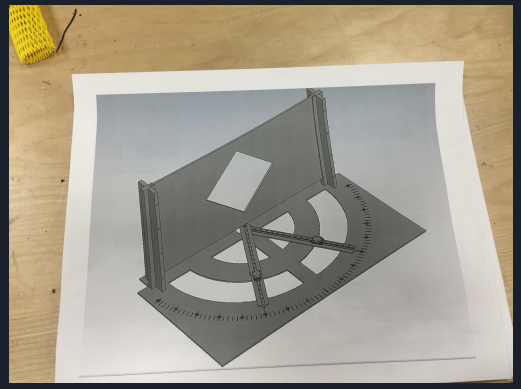
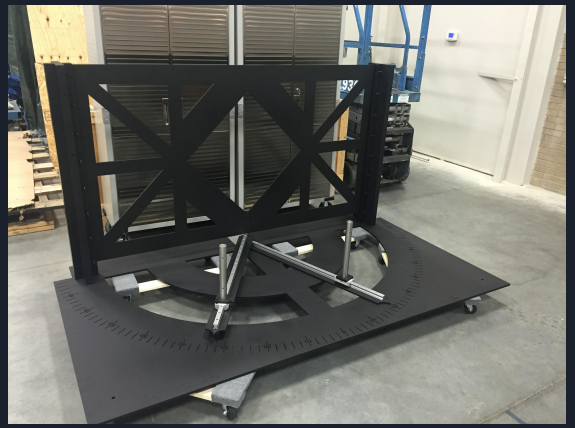
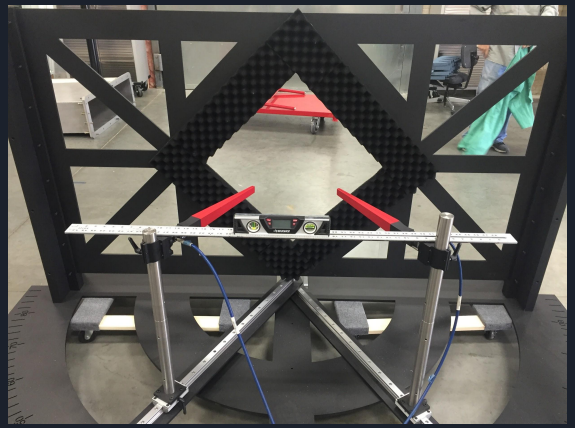
Projects and Research

