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Detection of Acute Lymphoblastic Leukemia and its Subtypes using Deep Learning

Naina Sharma
Department of Computer Science and Engineering,
MIT ADT University, Pune,
Maharashtra, India.

Aman Shrivastava
Department of Computer Science and Engineering,
MIT ADT University, Pune,
Maharashtra, India.

Aman Garg
Department of Computer Science and Engineering,
MIT ADT University, Pune,
Maharashtra, India.

Ankit Mukopadhyay
Department of Computer Science and Engineering,
MIT ADT University, Pune,
Maharashtra, India.

Dr. Mohd. Shafi Pathan
Department of Computer Science and Engineering,
MIT ADT University, Pune,
Maharashtra, India.

***Abstract*— Acute Lymphoblastic Leukemia (ALL), also known as Acute Lymphocytic Leukemia, is a form of blood cancer. In ALL, the term "acute" relates to the disease's quick progression and the production of immature blood cells rather than mature ones. ALL attacks white blood cells called lymphocytes referred to as "lymphocytic." It is the most prevalent kind of cancer in children, and if detected and treated early, it has a good chance of being cured. This is an in-depth analysis of the existing systems employed using artificial intelligence techniques to detect different forms of Leukemia.**

Keywords*— *Leukemia, Acute Lymphocytic Leukemia, Acute Lymphoblastic Leukemia, Blood Cancer, Deep Learning, Convolutional Neural Networks, Leukemia Detection, Artificial Intelligence.

I. INTRODUCTION

Every year, over 900,000 people worldwide are diagnosed with Leukemia, sometimes known as blood cancer, however many people are unaware of the hazards associated with such frequently incurable diseases. The bulk of blood cancers are uncommon, life-threatening disorders with small patient populations; they account for 7% of all cancers. Due to the complex, frequently scant nature of Leukemia, patients may feel abandoned and have trouble obtaining the essential aid and information.

Acute Lymphocytic Leukemia accounts for 74% of the total pediatric leukemia cases. The usual diagnosis is carried out late due to common symptoms, and therefore treatment is delayed. When it comes to Acute Leukemia, if therapy is not started on time, the patient might succumb to the ailment within a few months. Therefore, it is vital to diagnose cancer, be it of any type, in its early stages to ensure timely treatment and increase the chances of survival.

Customarily, the patients suffering do not have the liberty to exhaust their time as they need immediate care. Early diagnosis can help the healthcare sector achieve high recovery rates and increase the chances of survival. Unfortunately, due to the need for expensive equipment and facilities, many people around the globe cannot receive a proper diagnosis. We need systems that can use the latest technological developments in artificial intelligence to produce expeditious and more accurate results. We need an inexpensive solution to diagnose ALL at a grassroots level that will help aid patients and medical personnel.

II. EXISTING RESEARCH

Bibi et. Al presented an Internet of Medical Things (IoMT)-based architecture for improving and assuring Leukemia detection. Cloud computing connects clinical devices to network resources in the planned IoMT system. The system enables patients and healthcare providers to coordinate Leukemia testing, diagnosis, and treatment in real-time, potentially saving both patients and clinicians time and effort. To identify the various subtypes of leukemia, the system employs DenseNet-121 and ResNet-34.[1]

Ghadezadeh et Al. published a review paper in which they analysed the current state of all known ML-based Leukemia detection and classification models that handle PBS pictures comprehensively and systematically. The average accuracy of the ML algorithms used in PBS image analysis to diagnose Leukemia was better than 97%, showing that using ML to detect Leukemia from PBS images could yield incredible results. In this survey, deep learning (DL) surpassed all other machine learning algorithms in terms of precision and sensitivity in distinguishing different forms of leukemia. [2]

Salah HT et Al. conducted a review of prior research investigating the use of Machine Learning to diagnose various forms of leukemia. The automatic search was supplemented by hand-searching of references from related research and the top Google Scholar results. Fifty-eight publications were reviewed in total, with 22 studies included. There were 12 studies, eight studies, three studies, and 1 study that examined ALL, AML, CLL, and CML, respectively. [3]

M. Akter Hossain et Al. conducted a study on Be Acute Lymphocytic Leukemia (ALL), the most common leukemia. Oncologists are aware that cancer is much easier to treat if

