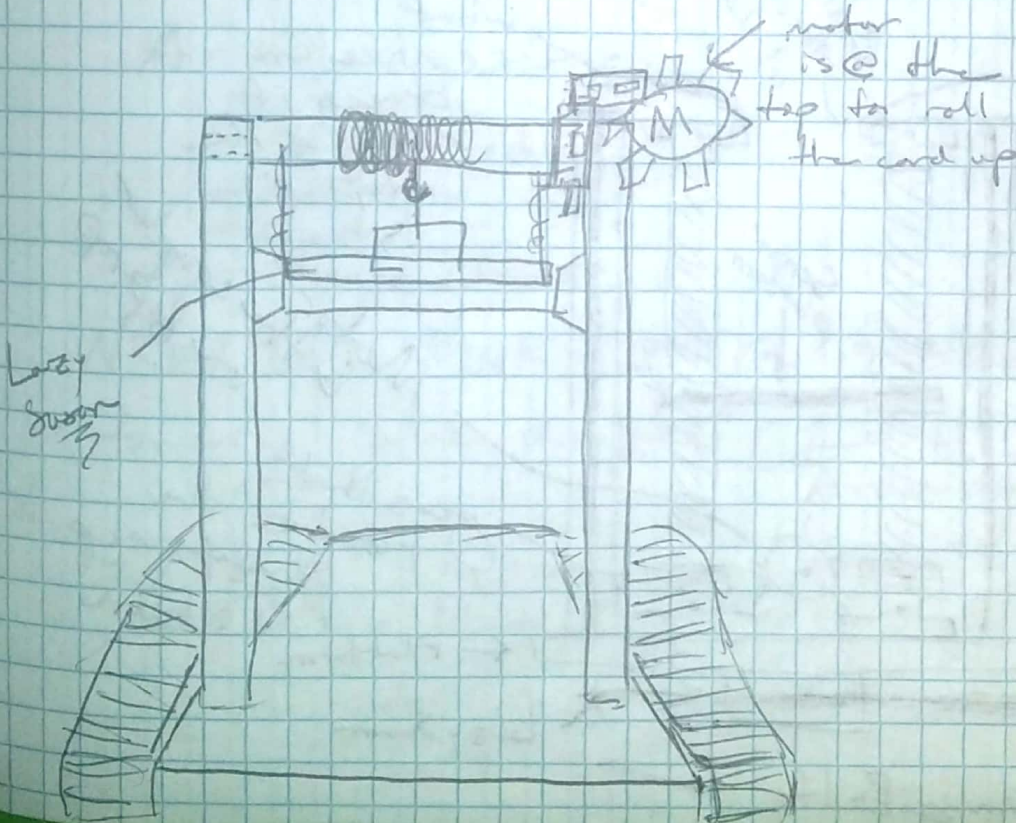
Meeting w/ just the group

★ All team members present ★

Another additional arm design to think about



Adrian has decided to go w/ a different design from the sensor lift



1/28/19
34

To-do

> Continue w/ Assembly of arm

✓ 2/8/19

> ^{Back} Begin migrating software for MQTT to raspberry pi

2/12/19 ✓

1/30/19

Continuing w/ the fabrication * All team members present *

Lazy Susan 8" heavy duty ring \$22.00

\$17.00

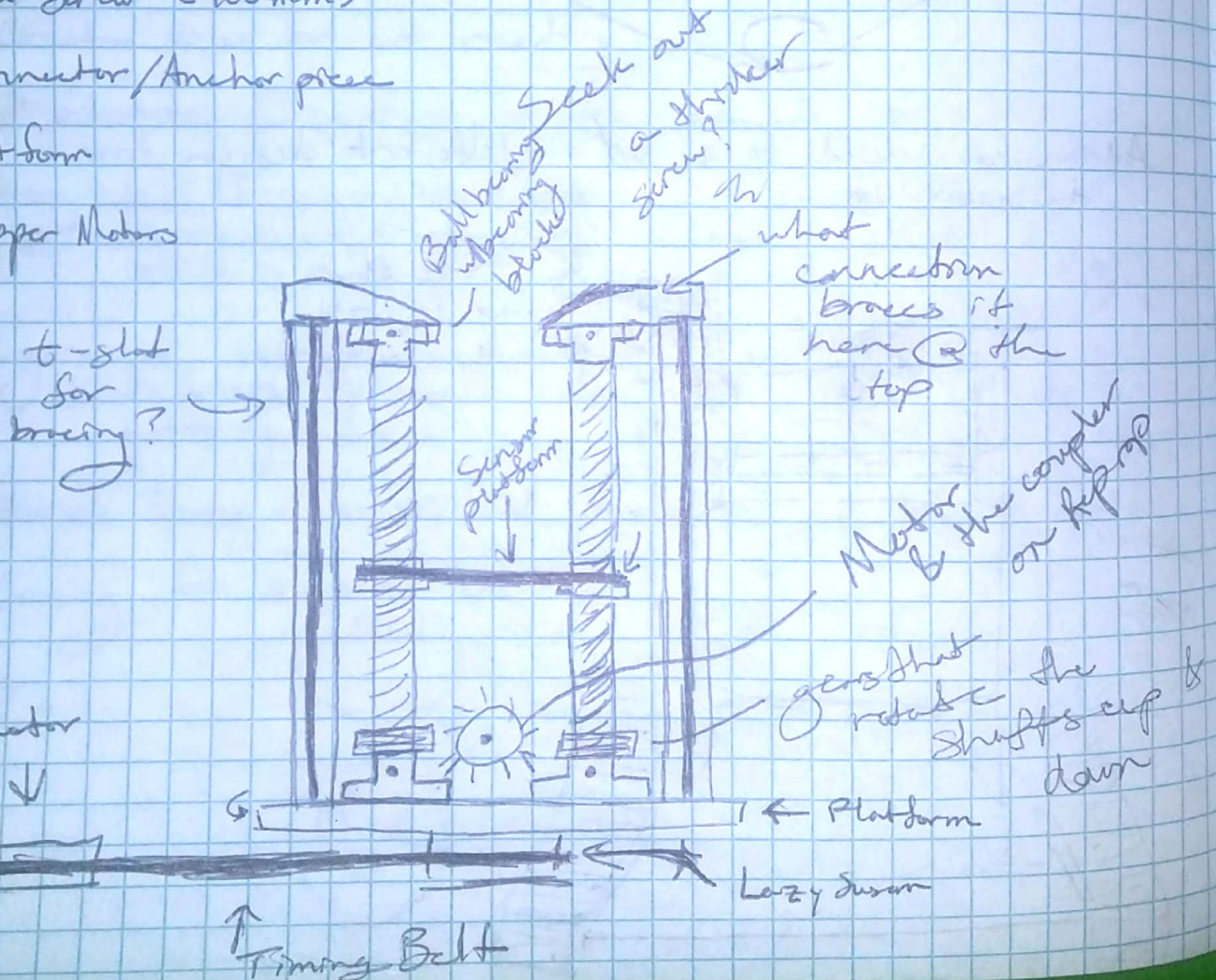
T-slot (x2)

Lead Screw (400mm)

* Connector/Anchor piece

Platform

Stepper Motors



Meeting w/ Advisor

2/5/19

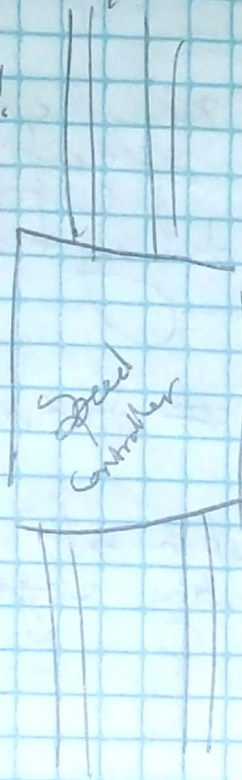
* All team members present *

> Updating Graber on West Lab visit

> Relay gives you an emergency shutoff capability!

> Equipment that isn't coming just yet.
(Air Quality sensor)

↳ Don't key
his it!
now!!



- RC Speed Controller
- 1kHz PWM signal
- Higher center value
(Faster in reverse or forward motion depending on how you ~~gasm~~ mble it!)

Air Quality sensors

- CO
- Formaldehyde
- Acetone
- Alcohol
- Thinner (Paint)

NEETRAC Visit 2/11 @ 12:30pm

Powering the device [DUE]
Arduino

- 7812 - Linear Regulator
- 7809 - Linear Regulator

[Signature]

Figure Figure out the pinout for the CO sensor
Finalize the mechanical arm design.

Don't ~~work~~

~~Lenek says:~~
~~RE~~
Lenek says:

V+
V-
GND
SDA
SCL

* Going w/ all sensors
analog for the
find ~~product~~ product

* I2C can send more
specific info
strings & numbers
during transmission

Expectations just output a # for now

Think about an addition of a graph or for
~~plotting the data~~ illustrating change
↳ just on in fact base

Recommendation

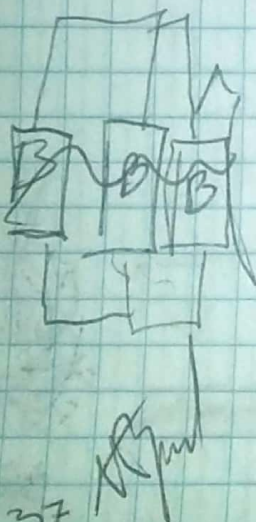
Which parts need ~~more~~ regulated power
vs. unreg

18650 cells Li ON batteries

Better Deal

>>>

Hy



~~Just for the~~ Just for the ~~needs~~ the raspberry
pi not for the motors
What is your current draw?

