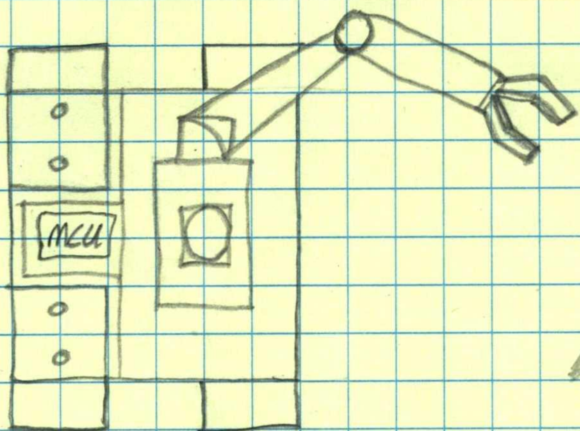
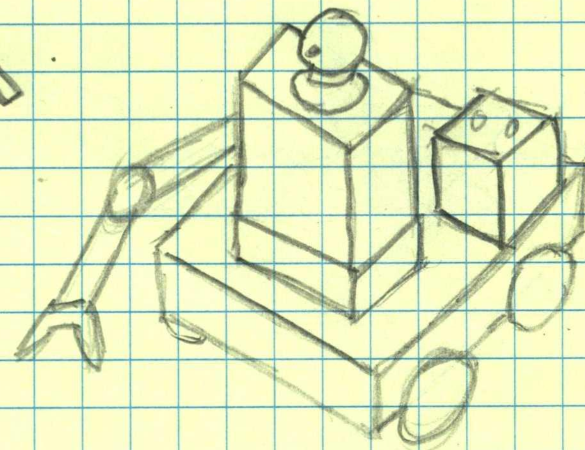
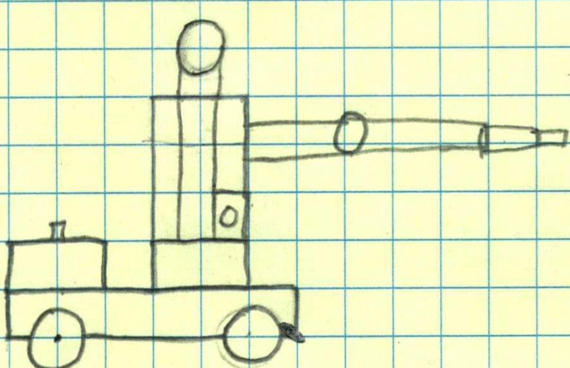
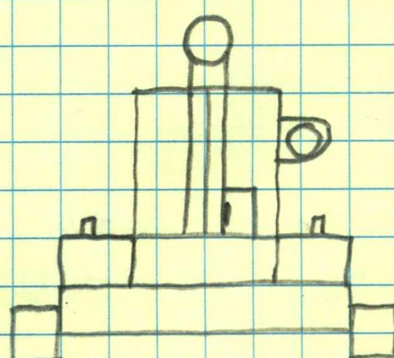
Bomb Squad Robotic Vehicle Designs

- Basic Robot RC Designs









- Motors & Power
  - 2 main motors for movement
  - Combinatorial 2 Degrees of Freedom motors for shoulder, elbow, & wrist motors (6)
  - For hand: 10 - 20 servo motors
    For clamp: 2 servo motors
  - One Main MCU
    - Two I/O MCU's for extra peripherals
  - Locking system for hand and arm.

- Interface
  - Kinect: C++ for just arm and face movements.
  - Arm/Hand Glove: Flex sensors for all major joints
  - IP Camera, wireless over internet.
  - PC & TV already owned
  - Joystick
    - Wireless Receiver circuitry
    - Driving while carrying
    - Sensors on hand to go back to user
  - Controls for locking arm in place & for precise movements.

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Subsystem Overview

Microcontroller
- Raspberry Pi, Beaglebone, or Arduino UNO
- C Language
- Code for arm motors
- Code for receiving & decoding from glove/Kinect
- Code for clamp/hand motors

Head/Neck Visual System
- Camera
- Control
- Functionality
- Extension
- Range Detection

Vehicle Control
- Main Motors
- Power
- Turning: Differential or Just in the program
- Control Transmitting/Receiving

Robotic Arm
- Power
- Modifications
- Capability/Mobility
- Sensors

Arm/Hand Glove
- Exterior flex sensors for major joints
- Accelerometers
- Gyroscope
- Interior feedback sensors
- Alternative: Microsoft Kinect
    - Microsoft SDK
    - More coding for skeletal tracking though.
    - Very suitable for this application.

