

2014

## Content-Based Image Retrieval for Detecting Brain Tumors and Amyloid Fluid Presence

Pournima Ghule  
*Grand Valley State University*

Follow this and additional works at: <https://scholarworks.gvsu.edu/cistechlib>

---

### ScholarWorks Citation

Ghule, Pournima, "Content-Based Image Retrieval for Detecting Brain Tumors and Amyloid Fluid Presence" (2014). *Technical Library*. 194.  
<https://scholarworks.gvsu.edu/cistechlib/194>

This Project is brought to you for free and open access by the School of Computing and Information Systems at ScholarWorks@GVSU. It has been accepted for inclusion in Technical Library by an authorized administrator of ScholarWorks@GVSU. For more information, please contact [scholarworks@gvsu.edu](mailto:scholarworks@gvsu.edu).

# **Content Based Image Retrieval for Detecting Brain Tumor and Amyloid Fluid Presence**

By  
Pournima Ghule  
December, 2014

# **Content Based Image Retrieval for Detecting Brain Tumor and Amyloid Fluid Presence**

By  
Pournima Ghule  
December, 2014

A project submitted in partial fulfillment of the requirements for the degree of

Master of Science in  
Computer Information Systems

**Grand Valley State University**  
**December, 2014**

---

**Jonathan Leidig**

**Date**

## Table of Contents

<b>1. Abstract .....</b>	<b>4</b>
<b>2. Introduction .....</b>	<b>5</b>
<b>3. Related Work .....</b>	<b>6</b>
<b>4. System Design .....</b>	<b>7</b>
<b>5. Algorithms Used.....</b>	<b>9</b>
<b>6. Results.....</b>	<b>10</b>
<b>7. Technologies Used.....</b>	<b>12</b>
<b>8. References.....</b>	<b>14</b>

## **Abstract**

Medical images play a vital role in identifying diseases and detecting if organs are functioning correctly. Image processing related to medical images is an active research area in which various techniques are used in order to make diagnosis easier. The brain is a vital organ in our body, and brain tumors are a very critical life altering condition. Identifying tumors is a challenging task and various image processing techniques can be used. Doctors can identify tumors from looking at the scan, and this project attempts to automatically derive these results. In this project, image processing is done for automatically detecting the presence of brain tumors in a given brain scan. Content-based image retrieval extracts features from a query or template image, computes a measure of similarity, and gives results by detecting tumors. Template matching is used to identify a template at any position within the image to identify tumor location.

Secondly, early detection of Alzheimer's, which in turn prevents dementia, can be determined from the presence of amyloid fluid along with the other factors. The amyloid fluid presence helps in detecting dementia at an early stage. The presence of this fluid can be found in a PET scan of the brain. Here, the idea is to show the color distribution from a scan image, i.e., the domination of given colors. Content-based image retrieval's low level feature based approaches such as color histograms are used. In this project, the conventional K- means algorithm is used for clustering the histograms, and identifying dominant colors.

## **Introduction:**

Each year more than 200,000 people in the United States are diagnosed with brain tumor. Brain cancer remains one of the most incurable forms of cancer. Image processing is a challenging field in which content based image retrieval plays a major role.

In a CBIR system, any color, texture, shape or template can be used as a reference to give desired output. CBIR is coordinated integration of an image matching technique where image matching plays significant role. In CBIR, A template is used as a measuring reference for calculating the match percent of the content of image involved in the search. The basic goal of this technique is to use the template to find input images similar to this template. The technique used here is that the template is compared with another image and at every position the amount or measure of every overlap is calculated. By sliding, are moving the patch one pixel at a time in left to right and top to bottom directions. The metric calculated represents how good or bad is the match is at that location. Basically, it is checking the similarity of the template to that of a particular area in the image. This project uses template matching for detecting tumor from MRI scan.

