

# Homework 1

16-311: Introduction to Robotics

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## Learning Objectives

1. Practice using MATLAB to manipulate an image.
2. Identify objects of interest in an image.

## 1 Image Manipulation

This section will be submitted on Autolab and graded by the TAs after the due date using an autograder. The goal of this section is to find a simplified Waldo figure in a series of images. Create a MATLAB function called `waldo` (remember, a function takes in parameters, in this case the name of our image file) that can read a `.png` (that will be saved in the same directory as your program) and output a file called `output.txt` containing the `x` (horizontal) coordinate of the center of Waldo, a space, and then the `y` (vertical) coordinate of Waldo where `1 1` is the first pixel in the top left of the image. Note that this is different from (row, column) form. So that the TAs can grade the files quickly, DO NOT include headers, extra text, or punctuation in the `.txt` file. A sample text file is linked later in this document for clarify.

Figure 1 below shows the Waldo figure. Please note that the white space around the figure does not count as the figure and so there may be pixels that are not white in these spaces on a valid Waldo.

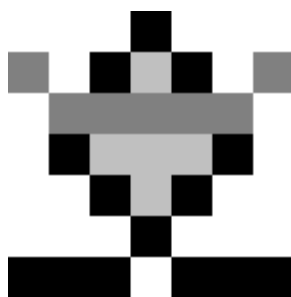


Figure 1: Large Waldo for illustrative purposes.

You can download the regular sized Waldo image from here: <http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/16311/www/current/homework/hw1/waldo.png>. This image will be in the same directory as your code for grading. Figure 2 shows a sample environment that you will be tasked to find waldo in.

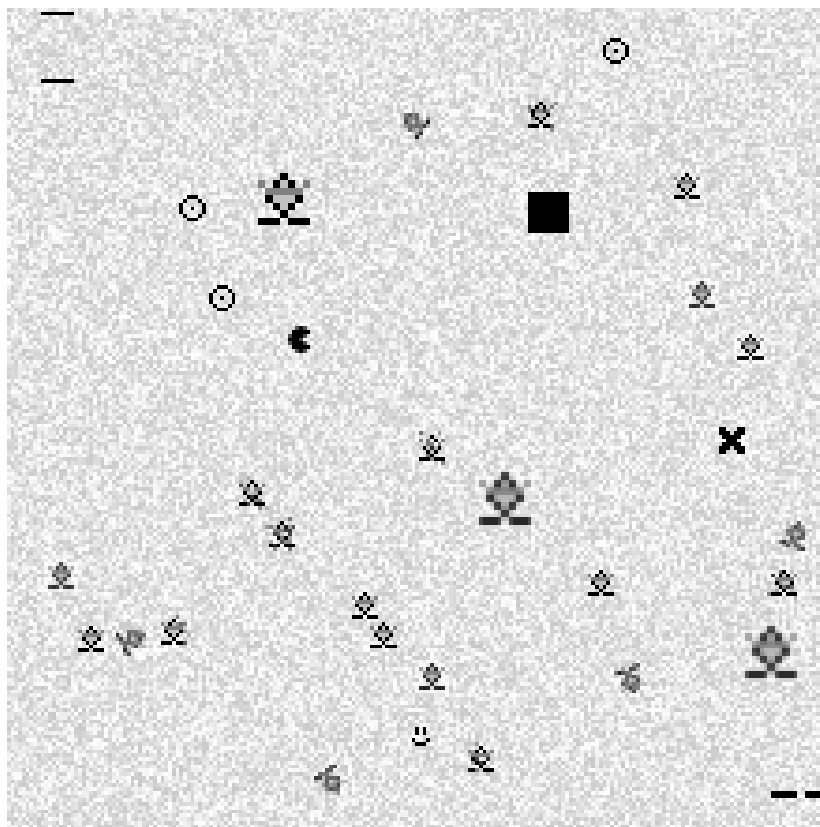


Figure 2: Sample environment for finding Waldos.

You can download the sample environment from here: <http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/16311/www/current/homework/hw1/waldoScene1.png> and a text file with the positions of Waldo is here: <http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/16311/www/current/homework/hw1/waldoSearch1output.txt>.

You will be graded based on an image that has:

- 5 exact copies of Waldo
- 4 blurred copies of Waldo
- 7 copies of Waldo with noise
- 5 rotated copies of Waldo
- 1 double-size copy of Waldo
- 2 double and blurred copies of Waldo
- 7 not Waldos (like a smiley face)

You will be graded based on the number of coordinate pairs that are within 2 pixels of the center of a small Waldo and 4 pixels within the center of a double-sized Waldo.

- 50 points for finding between 1 and 4 Waldos
- 80 points for finding 5 Waldos
- 85 points for finding 6 Waldos
- 100 points for finding all Waldos from three different varieties (i.e. all normal Waldos, all blurred Waldos, and the unblurred double Waldo, etc.)
- -5 for every inaccurate position
- -2.5 for every duplicate position

You are not permitted to use library functions that trivialize the problem. This includes `imrotate`, `imresize`, `matchfeatures`, `normxcorr2`, etc. You are allowed to use the functions `imread`, `imshow`, `rgb2gray` (and related ones), `convolve`, and `convolve2`. Your code should work with an input image of any size.

You can start from this MATLAB code: <http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/16311/www/current/homework/hw1/waldo.m>. You may change this code as much as you want or start from scratch with you own function. Whatever changes you make please ensure you are reading an image from the same folder as the function and writing to 'output.txt' your final (x, y) coordinate pairs.

Note: the origin for this assignment is the top left with x increasing to the right and y increasing down. Many image applications will specify row, column for the coordinates, but we will use (x,y) for this assignment.

Additional example: <http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/16311/www/current/homework/hw1/waldoScene2.png> and a text file with the positions of Waldo is here: <http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/16311/www/current/homework/hw1/waldoSearch2output.txt>.

## What To Submit

Submissions are due on Autolab by the date specified in the Schedule.

1. A single file waldo.m or .zip file that includes any helper files that finds Waldos in an image and outputs a .txt file with Waldo coordinates as specified in Section 1.
2. Please ensure that your main program can be run as described.