UNIVERSITY OF BRASÍLIA, DEPARTMENT OF COMPUTER SCIENCE

Assignment 1: Mission on Mars

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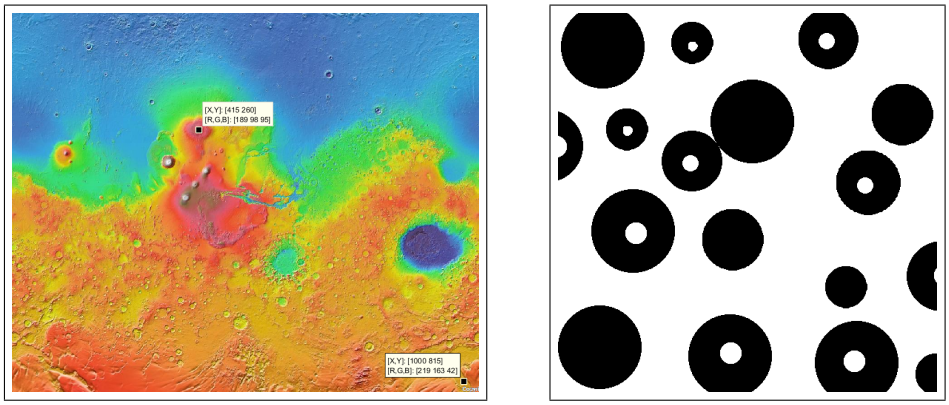
1 IN THE SEARCH FOR SUPPLIES

Suppose you are part of a team of astronauts that is exploring the Martian soil. You know that in the next days, additional supplies sent from Earth will be dropped by a space capsule. However, due to calculation errors the crew realizes that the actual landing position is going to be extremely far from the base of operations. You are on a mission whose objective is to find and retrieve the supplies. You have a RGB map of the Martian surface and you know that an equalized gray-scale image of the map is a good estimate of how difficult it is (how much energy it costs) to move from one location to another. Since energy consumption is an issue, you want to take the path associated with the least energy cost.

1.1 MAP PRE-PROCESSING

In order to successfully accomplish your mission, consider the following steps.

1. Load the Mars surface image $M_{RGB}(y,x)$.
2. Write a function to convert $M_{RGB}(y,x)$ to its gray-scale version $M_{Gray}(y,x)$ (do not use a built-in function that automatically performs the conversion).
3. Write a function to perform the histogram equalization of $M_{Gray}(y,x)$ generating $M_{Heq}(y,x)$ (do not use a built-in function that automatically performs histogram equalization).
4. Select $M_{Heq}(260,415)$ as the origin (base of operations) and $M_{Heq}(815,1000)$ as the destination (where supplies were dropped). Figure 2.1(a) shows the locations of the origin and the destination.



(a) (b)

Figure 2.1: (a) Base location and supplies landing zone; and (b) potential microorganisms.

1.2 Looking for a Path

Given the current position on the map, the next position is determined according to: (1) the value of the neighbouring pixels; and (2) the distance between neighbouring pixels and final destination. First calculate the Euclidean distance between all 8-neighbours of the current pixels and the destination. Then, mark as candidates the three 8-neighbours that are closest to the destination. The next position will be the candidate pixel with the lowest gray level.

Does this algorithm produce a path between the base of operations and the supplies' landing zone? If not, suggest modifications that yield a valid outcome. Suggested modifications must include assumptions about energy consumption.

Calculate the D_m distance between the base of operations and the landing zone. Mark the path on the original RGB map. Show the result.

2 Could There be Life?

When you arrived at the destination, you decided to take some samples of soil for analysis. Back in the base, using a microscope the biologists discovered that there were two kinds of structures that could indicate the presence of microorganisms. Figure 2.1(b) shows an example. As a programmer with knowledge in image processing you were asked to write a program that counts the total number of connected components and determines how many of them have holes (do not use a built-in function that counts connected component).

2.1 SUGGESTED ALGORITHM

CRIATE-LABEL-IMAGE(I, L)

```
1  for i = 0 to M − 1.
2      for j = 0 to N − 1.
3          p = I[i][j]
4          if (p == 0)
5              t = I[i − 1][j]
6              r = I[i][j − 1]
7              if (t == 1) AND (r == 1)
8                  L[i][j] = new_label
9              else if (t == 0) OR (r == 0)
10                     L[i][j] = known_label
11                 else if (t == 0) AND (r == 0)
12                         if same_labels
13                             L[i][j] = label
14                         else if different_labels
15                             L[i][j] = any_label
16                             save_label_equivalence()
17 unify_equivalent_labels()
18 // 1-Background; 2 to N+1 spot label (N spots)
19 organize_labels()
```

Use the image in Figure 2.2 to analyze the algorithm.

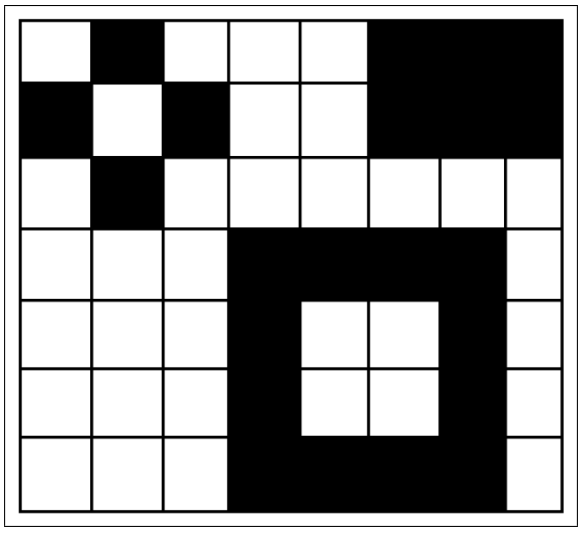


Figure 2.2: Debug.