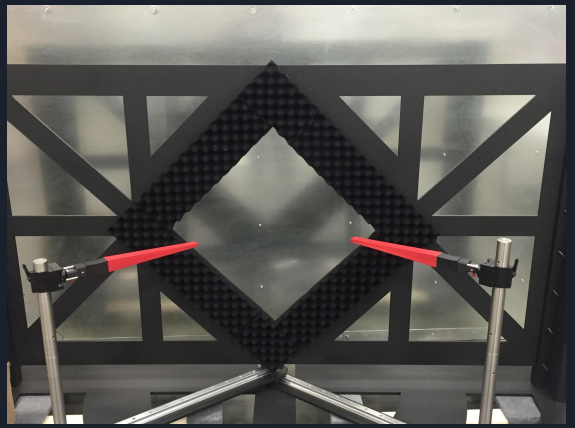
Rick Hubbard

Scatterometer Custom Build Phase

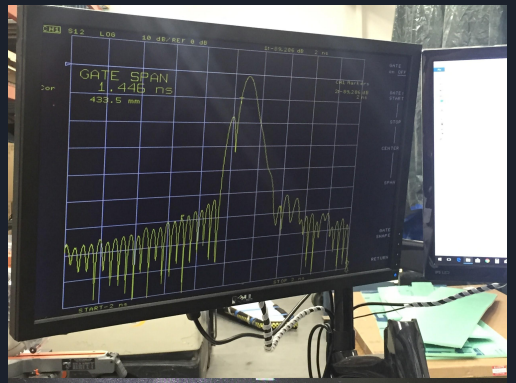


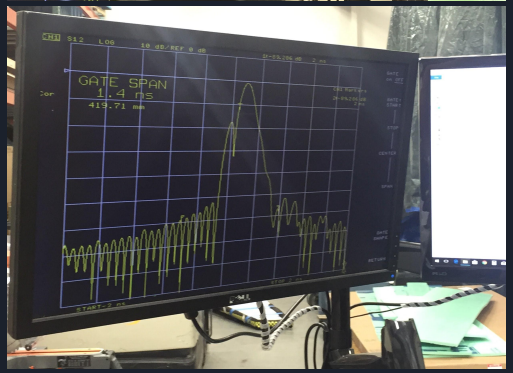


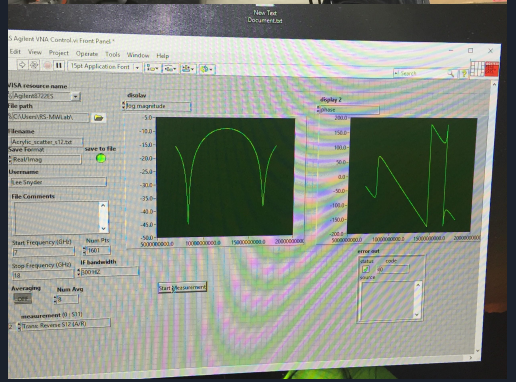


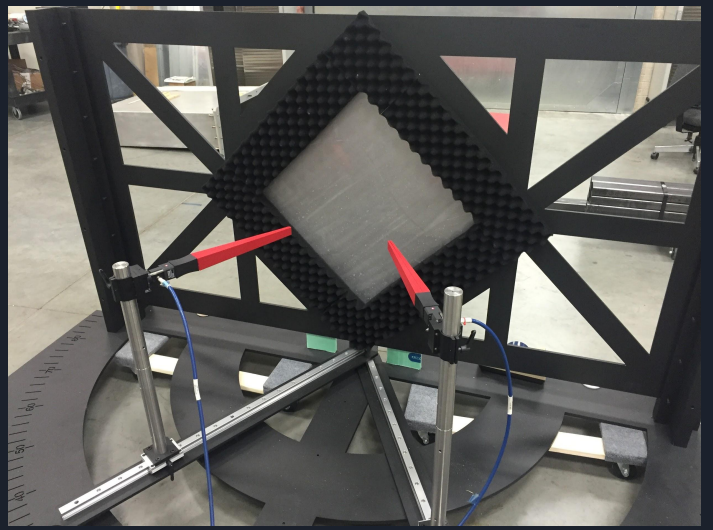


Scatterometer Testing Phase









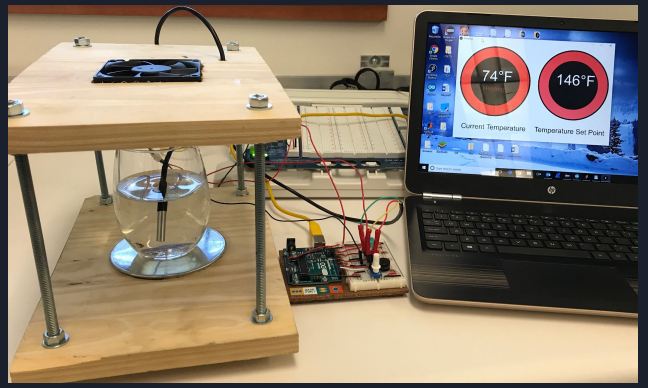
Arduino Microcontroller Project

Code Excerpt from Processing

```
//displays temperature probe reading
 textFont(f,75);
 fill(255);
 text(value2 + "°F",130,200);
 //textFont(f,16);
 //fill(255);
 //text("The current temperature is:", 100,180);
//system is heating...display heating
 if (value2 < value1)
 {
  textFont(f,32);
  fill(204,0,0);
  text("Heating", 140,250);
 }
 //system is idle....display idle
 if (value1 == value2 || (value2 > value1 && value2 < value1+5))
 {
  fill(255);
  text("Idle", 175,290);
 }
 //system is cooling...display cooling
 if (value2 > value1+5)
 {
  textFont(f,32);
  fill(255);
  text("Cooling", 145,250);
 }
```

Figure 5: Part of the Processing code to match the digitial interface colors with that of the LEDs.