Alzheimer's disease is a neurodegenerative disorder which is progressive and fatal, affecting many people as the fourth most common cause of death in United States. In the second part of the project, early detection of Alzheimer's can be completed by knowing the amount of amyloid fluid accumulation in the brain. There are various treatments for Alzheimer's but it is difficult to cure. Hence detecting it in early stages helps in preventing the progression of this disease. It is important to detect dementia in the early stages before irreversible brain damage or mental decline occurs. PET (positron emission tomography) imaging reveals the presence of amyloid plaques in the brain. According to amyloid hypothesis, accumulation of Abeta in the brain is

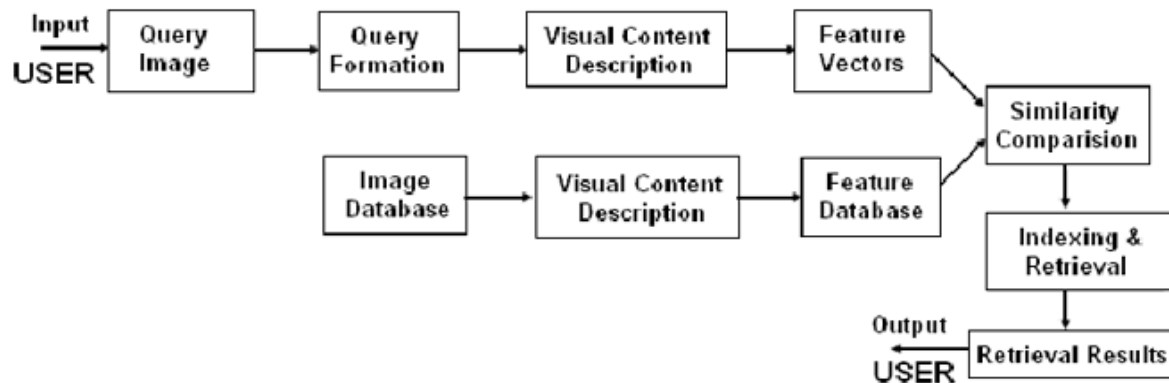
primary factor in Alzheimer's diagnosis. This project identifies the color domination in the scan by automatically pulling out the color profiles, showing the amount of amyloid accumulation. The presence of amyloid is not the only cause to detect Alzheimer's but it is one of the factors which show early detection of dementia.

### **Background and related work:**

Various approaches have been proposed and carried out in the field of brain tumor detection such as segmentation method, histogram equalization, thresholding, morphological operations . Automated Segmentation and Classification of Brain Magnetic Resonance Imaging by Luiza Antonie[1]. Also, detected tumors are represented in 3 dimensional views. Most of the method have the drawback of computational time required. Also most of them are implemented in MATLAB or in the other image processing tools. In this project using computer vision and image processing techniques to find tumor in a MRI scan is implemented. Here, OpenCV software tool for image processing is used along with Python.

Python is a general purpose programming language which is very popular because of its simplicity and code readability. OpenCV-python is a Python API of OpenCV. It combines the best qualities of OpenCV C++ API and Python language. OpenCV-Python works as a wrapper around original C++ implementations. Python enables the programmer to design code or express ideas in fewer lines of code without losing readability. Hence, computationally intensive codes can be written in Python.

## CBIR Design:



**FIGURE 1:CBIR INDEXING AND SEARCH**

### CBIR consists of 3 types of retrieval

#### 1. Color

Color similarity is achieved by computing a color histogram for each image that identifies the proportion of pixels within an image holding specific values (that humans express as hues or colors)examining images based on the colors they contain is one of the most widely used techniques because it does not depend on image size or orientation. Color searches will usually involve comparing color histograms, though this is not the only technique in practice.

#### 2. Shape

Shape does not refer to the shape of an image but to the shape of a particular region that is being sought out. Shapes will often be determined first applying segmentation or edge detection to an image. Other methods like use shape filters to identify given shapes of an image

