Artificial Neural Networks for Brain Cancer Classification

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Abstract: The detection and categorization of brain tumours is now possible because to new technology. The MRI images of individuals who have been diagnosed with Astrocytoma are analyzed by the system, which makes use of an artificial neural network, in order to identify tumour blocks or lesions also to classify the type of tumour. These approaches are described below. The Grey Level Co-occurrence Matrix (GLCM) was the tool that made it feasible to characterize the different textures of tumours. A contrast is drawn between each of these traits and those that are already included in the Knowledge Base. Finally, after years of research and development, a Neuro Fuzzy Classifier has been created that is capable of correctly identifying the various subtypes of brain cancer. An initial phase of testing focused on learning and training, followed by a second phase focused on recognizing and assessing, have been carried out on the system in its entirety. The Radiology Department at Tata Memorial Hospital (TMH) was kind enough towards supply the training data for the system, which consisted of MRI scans of patients who had already been diagnosed with brain cancer. The method was also validated by using unlabeled MRI image data taken from patients with brain tumours treated at TMH. The classification of these samples and the handling of outliers were both determined to be successfully handled by the system.

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1. INTRODUCTION

For several decades, developing new cancer treatments has been a top goal, despite the fact that doing so is both time-consuming and costly. Because brain tumours are typically innocuous and can be efficiently treated before they have a chance to metastasize, researchers have high hopes that they will one day be able to uncover the factors that contribute to the development of cancer and identify less invasive methods for curing the disease. About forty percent of all primary cases can be cured successfully with surgical intervention and, on occasion, radiation [1]. It appears that for no apparent cause, there has been an increase in the occurrence of malignant brain tumours. Because of its better soft tissue contrast and noninvasive nature, magnetic resonance imaging (MRI) has swiftly superseded other imaging modalities as the gold standard in a short amount of time. The magnetic resonance imaging (MRI) technique offers a picture of the human body’s innermost components that has never been seen before. In comparison to the capabilities of other imaging modalities, the level of detail that can be observed by us is astounding. Both from a health care and a financial point of view, it is of the utmost significance to diagnose brain cancer as quickly and accurately as possible [2]. Traditional methods that rely on expert employees are losing favour since they are laborious, restrictive, and fraught with an undetectable level of subjectivity. A magnetic resonance imaging (MRI) scan can now be used to accurately diagnose and classify brain tumours affected by the cancer community as a whole. Affected by the cancer community. The field of medicine has discovered that this technique is helpful for computer-aided design (CAD), mammography, and other techniques used to identify cancer. Because of the complex nature of the disease, researchers have classified more than a hundred different subtypes of brain cancer. Brain tumours, despite the fact that they are considered to be benign, represent a considerable risk of death due to the fact that, similar to malignant tumours, they compress healthy brain tissue and induce malfunction. Gliomas constitute 44.4% of all primary brain tumours, which is close to half of all primary brain tumours. Glioblastomas make up 51.9% of all gliomas, whilst the remaining 21.6% of gliomas are made up of several different forms of astrocytomas [1],[2]. Brain tumours are the most common type of cancer to cause death in people below the age of twenty. They had the second greatest death rate from cancer among men ages 20 to 29, making them the second most vulnerable age group. A brain metastasis is the term used to describe the process by which cancer has spread to the brain from another section of the body. It is thought that 10–15 percent of those who have cancer are afflicted with metastatic brain tumours [3]. There are many different categories of brain cancer, despite the fact that astrocytoma is the most common type [4]. The following paragraph will offer a concise summary of the techniques and activities involved in the research. In this section, we will cover the many different methods that may be used to classify pictures and extract features.
2. METHODOLOGY

This approach involves classifying the various forms of cancer based on analysis of MRI scans of patients who have been diagnosed with brain tumours. Multiple image processing methods are used in the process of cancer detection. These methods include histogram equalisation, image segmentation, picture augmentation, and feature extraction using a grey level conjunction matrix [5]. The obtained features are now included in the database of human knowledge. A specialised Neuro Fuzzy Classifier is used to categorise the various forms of brain cancer. These pictures are the product of magnetic resonance imaging scans taken at Tata Memorial. Priority was put during development of this system to creating a user-friendly GUI.

