Assignment 6: Word Search and Edge Detection

Assigned: Thursday, March 7, 2013

Due: 12:30 MST, Thursday, March 14, 2013

The coded solution to the following problem is to be done by you and only you. You may use your text, notes, online tutorials, etc., but the code must be your own. Bear in mind that any help you seek should be for MATLAB issues, not for help writing your program! If you have trouble compiling or debugging your code, see the professor as soon as possible. Be sure to submit a .zip folder called "Last_Name, First_Name" with (1) a .txt file documenting the command window followed by text of all your code, and (2) all M-files you wrote for the assignment.

Problem Statement

Complete the following two tasks:

1. Write a function that searches for the word `CAT` in a word search puzzle. Your function should take as inputs the game board, the matrix element index, and the word you're searching for, and should return which of the 8 possible directions (N,NE,E,SE,S,SW,W,NW) your word appears starting from the input row and column index. Write a script that loads the puzzle board `sample_board`, searches it for appearances of `CAT`, and prints all locations of the word `CAT` as a starting coordinate and direction.

2. Write a function that applies an edge detection filter to an image. Your function should take the matrix representing a grayscale image and the edge mask as inputs, and the function should return the filtered image. See Appendix 1 for information on image processing. To show that your function works, write a script file that loads the image matrix `sample_image` and then applies the edge detection filter to display the filtered image. See Appendix 2 for a method to display the filtered image.

Example:

```
>> main_word_search
CAT starts at (1,2) and goes east.
CAT starts at (1,2) and goes south.
CAT starts at (1,5) and goes south west.
CAT starts at (3,1) and goes north.
CAT starts at (3,1) and goes south east.
CAT starts at (3,5) and goes west.
CAT starts at (5,1) and goes north east.
CAT starts at (5,2) and goes north.
CAT starts at (5,4) and goes north west.
```

Appendix 1:
A *digital image* is a numeric representation of a two-dimensional image. We will consider only *raster* images, where the digital image is a two-dimensional matrix whose elements are referred to as *pixels*. The numerical values stored in each matrix element correspond to a unique pixel color. For 8-bit grayscale pictures, pixel values range from 0 (black) to 255 (white). In many areas, it is sometimes useful to take an image and group areas of colors by identifying 'edges' where color changes.

To identify these edges, we use the *edge mask*

$$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$$

and examine 3x3 sub-matrices of our matrix representing the image and update pixel values. For example, when examining the 3x3 sub-matrix A of our image matrix

$$A = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix},$$

we let x be the sum of the matrix entries of

$$\begin{pmatrix} -1 \cdot a & -2 \cdot b & -1 \cdot c \\ 0 \cdot d & 0 \cdot e & 0 \cdot f \\ 1 \cdot g & 2 \cdot h & 1 \cdot i \end{pmatrix}$$

and y be the sum of the matrix entries of

$$\begin{pmatrix} -1 \cdot a & 0 \cdot b & 1 \cdot c \\ -2 \cdot d & 0 \cdot e & 2 \cdot f \\ -1 \cdot g & 0 \cdot h & 1 \cdot i \end{pmatrix}$$

and store $\sqrt{x^2 + y^2}$ into the element of a matrix representing the image after applying the filter whose index corresponds with the top-left corner of sub-matrix A.

Appendix 2:
For a matrix `image` storing a raster image in a type double matrix, the command

$$\texttt{figure, imshow(uint8(image));}$$

will display the raster image stored in `image`.