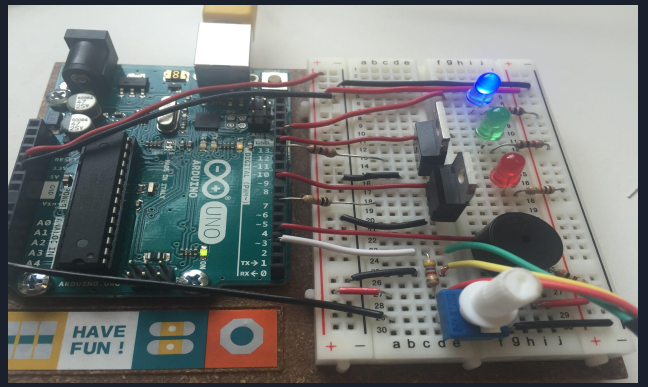
Table 1: Components used in KTR System	
Component	**Quantity**
LEDs	3 (red, blue, and green)
1 kΩ Resistors	3
360 Ω Resistor	1
470 Ω Resistor	1
Piezo Speaker	1
Fan	1
Stemless wine glass	1
DS18B20 Digital Thermometer	1
20 ohm Power Transfer Resistor (heater)	2
Potentiometer	1
Transistors	2
12 V 0.5 A Fan	1
Arduino Uno Microcontroller	1
Processing 3.3.3	1
Digital Interface	1
Wires	Significant amount



Code Excerpt from Arduino

```
sensors.requestTemperatures();
  //compare temperature from probe to set temperature
  //if temperature is less than set temperature turn on heater
  while(sensors.getTempFByIndex(0) < (analogRead(potPin)/3))
  {
    //print the temperature and set temperature to serial port for processing to use
    //set temperature probe to an integer
    temp = sensors.getTempFByIndex(0);
    Serial.print(analogRead(A5)/3);
    Serial.print(",");
    Serial.println(temp);
    //turn on Red LED indicating heater is on
    digitalWrite(HeatingPin, HIGH);
    //set pin to transistor to high to turn on heater
    digitalWrite(powerPin, HIGH);
    //request temperature from probe again for comparison
    sensors.requestTemperatures();
  }
```