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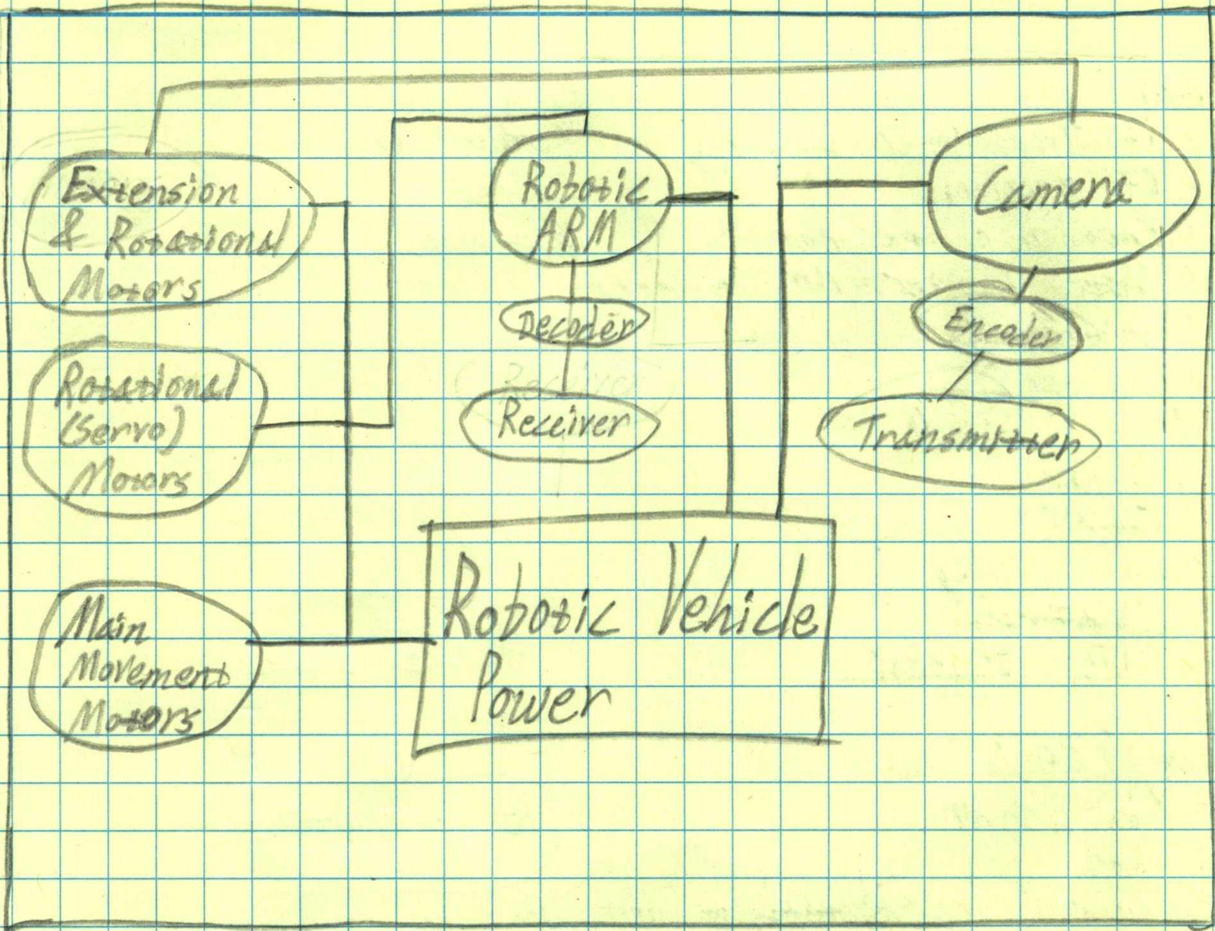
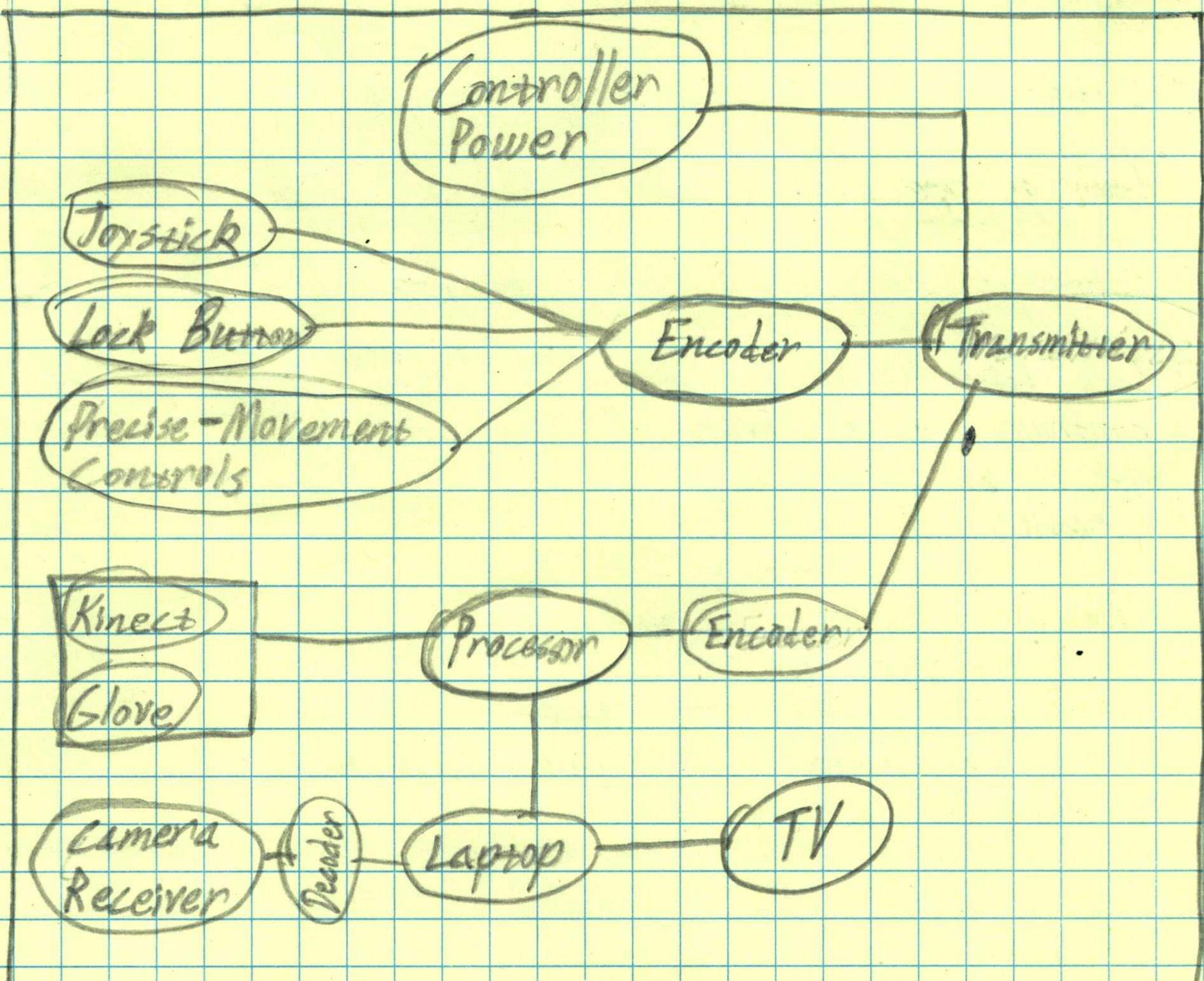
Block Diagram 1