~~After~~
A

Series

3-5-3-5-3

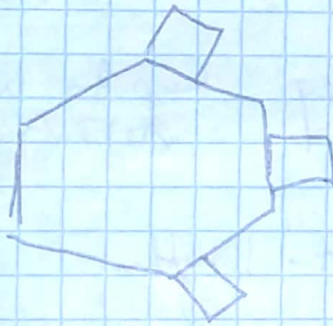
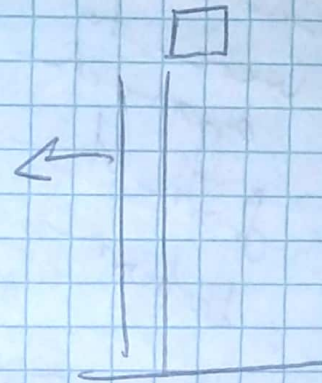
TB - do

Get new power supply! ✓

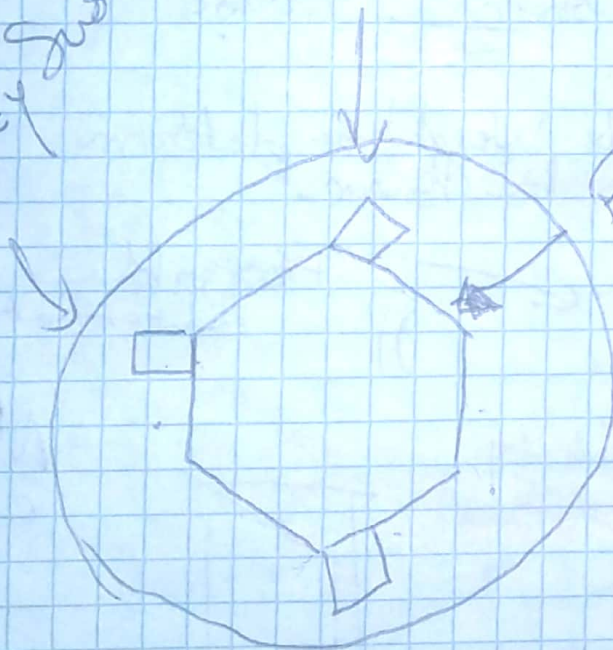
- come up w/ circuit layout for power supply
2/12/19 ✓

Pick up Samsung Battery (21700 or
- super high drain (18650)
Rough cells 18\$ for 4 cells ✓

Simplify power setup! ✓



Loose screw



Platform shape

Using a timing belt for stability instead of a long screw

MB

Meeting for Mech. Arm

2/6/19

Finishing pre-made parts

↳ machining takes too long

★ Meeting

✓ Grober & Adron

Switching out from lead screw to timing belt

↳ being careful of the weight distribution

If the camera were to approach from the bottom



⊗ this may be on or on angle

Look at the GT2 pulley (up to 10m)
Φ12.98

Kit, Epoxy Resin & Patch

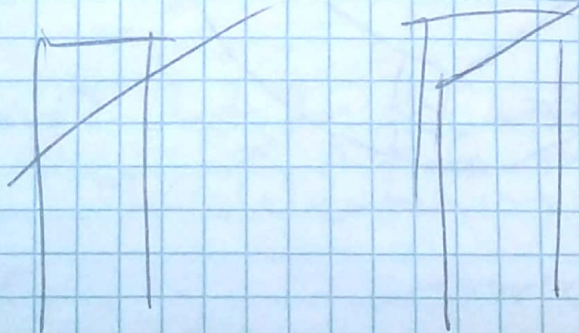
↳ Look up the length

GT2 Timing Belt Joining Videos

> Friction & Weight of platform needs to be known

2 GT Timing Belt ← Possible alternative

Tap the

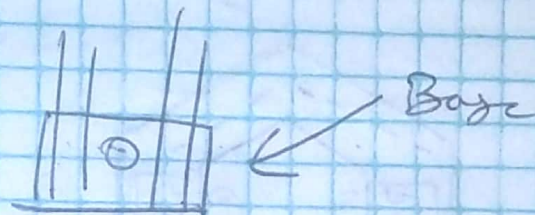


Miter cuts!

Elbow
Bracket for the t-slot

T-slot slider
- advantages
of nylon insert
to avoid

10 teeth 48 pulses 2mm pitch



McMaster Carr
Lead 2000mm
Bull Screw

Belt vs. Rod



Adrian

is
pursuing rate



Σ (Nelson) on pursuing this route

Making a new parts list for the hexagonal base

80/20 Inc

→ 6ft 45-4545-Lite T-slot \$30.75

→ ~~6ft~~ Right Hand Threaded Lead Screw (9/64") \$18.53
[635PK692] 20.8

→ Flange Nuts (Right Hand) 9/64" - 20.8 \$17.23
~~E6642K22.7~~

Mc - Master Carr

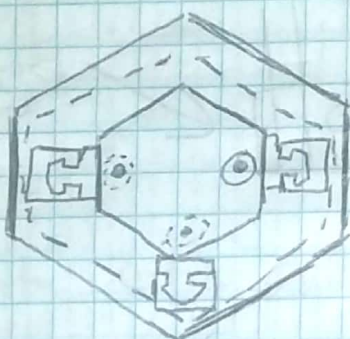
→ 6' 1/4" - 20 Lead Screw [Right Hand]: \$151.28
[1562635PK133]

Mc - Master Carr

→ Flange Nuts Acetal Plastic 1/4" - 20 [Right Hand]: \$17.10
[6350K136]
171

→ 25 Series Standard Sliding Door Glide
Profile

→ [2059] 80 - 20 10 series Standard Sliding Door Glide \$6.05



Flange Nut

Lg. 1"

Dia. 1/2"

Flange

Dia. 1"

Thickness: 3/16"

of Thread Starts: 2

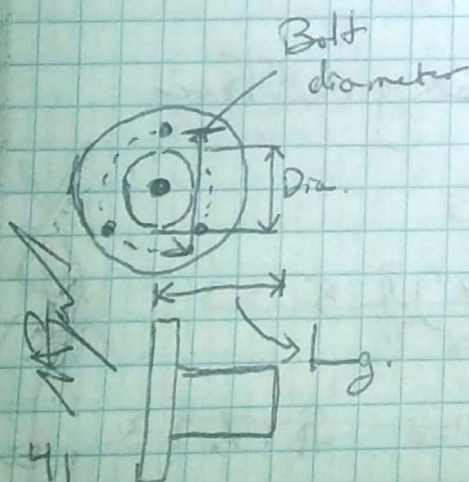
Speed Ratio: 2:1

Travel Distance: 0.1" per turn

Bolt Circle Dia: 3/4"

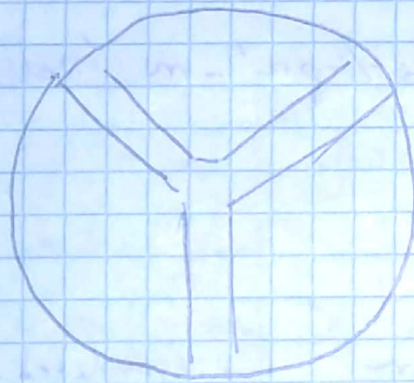
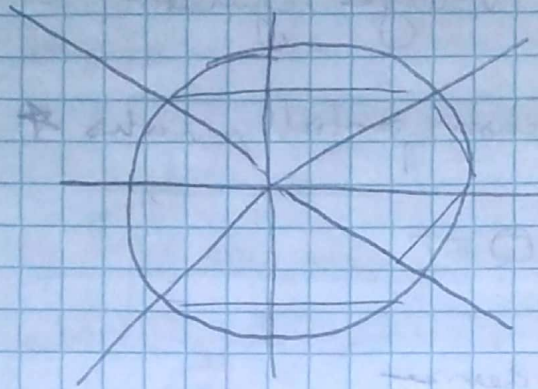
Mounting Hole

39/64"



Designing the hexagonal platform

$$360/6 = 60$$



To-do

- > Finish hexagonal base 2/11/19 ✓
- > Finalize between 2 designs 2/10/19 ✓

42

Lab Testing w/ Group

2/11/19

* All team members present *

Testing of the sensors

- Temperature sensor is a bit wonky

Heat-sink Voltage regulator

* temperature sensor partially works *

Software MQTT

On the same device

- install mqtt

Run

mosquitto_sub -v -t 'test/topic'

← for the subscriber

mosquitto_pub -t 'test/topic' -m 'hello world' ← for publisher

To-do

Fix PC to Raspberry Pi com

Completed 2/12/19 ✓

Work on Raspberry Pi to Arduino Serial com

Completed 2/12/19

13/1

Solo Software Testing

2/12/19.
★ Just Nelson
meeting ★

Client & Broker Relationship

Broker produces msgs & manages all subscribers

Need to both be on the same network

Subscriber needs to use the ip address from the broker (publishing device)

They need to be on the same topic as well

broker = "IP of publishing device"

port = 1883

topic = "topic"

def on_connect(...)

{ Callback

def on_message(...)
{ Callback

client = mqtt.Client()

client.on_connect = on_connect

client.on_message = on_message

client.connect(broker, port)

client.publish(topic, "msg") ← publishing line

client.loop_forever()

rPi Mqtt Subscriber.py — works with — pc Solo Communication.py

Keyboard

rPi Mqtt Keyboard Reader.py — works with — Keyboard Mqtt Transmitter.py

To do

2/15/19 create demo video of effective transmission

Just Nelson

44

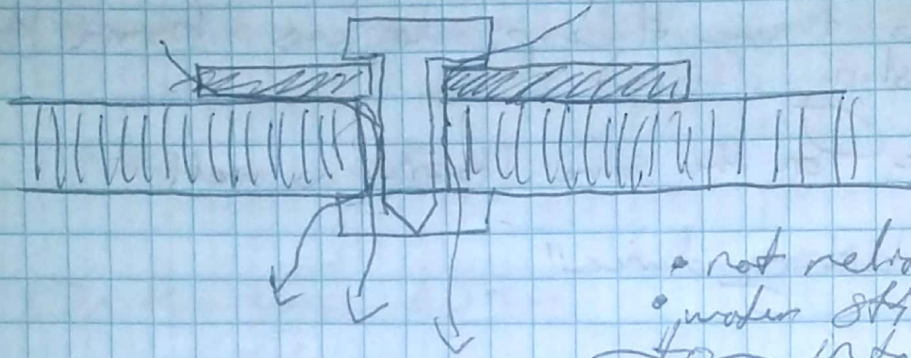
Advisor Meeting

2/22/19

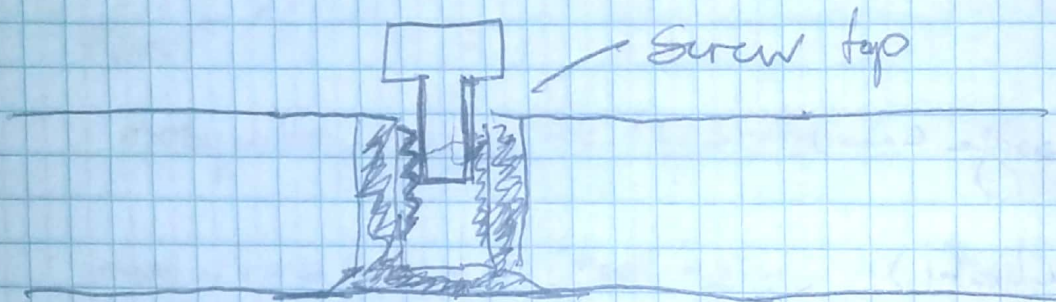
★ All team members present

Stiffening 6061 [it is pretty brittle]

