Automatic Fast Detection of Tumor suspect areas on CT Scan

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Abstract

Our research deals with a fully automatic and fast visualization of possible tumoral areas on CT Scan images. To achieve this task, we use the bilateral symmetry of the human body and the asymmetry introduced by the presence of tumors. Our work was initially dedicated to the head and neck area but it should work well for any other body part and even better for more symmetric areas like the brain.
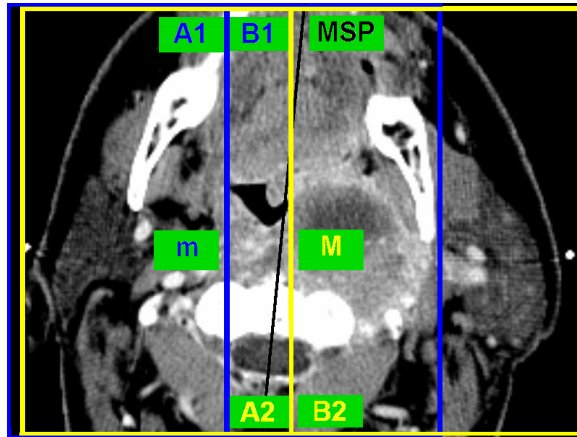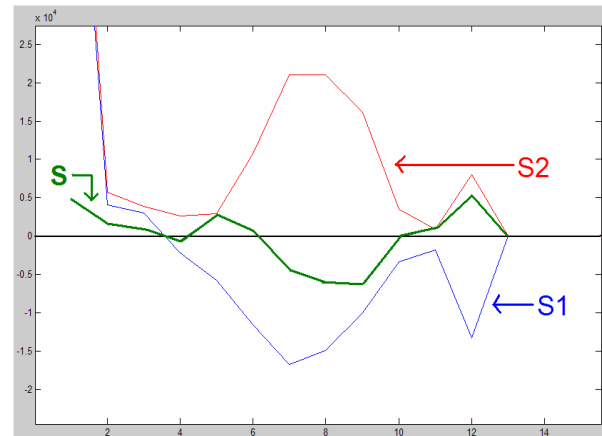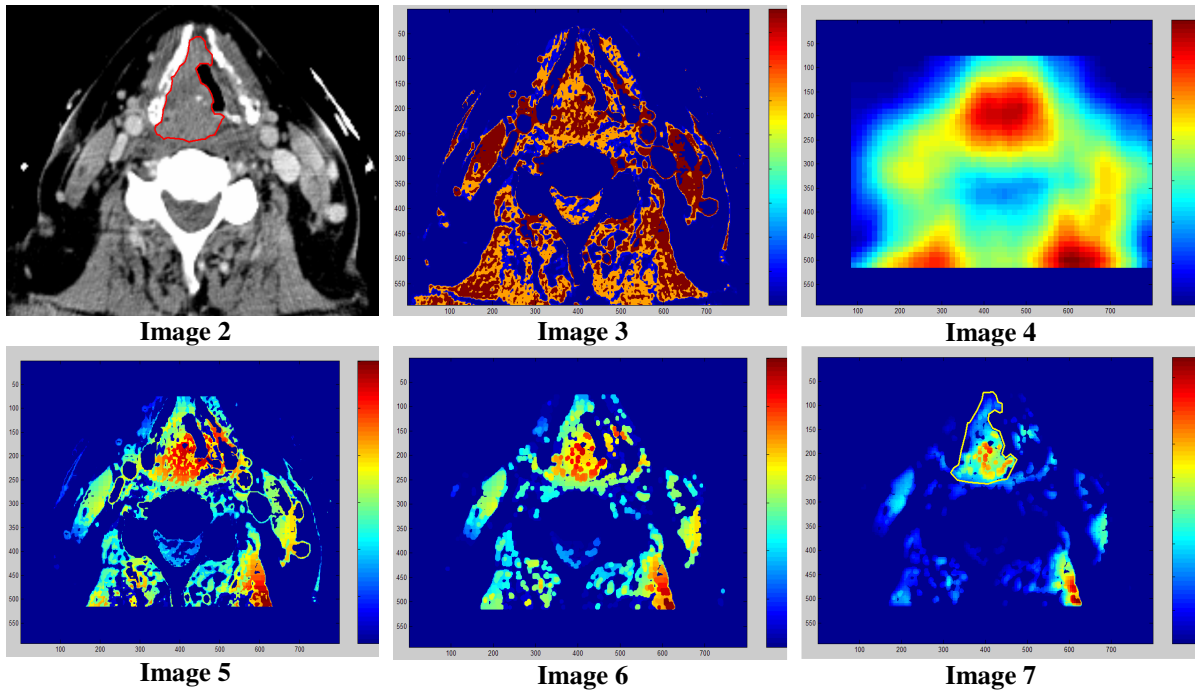
Image 1

Figure 1

After observing the specialists modus operandi for tumor detection on CT Scan images, we realized that any lack of bilateral symmetry was for them a serious alert. Than they look more carefully to the gray levels and to the structure regularity of the image to precisely locate the tumor. So we make our computations on the image reduced to only 12 gray levels: a few gray levels means that we have a global view of the image and we do not care about details and this is what specialists do first.

