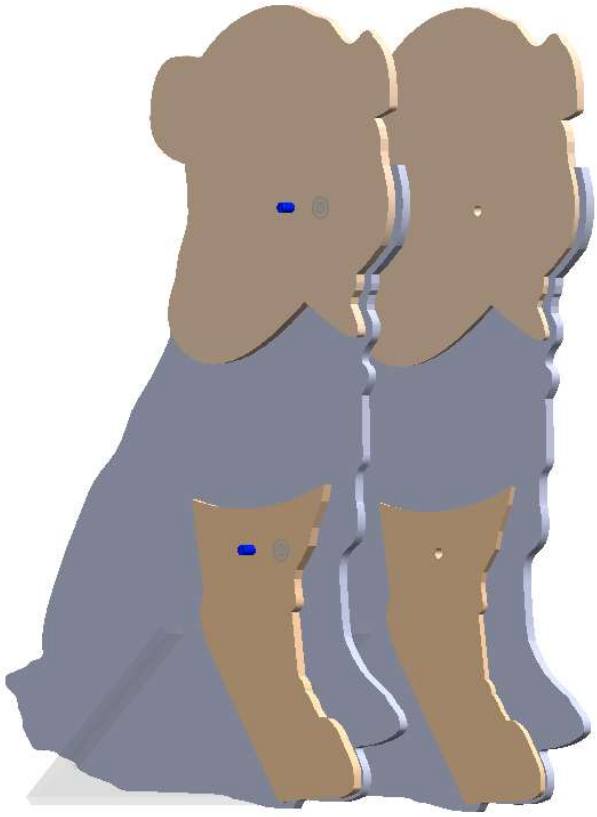
Lab 3 - Waldo

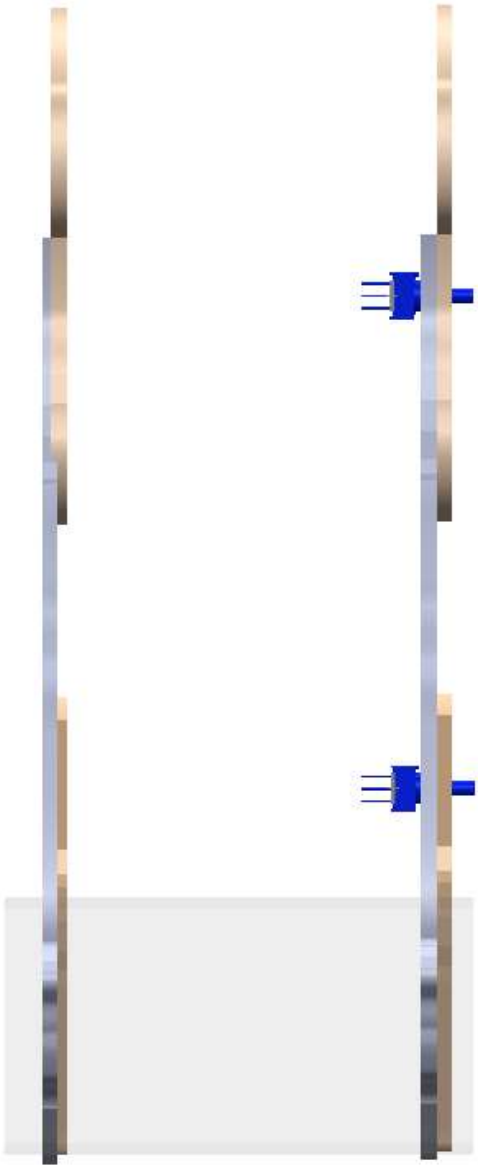
Sheil Sarda sheils@seas.upenn.edu

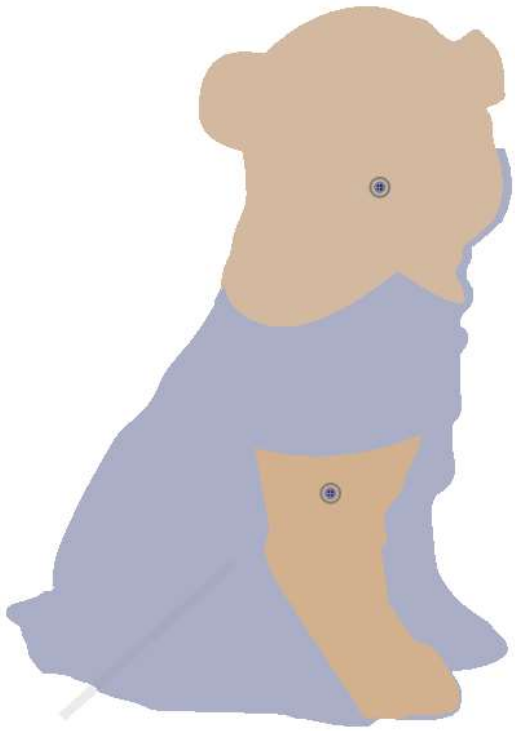
3.2 Waldo Output

3.2.1 Drawing for Input and Output

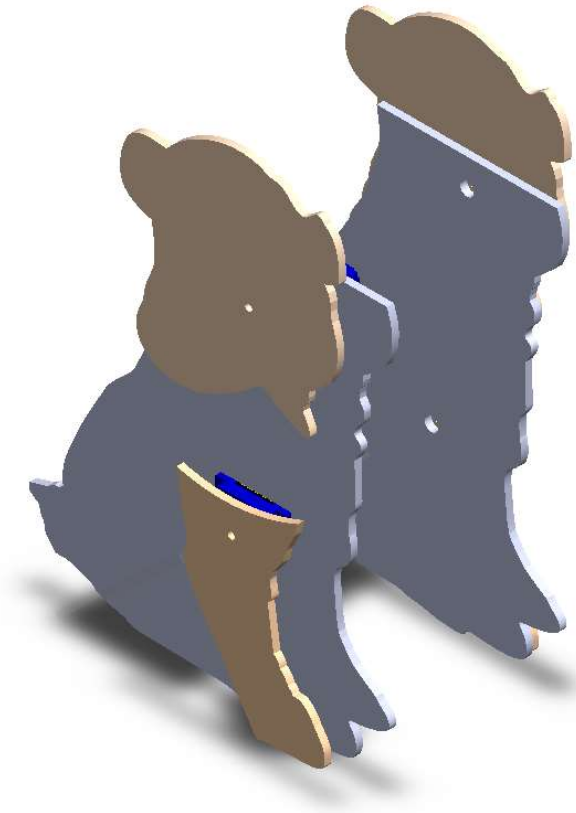
Input Waldo Design

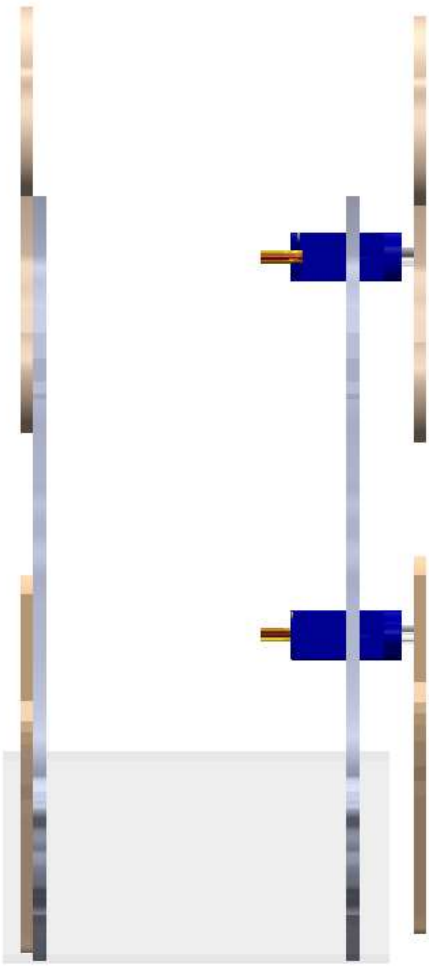


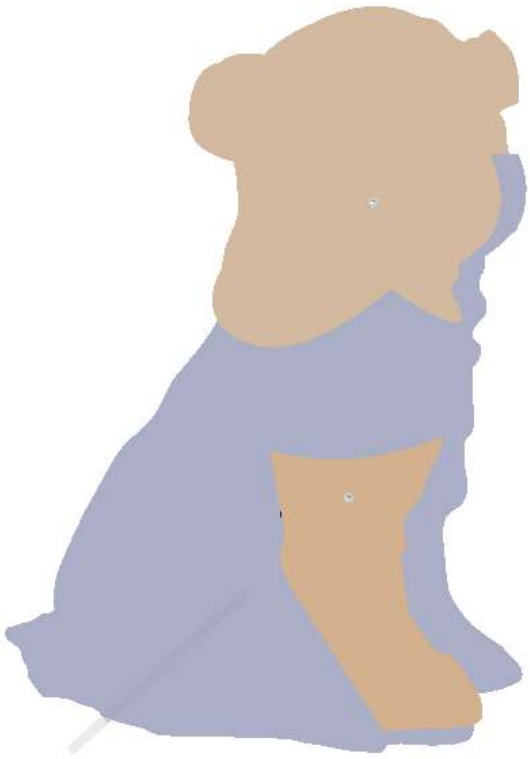




Output Waldo Design







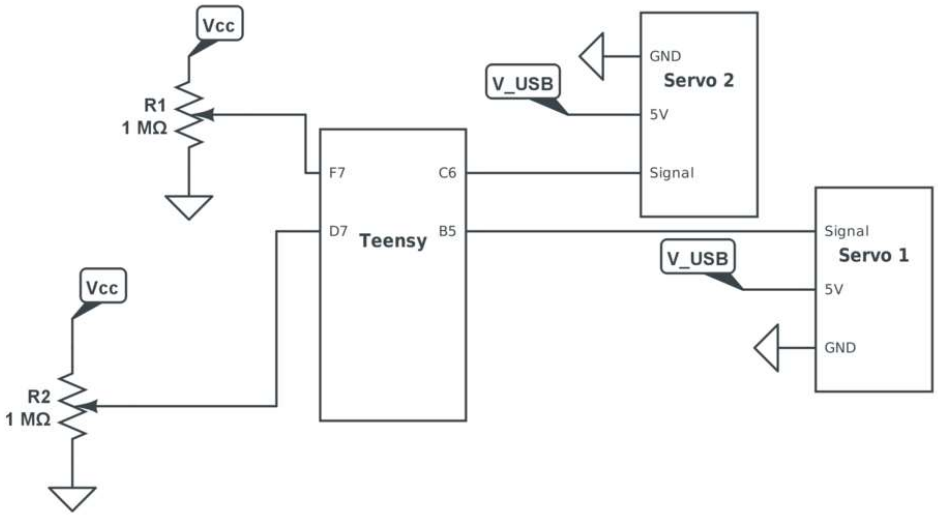
Dimensions

Length	8 inches
Width	6.5 inches

Intented motion of moving parts

On the Waldo Input robot, the paw and the head are free to rotate about the potentiometer. These actions will be replicated on the Waldo Output robot.

3.2.2 Circuit Diagram and Analysis



Current ratings: Output

Current source / draw	Worst Case
BestOn Power Supply (Source)	2100mA
SG90 Servo (Load)	700mA

Current ratings: Input

Current source / draw	Worst Case
Teensy via USB 2.0 (Source)	500mA
Potentiometer (Load)	I = V/R = 3.3V / 1kOhm = 3.3mA

Total current draw in the worst case (teensy, potentiometers, servos)

In the worst case on the Output side, as described above, the SG90 servo powered by the BestOn power bank will be able to handle the current draw.

On the Input side, the Teensy will also be able to power the potentiometer in the worst case.