↳ have to heat it up first & make it malleable
↳ too

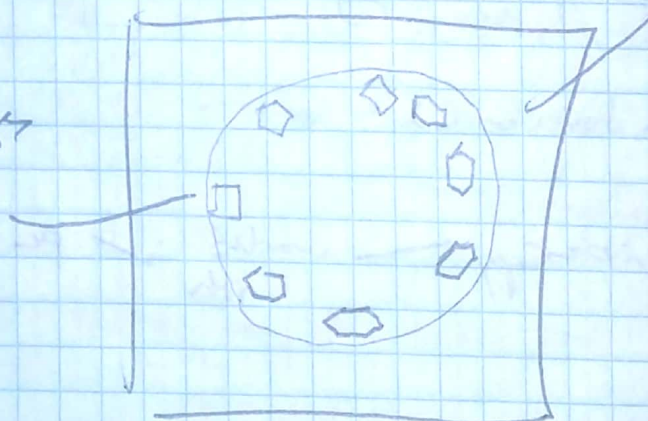


• not reliable
• water gets in stream
↳ into the robot



Epoxy is also an option

hex nuts
that
could be



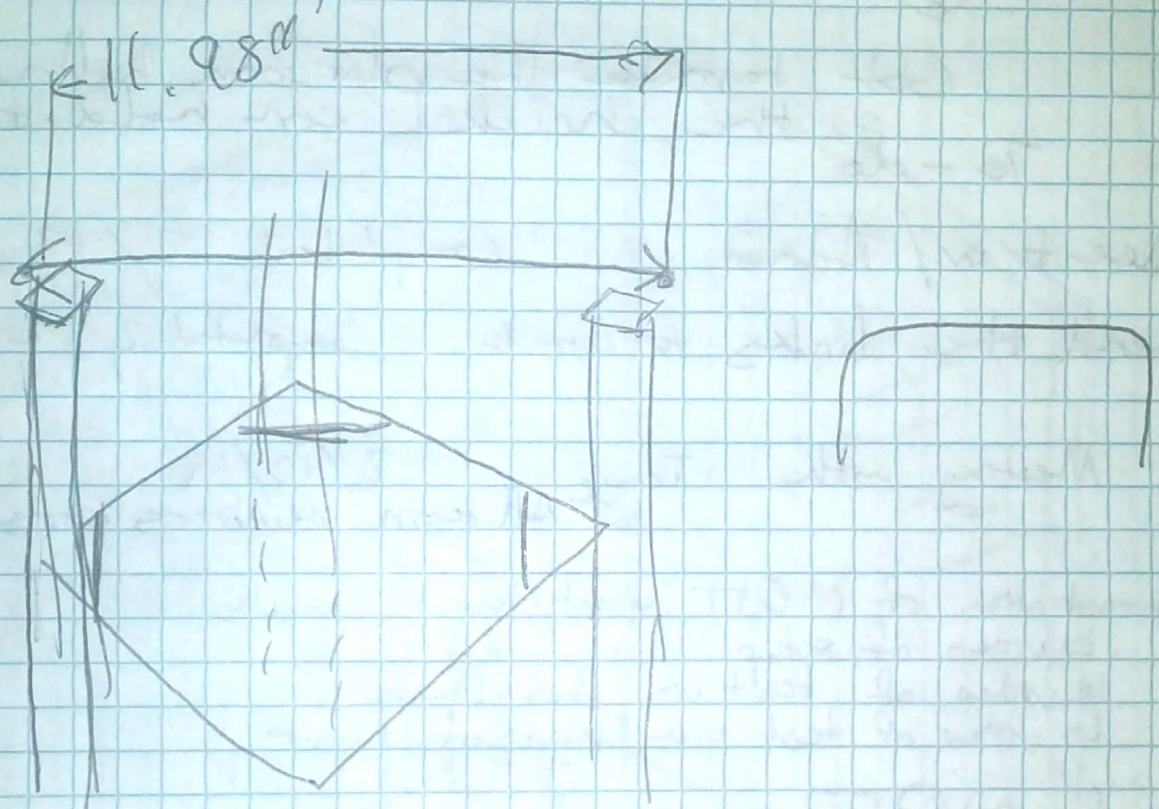
put an
impression
in the
sheet

welding or epoxy

Stacking method

- Pro
brings the turntable higher!
keeps it from running into
the caterpillar tracks

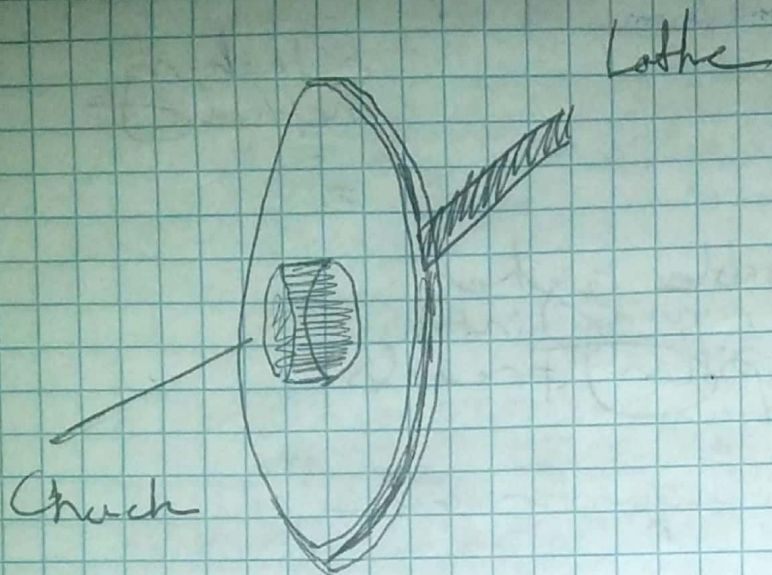
Make the top plate a quarter inch



Model the top plate of the robot

Adrian needs CAD files of

- Bolts
- Pulley
- Sliders (Figure 8)
- Belt tensioner
- GT2 Timing Belt
- Nema Stepper Motor
- Torsion spring
- Aluminum Gear Clamps
- T-slot slider 8 80x40
- Alvarez
- 42x42x20mm



Grab CAD
to get models
also

Got to make the platform hollow
so the chuck can hold it
To-do

Meet w/ Adrian

Completed 2/13 ✓

Send the links to Lennex

Completed 2/12 ✓

Meeting with Team

2/13/19

★ All team members present ★

Demonstration of MQTT client/broker connections

↳ video of setup

↳ video of test w/ Bob Buck

↳ video of test w/ keyboard input

See if MQTT can go both ways

To-do

2/20/19

Setup a demo where MQTT goes both
ways ✓

Run the broker & client simultaneously
& test
2/27/19 ✓

[Handwritten signature]

Advisor Meeting

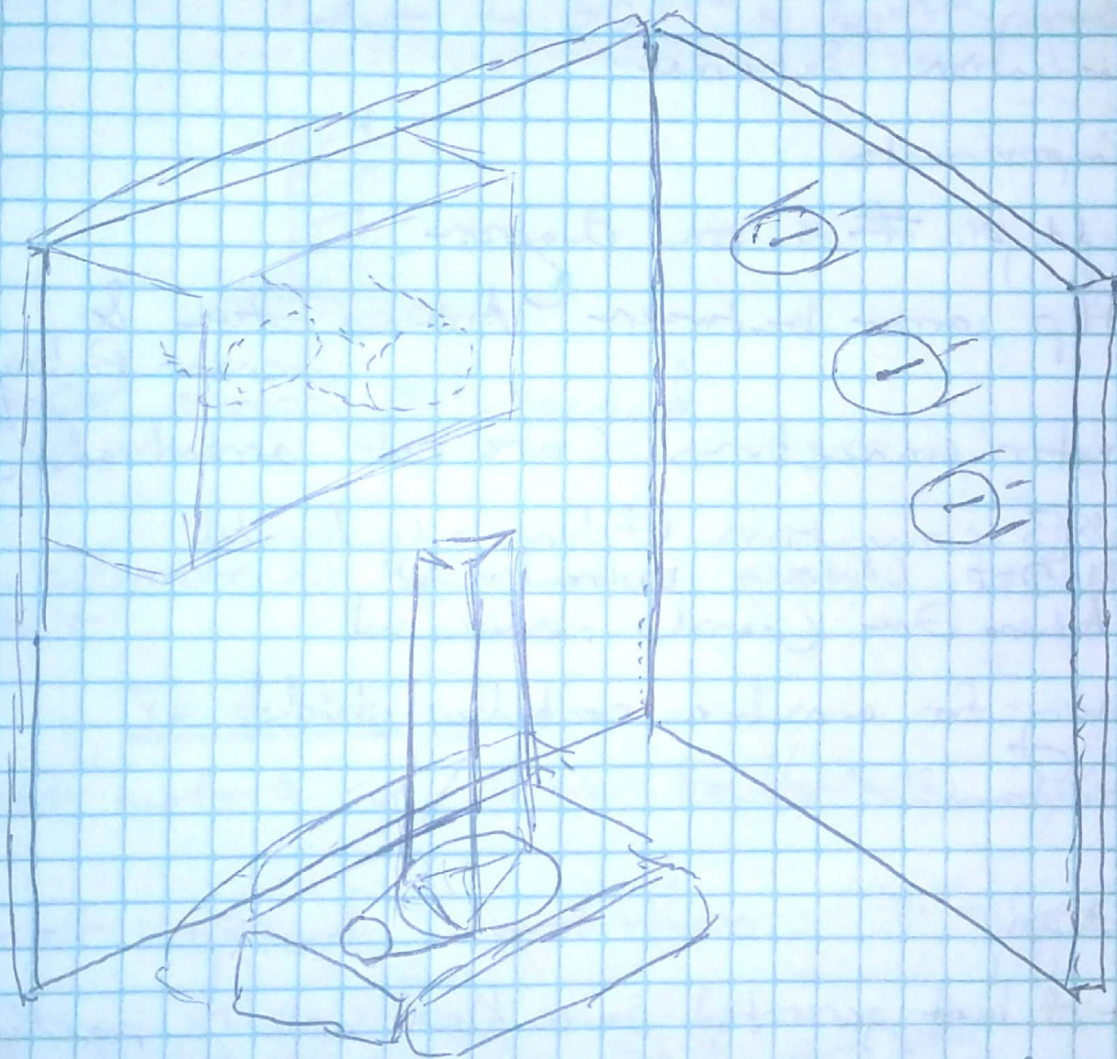
2/19/19
* All team members present *

Adrian's design

- adding on additional part to the arm

Building a staging corner

- one side hooded
- one side gauges @ various heights



- pneumator act to change the reading from ϕ

Temperature Reading

- Dependent on what you decide it is good air

IR Temp Sensor

- ↳ the spread of the narrow ray may be too great
- ↳ trying to get around that
- ↳ temperature is in $^{\circ}\text{C}$ & needs to be converted to $^{\circ}\text{F}$

Communication Scheme

↳ Improvements

- add pin #s in diagram
- flip arrow between Arduino Due & Sensor Package
- motor connections (are not arrowheads)
- USB connection (future bidirectional)
- MQTT (future bidirectional)
- Arduino Due (serial) - bidirectional

↳ Looking for a motor controller shield

↳ Printer band?