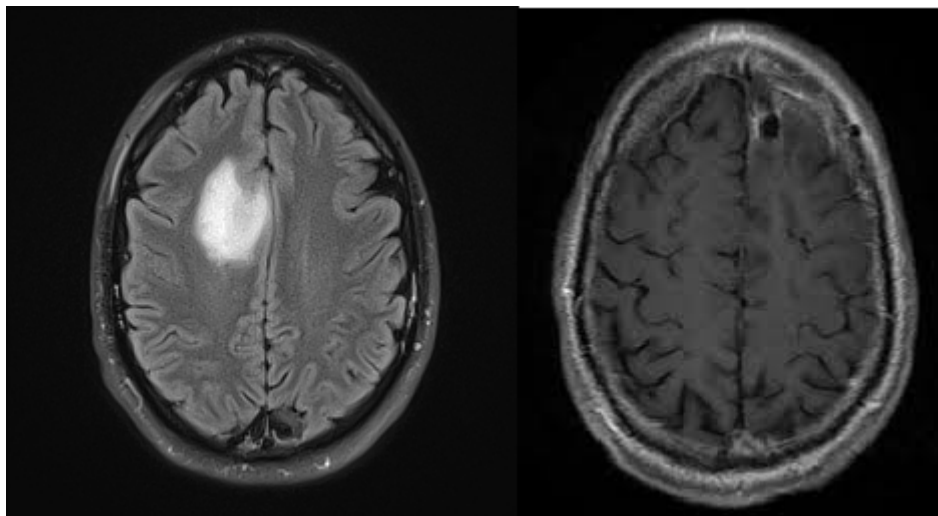
#### 3. Texture



Texture measures look for visual patterns in images and how they are spatially defined. These sets not only define the texture but also where in the image the texture is located. Texture is a difficult concept to represent. The identification of specific textures in an image is achieved primarily by modeling texture as a two-dimensional gray level variation

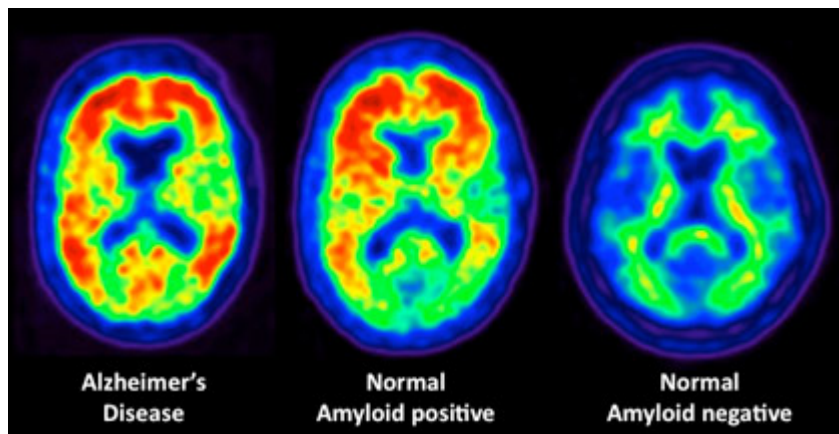
### **Content/Images:**

For the first part of template matching in detecting tumor, MRI scans are used. MRI is suitable for examining soft tissue in ligament and tender injuries or tumors etc. MRI scans are better than the CT scan as it does not use radiation. There are many methods in OpenCV which can be used for template matching such as `TM_CCOEFF`, `TM_CCOEFF_NORMED`, `TM_CCORR`, `TM_CCORR_NORMED`, `TM_SQDIFF`, and `TM_SQDIFF_NORMED`. Among these methods `TM_SQDIFF` gives the best match. OpenCV comes with a function `matchTemplate()`. It simply slides the template over the input image against the template image. This returns grayscale image, in which each pixel represents how much does it match with the neighboring pixel in the input image. The following in figure 2 is an example of MRI scan images used in this project, one with tumor and one without tumor.



**FIGURE 2: MRI SCANS WITH AND WITHOUT A TUMOR.**

For the second part, PET scans of brain is used where accumulation of amyloid fluid representation is shown. This is a color scan which is useful in detecting the amount of amyloid fluid present in the brain. To represent and cluster dominant colors in the scan K-Means clustering algorithm is used. Here, The goal is to partition the data points  $n$  into  $k$  clusters. The presence of amyloid does not necessarily means diagnosis of Alzheimer's disease or any other cognitive disorder, but a negative scan indicating absence or minimal amount of amyloid reduces the possibility that a patient's cognitive impairment is because of Alzheimer's. Figure 3 of amyloid fluid found in PET scan gives clear understanding of how the distribution of fluid is visible.



**FIGURE 3: PET SCANS**

#### **Algorithm's used:**

##### 1. Template Matching:

For the detection of brain tumor Template Matching is a method for searching and finding the location of a template image in a larger image. OpenCV comes with a function `cv2.matchTemplate ()` for this purpose. It simply slides the template image over the

input image (as in 2D convolution) and compares the template and patch of input image under the template image. Several comparison methods are implemented in OpenCV. (You can check documentation for more details). It returns a grayscale image, where each pixel denotes how much does the neighborhood of that pixel match with template.

If input image is of size  $(W \times H)$  and template image is of size  $(w \times h)$ , output image will have a size of  $(W-w+1, H-h+1)$ . Once the result is produced `cv2.minMaxLoc ()` function can be used to find the maximum/minimum value and location.

