A Brief Survey on Leukemia Detection Systems

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Abstract – *Every year, over 900,000 individuals worldwide are diagnosed with Leukemia, i.e., Blood Cancer, but many people are oblivious of the dangers involved with such often incurable diseases. The majority of Blood Cancers are rare, life-threatening illnesses within limited patient populations; together, they account for 7% of all malignancies. Patients may feel abandoned and have difficulty finding the necessary assistance and information due to the complex, often sparse nature of Leukemia. When it comes to Acute Leukemia, if therapy is not started on time, the patient might succumb to the ailment within a few months. It is vital to diagnose Cancer be it of any type, in its early stages to ensure timely treatment and increase chances of survival. Detecting Leukemia manually in labs by medical personnel examining blood samples is a time and resource-consuming procedure. Customarily, the patients suffering do not have the liberty to exhaust their time as they need immediate care. We need systems that can make use of the latest technological developments in artificial intelligence to produce expeditious and more accurate results. This is a survey paper focusing on some existing Leukemia detection and categorization systems, surveys and thesis published by various individuals over the years using various techniques and algorithms under artificial intelligence.*

***Key Words*: Leukemia, Blood Cancer, Deep Learning, Convolutional Neural Networks, Leukemia Detection, Internet of Things, Survey.**

1. INTRODUCTION

Leukemia is a type of cancer that affects the Blood and Bone Marrow. The bone marrow of Leukemia patients exhibits this rapid, unchecked proliferation of abnormal cells. Unlike other diseases, Leukemia usually does not form a mass (tumour) that can be detected by imaging tests such as X-Rays. It is made by developing blood cells in the Bone Marrow. Hematopoietic Stem Cells are progenitor cells of all blood cells and undergo several developmental stages before they become adults. Blood cells proliferate and divide in the bone marrow to make Red Blood Cells, White Blood Cells, and Platelets. However, when a person suffers from Leukemia, one of these types of blood cells begins to develop rapidly and out of control. These abnormal cells, known as Leukemia cells, arrogate the space inside the Bone Marrow. Leukemia can now be identified by automatic specialised tests, such as Cytogenetics, Immunophenotyping, and Morphological Cell Categorization, but the drawback is that they necessitate expert operators to scrutinize microscopic pictures of blood or bone marrow, which also leads to a substantial delay in the treatment procedure. Another issue is that these approaches are not employed in cases with regular symptoms and are therefore performed only in exceptional cases.

Early detection of Acute Lymphoblastic Leukemia (ALL) symptoms in individuals can considerably improve their chances of survival. The approach of blood cell observation employing Cytogenetics and Immuno-phenotyping Diagnostic Procedures is now recommended for its high accuracy. The difficulty with such procedures is that they are slow and unstandardized since they depend on the operator's capabilities and enervation. The use of microscopic pictures to identify Leukemia in human blood samples is only fitting for low-cost and remote diagnosis systems. That's where new-age solutions come into play. Using Deep Learning, Machine Learning and Neural Networks various researchers have developed systems that provide a smooth and exceptionally accurate way to detect and classify different types of Blood Cancer.

2. LITERATURE SURVEY

Research conducted by Bibi et. Al proposes an Internet of Medical Things (IoMT)-based architecture for improving and ensuring Leukemia detection. Clinical devices are linked to network resources in the proposed IoMT system using cloud computing. The technology allows patients and healthcare providers to coordinate testing, diagnosis, and treatment of Leukemia in real-time, potentially saving time and effort for both patients and clinicians. The system uses DenseNet-121 and ResNet-34 to identify the different subtypes of Leukemia. [1]

A review paper by Ghadezadeh et. Al examined the present state of all known ML-based Leukemia detection and classification models that handle PBS images in a thorough and systematic manner. The average accuracy of the ML algorithms employed in PBS image analysis to diagnose Leukemia was greater than 97 per cent, indicating that utilizing ML to detect Leukemia from PBS images might provide amazing results. In this survey, Deep learning (DL) outperformed all other machine learning algorithms in terms of precision and sensitivity in recognizing distinct types of Leukemia. [2]