Power Supply

- a lot of heat generated so a heat sink is needed
- dissipating the wattage
- significant heat sink required
- Buck Converter (Step down), would replace the voltage converter
- Same # of batteries needed

Diagram Feedback

- small diagrams
- full schematic diagram in the appendix

Arm Design

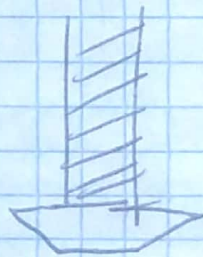
t-slot plate nut

↳ use metric pieces

- metric bolt

- metric nut

(due to 30mm x 30mm profile)



Stepper motors still needed

Get an estimate of how much more is needed to finish it

To - do

Test motors w/ new batteries 2/22/19 ✓

Test speed controllers 2/22/19 ✓

Continue building mgth scripts
2/22/19 ✓

✓

Meeting on West Lab

★ All team members present

4/2/22/19

Motor testing

→ Successfully tested the motors on the robot

↳ soldered the battery holders

2 in series // 2 in series

↑
in parallel

→ Robot is pretty fast & will definitely need to be slowed down

MQTT Controller

→ Enabled communication between the controller
RC & ~~RPI~~ RPI

→ Issues

- too quick for the publishing to the topic on the raspberry pi.
- try just clearing it

To-do

Work on broker & client communication for sending controller commands

2/26/19 ✓

Meeting in Hive

2/25/19

* All team members present *

Continuing the work on the RPi control via MQTT

Testing Criteria for today

- ↳ Does MQTT go both ways?
- ↳ Flushing the command's script from the PC to the RPi to improve speed
- ↳ Translating controller actions to Arduino feedback
- ↳ Create a broker on the RPi to send to PC for GUI
 - ↳ This works!
 - ↳ Developing a subscriber that receives the data structure

Air Quality Sensor

Temp Sensor

Gas Content Sensor

3 sensors

↓
emulate them using
a random function
in python

To-do

Create string delimiter for GUI msgs

2/28/19 ✓

Handwritten signature

Meeting w/ the Advisor 2/26/19
★ All team members present ★

Gauge for the wire was too thick
↳ Lemek & Stephanie lowered it
8AWG → 12AWG

↳ Adding a 20 amp fuse for current control

Controller Functions

↳ General movement

- Fwd, Rev, Left, Right
 - > independent for each motor
- Rotate lazy susan
 - > controlling the stepper motor
- Lift/Lower camera
 - > controlling the pulley
- Reset
 - > bring camera back to default pos.
- Toggle speed control
 - > slow speeds
- Capture images
 - > useful for gauge images

★ 2 controller upgrade → in afternoon

↳ 1 pilot

↳ 1 observer / camera sensor control

Updated Battery / Full Plan Schematic

↳ forming the connection between the
DVE & RPi (serial)
& adding sensors

GUI

↳ adding tool bars or events

↳ full screen capability for camera view

↳ gauge graphs

• 360° rotation

> arm direction

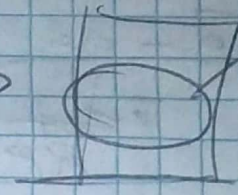
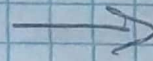
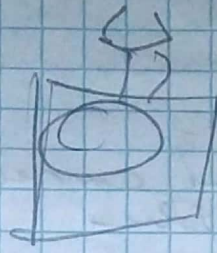
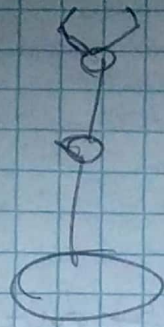
> air quality gauge

← assist w/ math here

Default position for the arm



← Sharpte Solution



 $\Rightarrow$ arm direction

* Reverting the camera back to the find direction for robot movement

* Creating a locking state condition that restricts the movement of the robot until the camera is facing forward & secured

Mechanical Arm

↳ sound design

↳ 2 pulleys for the arm lift

↳ use of steel components to prepare for the extra forces for lifting

~~Find a~~

↳ ~~Find a~~ Finding a larger pulley, design which takes into account for the more intricate things

↳ ~~Find a larger pulley~~ Sturdier to mount the arm using L-brackets

↳ Top plate is a circle

↳ Silicone as an alternative for sealing

↳ avoiding drilling holes for the belt, mount on the bottom

Stepper Motor Controller

↳ needed for stepper motors

↳ 2 phase 2 phase motors

54

Things to be discussed

- Plate is just a little too short

To-do

Test serial connection between ~~GUI~~
RPI & Dev 3/5/19 ✓

Test sending info over OOP format ✓
3/5/19

Troubleshooting in the Hive 2/27/19 ✓

Issues found

- ↳ lag in sending commands within 2000 ms window
- ↳ client stops often a while
 - > getting it to loop infinitely
 - > keeps going as long as input is continuously fed in.

Building a PC class communication script

PC side

- Xbox Class

• methods

> init()

> listen()

> on_connect()

> on_message()

- Data Pkger Class

• methods

> on_connect()

> on_message()

> data Pkg()

GUI side RPi Side

- XBox Controller Receiver

• methods

> init()

> on-connect()

> on-message()

- Data Pkgr

• methods

> on-connect()

> on-message()

>

To-do

Continue developing classes for handling the following items

XBox controller
Client

GUI Publisher

3/5/19 ✓

Subscriber ✓ 3/5/19

Meeting up @ West Lab

3/1/19

> Testing serial connection between RPI & DUE

↳ unsuccessful, no response on the DUE side
(later successful 4/2/19)

> Testing GUI info sending from OOP format

↳ successful ✓

To-do

Trivialize the serial test do on LED response
3/16/19 ✓

Get / order a cord 6ft long to connect RPI & DUE

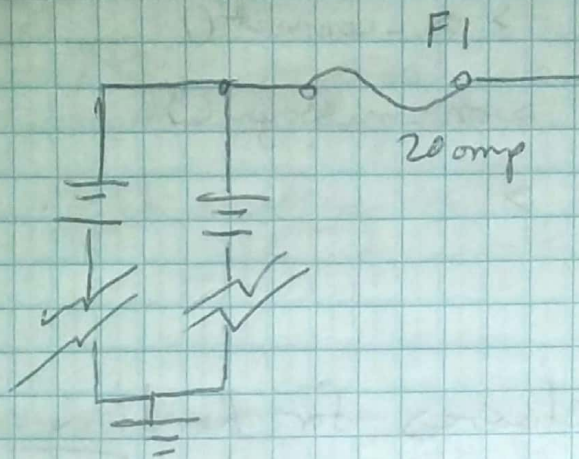
3/12/19 ✓

Meeting w/ Advisor

3/5/19

* All team members present *

Added a Fuse holder for 20 amp fuse
↳ connected in series

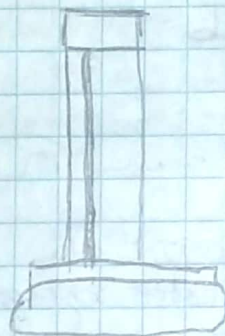


- splice the wire connect them together
- heat shrink the connection
- Ckt protection

• Waterproofing the cables

Waterproof ethernet connector

↳ Allied Electronics



Connecting RJ Bumper,

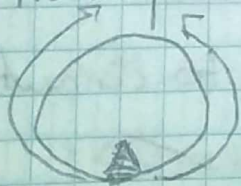
PX0837/5MOO : Molex #

Sunny side ribbon for RPi camera is short, thus ethernet cord is needed to connect the RPi to either the repeater or PC

Wireless → for demo

Wired Connection → for standard use

* No wrap around to prevent cord entanglement
0° → 35°



! never cross over this so there is no entanglement

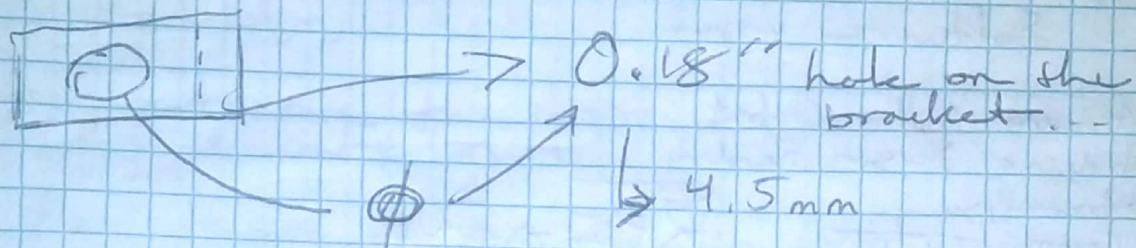
Will need 6-8 wires, vs. the standard 4 wires

Check lab for ethernet cables, coiled to prevent slack
~~isn't~~ ~~isn't~~ [uncoiled 11.5 feet]

Budget (comes over already) *

Mechanical Arm

- ↳ update on schematic
- ↳ flipped location of the motor to the bottom
- ↳ using collar clamp to secure the rot!



2 idlers!

changed top plate to a strict circular shape
↳ slightly off center

Bringing 2D sketches of each part to the next meeting

Schedule the machinery, a proactive thing, bring a DXF file
from Solidworks

GUI

- ↳ Live streaming (very slow log buildup)
- ↳ Login window
- ↳ Live live plot works
- ↳ Graphs live like
 - graphs have toolbars
- ↳ Screen shot feature
- ↳ method for on & off status
 - back end as well
- ↳ implementing gStreamer!

[Handwritten signature]

Final Order

→ an additional \$204.22

To - do

- CAD Drawings of individual parts
- Take DXF files to Invention Studio
- Build classes for MQTT comm & implementation
- Enable serial connection both ways
- Create separate page for graphs on the GUI
- Tighten up design notebooks

Due Date

3/5/19

3/5/19

3/12/19

3/12/19

3/15/19

Software work

- Arduino Motor Control
- Arduino Sensor Reading
- Streaming
- ~~Communications~~

RPI → GUI

↓

PC

↓

GUI

Sensor functions!