## 2. K-Means Clustering:

In the second part for representing color domination in the scan, K-Means Clustering is used.

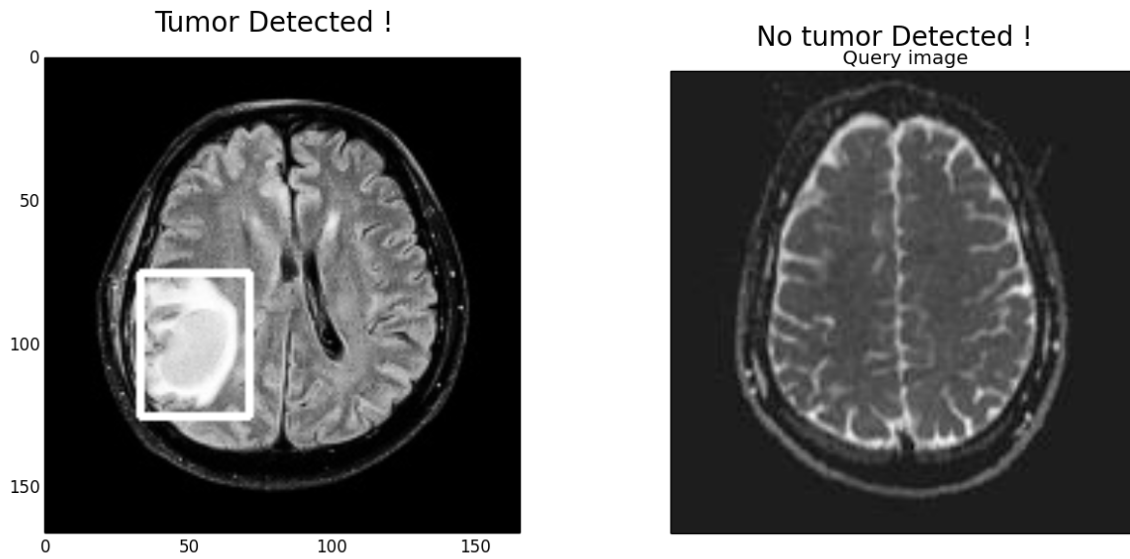
The neat thing about this algorithm is, since it relies only on a simple distance calculation, it can be extended to multi-dimensional data. Color is often represented using three channels, Red, Green, and Blue. Our algorithm treats all the pixels in the image like points on a 3-dimensional space. K-means is a clustering algorithm that generates  $k$  clusters based on  $n$  data points. The number of clusters  $k$  must be specified ahead of time. Although algorithms exist that can find an optimal value of  $k$ , they are outside the scope of this blog post. In order to find the most dominant colors in our image, the pixels were treated as the data points and then applied k-means to cluster them.

The scikit learn implementation of k –means to avoid having to re-implement it.

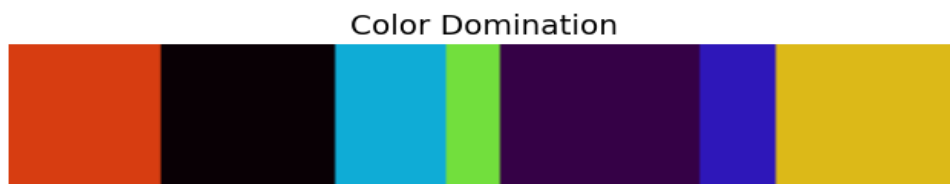
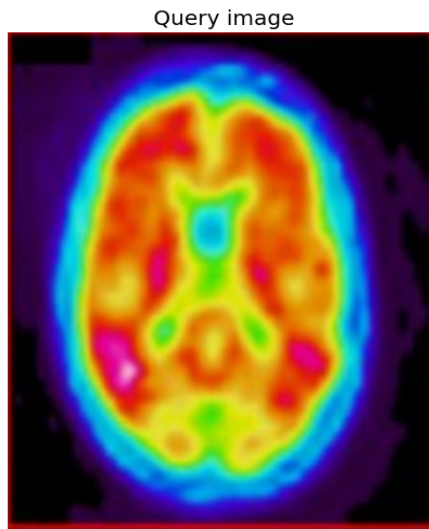
### **Results:**

After successful implementation of the algorithms for brain tumor, this application will show the location of tumor by drawing rectangle around it for the exact location. In case of absence of tumor, it will display message that no tumor is detected. In case of amyloid fluid presence, distribution of detected colors in scan is successfully displayed.