Figure 4: Part of the temperature code

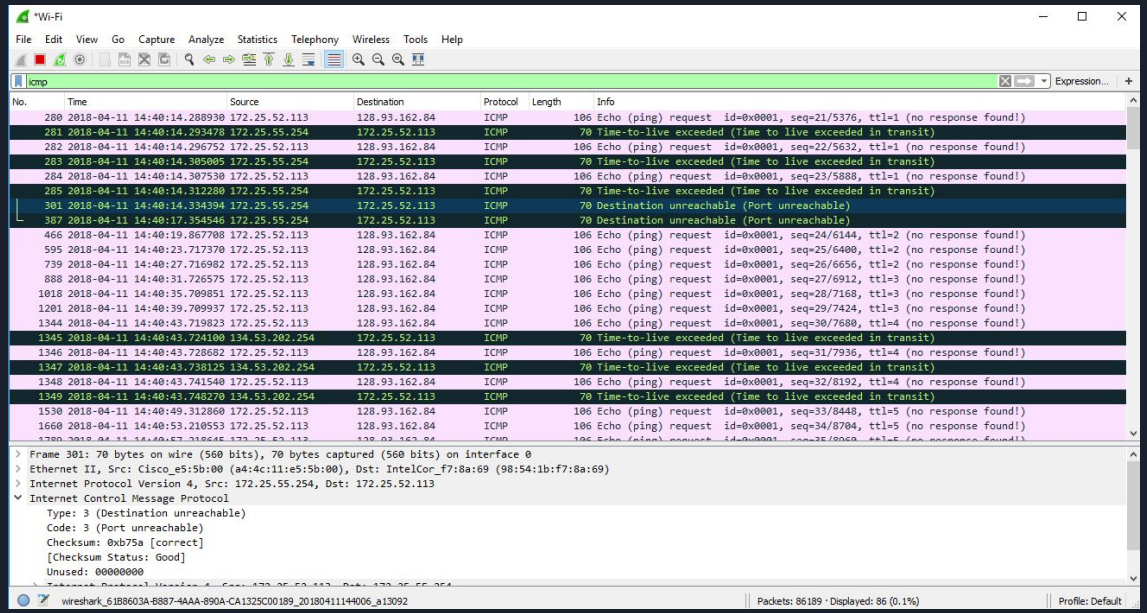


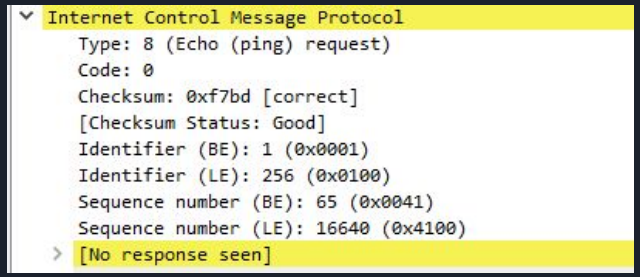
Java Computer Learning Tic Tac Toe Game

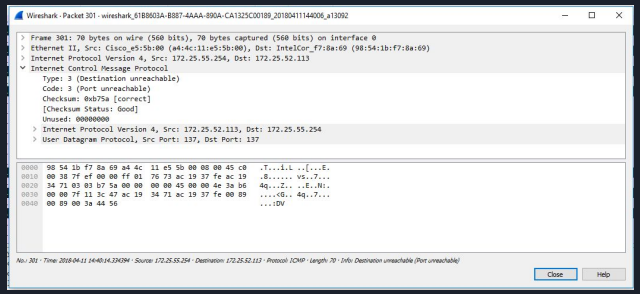
```
Welcome to Tic Tac Toe
This is a one player game against a computer
At the beginning of each of your turns you will be asked to enter a number 0-8 corresponding to which square you would like to take.
The board is numbered as follows:
0 | 1 | 2
---------
3 | 4 | 5
---------
6 | 7 | 8
Now lets get started
  |   |
---------
  |   |
---------
  |   |
Please enter a number 0-8 to indicate which square you'd like to claim: 4
The computers best move is: 8
  |   |
---------
  | X |
---------
  |   | O
Please enter a number 0-8 to indicate which square you'd like to claim: 0
The computers best move is: 6
X |   |
---------
  | X |
---------
O |   | O
```

```
//method to create all variations of a tic tac toe board
private static void boardCreate()
{
    int s0 =0;
    int s1 =0;
    int s2 =0;
    int s3 =0;
    int s4 =0;
    int s5 =0;
    int s6 =0;
    int s7 =0;
    int s8 =0;

    String[] createdBoard = new String[9];

    while(s0<3)
    {
        while(s1<3)
        {
            while(s2<3)
            {
                while(s3<3)
                {
                    while(s4<3)
                    {
                        while(s5<3)
                        {
                            while(s6<3)
                            {
                                while(s7<3)
                                {
                                    while(s8<3)
                                    {
                                        createdBoard[0] = spaceFill(s0);
                                        createdBoard[1] = spaceFill(s1);
```

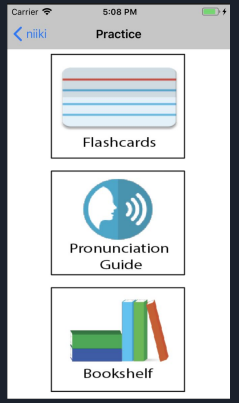
Wireshark Wireless Data Interception Project