- * Email Alex K for times his group (Done 3-19)
- * Documentation on website (Done 3-20-19) ✓
→ Notes

3/6/19

Machine Shop visits

→ MR De

only west waterjet cuts for the aluminum plates

• 1 1/8" steels

→ top of the lazy - Susan

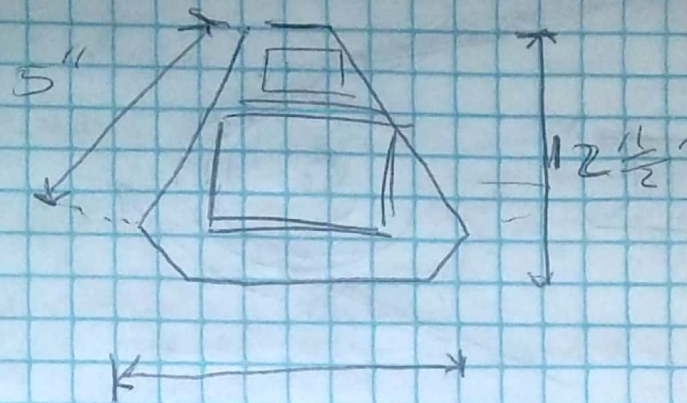
→ top of arm

• all the platforms arm - work well

→ 4 2 x 12 x 24's

* Adrian, Lemele, Nelson
Stephanie, Elizabeth present *

Size of plot form



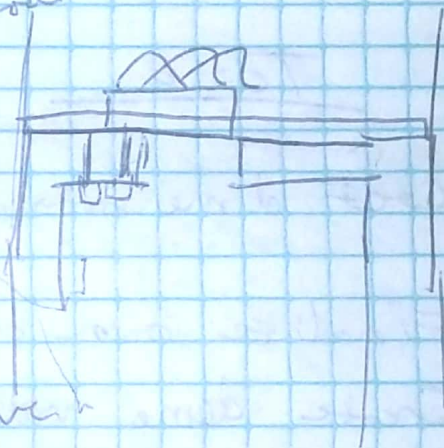
Trying to make sure the sensor fit on the elevator plate

How to mount the sensors?
 ↳ box attached to lift.

~~Attachment~~



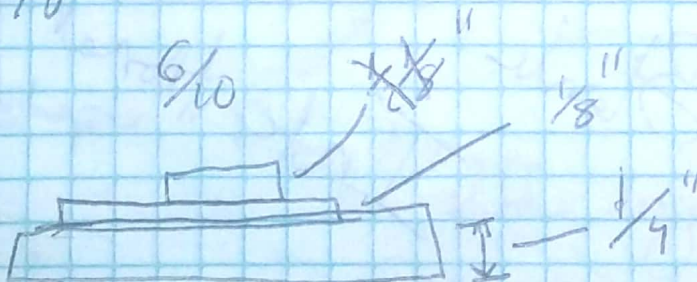
Fast board



What we have? vs. What we need

Screws
to be tapped??

$\frac{1}{8}$ "



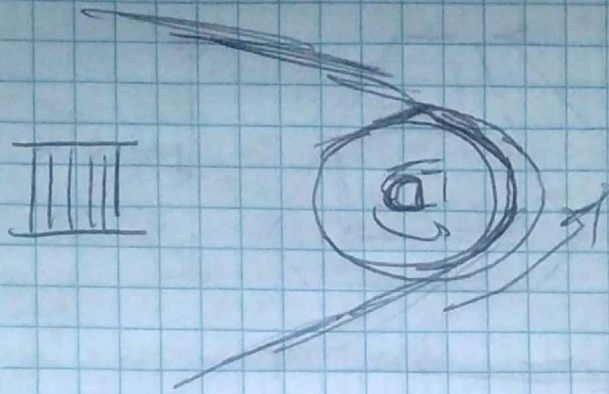
$$\frac{4}{8} + \frac{2}{8} + \frac{1}{8} = \frac{7}{8}$$

Aluminum won't be tapped

Shall 5mm

60

Use a small rubberband to fasten it



Gorilla Glue to expand & close the hole
Belt $\frac{1}{4}$ " thickness

3D Print it / manufacture it ourselves

Get timeline for aluminum plates

To-do

Get dimensions of screw holes 3/5/19 ✓

Finalize arm drawing 3/12/19 ✓

Create demo video for OOP scripts 3/12/19 ✓

Left Blank Intentionally

Meeting w/ Advisor

★ All team members present ★

3/12/19

Mechanical Arm

↳ Finished the drawing (stored in drive (Adrian))

Adobe PDF: 3D PDF creator on solidworks

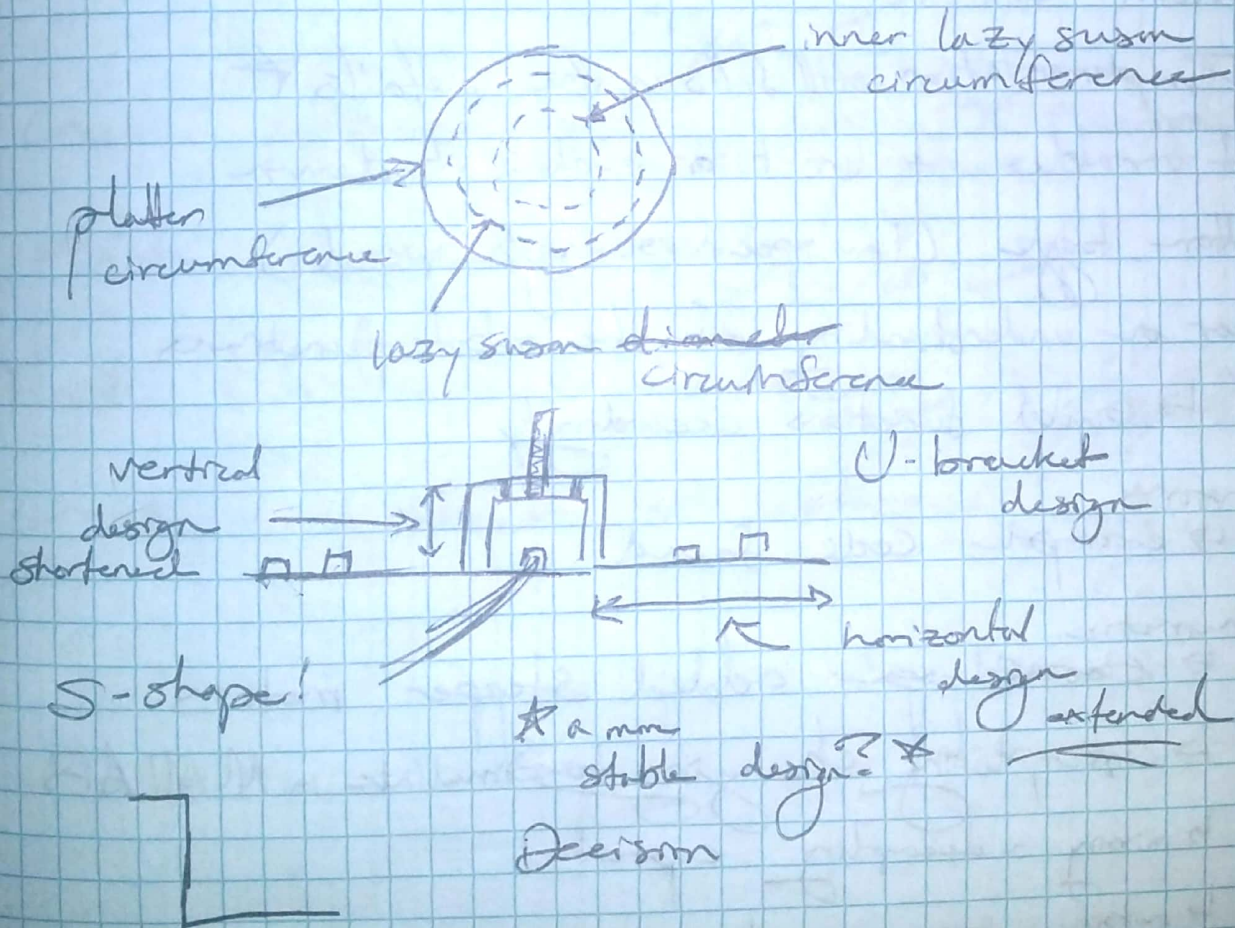
Made it for the
- top of the robot

★ After speaking to people in Montgomery Knight he advised us to get just a $\frac{1}{2}$ " plate.

↳ will assist in threading as well

↳ blind holes will be tapped

↳ expanded plate on top of lazy susan is slightly larger than the diameter of the lazy susan.



QXF files finished ✓

GUI Updates

↳ Nothing new

↳ Busy w/ other +

• Higher Priority !!

- finish mechanical design (more complex)
- assist other parts of the projects

• Control System Design

Crawling Mode vs. Speed Mode

Stepper Motor Turn

Default Reset!

Motor Control

★ Implementation still fills in the details ★

Set variables to limit or scale it down

Button toggle (low speed vs. high speed)

Clear of understanding of the robot functions

↳ build functions accordingly

• Sensors

↳ example code found

• Schematics

↳ ~~stepped up~~ added stepper motors

↳ contemplating changing to Simulink in MATLAB

↳ missing a decoupling capacitor

↳ missing some grounds

Action Items

Fill out sheet for team member info for the expo!
(Nelson)

Get the platter water jetted

U-shaped design ?? (Nelson)

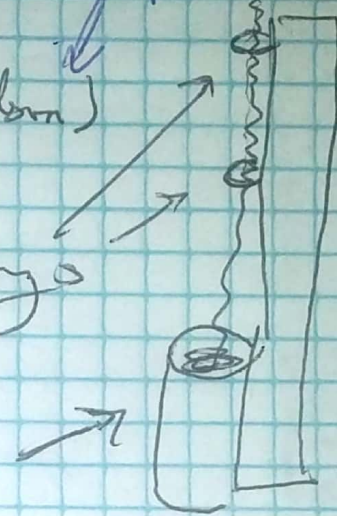
↳ CAD Drawings

↳ Open Assembly

Rings

Cap

completed 3/13/19



To-do

Complete U-bracket design for stepper motor!