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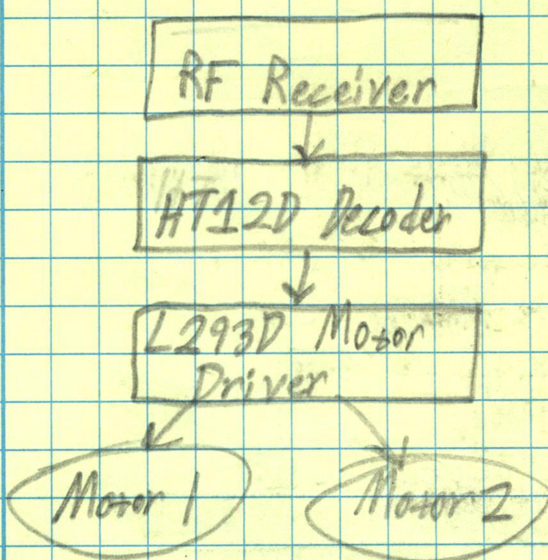
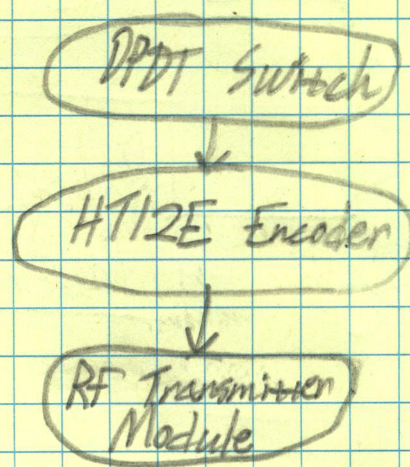
RC Car Research

- Parts:
  - RF Transmitter
  - RF Receiver
  - Encoder & Decoder
  - Motor Driver
  - Switches
  - Battery

Possible Electric Motor:
Cordless Drill Motors paired with 2.2 Ah batteries





- * Embedjournal.com/make-a-rc-robot-car
- Turning: Speed Controllers, differential, or Algorithms
- Battery: 12V, 5Ah SLA Battery - $16 @ Bobtrz.com.au
- Code for locking arm in place then precise movement controller takes over.
- Measurable Data??
- ConOps Presentation:

1 Intro	Nathan
2 Need Statement	Kevin
3 Concept	Fu
4 Objective	Michael
5 User Control	Fu
6 Hand or Clamp Design	Nathan
7 System	Kevin
8 Goals	Michael

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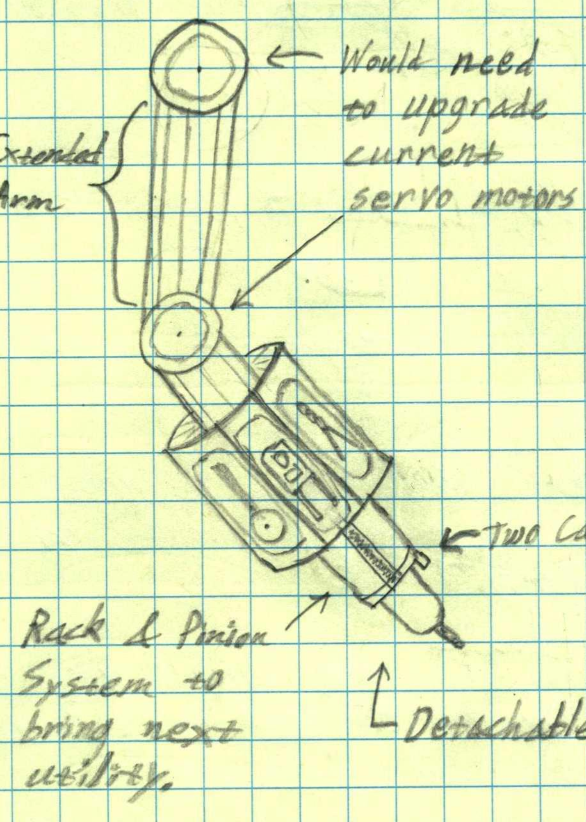
ConOps Presentation Review

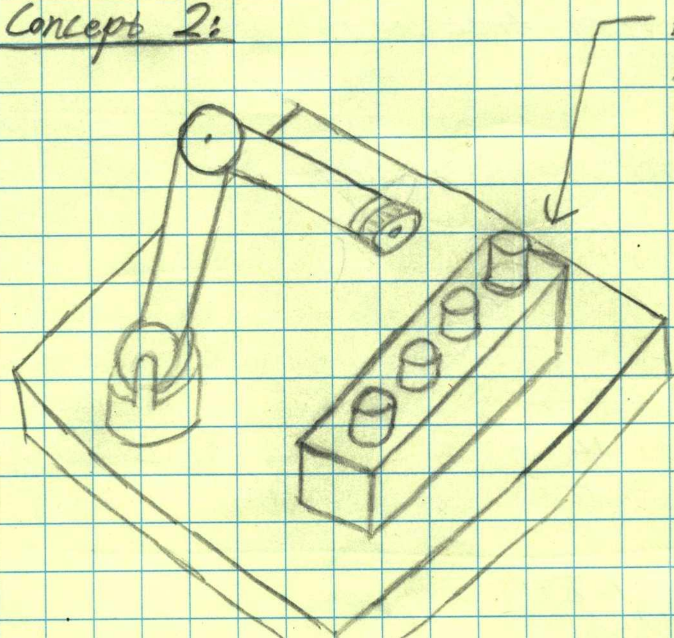
- Find another application: "Too ambitious, not enough time."
  - Facial Recognition Arm Movement
  - Manufacturing Sector: Amazon Robot
  - Modifiable Hand for drill attachments
  - Revolver attachments
    - Bit Attachments

Concept 1:

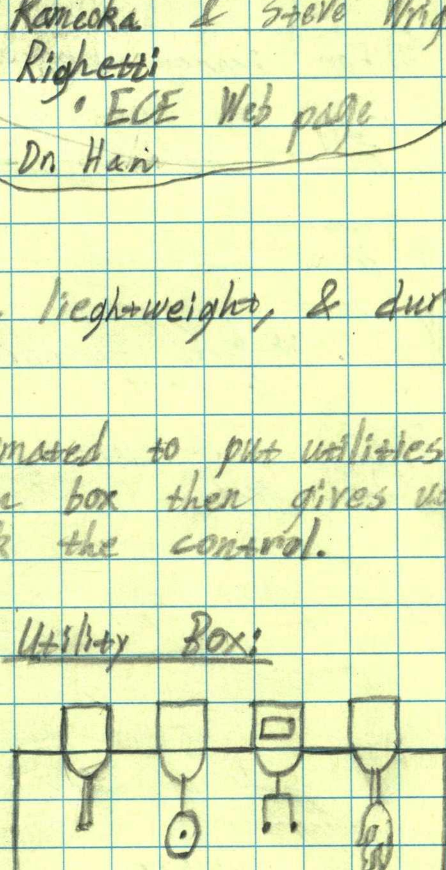


Utility Attachment System:
- Drill
- Electric Saw/Dremel
- Wire Cutters
- Needle Camera
- Lighter
- Digital Multimeter
- Laparoscope
- * Medical Application
  - Kaneoka & Steve Wright
  - Righetti
    - ECE Web page
  - Dr. Hari

Concept 2:



Utility Box:



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Team Meeting 2/14/16

- MiniLab:
  - $V_{in} = 1.5$ (V_{pk})
  - 1.5V DC offset
  - Freq: 10 Hz – 10kHz

Input: Takes input & converts specified Input Analog Signal to a scaled analog signal

Control Block: Captures input, computes PWM.

Output: Receives PWM & creates replica of original input

- Professor Email Questions

1) Should we lean into surgical tools, treatment, or analysis tools?

2) What are some possible tools or equipments in this area?

3) For image processing, what would be the best way to put the doctor or medical professional into the situation directly.

4) What kind of sensors on the arm would be good for the doctor to have for a particular feedback?
   - Haptic Feedback?

5) Any particular medical treatment we should look out.

6) Do you have any other suggestions for us?

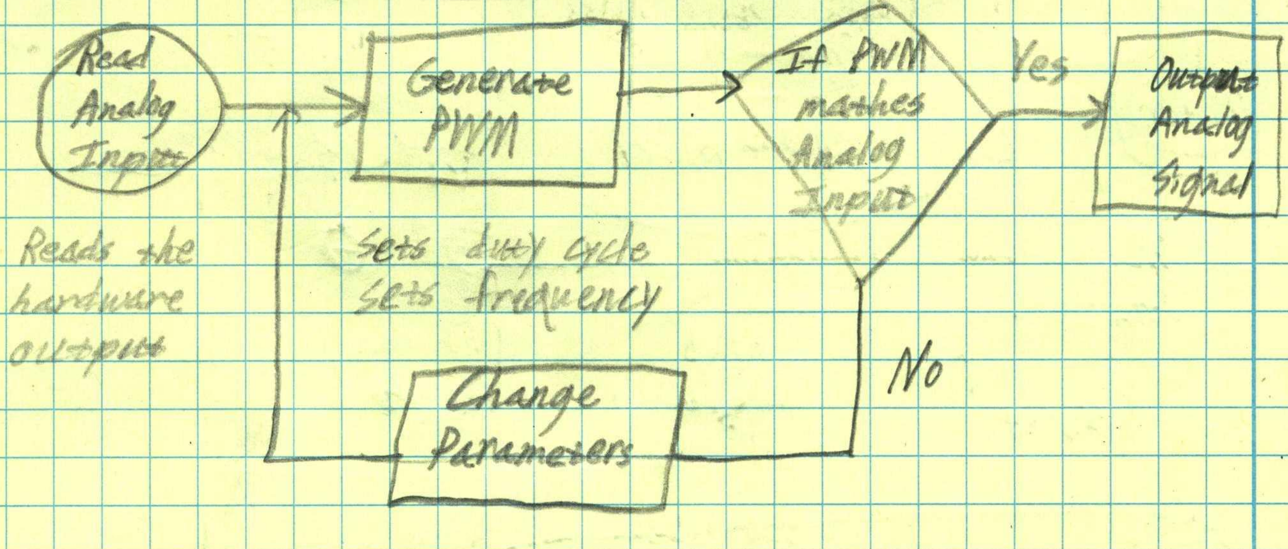
MCU's

Parameter	Raspberry Pi 2	BeagleBoard
RAM	1 Gb	512 Mb
Processor	9 MHz Quad	1 GHz ARM
GPIO	26/40 pins	65/92 pins
USB Port	4 usb ports	1 usb port
Camera	Camera interphase port	None
Add-On Board	Larger Range	More Limited
Memory	Micro-SD	4G + Micro-SD
Software	Quadcore/1 Gb Ram	ARM/512 Mb
OS	Raspbian	Angstron
Online Help	More	Less
Cost	$35	$50