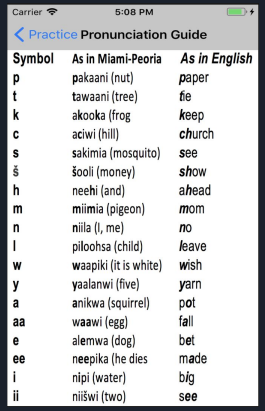


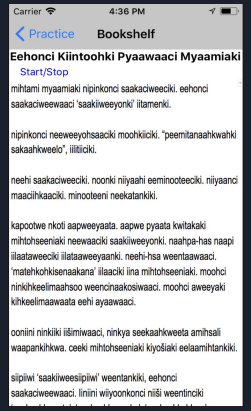


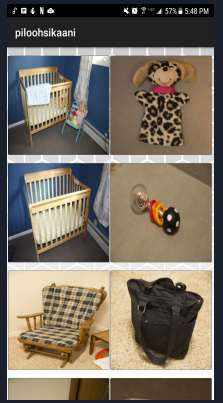


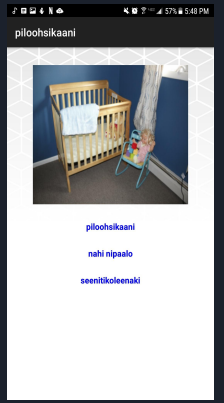
Niiki Language App (iPhone and Android)