A study by Salah HT et. Al comprised of a compilation of other studies which examine the usage of Machine Learning in diagnosing the different types of Leukemia. Hand-searching of references from similar research and the top Google Scholar results supplemented the automated search. A total of 58 papers were read in their entirety, with 22 studies being included. There were 12, 8, 3, and 1 research that discussed ALL, AML, CLL, and CML, respectively. [3]

A study by M. Akter Hossain et. Al focused on Be Acute Lymphocytic Leukemia (ALL) as it is the most frequent kind of Leukemia. Oncologists are well aware that cancer is considerably easier to treat if discovered early. They suggested a hands-on technique to detect the abnormal blood components prevalent in cancer patients (e.g., neutrophils, eosinophils, basophils, lymphocytes, and monocytes). They selected 14 features to prepare the dataset before determining four essential attributes that are important in determining a Leukemia patient. [4]

A paper by Litjens et. Al proposed "deep learning" as a method for improving the fairness and efficiency of histopathology slide analysis. There is an indication that using prostate cancer identification on biopsy and breast cancer metastasis detection in the sentinel lymph node as examples, this unique technique may lessen the load on pathologists while boosting the objectivity of diagnosis. All slides containing micro and macro-metastases of prostate and breast cancer can be recognized automatically without the need for extra immunohistochemical markers or human involvement, however, slides containing benign and normal tissues cannot. They discovered that they can exclude 30-40% of the population. The paper concludes that deep learning has enormous promise for improving prostate cancer detection and classification. [5]

A thesis by P. Jagadev et. Al aims to build an image processing technique for diagnosing Leukemia, hence automating the process. The study used 220 blood smear images from leukemic and non-leukemic patients. The k-means clustering approach, Marker controlled watershed algorithm, and HSV colour-based segmentation algorithm was employed as image segmentation approaches. Because most prior techniques were confined to detecting Leukemia or categorizing it into one or two subtypes, the goal of this thesis is to detect Leukemia and determine whether it is AML, CML, CLL, or ALL, thereby expanding the classification process in the field of research. [6]

A study by A. Ratley et. Al examined several image processing and machine learning approaches used for Leukemia detection and attempt to focus on the benefits and limits of other comparable studies in order to summarize a conclusion that will be useful to other researchers. [7]

A system proposed by Raje et. Al aimed to identify Leukemic cells using microscopic pictures. The capacity to diagnose Leukemia early and successfully assists in the delivery of appropriate therapy. Therefore, to distinguish white blood cells from other blood components such as erythrocytes and platelets, statistical criteria such as mean and standard deviation are utilized. Geometrical parameters such as the size and perimeter of the white blood cell nucleus are explored for Leukemia diagnostic prediction. The proposed method was tested on a large number of pictures, with promising results for images of different quality. [8]

Research by Zhao J et. Al presents a system for automatically detecting and classifying WBCs in peripheral blood pictures. It first presents an algorithm for detecting WBCs in microscope pictures based on a simple colour R, B, and morphological operation relationship. A granularity feature called PRICoLBP and SVM is made use of to differentiate eosinophils and basophils from the rest of the WBCs. Finally, convolution neural networks are utilized to automatically extract high-level properties from WBCs, and these features are then used in a random forest to recognize the other three types of WBCs: neutrophil, monocyte, and lymphocyte. [9]

A paper by Tatdow Pansombut et. Al presented the recognition of acute lymphoblastic Leukemia (ALL) subgroups for WHO classification. They used a CNN classifier to test the viability of a deep learning strategy for identifying lymphocytes and ALL subtypes and compared it to a popular support vector machine (SVM) approach that uses handcrafted feature engineering. It also makes use of MLP Classifier and Random Forest Technique. [10]

3. CONCLUSION

We propose a system that has the ability to identify Leukemia using microscopic pictures of blood cells and achieve accuracy levels that surpass that of practising physicians. The healthcare system can be significantly benefitted from this technology as it can provide access to medical imaging knowledge in sparsely populated and remote locations of the world that have fewer medical personnel. We suggest a method for segmenting stained blood smear pictures using Colour-Based Clustering under Image Processing to retrieve the nucleus region and cytoplasm area. Support Vector Machine Classifiers when clubbed with a pertinent feature-set yield great results. Therefore, we proffer using SVM with a granularity characteristic to separate the Eosinophils and Basophils from other White Blood Cells. The other three categories can then be determined by employing Convolutional Neural Networks to extract characteristics, which can subsequently be used by the Random Forest Technique to categories those WBCs.