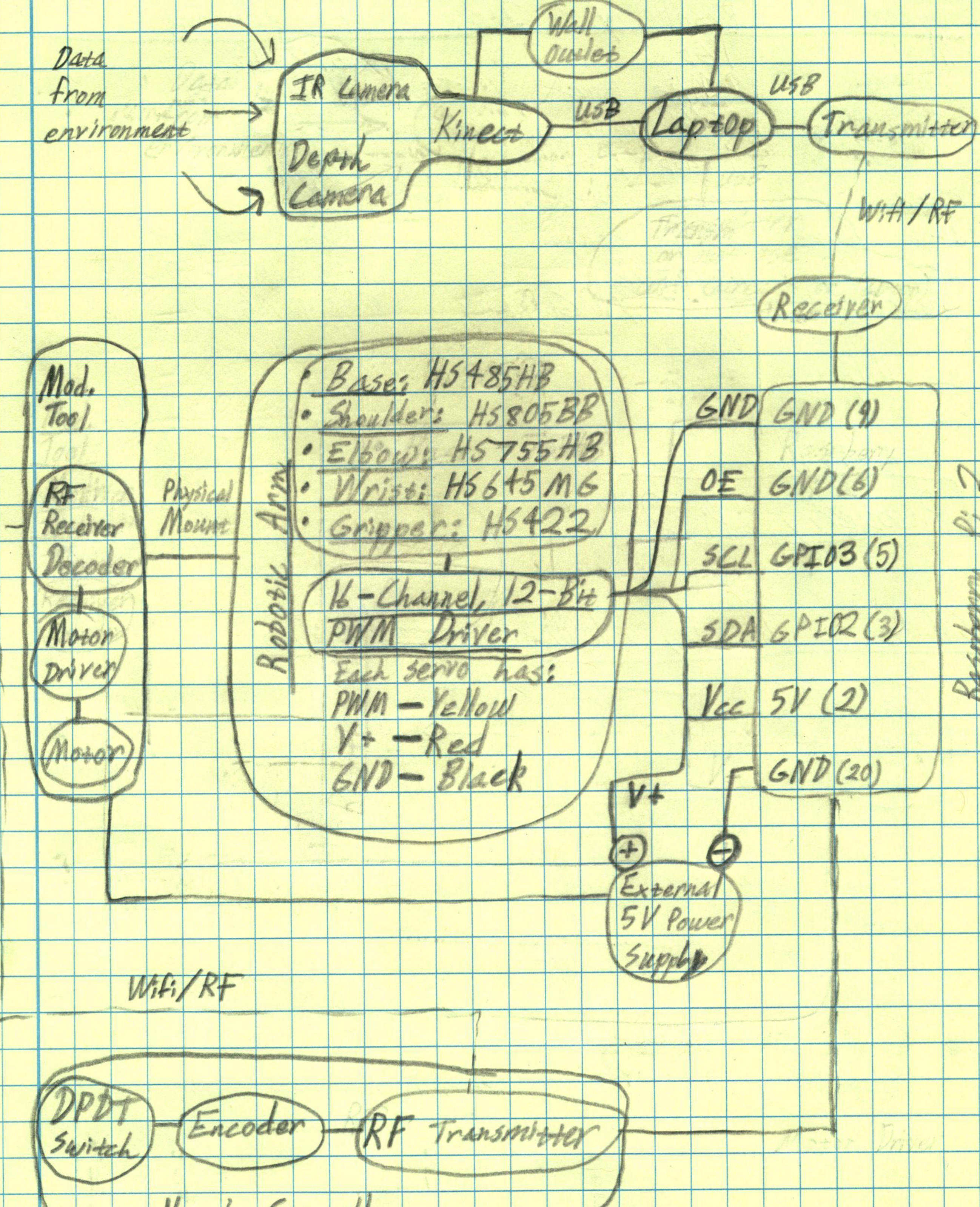
Winner:

Raspberry Pi 2

Software Design, Flowchart – Minilab



Interconnections Chart



Weight: 1.548 lbs.

Reference: www.lynxmotion.com/driver.aspx?Topic = assem01
· Shows assembly guide & user manual: AL5D-KT

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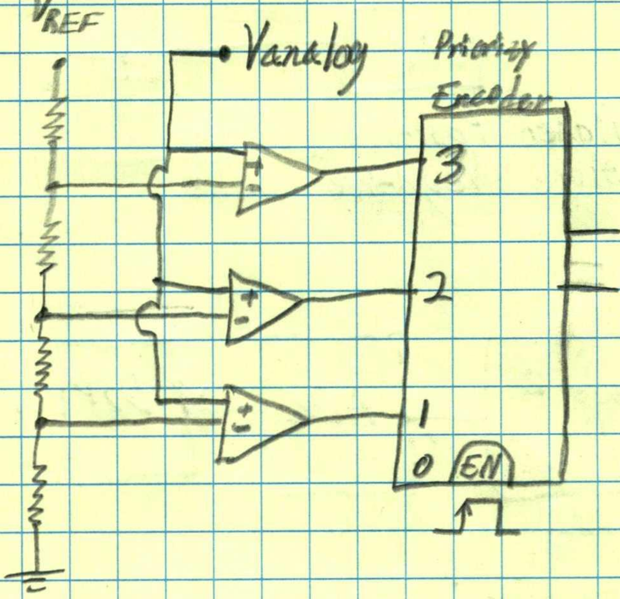
Mini-Lab, 2/27/16

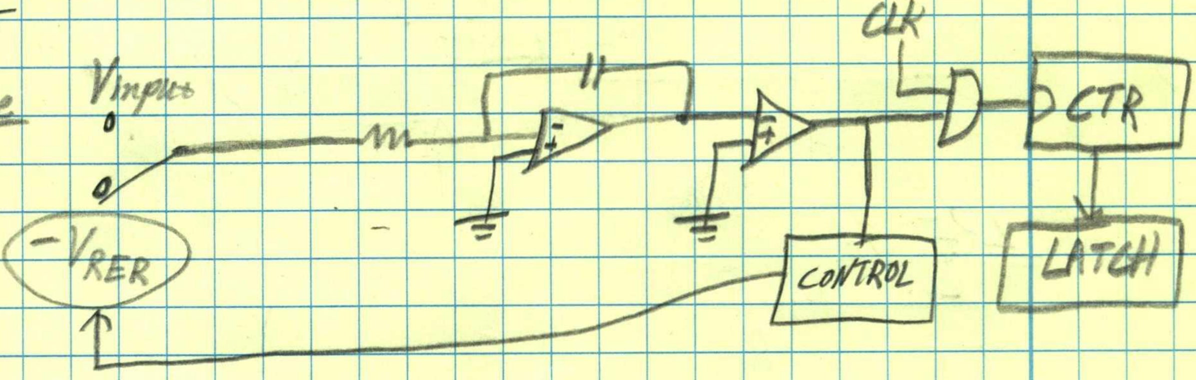
Youtube: ADC by Columbia Gorge Community College

- ADCs: Flash - Advantage: Fastest, simplest & highest throughput
  Disadvantage: Lots of hardware
  Dual Slope - Adv: Less hardware
  Disadv: Slower