3/13/19 ✓

Create software diagram for OOP scripts
Still in progress

Finish design notebook

3/15/19 ✓

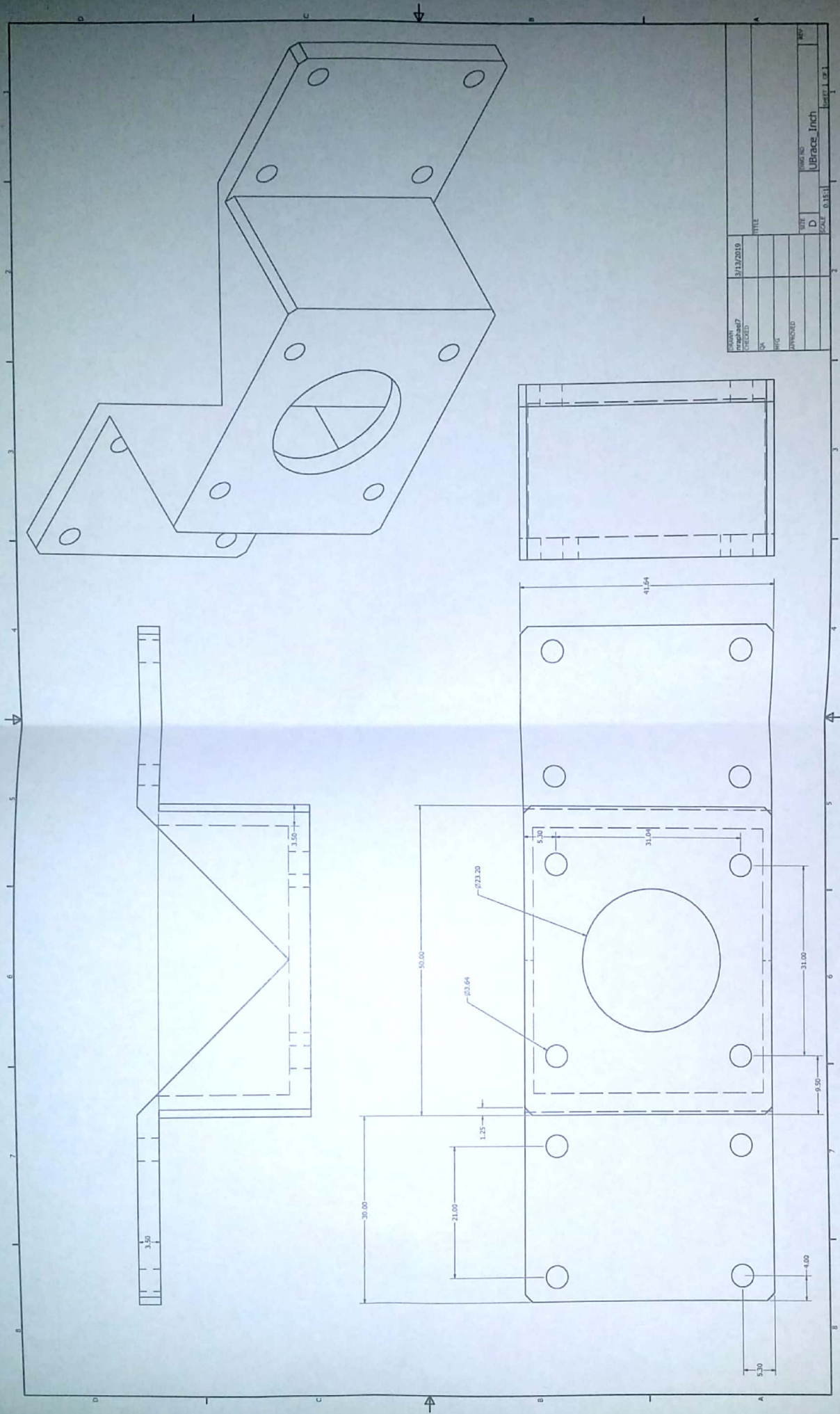
Finish Orthographic Drawing for U-bracket

3/13/19 ✓

Create Link sheet for software

3/15/19 ✓

By Nelson



65 April

Github Links to find software

MQTT code

<https://github.com/4012GraberSeniorDesign2019/Graber-Senior-Design-SrcCode>

GUI code

<https://github.com/LemekRobinson/Graber-Senior-Design-UI>

Project Website

<https://github.com/4012GraberSeniorDesign2019/Website>

Mechanical Arm

Used grab cad links for motor mounts camera mounts and other mechanical arm parts

<https://grabcad.com/>

Parts that were machined professionally

<https://www.mcmaster.com/>

66/18/20

Meeting with Group

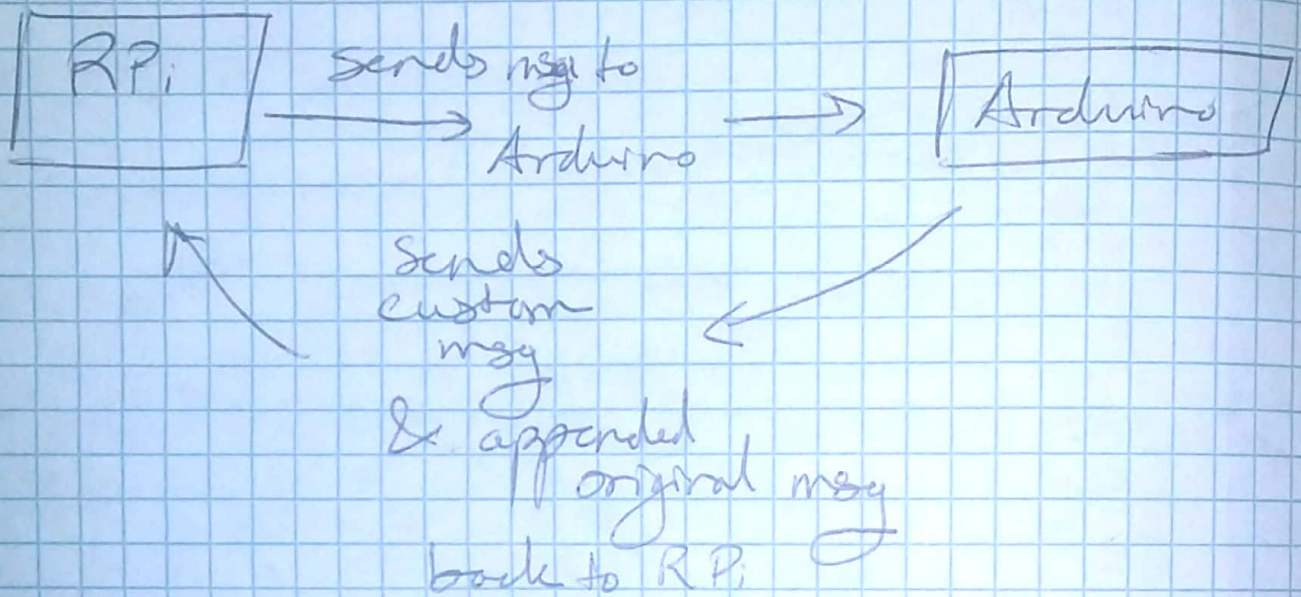
3/25/19

All Team members present!!

Software Wise

Serial communication between Arduino & RPi is successful!

Serial Test conducted
~~Sends~~



Now that this is successful, the custom msgs for motion can now be implemented

CAD Wise

Fix/adjust the U-brace design
apply slots! - Finished 3/27/19 ✓
Geometry still exists

Meeting with the Advisor

3/26/19

All team members present!

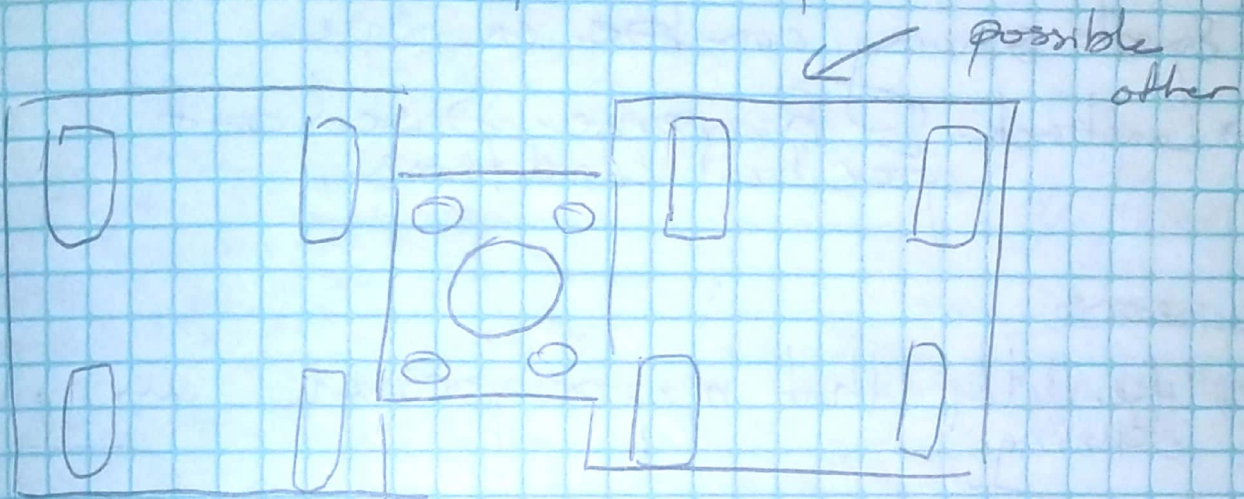
Mechanical Arm Update

Design 95% done

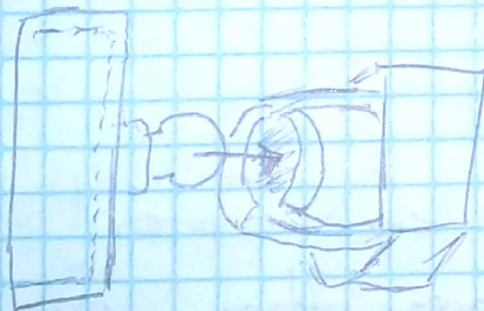
Parts were just received so the machining will take place this week

Ø% Machined

First come first serve for the machining!
Same thickness as previous piece



Warm water for PLA to soften it so we can push the ball into the socket



Rad

68

GUI

↳ Lots of great new features

- Graph Freeze (F)
- Graph Enlarge (V)

↳ Gauge (if for on quality) is less computation, heavy, just rewrites the gauge arrow!

* Unfortunately there is lag

Serial Comm

↳ Synchronizing can be an issue

↳ Loopback & Response based off specific conditions

Sensors

↳ the delay that may be present during sensing

↳ might need scheduling

- Arduino loop is extremely fast

Controls

Duty Cycle for each motor!

One function, more than one input

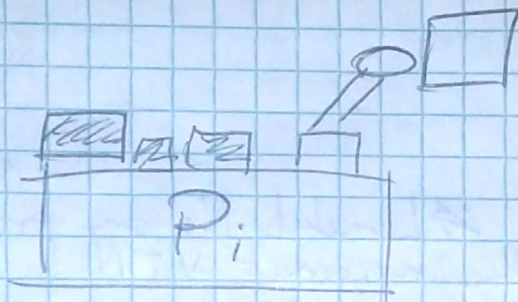
Constants set @ the begin

Control System Design Spreadsheet

↳ needs to be filled in

Class meet time is April 8th

Possible Sensor Package Lay out

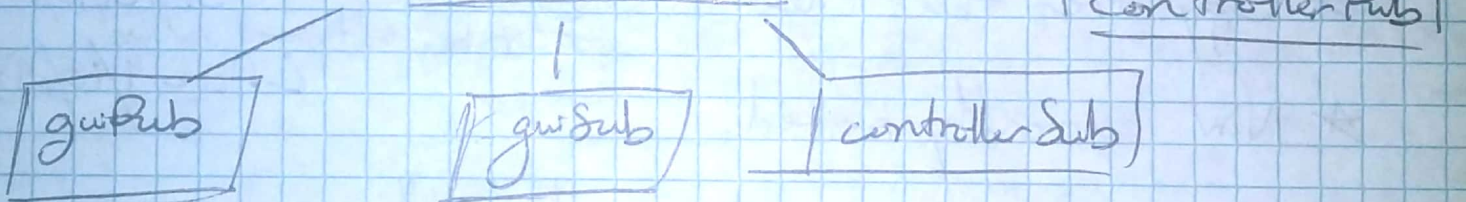


Software

★ Just Nelson present ★

Design

4/1/2019



gw Pub

methods

init

get Client

build Publisher

add Publisher Params

connect Publisher

start Publish Loop / stop Publish Loop

publish Info

receive Gw Data

check Connection

check Client Details

[Signature]

70

gui Sub

404-367-2503

methods

init
get Client
build Subscriber
add Subscriber Params
connect Subscriber
start Subscriber loop / stop Subscriber loop
check Connection
check Client Details
parse GUI Data

Website Setup

4-8-19

Setup & download the onyconnect VPN ** Lemek & Nelson present **

Download & setup Filezilla

- username
- password
- port: 22
- host server

To-do

Update document

(Done 4/12/19)✓

Finish About page

(Done 4/15/19)✓

Sort software index

(Done 4/15/19)✓

* Copy over the files

* Now currently hosted!