REFERENCES

[1] Bibi, Nighat & Sikandar, Misba & Ud Din, Ikram & Al-Mogren, A.s & Ali, Sikandar. (2020). IoMT-Based Automated Detection and Classification of Leukemia Using Deep Learning. Journal of Healthcare Engineering. 2020.

[2] Ghadezadeh, Mustafa & Asadi, Farkhondeh & Hosseini, Azamossadat & Bashash, Davood & Abolghasemi, Hassan & Roshanpoor, Arash. (2021). Machine Learning in Detection and Classification of Leukemia Using Smear Blood Images: A Systematic Review. Scientific Programming. 2021.

[3] Salah HT, Muhsen IN, Salama ME, Owaidah T, Hashmi SK. Machine learning applications in the diagnosis of Leukemia: Current trends and future directions. Int J Lab Hematol. 2019

[4] M. Akter Hossain, M. Islam Sabik, I. Muntasir, A. K. M. Muzahidul Islam, S. Islam and A. Ahmed, "Leukemia Detection Mechanism through Microscopic Image and ML Techniques," 2020

[5] Litjens, Geert & Sánchez, Clara & Timofeeva, Nadya & Hermsen, Meyke & Nagtegaal, Iris & Kovacs, Iringo & Hulsbergen-van de Kaa, Christina & Bult, Peter & Ginneken, Bram & van der Laak, Jeroen. (2016). Deep learning as a tool for increased accuracy and efficiency of histopathological diagnosis. Scientific Reports.

[6] P. Jagadev and H. G. Virani, "Detection of Leukemia and its types using image processing and machine learning," 2017

[7] A. Ratley, J. Minj and P. Patre, "Leukemia Disease Detection and Classification Using Machine Learning Approaches: A Review," 2020

[8] Raje, Chaitali & Rangole, Jyoti. (2014). Detection of Leukemia in microscopic images using image processing.

[9] Zhao J, Zhang M, Zhou Z, Chu J, Cao F. Automatic detection and classification of leukocytes using convolutional neural networks. Med Biol Eng Comput. 2017

[10] Tatdow Pansombut, Siripen Wikaisuksakul, Kittiya Khongkraphan, Aniruth Phon-on, and Friedhelm Schwenker. 2019. Convolutional Neural Networks for Recognition of Lymphoblast Cell Images. Intell. Neuroscience 2019

[11] S. Mohapatra, D. Patra, and S. Satpathy, "Unsupervised blood microscopic image segmentation and unsupervised blood microscopic image segmentation and Leukemia detection using color based clustering," International Journal of Computer Information Systems and Industrial Management Applications 2012.

[12] C. Reta, L. A. Robles, J. A. Gonzalez, R. Diaz, and J. S. Guichard, "Segmentation of bone marrow cell images for morphological classification of acute Leukemia," in Proceedings of the 23rd International FLAIRS Conference, Daytona Beach, FL, USA, May 2010.

[13] Y. Song, L. Zhang, S. Chen et al., "A deep learning based framework for accurate segmentation of cervical cytoplasm and nuclei," in Proceedings of the 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Chicago, IL, USA, August 2014.

[14] Shafique S, Tehsin S. Acute Lymphoblastic Leukemia Detection and Classification of Its Subtypes Using Pretrained Deep Convolutional Neural Networks. Technology in Cancer Research & Treatment. January 2018.

[15] Rehman, A, Abbas, N, Saba, T, Rahman, Syed Ijaz ur, Mehmood, Z, Kolivand, H. Classification of acute lymphoblastic Leukemia using deep learning.