Flash
(2-bits)

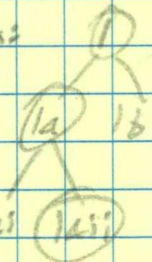


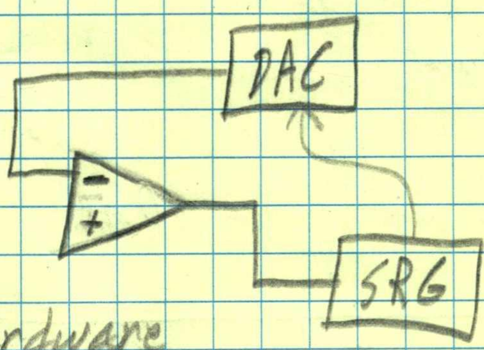
Dual Slope



Successive Aproximation
Start with output values, compare with input

Ex:





$$\begin{array}{cccc} 8V & 4V & 2V & 1V \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 2^3 & 2^2 & 2^1 & 2^0 \end{array}$$

MSB → LSB

- Fixed conversion time, and less hardware

→

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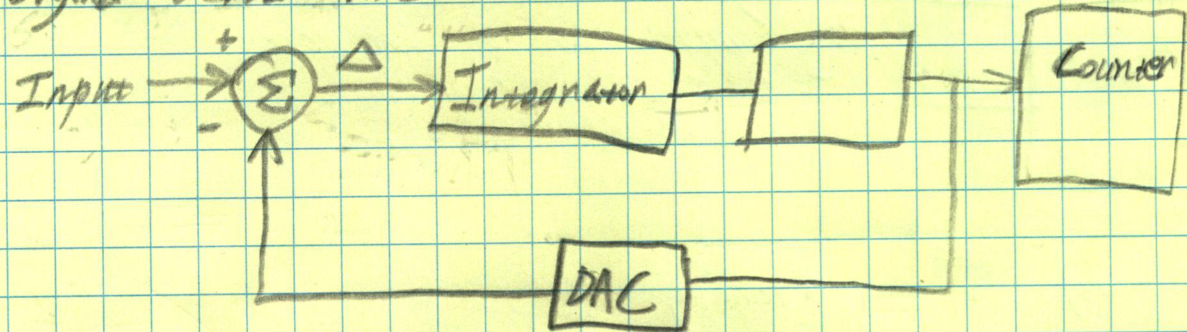
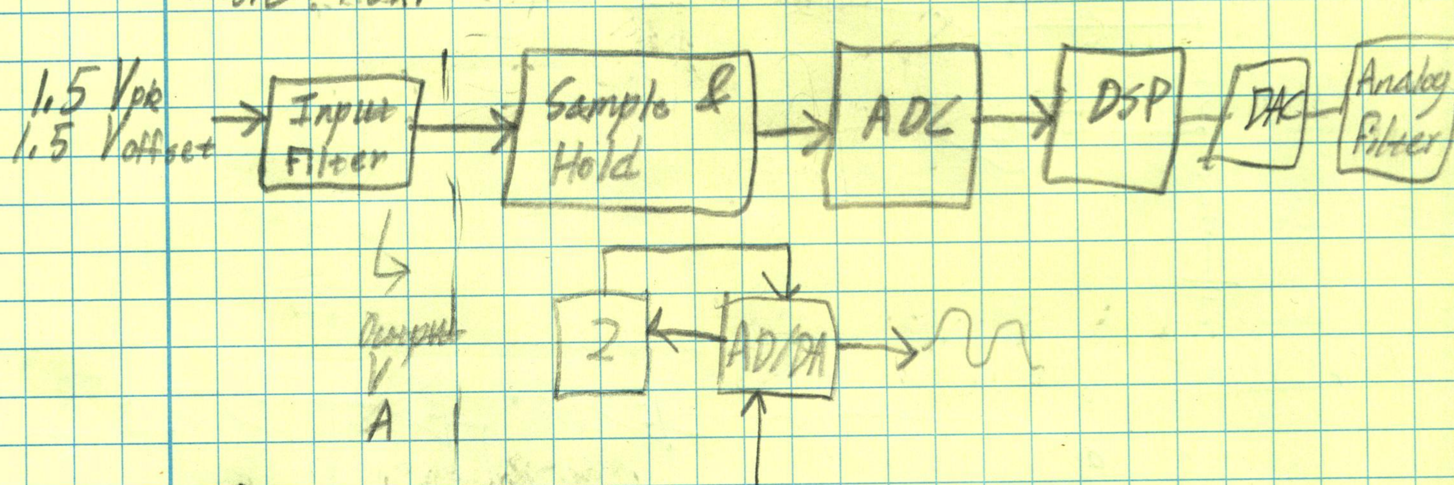
Mini-Lab Continued

- Sigma-Delta ADC



- More 1's: More Positive Value
- More 0's: More Negative Value

Basic FSR:

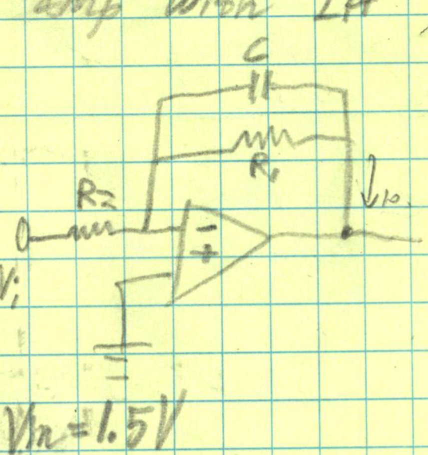


LPF

$i_1 - i_c = 10mA$

$\frac{V_{in} - V_{out}}{R_1} - C\frac{dV_{out}}{dt} = 10mA$

Use non-inverting amp with LPF



$V_{in} = 1.5V$

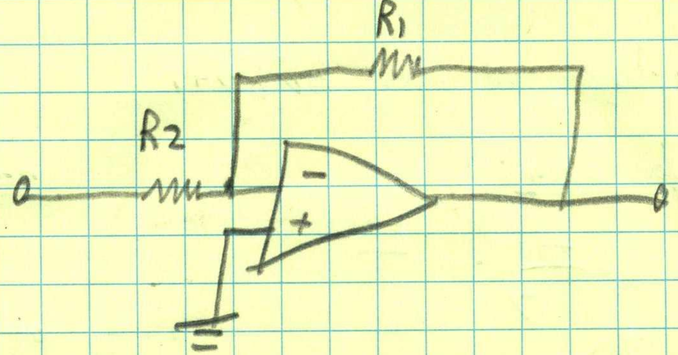
$V_{out} = 0.5V$

$\frac{V_{out}}{V_{in}} = \frac{-R_1}{R_2} = \frac{-1}{3} = \frac{50k}{150k}$ $I \approx 10mA$