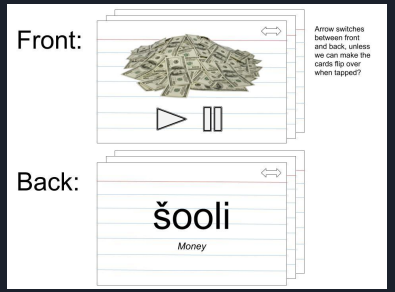




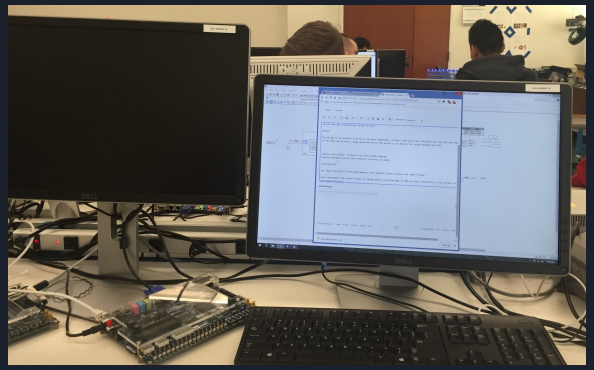


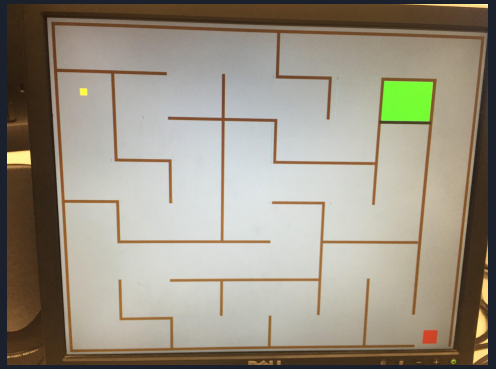


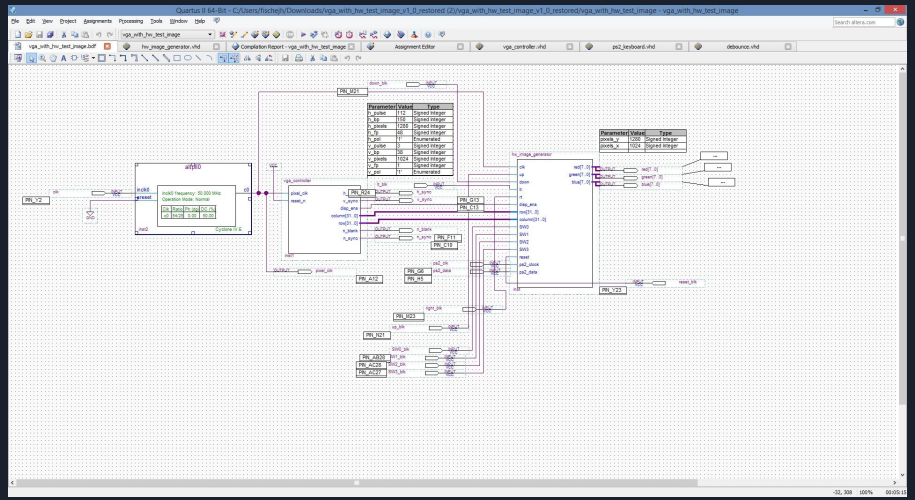


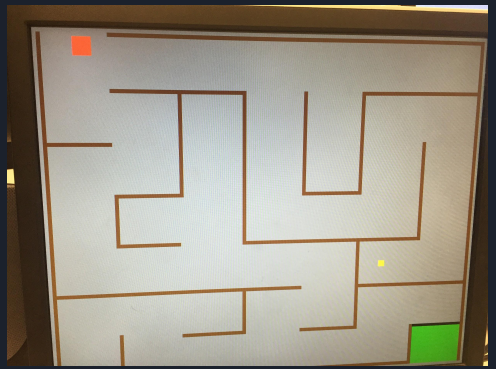


VHDL FPGA Maze Project

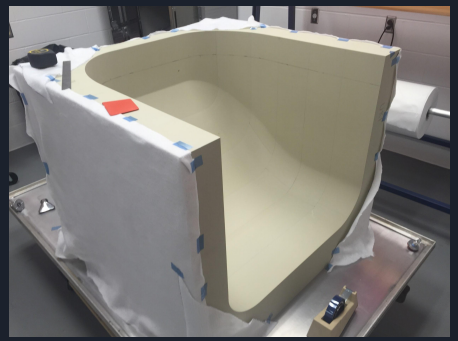


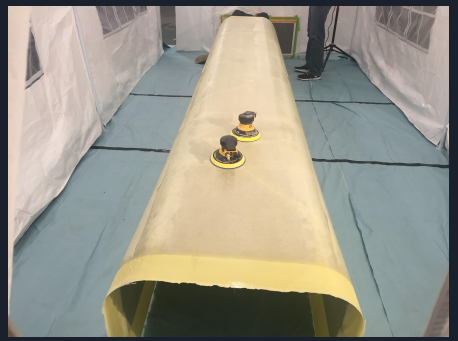


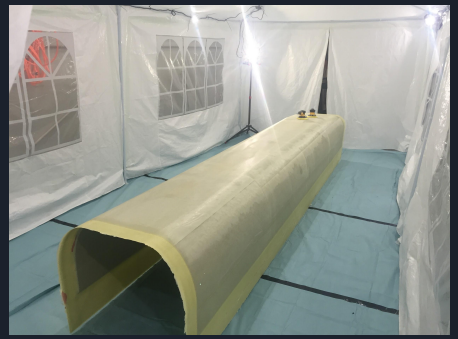


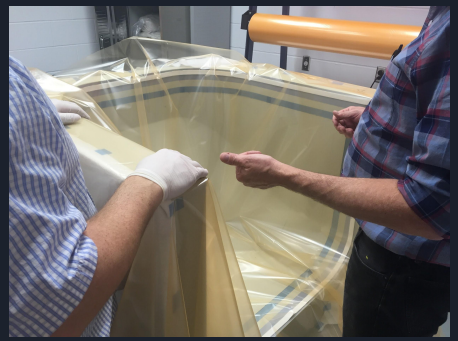


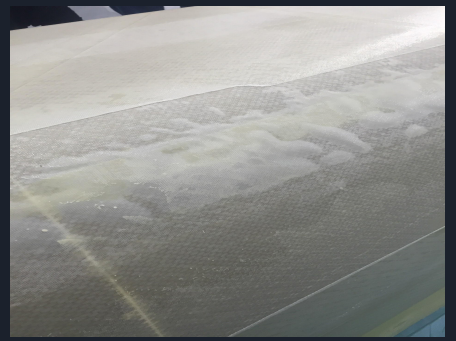
RF Composite Radome

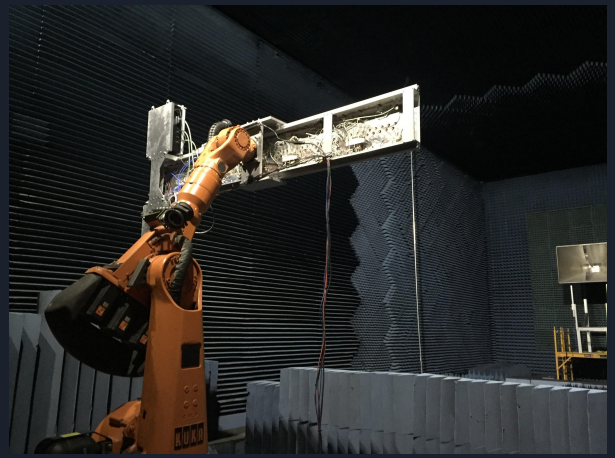


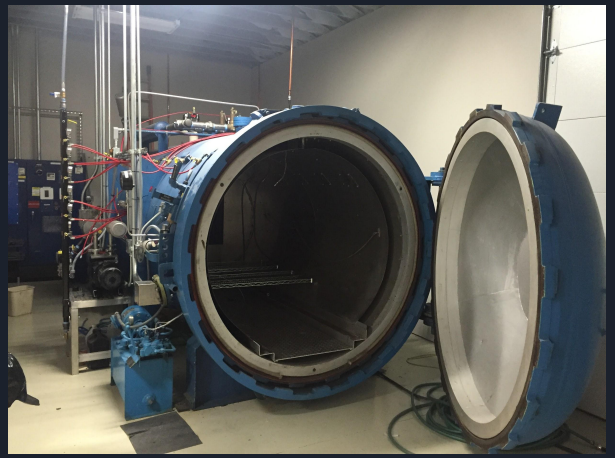




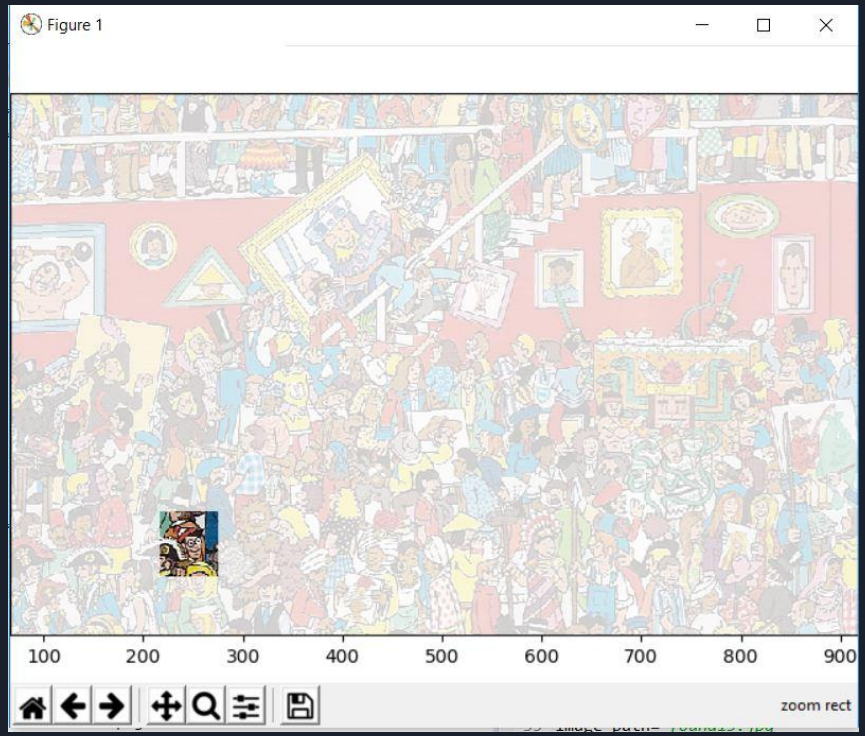








Find Waldo Computer Vision Program



Tensorflow and Python Code

```
from matplotlib import pyplot as plt
import numpy as np
import sys
import tensorflow as tf
import matplotlib
from PIL import Image
import matplotlib.patches as patches
import cv2
import tkinter as tk
from tkinter import ttk

cap = cv2.VideoCapture(0)

while(cap.isOpened()):  # check !
    # capture frame-by-frame
    ret, frame = cap.read()

    if ret: # check ! (some webcam's need a "warmup")
        # our operation on frame come here
        rgb = cv2.cvtColor(frame, cv2.COLOR_BGR2BGRA)

        # Display the resulting frame
        cv2.imshow('frame', rgb)

    if cv2.waitKey(1) & 0xFF == ord('q'):
        out = cv2.imwrite('capture.jpg', frame)
        break
# When everything is done release the capture
cap.release()
cv2.destroyAllWindows()

model_path = 'frozen_inference_graph.pb'
image_path='found13.jpg'

def draw_box(box, image_np):
    #expand the box by 50%