3.2.3 Circuit Diagram and Analysis

Code submitted on Canvas submission. Also included here for reference:

```
/* Name: main.c
 * Author: Sheil Sarda
 */
#include "teensy_general.h"
#include "t_usb.h"
#include <stdbool.h>
#include <string.h>
#include <math.h>
```

```
#define CLOCK_SPEED 16e6
#define PRESCALAR 256

#define TARGET 10e3
#define USB 1
#define MAX_ADC 1023
#define MAX_ANG 300

#define FREQ_HZ    50    // variable for frequency
#define DUTY_CYCLE 0.08    // duty cycle
#define MAX_DUTY 0.111
#define MIN_DUTY 0.055

#define PAW_MIN 60.0
#define PAW_MAX 200.0

#define HEAD_MIN 40.0
#define HEAD_MAX 230.0

void setup_ADC(char adc_num){

    set(ADMUX, REFS0); // AVcc

    // 128 ADC prescalar
    set(ADCSRA, ADPS0);
    set(ADCSRA, ADPS1);
    set(ADCSRA, ADPS2);

    switch(adc_num){ // Disable digital input
        case 0 : set(DIDR0, ADC0D);   break;
        case 1 : set(DIDR0, ADC1D);   break;
        case 4 : set(DIDR0, ADC4D);   break;
        case 5 : set(DIDR0, ADC5D);   break;
        case 6 : set(DIDR0, ADC6D);   break;
        case 7 : set(DIDR0, ADC7D);   break;
        case 8 : set(DIDR2, ADC8D);   break;
        case 9 : set(DIDR2, ADC9D);   break;
        case 10: set(DIDR2, ADC10D);  break;
        case 11: set(DIDR2, ADC11D);  break;
        case 12: set(DIDR2, ADC12D);  break;
        case 13: set(DIDR2, ADC13D);  break;
    }

    set(ADCSRA, ADEN); // enable ADC
    set(ADCSRA, ADSC); // first conversion

}

void setup_next(char adc_num){

    unsigned int mask1 =
                        (1 << MUX0) |
                        (1 << MUX1) |
                        (1 << MUX2);

    ADMUX &= ~mask1;

    clear(ADCSRB, MUX5);

    switch(adc_num){
        case 0 :                        break;
        case 1 :    set(ADMUX, MUX0);   break;
        case 4 :    set(ADMUX, MUX2);   break;
        case 5 :    set(ADMUX, MUX2);
                    set(ADMUX, MUX0);   break;
        case 6 :    set(ADMUX, MUX2);
                    set(ADMUX, MUX1);   break;
```

```
        case 7 :    set(ADMUX, MUX0);
                    set(ADMUX, MUX1);
                    set(ADMUX, MUX2);   break;
        case 8 :    set(ADCSRB, MUX5);  break;
        case 9 :    set(ADCSRB, MUX5);
                    set(ADMUX, MUX0);   break;
        case 10:    set(ADCSRB, MUX5);
                    set(ADMUX, MUX1);   break;
        case 11:    set(ADCSRB, MUX5);
                    set(ADMUX, MUX1);
                    set(ADMUX, MUX0);   break;
        case 12:    set(ADCSRB, MUX5);
                    set(ADMUX, MUX2);   break;
        case 13:    set(ADCSRB, MUX5);
                    set(ADMUX, MUX2);
                    set(ADMUX, MUX0);   break;
    }

}

int read_adc(char next_adc){

    set(ADCSRA, ADSC); // first conversion

    setup_next(next_adc);

    while(!bit_is_set(ADCSRA, ADIF));

    unsigned int result = ADC;

    set(ADCSRA, ADIF); // clear compute flag
    return result;
}

void setup_PWM(float duty, char timer){

    switch(timer){
        case 1:
            set(DDRB, 5); // output compare

            // (mode 14) up to ICR1, PWM
            set(TCCR1B, WGM13);
            set(TCCR1B, WGM12);
            set(TCCR1A, WGM11);

            set(TCCR1A, COM1A1); // clear OC

            ICR1 = CLOCK_SPEED/(FREQ_HZ * PRESCALAR);
            OCR1A = ICR1 * duty;
            break;

        case 3:
            set(DDRC, 6);

            set(TCCR3B, WGM33);
            set(TCCR3B, WGM32);
            set(TCCR3A, WGM31);

            set(TCCR3A, COM3A1);
            ICR3 = CLOCK_SPEED/(FREQ_HZ * PRESCALAR);

            OCR3A = ICR3 * duty;
            break;
    }
}

void change_PWM(float duty, char timer){
    switch(timer){
```

```
        case 1: OCR1A = ICR1 * duty;
                break;
        case 3: OCR3A = ICR3 * duty;
                break;
    }
}

int main(void){
    teensy_clockdivide(0); //set the clock speed
    #ifdef USB
        m_usb_init();
        while(!m_usb_isconnected());
    #endif

    // set 256 prescalar  - Servo PWM
    set(TCCR3B, CS32);
    setup_PWM(DUTY_CYCLE, 3);

    // set 256 prescalar  - Servo PWM
    set(TCCR1B, CS12);
    setup_PWM(DUTY_CYCLE, 1);

    setup_ADC(10);  // ADC10 or PD7
    setup_ADC(6);   // ADC6 or PF6

    unsigned int result1, result2;
    float duty1, duty2;

    while(1){

        result2 = read_adc(10); // gives you ADC6
        result1 = read_adc(6);  // gives you ADC10

        result2 *= ((float) MAX_ANG / MAX_ADC);
        result1 *= ((float) MAX_ANG / MAX_ADC);

        duty1   = ((float) fmax(result1 - HEAD_MIN, 0.0));
        duty1   = ((float) (duty1*(MAX_DUTY - MIN_DUTY)/HEAD_MAX) + MIN_DUTY);

        duty2   = ((float) fmax(result2 - PAW_MIN, 0.0));
        duty2   = ((float) (duty2*(MAX_DUTY - MIN_DUTY)/PAW_MAX) + MIN_DUTY);

        // need to flip paw
        duty2   = MAX_DUTY - duty2;

        change_PWM(duty1, 3);
        change_PWM(duty2, 1);

        #ifdef USB
            m_usb_tx_string("LEFT: ");
            m_usb_tx_uint(result2);
            m_usb_tx_string(" duty: ");
            m_usb_tx_uint(duty2*100);

            m_usb_tx_string("  RIGHT: ");
            m_usb_tx_uint(result1);
            m_usb_tx_string(" duty: ");
            m_usb_tx_uint(duty1*100);
            m_usb_tx_string("\r\n");
        #endif
    }
}
```

3.2.4 Dance Video