2/28/16 $2\pi f = \omega = \frac{1}{RC} \rightarrow f = \frac{1}{2\pi(50k)C}$ $C = 3.183 \cdot 10^{-10} F$

Mini-Lab Continued

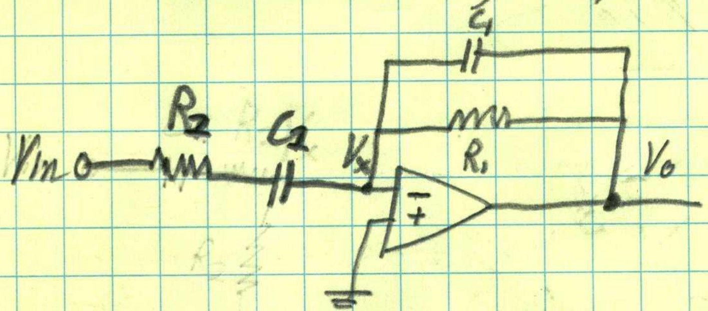
→ **Analog Output:**



$R_1 = 150k$

$R_2 = 50k$

- HPF & LPF for Analog Input



$R_1 = 50k\Omega$

$R_2 = 150\ k\Omega$

$$10\ Hz = \frac{1}{2\pi(150k\Omega)C_2}$$

$C_2 = 106.1\ nF$

$$\frac{V_x - V_{in}}{R_2 + \frac{1}{sC_2}} = \frac{V_o - V_x}{R_1 \,||\, \frac{1}{sC_1}}$$

If $C_1 = 10\ nF$

$$10kHz = \frac{1}{2\pi(R_1)(10nF)}$$

$R_1 = 15,915\ \Omega$

$$10\ Hz = \frac{1}{2\pi(R_2)(10nF)}$$

Non-Inverting Op Amp

$$10\ kHz = \frac{1}{2\pi(1k)C}$$

$C = 1.6 \cdot 10^{-8}\ F$

$$10\ Hz = \frac{1}{2\pi(150k)C}$$

$C = 106\ nF$

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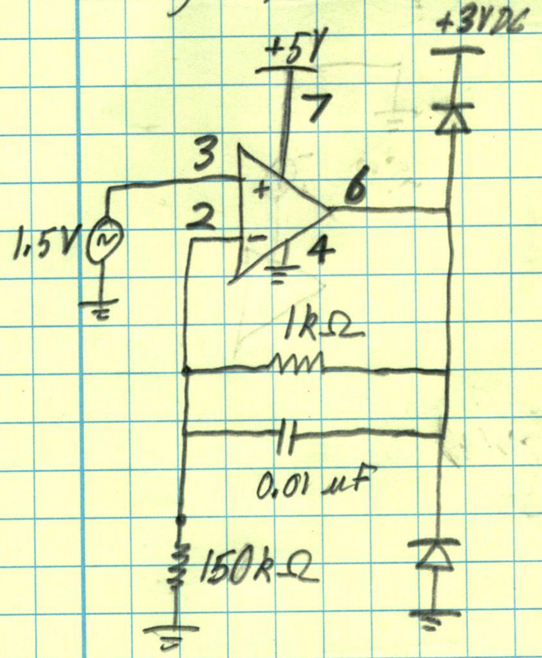
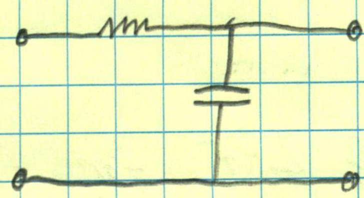
MiniLab Continued..

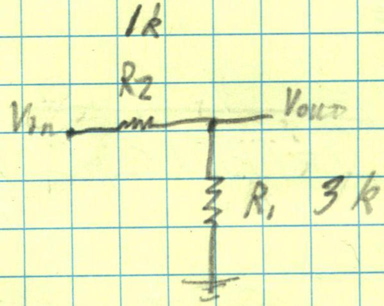
- Op-Amps to use: AD8541

Analog Input:



Analog Output:



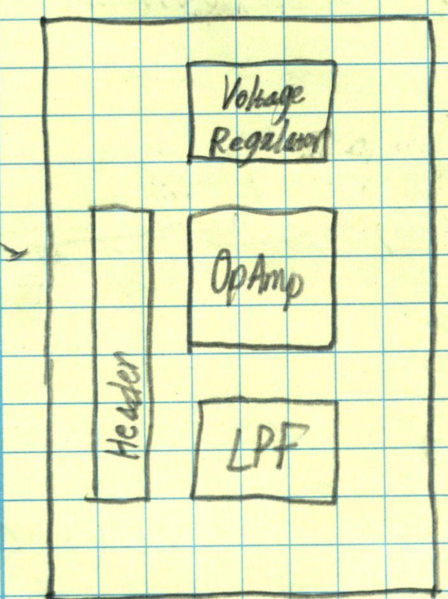


$$3V = 5V \frac{R_1}{R_1 + R_2}$$

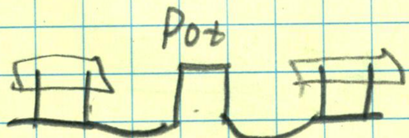
$$0.6R_1 + 0.6R_2 = R_1$$

$$0.4R_1 = 0.6R_2$$

$$R_2 = \frac{2}{3} R_1$$



- Parts:
  DIP Socket
  13×2 Header
  2 or 3 Jumper



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wholetpaul@tamu.edu Robert Paul Trettenero 832-752-0976

FSR Calculations

- Power Consumption:

Arm: $1610\ mA \cdot x = 5Ah$

$x = 3.105$ hours

Pi: $1.2A \cdot x = 5Ah$

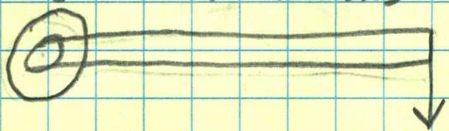
- Servo Movement

Kinect time → Pi PWM

$5.208 \cdot 10^{-8}s$ period

Servo expects 20 ms (50 Hz) at least.