4-9-19

Team Meeting w/ Advisor

All members present!!

Fabrication of

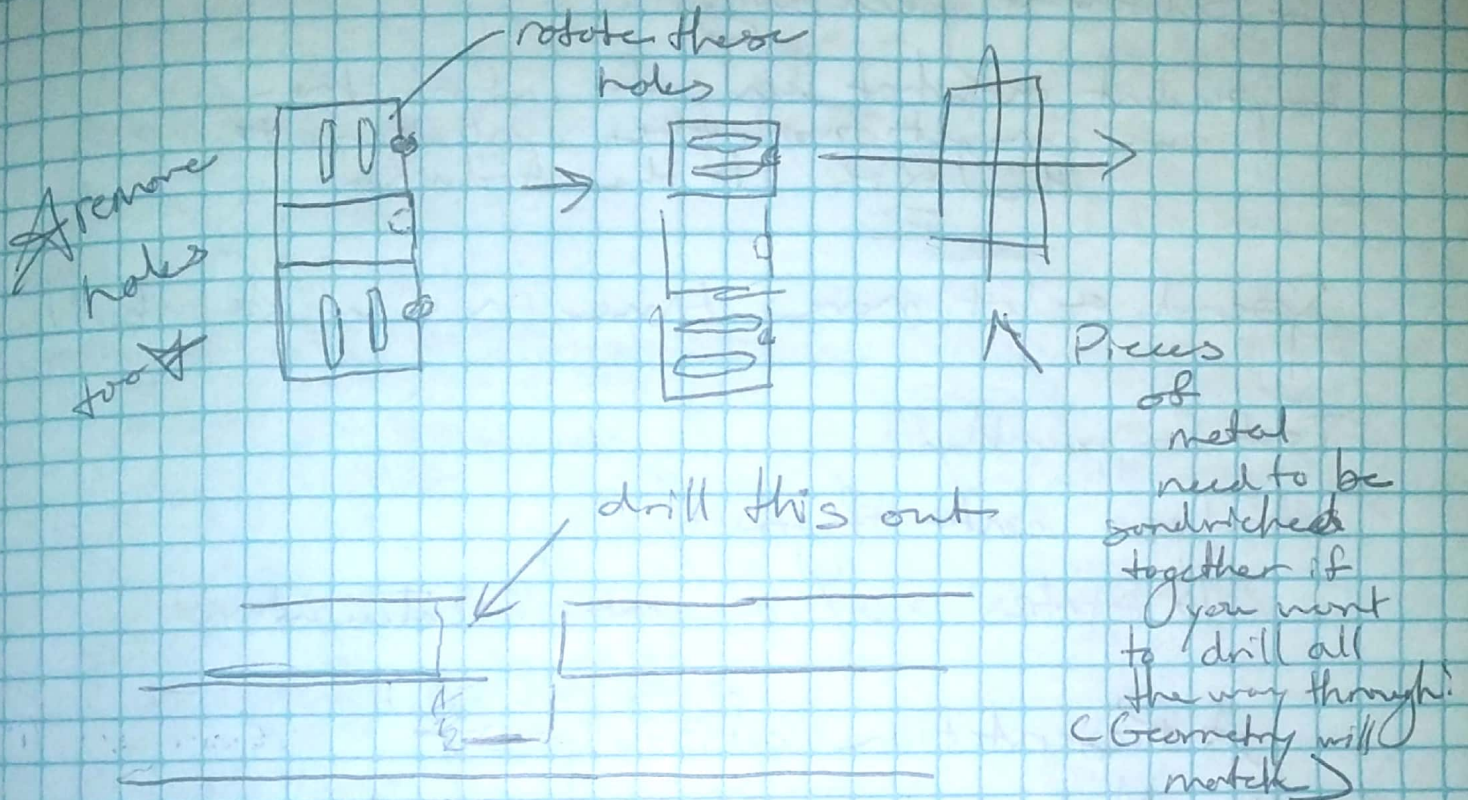
- aluminum top plate : completed
- sensor plate : completed
- pulley rod : ~~in~~ complete
- a bracket needs to be reported under : ~~in~~ complete
- cuttings on the turntable : complete
- attach pulley system : incomplete
- drill hole for gland : complete

My

* Retake photos for the poster

↳ get it w/ better backdrops

Adjusted the u-bracket to make the
sides screw holes



Didn't need to thread both because

Software

↳ Need to incorporate data streaming to GUI

↳ Need to update streaming method

↳ Movement code has been started

↳ reaction time is key here though !!

↳ tested stepper motor (400 steps in rotation!)

* Collaborate w/ Lemele to discuss this

* 3D printing acceleration / Stepper Motor Arduino

Acceleration *

↳ code base !!

↳ incorporating the reset button !! 72

Have everything @ 95% level

More resolution ???

2 or 3 different speed settings ?

Dependent on what kind of information
we can get from the controller to
the RR to the Arduino

Spend a lot more time in West Lab!!!

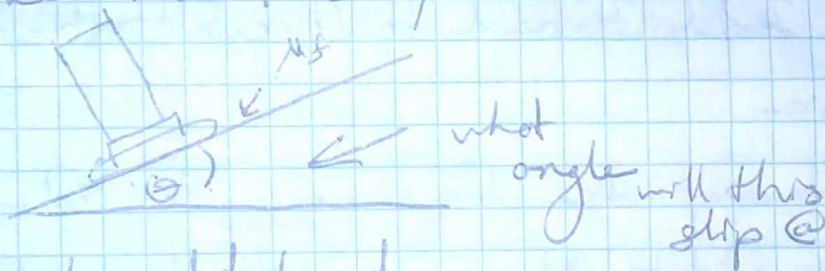
Test the assembly!!

Analyze center of gravity

↳ Statues w/ a centroid calculation

★ Presentation after expo ★

4/16 Meet next Tuesday in the lab! ★



Easy fix is to add lead

~~How project sum~~

To-do

Project Summary Update

Presentation : Finished 4/25 ✓

Final Project Report (Work in progress)

Website (Work in progress)

Design Notebook Finished 4/26 ✓

Poster Draft + 11
↳ Finished 4/13 ✓

All Poster elements are high level
 Flow-charts for algorithms
 Images of CAD assembly
 Images of execution
 GUI $\rightarrow$ HUD image
 A Borrow card from Dulbe $\rightarrow$
 for poster

Provide Context

~~Event the 4012p~~

Ask for dimensions & for poster board
 poster laminated!

Software Meeting

4/11/19

↳ Lemek & Nelson present!

Correct subscribing error in gnu subscribe class

Here is the fix!

~~Usc~~

clientObjClass.py
 method

this

(line receives the data)

def printFromSubscriber(self):

* data = subscribe.simple(self._topic, hostname
 = self._broker, port
 = self._port)

Paul

74

test
internally
blank!!!