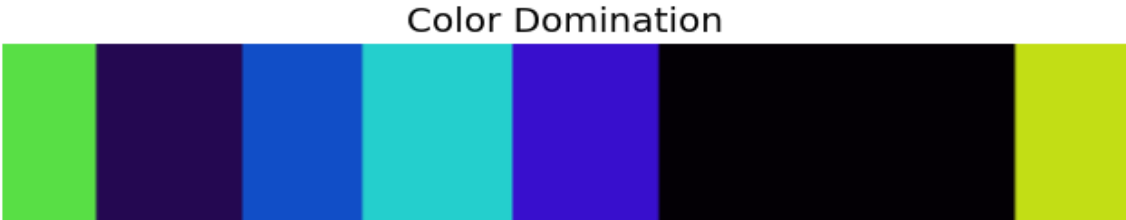
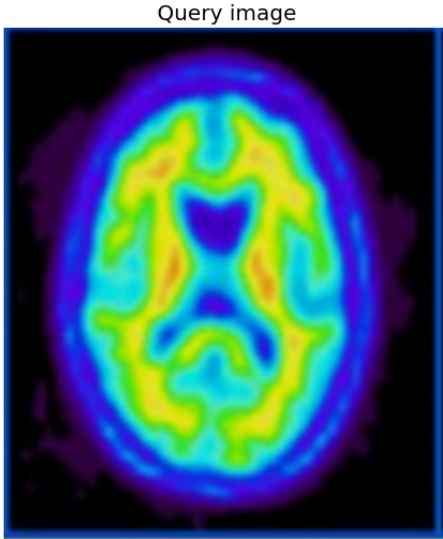
## 1. Brain Tumor Detection



2. For the second part we can see distribution of amyloid fluid which will be in red color.



The absence of amyloid fluid



**Technologies Used:**

- 1. OpenCV:

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. OpenCV is written natively in C++ and It has C++, C, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS.

- 2. Python:

For image processing and computer vision. The following Python libraries are used.

1. NumPy

This library provides support for large, multi-dimensional arrays. Using NumPy we can store values of an image in RGB color space into array which makes it computational efficient and also resource efficient. To perform numerical analysis on an image this library is widely used.

2. SciPy

This adds further support for technical and scientific computing and includes many distance functions and various implementations of feature extraction functions. Many distance functions which are very useful in comparing images such as Euclidean distance measure is present in this library.

3. Matplotlib

For plotting images also analyzing it or simply for viewing the images this library is used. It is flexible to use even when plotting with accuracy of set of images.

4. OpenCV

For the image processing, very powerful techniques are present in this library. For real time as well as making computer vision processing feasible this library is used. This is written in C++ but bindings with Python and Java are provided as well.

5. Scikit-learn

This is a machine learning library that can do advanced image processing such as clustering, classification models and vector quantization . It also provides many image feature extraction functions.

## References:

- [1] Automated Segmentation and Classification of BrainMagnetic Resonance Imaging by Luiza Antonie
- [2] An Efficient Brain Tumor Detection Algorithm Using Watershed & Thresholding Based Segmentation by Anam Mustaqeem Department of Software Engineering, UET Taxila Ali Javed Department of Software Engineering, UET Taxila Tehseen Fatima Department of Computer Engineering, UET Taxila
- [3] Programming Computer Vision with Python, Tools and algorithms for analyzing images By Jan Erik Solem, Publisher: O'Reilly Media ,Final Release Date: June 2012
- [4] Practicle Python and OpenCV, An introductory, example driven guide to image processing and computer vision. by Adrian Rosebrock
- [5] Amyloid Imaging: A “Game Changer” in the Diagnosis of Alzheimer’s Disease by UCSF Department of Radiology Team on September 17, 2013,  
<http://blog.radiology.ucsf.edu/neuroradiology/amyloid-imaging-a-%E2%80%9Cgame-changer%E2%80%9D-in-the-diagnosis-of-alzheimer%E2%80%99s-disease/>
- [6] OpenCV-Python Tutorials  
[https://opencv-python-tutroals.readthedocs.org/en/latest/py\\_tutorials/py\\_tutorials.html](https://opencv-python-tutroals.readthedocs.org/en/latest/py_tutorials/py_tutorials.html)
- [7] OpenCV-Python Tutorials  
<http://docs.opencv.org/3.0-beta/doc/tutorials/tutorials.html>
- [8] OpenCV-Python Tutorials by Abid Rehman.  
<http://opencvpython.blogspot.in/2011/04/welcome-to-opencv-python.html>
- [9] Automated Brain Tumor Detection and Identification Using Image Processing and Probabilistic Neural Network Techniques by Dina Aboul Dahab, Samy S. A. Ghoniemy<sup>2</sup>, Gamal M. Selim<sup>3</sup> Dep. of Computer Engineering, Arab Academy for Science, Technology & Maritime Transport Cairo, Egypt
- [10] Content Based Image Retrieval Using Color and Shape Features Reshma Chaudhari<sup>1</sup>, A. M. Patil<sup>2</sup>.
- [11] Gopal,N.N. Karan, M. , —Diagnose brain tumor through MRI using image processing clustering algorithms such as Fuzzy C Means along with intelligent optimization techniques — ,