- Torque Calculations



$T = F \cdot r \sin\theta$

Length = 19"

$T = F \cdot r \cancel{\sin\theta}^{1}$

$$274.98\ oz.in \left(\frac{0.0625\ lbs}{1\ oz}\right)\left(\frac{ft}{12in}\right) = 1.432\ ft.lbs$$

$$\frac{1.432\ ft.lbs}{12\ ft} = \frac{x}{19\ in} = 2.267\ ft.lbs$$

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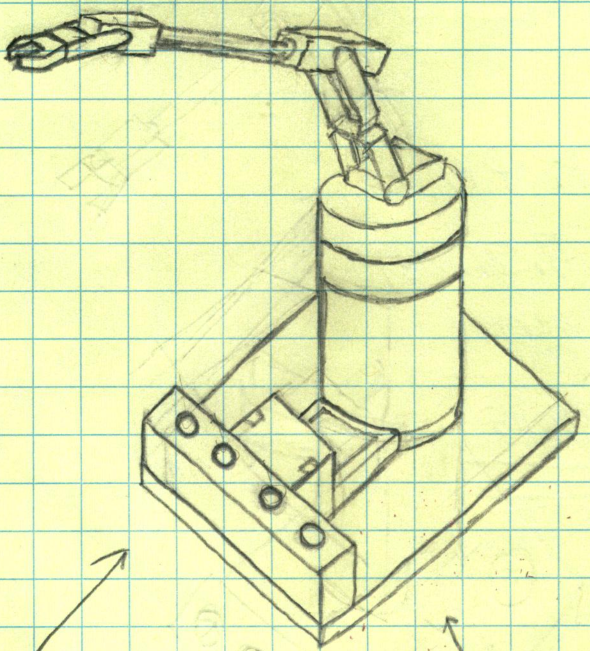
Base Designs 3/17/16

Upright:

Possible additional motor addition

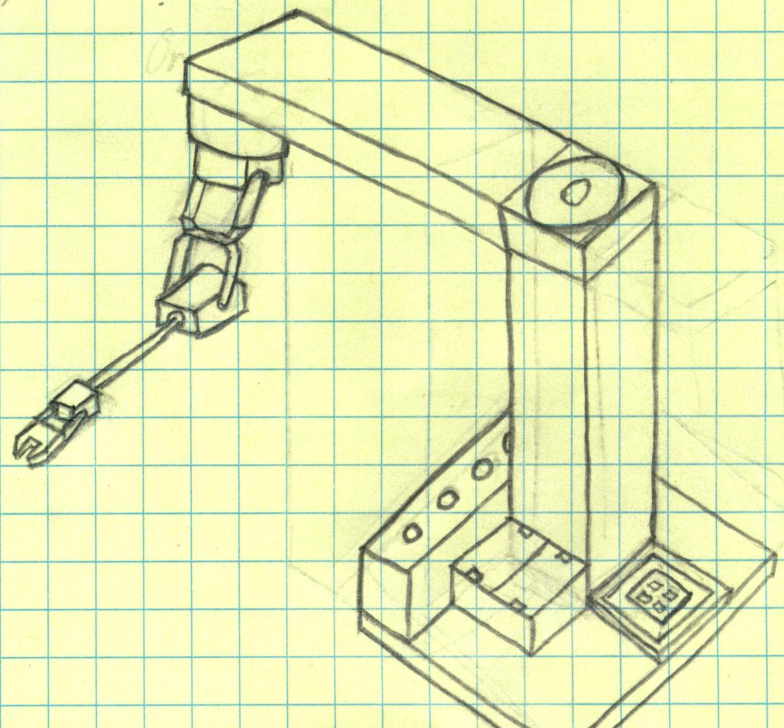


Elevated by approx. 1ft.

Tool set holes need to be made compared to wrist

Need battery & pi mounts

Hanging:



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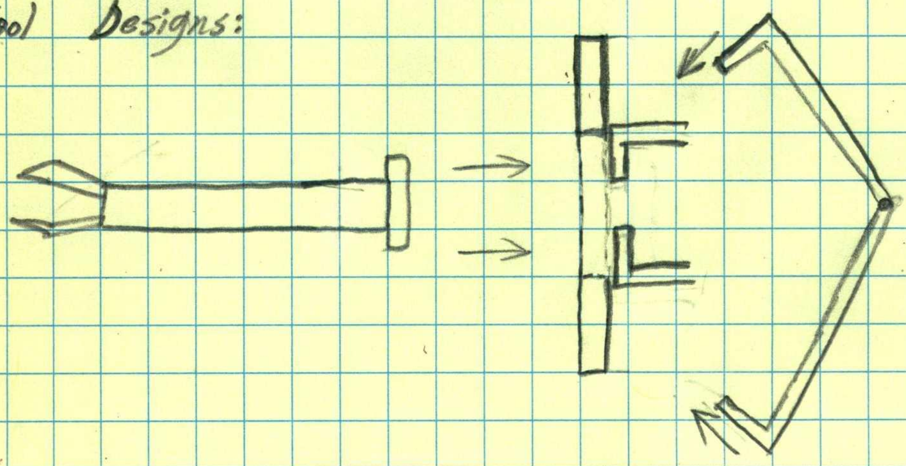
Hand Design 3/17/16

- Reference www.intuitivesurgical.com for specialized instruments
- Tool Designs:



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