    box += np.array([-(box[2] - box[0])/2, -(box[3] - box[1])/2, (box[2] - box[0])/2, (box[3] - box[1])/2])

    fig = plt.figure()
    ax = plt.Axes(fig, [0., 0., 1., 1.])
    fig.add_axes(ax)

    #draw blurred boxes around box
    ax.add_patch(patches.Rectangle((0,0),box[1]*image_np.shape[1], image_np.shape[0],linewidth=0,edgecolor='none',facecolor='w',alpha=0.8))
    ax.add_patch(patches.Rectangle((box[3]*image_np.shape[1],0),image_np.shape[1], image_np.shape[0],linewidth=0,edgecolor='none',facecolor='w',alpha=0.8))
    ax.add_patch(patches.Rectangle((box[1]*image_np.shape[1],0),(box[3]-box[1])*image_np.shape[1],
box[0]*image_np.shape[0],linewidth=0,edgecolor='none',facecolor='w',alpha=0.8))
    ax.add_patch(patches.Rectangle((box[1]*image_np.shape[1],box[2]*image_np.shape[0]),(box[3]-box[1])*image_np.shape[1],
image_np.shape[0],linewidth=0,edgecolor='none',facecolor='w',alpha=0.8))

    return fig, ax
```

```
while(cap.isOpened()):  # check !
    # capture frame-by-frame
    for t in range(0,250):
        ret, frame = cap.read()

        if ret: # check ! (some webcam's need a "warmup")
            # our operation on frame come here
            rgb = cv2.cvtColor(frame, cv2.COLOR_BGR2BGRA)

            # Display the resulting frame
            #for t in range (0, 20000):
            cv2.imshow('frame', rgb)
        name = "frame%d.jpg"%count
        cv2.imwrite(name, frame)
        count += 1
            cv2.waitKey(1)
    break
```

```
detection_graph = tf.Graph()
with detection_graph.as_default():
    od_graph_def = tf.GraphDef()