Page(s): 1 – 4, Computational Intelligence and Computing Research (ICCIC), 2010 IEEE International Conference, 28-29 Dec. 2010.

[12] T. Logeswari, M. Karnan, —An improved implementation of brain tumor detection using segmentation based on soft computing, Page(s): 006-014, Journal of Cancer Research and Experimental Oncology Vol. 2(1), March 2010.

[13] Aaron Lefohn, Joshua Cates, Ross Whitaker. "Interactive GPU-Based level sets for 3D Brain Tumor Segmentation", April 16, 2003.

[14] Ahmed Saad, Ben Smith, Hassan. "Simultaneous Segmentation, Kinetic Parameter Estimation and Uncertainty Visualization of Dynamic PET Images", MICCAI 2007.

[15] K.W.Law, F.K.Law, Francis H.Y.Chan. "A Fast Deformable Region Model for Brain Tumor Boundary Extraction", IEEE, Oct 23, USA, 2002.

[16] Amini L, Soltanian-Zadeh H, Lucas.C. "Automated Segmentation of Brain Structure from MRI", Proc. Intl.Soc.Mag.Reson.Med.11(2003).

[17] PyimageSearch- be awesome at building image search engines.

<https://www.pyimagesearch.com/>.

[18] Angela Barr, Giovanni Carugno, Sandro Centro, Georges Charpak, Garth Cruickshank, Marie Lenoble and Jacques Lewiner. "Imaging Brain Tumors Using a Multi-Wire Gamma Camera and Thallium-201", IEEE, 2002.

[19] Aria Tzika.A, Maria K. Zarifi, Liliana Goumnerova, Loukas G.Astrakas, David Zurakowski, Tina Young-Poussaint, Douglas Anthony, R. Michael Scott, Peter McL.Black. "Neuroimaging in Pediatric Brain Tumors: Gd-DTPA-Enhanced, dynamic, and Diffusion MR Imaging Compared with MRSpectroscopic Imaging", Neuroradiol 23, February 2002.

[20] Azadeh yazdan-shahmorad, Hamid soltanian-zadeh, Reza A.Zoroofi. "MRSI- Brain tumor characterization using Wavelet and Wavelet packets Feature spaces and Artificial Neural Networks", IEEE Transactions on EMBS, Sep 1-5, 2004.

[21] Azadeh yazdan-shahmorad, Hesamoddin Jahanian, Suresh Patel, Hamid SoltanianZadeh. "Automatic Brain Tumor Segmentation Using Diffusivity Characteristics", IEEE, ISBI, 2007.



- [22] Benedicte Mortamet, Donglin Zeng, Guido Gerig, Marcel Prastawa, Elizabeth Bullitt. "Effects of Healthy Aging Measured By Intracranial Compartment Volumes Using Designed MR Brain Database".
- [23] Boada F.E, Davis.D, Walter.K, Torres- Trejo.A, Kondziolka.D, Bartynski.W, Lieberman.F. "Triple Quantum Filtered Sodium MRI of Primary Brain Tumors, "IEEE, USA, 2004
- M.S. Atkins and B.T. Mackiewicz "Fully Automatic Segmentation of the Brain in MRI" 1998.
- [24] L.P. Clarke et al. "MRI Segmentation: Methods and Applications" 1995
- [25] M.C. Clark et al. "Automatic Tumor Segmentation Using Knowledge-Based Techniques" 1998.
- [26] V.N. Vapnik "The Nature of Statistical Learning Theory " 1995.
- [27] R. Gonzales and R. Woods "Digital Image Processing.