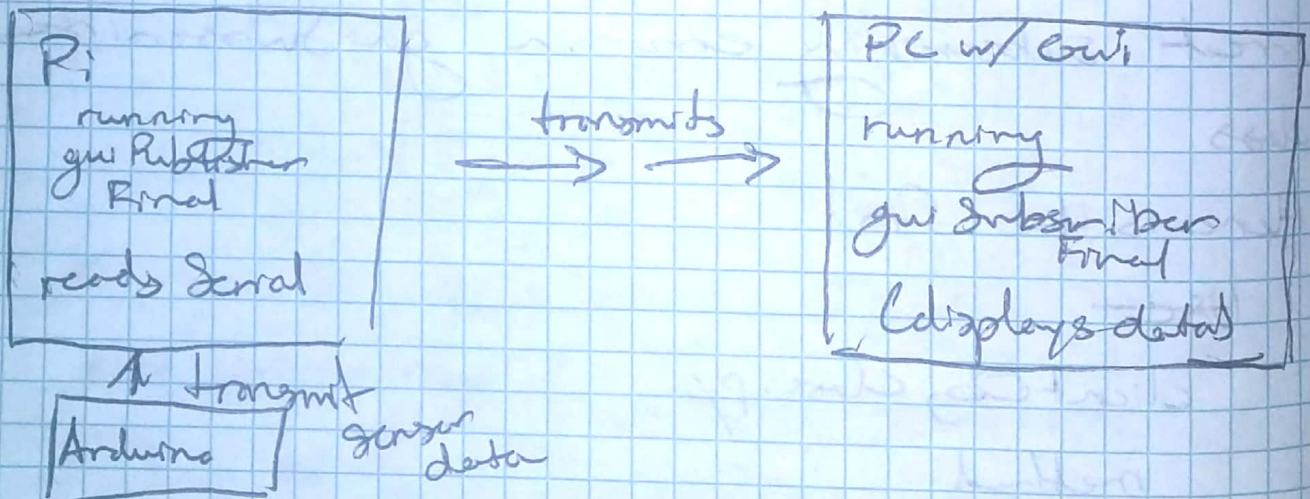
Team Meeting

4/12/19

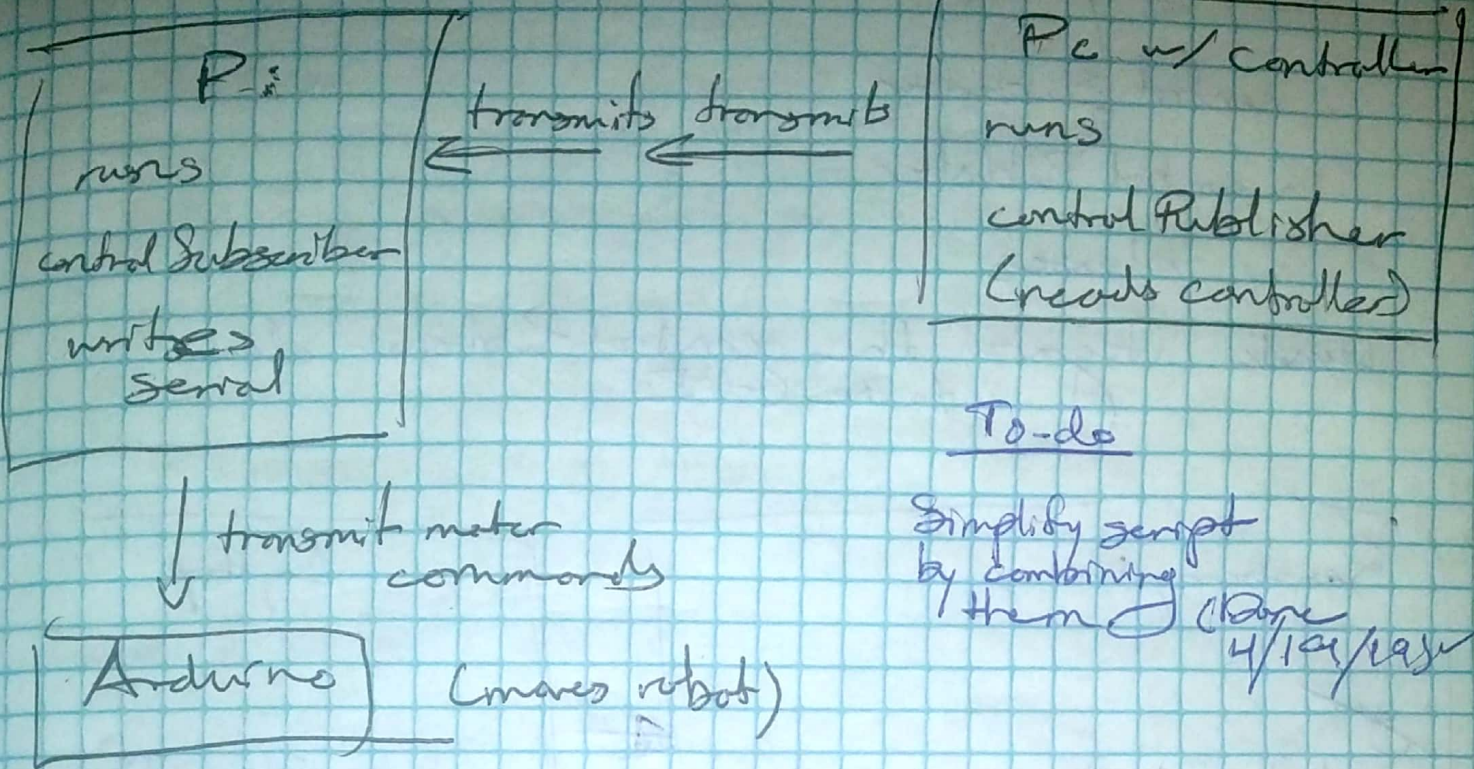
Adrian
Lemke
Stephanie
Elizabeth

All members present!!

gui / Communication



controller Communication



To-do

Simplify script by combining them (Done 4/14/19)

4/15/19

Meeting w/ Team in the Lab

* All members present! *

password for

RP: pinSPR19

Tasks

Create

control Publish.py (✓)

control Subscribe.py (✓)

Combo gui Pub/controller Sub

while True:

serial

read(guiData)

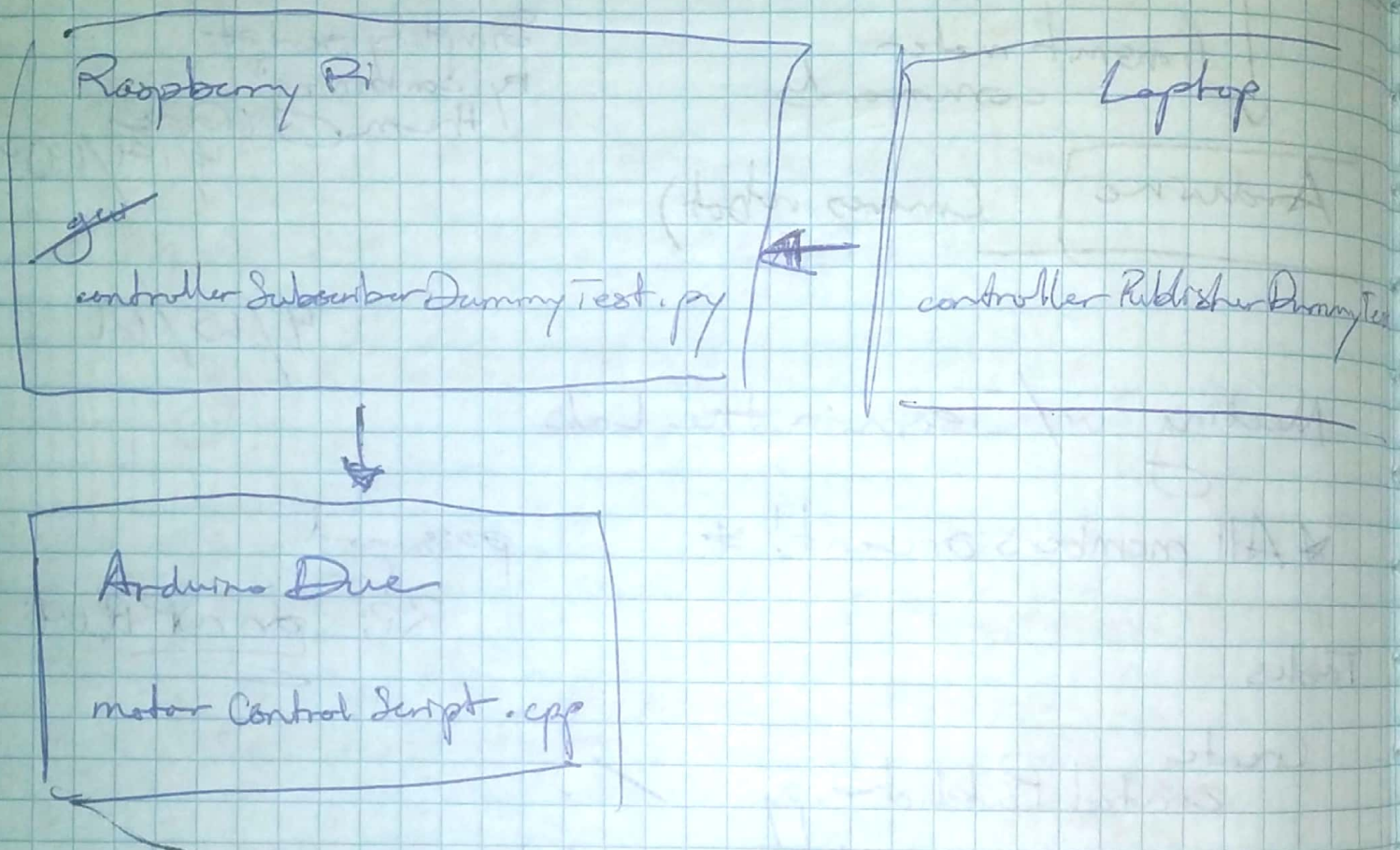
write (movement Data)

→ add set COM port ~~no need~~ method! anymore

[Signature] 76

Successfully created the
control Subscriber
&
control Publisher
classes

Lemek integrated the control Publisher class
into the GUI



Lemek's port is causing issues !!

↳ Fix it how?

→ Separate
initialization &
action

To-do

Correct Lemek's port 4/18/19 ✓

Integrate Scripts

4/18/19 ✓

Integrate Streaming

4/20/19 ✓

77 R/R

Meeting with Advisor

4-16-19

- All team members present!

Deciding a presentation time

- Reading Period?

Friday?

- Consensus Wednesday?

1111
1111

Lemke & Nelson

- run the serial test again & debug it again!

Demonstrating the rotation w/ the Arduino

Once we debug the serial test part & it works the result can be replicated over & over & over again.

Gathered video & pictures for the website

Microswitch? - Detecting when it hits the top plate

Get it from the sensor design lab!

* Found in West's Lab!

To-do

Finalize assembly

4/21/19 ✓

Perform demo for advisor

4/16/19 ✓

APJ

78

Meeting w/ Team

4/17/19

* All team members present! *

Arduino Code

Possible string construction

D-pad Up pressed = Udp
released = Udr

Left Joystick up = Lju
centered = Ljc

Right Joystick up = Rju
centered = Rjc

Xbox button pressed = ~~Xbp~~ Xbp
released = ~~Xbr~~ Xbr

~~Xbutton~~ pressed = ~~Xbp~~
released = ~~Xbr~~

To-do

Created a excel file for action encoding 4/20/19 ✓

Turning requires two signals @ once 4/20/19 ✓

Meeting w/ Lemck

Lemck was present!

4/20/19

Debugging the video stream via raspberry Pi to the GUI

↳ worked once the socket connection was corrected

Debugging the movement code

79 17/ant ↳ movement code works but the speed of the motor is not that fast!

To-do

Thread or use multiprocessing to get the programs to work simultaneously 4/22/19 ✓

Improve acceleration speed

↳ ~~Wasn't improved~~

serial handshake is bad

4/21/19 ✓

Meeting w/ entire team

4/22/19

* All members present! *

Programs were put into multiprocessing sequence

↳ Video streaming is now terrible as a result (horrible lag)

Double-checking the Arduino movement code ~~conditions~~ conditionals

Button configuration

Button	Action	String
Left Joystick	Up	Lj_u
	Down	Lj_d
	Left	Lj_l
	Right	Lj_r
	Center	Lj_c
Right Joystick	Up	Rj_u
	Down	
	Left	
	Right	
	Center	
D-pad Up	pressed	
	released	
D-pad Down	pressed	
	released	
D-pad Left	pressed	
	released	
D-pad Right	pressed	
	released	
Xbox button	pressed	
	released	

ATP

30

Modifying it to keyboard controls

Key: up
Key: down
Key: left
Key: right
'a'
'w'
's'
'd'
'b'
Key: esc = break
 → (break the code)

} camera

} robot movement!

Reconfiguring Movement!

Running the demos for Expo

Code on Arduino

↳ runs movement

↳ reads data

↳ can communicate w/ Rpi

★ Removed sending movement commands over the Rpi ★
↳ instead send serial commands via the Arduino Serial Monitor for maneuvering!! ★

To-do

Separate the following into demo parts

Streaming 4/21/19 ✓

Gui Data observation & parsing 4/21/19 ✓

Movement 4/21/19 ✓

Wired connection for movement 4/21/19 ✓

81 Miguel

Final to-do list

4/25/19

Complete website by May 2nd (personal deadline April 30th)
Complete final presentation ✓ Finished April 24th
Complete final report (work in progress)

End of
Design
Notebook
April

April

82