CHAPTER 5
SUMMARY AND CONCLUSION

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1.1. SUMMARY

In this section, we have illustrated the content of thesis along with the research contributions. The research work has been started with the idea of giving better understanding of the current medical image processing techniques, various imaging modalities and their needs. We have articulated need for medical image processing for the healthcare system. We felt that it is necessary to implement the algorithm in cloud computing by considering the emerging technologies like cloud computing in information technology. We have incorporated the technologies like Hadoop and Spark which can support medical image processing in the cloud. It is the motivation of the study as well as the research gap found which needs to be addressed in the current fast growing technologies.

The detailed literature survey from the beginning of medical imaging till the area of research gap found has been carried out to emphasize on the need of the research. The research has contributed in two major areas. Firstly parallel genetic algorithm for brain MRI segmentation has been analysed with the various brain MRI processing algorithms and their advantages and disadvantages were discussed. Secondly to support the novel approach, the medical image processing in the cloud with Hadoop and Spark has been analysed to fill the research gap.

Proper data collection procedures and suitable methodology were executed to get the better results after processing the data. Since the dataset needs

cleaning of artifacts, we have applied the necessary and effective preprocessing techniques to prepare the images for further processing. Since the implementation of the proposed methodology is in cloud, transferring of data needs efficient lossless compression techniques for to and fro communication with the cloud. The novel approach of introducing average migration technique in the parallel genetic algorithm for segmentation of brain tumor is carried out and discussed in detail.

Medical Image Processing does not stop only with the processing algorithms. PACS and DICOM are enabling us to go beyond processing and make the medical image available for various users within the legal limitations.

All the devices such as scanners, servers, terminals, printers, and network hardware used for the acquisition transmission and storage of images are integrated by DICOM for PACS. It enables easy transmission of the medical image information between various users (Philbin, Prior, and Nagy, 2011).

The implementation of the newly introduced PGA with average migration technique was carried out and their performance was evaluated in various conditions with Hadoop and Spark. It can be described as a landmark of novel approach towards medical image processing of brain MRI segmentation.

1.2. CONTRIBUTION OF THIS RESEARCH

- The research has studied healthcare systems and their trends with respect to the quality of the process, need for the time, increasing

challenges for the professionals in the field, various factors influencing the increase in brain tumor, the influence of medical image processing in diagnosis and treatment.

- Analysis of various imaging modalities and the images produced by them have been carried out to bring out the reality in the current medical image acquisition field.
- Different image processing algorithms such as Thresholding algorithms, Region-Based Methods, Edge-Based Segmentation algorithms such as K-Means, Fuzzy C Means, and Hybrid Algorithms were analysed. The different methodologies proposed by various authors based on the above algorithms were investigated and the understanding of their impact on the output of segmentation is projected.
- There is a comprehensive study on Genetic Algorithms and their involvement in enhancing the efficiency in brain tumor segmentation.
- Different operators of GA such as Selection Operator, Crossover Operator, and Mutation Operator are pondered over in a complete manner. Crossover Operator which is a key differentiating element of GA from other optimization methods is well defined with the support of different methodologies based on GA.
- An added advantage of parallelism has been brought from Parallel Genetic Algorithm to reduce the execution time especially with huge number of MR images stored in Hadoop File System (HDFS). PGAs

are investigated with respect to optimization in accuracy, execution time and a different number of client machines.

- The proposed architecture "LISA" gives a novel approach "Average Migration Technique" that adopts PGA to enhance the efficiency in the accuracy of brain MRI segmentation. The migration of demes are encouraged in an average manner to bring out the natural crossover and meanwhile retain the high probability of mutation by avoiding the early convergence of result.
- The algorithm has been implemented with single cluster Apache Hadoop and Spark as well as with multiple clusters. Hadoop's map reduce technology has been incorporated with PGA of average migration technique to augment the proficiency still better.
- Multiple clusters are adopted in the Amazon Cloud EC2, to test the effectiveness of parallelism. In Hadoop environment, there were one namenode, one secondary namenode, and four datanodes to run the algorithm.
- Based on the data size and the number of clusters, execution time was calculated in every level to test the performance of the proposed methodology in Hadoop as well as in Spark.
- To conclude our research contribution, we could say that the research has made a positive increase in the accuracy in segmenting tumor in brain MRI using our novel PGA and brought out the effectiveness of the Hadoop/Spark architecture to implement the medical image processing for the future researchers.

1.3. FUTURE WORK

Even the research we carried out could give a novel framework for brain MR image processing in cloud, still there are areas which can be considered for future work. We have taken the references of few ongoing studies for which our research can make a platform for further construction.

Since the medical image data is significantly increasing in volumes every day, effective mechanisms can be derived to store the data on the remote machine in the cloud to save the problems in cloud storage (Palankar, 2008). Since storage and maintenance of medical image is a burdensome task, bringing these images directly to the cloud will be of great help for the institutions. There is a study on storage in clouds namely "To Lease or Not to Lease from Storage Clouds" by Walker, Brisken, and Romney (2010). In the study they have established a model for financial decision depends on differential net present value. Moreover, the results reveal that it would be cost effective to use a cloud-based storage model for organizations storing 10 TB per year and retain their data for up to 9 years. It is added that storage component (Huang et al., 2005) of a cloud PACS adds more cost effectiveness to the biggest healthcare establishments.

Since it is an era of mobile applications, mobile applications can be developed for the proposed architecture "LISA", to render, access and visualize the processed images over the mobile. Mobile Applications will make the tasks easier for the healthcare professionals.

Since huge volumes of similar brain MR images are added to the database, the efficiency of the proposed algorithm can be used to cluster the set of images of similar problems diagnosed for the patients and the treatment

procedures related to the diagnosis. It will lead to the development of an expert system which may support doctors to take faster and efficient decision on the future course of action.

Processing medical image data in the remote cloud will require more bandwidth and low bandwidth network may cause latency in processing. The effective Lossless Image Compression algorithms, especially for medical image transmission to the cloud, can be invented to make the transmission faster (Teng et al., 2010).

Another area of medical image processing is to maintain the privacy maintenance of patient data. When the data is accessed and transmitted globally, there should be a guarantee that the privacy and security of data are not in jeopardy. The efficient algorithm can be achieved to maintain the privacy of data over the cloud.

The essential issues such as data latency, data ownership, cost effectiveness and data security with medical imaging hosted in remote clouds can be addressed by adopting suitable algorithms to enjoy the efficiency of the proposed methodology. Load balancing is another area of interest to be addressed when the huge size of medial image data is transferred over the low bandwidth network and stored in the public cloud. The efficient mechanism can be tailored to balance the load in the host cloud as well as to speed up the transfer in the network.

Finally, the best mechanism within the boundary of legal and ethical policies can be worked out to cut down the expense (Deelman et al., 2008) burden using cloud services to give a better healthcare service even to the least in the developing country like India.