![Block Diagram]

The capabilities of the system are segmented into a training stage and a testing stage respectively. During the period of learning, the ANN is given the instruction to distinguish astrocytic gliomas, which are a particular kind of brain tumour. After the photographs have been processed with normal image processing techniques like Histogram Equalisation, Thresholding, Sharpening Filter, and so on, the Grey Level Co-occurrence Matrix is used to extract textural information from MRI scans. This is done in order to better understand the patient’s condition. By incorporating the derived features into the knowledge base, the process of accurately classifying images that have not yet been viewed is facilitated. These features, after being normalised so that they fall somewhere between the range of -1 to 1, are then given into a classifier that is based on an artificial neural network. During the Recognition and Testing Phase, unlabeled MRI scans are analysed to determine whether or not Astrocytoma
tumours are present.

3. STAGES IN THE CLASSIFICATION OF THE IMAGE

Pathological Detection:
The system’s skills are separated into a training stage and a testing stage. Astrocytic gliomas are a subtype of brain cancer, and during training the ANN is taught to identify these. The Grey Level Co-occurrence Matrix is used to recover textural information from an MRI image after standard image processing techniques have been applied, such as Histogram Equalisation, Thresholding, and Sharpening Filter, etc. The image is then able to more faithfully depict the source material. When the developed features are added to the Knowledge Base, it is much easier to correctly identify previously unseen images. These features are then normalised so that they lie on a scale from -1 to 1, before being supplied into an artificial neural network-based classifier. In the Detection and Evaluation Stage, unlabeled MRI scans are analysed to determine the presence or absence of astrocytoma lesions. The contrast between the tumour and the rest of the brain needs to be increased, as this is the most important adjustment. It’s possible that there is a difference between the cancerous part of the brain and the rest of the brain, but it would be impossible for people to see it. Therefore, a sharpening filter is applied to the digital MRI, which results in a significant improvement in the contrast between the healthy brain tissue and the area affected by cancer. If there are any breaches in continuity at the edges, you can fix them by using the dilation operator. An operator is then used to the stretched image in order to fill in the neighbouring contours, which ultimately results in a representation of the scene that is more accurate. After that, centroids of each filled area in an image are determined through calculation. After doing a logical analysis on the previously recovered region, the next stage in the process of extracting a big region from an MRI picture is to perform the step immediately after it.

Tumor Segmentation
In order to identify the categorization of the Unknown sample Image, a comparison is done between the features that were returned and the features that the Unknown sample Image already possesses. The Grey Level Co-occurrence Matrix, or GLCM, is a set of characteristics that can be used to identify the benign or malignant nature of a brain tumour. GLCMs can be categorised with a variety of different sorts of textures. There is a co-occurrence matrix that corresponds to each of the four potential spatial angles (0 degrees, 45 degrees, 90 degrees, and 135 degrees; [6], [7]). These angles range from 0 degrees to 135 degrees. The input for the fifth matrix is the weighted average of the previous four matrices.

Knowledge Base
Knowledge could be defined as any body of information that can be used to set apart one class from another. Certain characteristics will be shared by malignancies and other forms of brain tissue under these conditions, while others will be absent. Books and databases are the basic types of MRI volume information sources. The first is the imaging system’s pixel intensity in the feature space, which is utilised to define various tissue characteristics. The second component is how the image communicates with the surrounding anatomical space. This factor considers the locations and shapes of different
tissues within the image is located in the brain tumours can take any form and present in any region of the brain [3, 7], effectively treating them calls for a deep familiarity with brain anatomy. This allows us to directly make use of the information stored in the feature space.

**Nero-FuzzyClassifier.**

The patient’s immediate environment is scanned by a Neuro-Fuzzy Classifier for signs of malignancy. Artificial neural networks (abbreviated ANN) are systems of interconnected nodes in a computer network. Each node’s output is given a weight before being added to the input of the next node in the network. The value of a node output remains often not resolute by the value of the node’s input but rather by the node’s activation function. "weight" stands for the multiplicative weighting factor among the input and output of nodes $j$ also $i$, and is represented by the notation "$w_{ji}$." An ANN is a data-driven, adaptive, and typically nonlinear system (expressed by an input/output map) that serves some sort of purpose. Typically, ANNs are implemented in machine learning settings. An adaptable system is one that can adjust its settings while it’s running without affecting its functionality. The Learning and Training Phase describes the current stage of the procedure. The artificial neural network’s parameters are locked in after the training phase, and the system is put into action during the recognition and testing phases to solve the issue at hand.