    with tf.gfile.GFile(model_path, 'rb') as fid:
        serialized_graph = fid.read()
        od_graph_def.ParseFromString(serialized_graph)
        tf.import_graph_def(od_graph_def, name='')

def load_image_into_numpy_array(image):
  (im_width, im_height) = image.size
  return np.array(image.getdata()).reshape(
      (im_height, im_width, 3)).astype(np.uint8)


with detection_graph.as_default():
  with tf.Session(graph=detection_graph) as sess:
    image_np = load_image_into_numpy_array(Image.open(image_path))
    image_tensor = detection_graph.get_tensor_by_name('image_tensor:0')
    boxes = detection_graph.get_tensor_by_name('detection_boxes:0')
    scores = detection_graph.get_tensor_by_name('detection_scores:0')
    classes = detection_graph.get_tensor_by_name('detection_classes:0')
    num_detections = detection_graph.get_tensor_by_name('num_detections:0')
    # Actual detection.
    (boxes, scores, classes, num_detections) = sess.run(
        [boxes, scores, classes, num_detections],
        feed_dict={image_tensor: np.expand_dims(image_np, axis=0)})

    if scores[0][0] < 0.1:

        sys.exit('Wally not found :(')


    print('Wally found')

    win = tk.Tk()
    win.title("Waldo Found")
    win.geometry("850x500")
    frame = ttk.Frame(win, padding="100 300 10 10")
    frame.pack(fill=tk.BOTH, expand=True)
```

Object Detection Results

Program successfully detected Wally in the included 4 evaluation images and was also able to successfully find Wally in an additional 17 images for a total of 21 images.