

Chapter 37

Computational Intelligence Techniques for Pattern Recognition in Biomedical Image Processing Applications

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ABSTRACT

Medical image classification is one of the most widely used methodologies in the biomedical field for abnormality detection in the anatomy of the human body. Image classification belongs to the broad category of pattern recognition in which different abnormal images are grouped into different categories based on the nature of the pathologies. Nowadays, these techniques are automated and high accuracy combined with low convergence rate has become the desired features of automated techniques. Artificial Intelligence (AI) techniques are the highly preferred automated techniques because of superior performance measures. In this chapter, the application of AI techniques for pattern recognition is explored in the context of abnormal Magnetic Resonance (MR) brain image classification. This chapter illustrates the theory behind the AI techniques and their effectiveness for practical application in medical image classification. Few experimental results are also provided to aid the conclusions. Algorithmic approach of the AI techniques such as neural networks, fuzzy theory, and genetic algorithm are also dealt in this chapter.

INTRODUCTION

Computational applications are becoming increasingly important in day-to-day life. But the complexity and the practical difficulties involved in these applications are significantly high. Several

techniques are being developed to counter these drawbacks to make them suitable for real-time applications. Again, the pros and cons of these techniques are considerably different which lay an emphasis to highlight the optimal problem solving techniques. Among the problem solving techniques, machine learning algorithms are highly preferred because of its high accuracy.

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The technique of incorporating intelligence in these machine learning algorithms have yielded significantly superior results. In this chapter, the theory and the applications of some of the Artificial Intelligence (AI) techniques are explained in the context of solving the practical problems in medical image classification.

Medical image classification is one of the primary computational applications in the biomedical field. This process involves the categorization of abnormal images into different groups. This process is extremely important for diagnosing the nature of abnormalities in the human body. Since the subsequent treatment planning is purely based on the disease identification technique, the accuracy of this process must be exceedingly high. Another significant requirement of this image classification technique is the low computational speed. Even though many automated techniques are available, machine intelligence techniques are holding a significant position because of its superior performance measures. The commonly used AI techniques are Artificial Neural Networks (ANN), Fuzzy theory, Genetic Algorithm (GA), etc.

One of the significant machine learning approaches is the Artificial Neural Networks. These are developed based on natural behaviour of the human beings. The performance measures of these techniques are good enough for real-time applications. The structural and functional operations of the ANN are similar to the natural neurons which are completely computational in nature. Another approach namely, fuzzy theory is a recent version of AI techniques which is used to improve the accuracy of the inputs. This technique is a rule based system which ultimately improves the accuracy of the output. The combination of fuzzy theory and neural networks possess the advantages of both the techniques. A third approach such as GA is used to enhance the performance of the conventional AI techniques. This technique is used to eliminate the irrelevant inputs which significantly improve the quality of the outputs. This technique is based on the natural theory of evolution. The dimension-

ality of the input vectors is significantly reduced which enhances the accuracy besides improving the convergence rate. All these techniques have been successfully used for practical applications including the biomedical applications.

In this chapter, two algorithms of ANN, one algorithm of fuzzy theory and the concept of GA are explained with mathematical expressions. The basic theoretical background of these algorithms is also dealt in this chapter. The application of these algorithms is explained in the context of medical image classification. Abnormal Magnetic Resonance (MR) brain tumor images are used as the representative of medical images. A suitable methodology for image classification is proposed and these AI algorithms are tested with the input images. Experimental results are analyzed in terms of classification accuracy and convergence rate. A comparative analysis is performed to highlight the significant algorithm for MR brain tumor image classification. Thus this chapter deals with the problem solving AI algorithms for computational applications such as medical image classification.

BACKGROUND

Modern medical imaging technology such as MRI has given physicians a non-invasive means to visualize internal anatomical structures and diagnose a variety of diseases. MR images are typically interpreted visually and quantitatively by radiologists. The need for quantitative information is becoming increasingly important in clinical and surgical environment. Brain tumors are the leading cause of cancer death among humans. Hence early detection and correct treatment based on accurate diagnosis are important steps to avoid any fatal results.

Classification is the grouping of tumors on the basis of their characteristics. Classification of brain MR images has important research and clinical applications. Brain classification methods can be broadly categorized as manual methods

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