Back-propagation This study used ANNs with one input, one or two hidden, and one output layer [8],[9]. Back-propagation repeats Extracted Features. Errors are calculated if the neural network’s output differs from the target output (Grade of Tumour). This error is then used to guide the Artificial Neural Network’s future weight modifications, resulting in increasingly accurate predictions with each round of training. This behavior is known as back-propagation. The term "training" is more generally used to describe this tactic. The training process for these networks requires associating an input with an expected outcome. By employing a learning strategy, most commonly the generalized delta rule, we are able to achieve this mapping by modifying the values of the weights $w_{ji}$. ANNs are used for the task of identifying previously unseen images once the weights have been modified on the training set and then permanently stored [8]. The basic goal of the comprehensive delta rule is to minimize an error tenurewell-defined as [9], [10].

$$EP = \frac{1}{2} \sum_{l} (t_{l}P_{l} - O_{l}P_{l})^2$$

(1)

In this equation, each input vector, marked by the letter $p$, has a corresponding target output vector and an observed output vector, which are respectively designated by the letters $tp$ and $op$

4. **RESULTS AND DISCUSSION**

The created software is able to correctly categorise an MRI image of a patient with Brain Cancer into a Grade of Astrocytoma Tumour. During the Detection and Evaluation stages, MRI scans of individuals with confirmed cases of brain cancer are used. The system shows the user the extracted Tumour Region
from the brain’s outer skull in order to perform a test on the input image. The retrieved features from this region are compared to those previously present in the database of knowledge. The original Grade

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Test Image</th>
<th>Original Grade of Image</th>
<th>Classified Grade of Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Image 1</td>
<td>Grade I</td>
<td>Grade I</td>
</tr>
<tr>
<td>2</td>
<td>Image 2</td>
<td>Grade II</td>
<td>Grade II</td>
</tr>
<tr>
<td>3</td>
<td>Image 3</td>
<td>Grade III</td>
<td>Grade III</td>
</tr>
<tr>
<td>4</td>
<td>Image 4</td>
<td>Grade IV</td>
<td>Grade IV</td>
</tr>
<tr>
<td>5</td>
<td>Image 5</td>
<td>Grade I</td>
<td>Grade III</td>
</tr>
<tr>
<td>6</td>
<td>Image 6</td>
<td>Grade II</td>
<td>Grade IV</td>
</tr>
<tr>
<td>7</td>
<td>Image 7</td>
<td>Grade III</td>
<td>Grade III</td>
</tr>
<tr>
<td>8</td>
<td>Image 8</td>
<td>Grade IV</td>
<td>Grade IV</td>
</tr>
</tbody>
</table>

of Astrocytoma tumour type is listed in Table 2, along with the adjustments that the established system made to the image, and the outcome of Classification. Figure 2 illustrates the removal of the Tumour Region from the exterior of the skull that was the consequence of the procedure. The progression of the tumour as it reaches the Grade III stage is depicted in Figure 3.

**Figure 2.** Region Removed Without the Outer Skull
Figure 3. The end result of categorizing

So far provided findings indicate the method is effective in identifying and categorizing brain cancers. TMH cancer specialists have been briefed on the results of the classification of images of tumours in the brain that were first missed. The results corroborate the experts’ hypotheses and give them a new diagnostic tool in the war against cancer.

5. CONCLUSION

Current technology detects tumours only by location and size. Some cancers require a biopsy. Pathologists use powerful field microscopes to identify sick tissue. It’s laborious. This procedure’s tiredness may impair diagnosis accuracy. This study describes a method that automatically classifies sick tissues. The approach classifies an unidentified sample image into the most relevant Astrocytoma kind of Cancer, enabling exact diagnosis and real-time tracking without pathological testing. Artificial Neural Networks detect and classify brain tumours. Texture analysis teaches the Artificial Neural Network. These estimated co-occurrence matrices yield GLCM features. The aforementioned technique was effective in classifying cancer types in brain photos taken under changed clinical also technical situations by identifying high deviations in brain diseased areas. This analysis employed Tata Memorial Hospital Radiology Department MRI scans. This method accurately detects and classifies astrocytoma. These images were solely for system testing. Categorizing various cancers is possible with the approach. The system can be enhanced with PET, MRS, or CTS imaging. Large patient data sets improve system precision. Metabolic, genetic, and brain anatomical data could improve the system.
References