A very important parameter is the Mid Sagittal Plane (MSP in **Image 1**): this is the symmetry axis. We first tried to co-register the image with its left to right flipped image. But this method is slow and results are sometimes surprising. So we decided to concentrate our study on the airways (tumors are often located in this area) with too axis called "m" and "M" on **Image 1**, on the two sides of the airway. The symmetry is computed by subtracting the histograms of the windows "A1" and "B1" centered on the "m" axis (**Image 1**). We obtain the result called "S1" on **Figure 1**. We do the same with the windows "A2" and "B2" centered on the "M" axis and we get the "S2" result on **Figure 1**. Than we obtain the final result called "S" by adding "S1" and "S2". When the "S" curve is close to the horizontal axis, the gray levels are quite symmetric: there are as many pixels of these gray intensity on the both parts of the symmetry axis. When the curve "S" is far from the horizontal axis we have some asymmetric gray levels. We also can see if the asymmetry is mainly due to pixels on the right or left side and so to locate the side where most of the tumor is present. When we reconstruct an image from the "S" curve we get the **Image 3**. On **Image 2**, we can see the initial CT Scan image and the specialist segmentation.

Until this point we just made a global asymmetry study. As you can see on **Image 3** even if we visualize better the gray levels composing the tumor, there is still a lot of noise (as muscles have often gray levels closed to tumors).
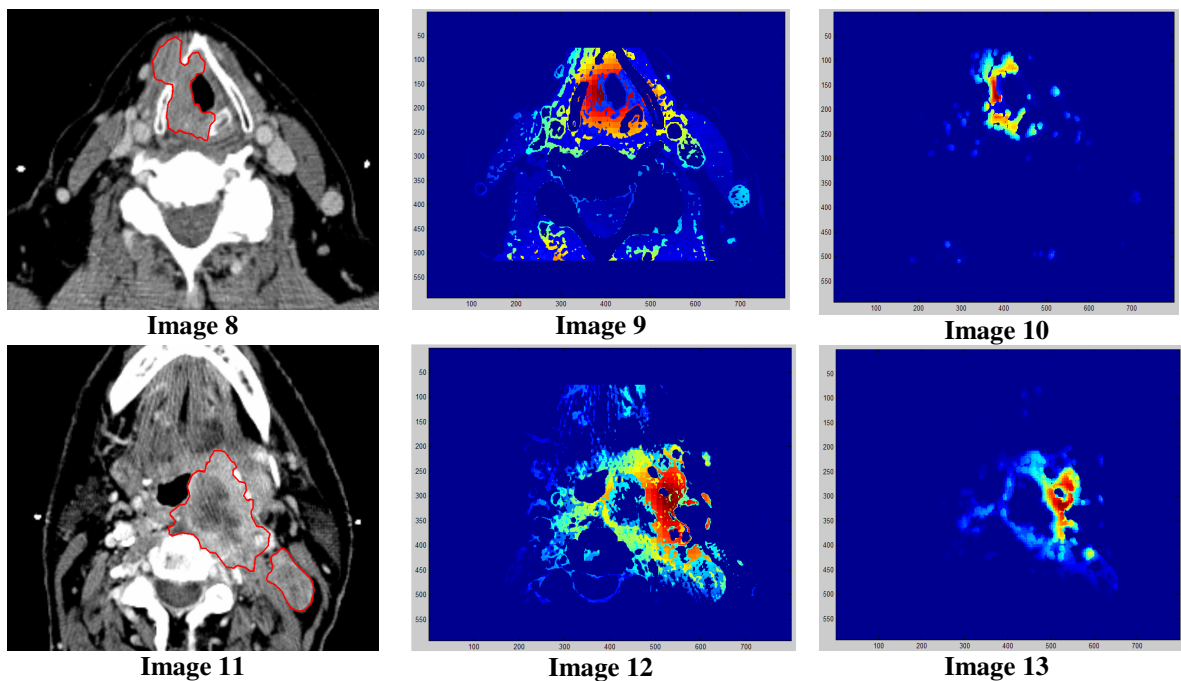We rapidly get some spatial information by computing for each asymmetric class the sum on a large window (160 pixels size). The spatial map is computed in **Image 4**.
By multiplying **Images 3 and 4**, we get **Image 5** where we see better the tumor. We do not obtain a good spatial definition which is not our purpose but we eliminate much noise. After an image opening (**Image 6**) and a median filtering we get the final **Image 7** where the tumor is well highlighted. These two last steps use some textural information.

Image 2

Image 3

Image 4

Image 5

Image 6

Image 7

We have some results from the **Images 8 and 11** where you can see the specialist tumor segmentation. Even if this method aims only to visualize the suspect gray levels, very difficult tumors are well detected and almost segmented (**Images 9, 10, 12, 13**)! Our preliminary tests were made on three different patients with different kind of tumours. No parameter is needed except the filtering window size which can be fixed once. All the process is fully automatic and fast (6 seconds in Matlab). Preliminary tests in C let us think that we will need less than one second for this asymmetry step.

This work is still at its beginning but the first results are already encouraging. After a first location of tumours using asymmetry information we will use other more low level methods to get an accurate segmentation. More tests and a C implementation will be done to confirm Matlab results.

Image 8

Image 9

Image 10

Image 11

Image 12

Image 13

Acknowledgements