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detected early. They proposed a hands-on technique for detecting aberrant blood components in cancer patients (e.g., neutrophils, eosinophils, basophils, lymphocytes, and monocytes). They used 14 features to construct the dataset before selecting four key attributes vital in determining a Leukemia patient. [4]

Litjens et Al. advocated "deep learning" as a strategy to improve the fairness and efficiency of histopathology slide analysis in their research. There is evidence that employing prostate cancer identification on biopsy and breast cancer metastasis detection in the sentinel lymph node is an example; this novel technique may reduce pathologists' workload while improving diagnosis objectivity. All slides with micro and macro-metastases of prostate and breast cancer can be identified automatically without additional immunohistochemical markers or human intervention; however, slides containing benign and normal tissues cannot. They discovered that they might exclude between 30 and 40% of the population. Deep learning, the report says, holds significant promise for improving prostate cancer detection and classification. [5]

P. Jagadev et Al. conducted a thesis that intends to develop an image processing technique for diagnosing leukemia, thus automating the process. The investigation used two hundred twenty blood smear pictures from leukemic and non-leukemic patients. As picture segmentation methodologies, the k-means clustering method, the Marker controlled watershed algorithm, and the HSV colour-based segmentation algorithm were used. Because most previous methodologies were limited to identifying Leukemia or classifying it into one or two subtypes, this thesis aims to detect Leukemia and determine whether it is AML, CML, CLL, or ALL, thereby broadening the classification process in the field of study. [6]

A. Ratley et Al. conducted a study that assessed numerous image processing and machine learning algorithms used for leukemia diagnosis and attempted to focus on the benefits and limitations of other comparable studies to provide a conclusion that will be valuable to future researchers. [7]

Raje et Al. suggested a system for identifying leukemic cells using microscopic images. The ability to correctly detect leukemia early aids in delivering suitable therapy. As a result, statistical criteria such as mean and standard deviation identify white blood cells from other blood components such as erythrocytes and platelets. For Leukemia diagnostic prediction, geometrical characteristics such as the size and perimeter of the white blood cell nucleus are being investigated. The proposed method was tested on many photographs, yielding encouraging results for images of various quality levels. [8]

Zhao J et Al.'s study proposes a system for automatically recognising and classifying WBCs in peripheral blood images. It begins with an algorithm for identifying WBCs in microscope images based on a simple colour R, B, and morphological operation relationship. To distinguish eosinophils and basophils from the rest of the WBCs, granularity features called PRICoLBP and SVM are used. Finally, convolution neural networks extract high-level attributes from WBCs, which are subsequently used in a random forest to recognise the other three types of WBCs: neutrophil, monocyte, and lymphocyte. [9]

Tatdow Pansombut et Al. published a report that recognised acute lymphoblastic leukemia (ALL) subgroups for WHO classification. They compared a standard support vector machine (SVM) approach that involves handcrafted feature engineering against the viability of a deep learning strategy for detecting lymphocytes and ALL subtypes using a CNN classifier. It also employs the MLP Classifier and the Random Forest Technique. [10]

III. PROPOSED SYSTEM

We propose a system that employs Convolutional Neural Networks and Image Processing to segment and segregate the characteristics of Peripheral Blood Smears of ALL blood samples. CNN has been found to yield excellent results when it comes to feature extraction and with architectures like VGG16 we can expect high accuracy levels. It was found that using optimizers like Stochastic Gradient Descent would cause problems such as underfitting for a vast database but using adaptive optimizers like Adam would be highly beneficial.

IV. CONCLUSION AND FUTURE SCOPE

Cancer continues to ravage the world and plagues millions of people every year. Even though a concrete cure is yet to be discovered it is always prudent to be a step ahead in the prognosis and treatment. Along those lines, our proposed system is aimed at achieving 75% accuracy rates in detecting different subtypes of Acute Lymphocytic Leukemia through the means of Convolutional Neural Networks. being a small but meaningful contribution to winning the war against Leukemia. It can facilitate the growth of the healthcare system in terms of early detection and diagnosis of ALL.

When we speak of future scope, the possibilities are endless and there is always room for improvement and innovation. Higher accuracy rates along with a more comprehensive dataset are some things that can be enhanced by further work. The platform where the system will be launched can be optimized and made user friendly with extensive information about the disease.

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