Acute Lymphoblastic Leukemia Detection in Microscopic Cell Images using Deep Learning Models

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ABSTRACT

Acute Lymphoblastic Leukemia (ALL) is a cancer of the lymphoid line of blood cells characterized by the development of large numbers of immature lymphocytes. Extensive research has been done over the application of machine learning algorithms for detection of ALL but use of Deep Learning (DL) models is relatively scarce. In this paper, we evaluate and compare the available DL architectures with our proposed model for ALL classification and obtain better results as compared to existing ones.

Keywords: Acute Lymphoblastic Leukemia (ALL) · Cancer · Classification·Deep Learning.

1   INTRODUCTION

Cancer is a group of diseases involving abnormal cell growth with the potential to invade or spread to other parts of the body [1][2]. Cancer has a major effect on societies worldwide as it is one of the leading causes of deaths. In 2015, about 90.5 million people were known to be cancer affected with about 14.1 million new cases occurring each year (not including skin cancer and other melanomas), and led to deaths of 8.8 million people [3][4][5]. Leukemia is one of the most common cases of cancers. Leukemias are cancers that start in cells that would normally develop into different types of blood cells. Most often, leukemia starts in early forms of white blood cells, but some leukemias start in other blood cell types. There are several types of leukemia, which are divided based mainly on whether the leukemia is acute (fast growing) or chronic (slower growing), and whether it starts in myeloid cells or lymphoid cells. Knowing the specific type of leukemia helps doctors better predict each person's prognosis (outlook) and select the best treatment [6].

Acute Lymphoblastic Leukemia (ALL) is a cancer of the lymphoid line of blood cells characterized by the development of large numbers of immature lymphocytes [7]. As an acute leukemia, ALL progresses rapidly and is typically fatal within weeks or months if left untreated [8]. Figure 1 shows the types of ALL (L1, L2, & L3) and Table 1 gives the types of ALL, along with the type of cells affected as well as characteristics of the affected cells. In 2015 there were 876,000 cases of ALL which resulted in 111,000 deaths. In 2019 there have been 5930 cases of ALL and 1500 deaths so far [9]. Diagnosing ALL begins with a thorough medical history, physical examination, complete blood count, and blood smears. Bone Marrow Biopsy. Lumbar Puncture & Medical Imaging (Metastasis). Pathological examination and Cytogenetics [10].

Lymphocytes are the main cells that make up lymph tissue, a major part of the immune system. Lymph tissue is found in lymph nodes, the thymus, the spleen, the tonsils and adenoids, and is scattered throughout the digestive and respiratory systems and the bone marrow. Lymphocytes develop from cells called lymphoblasts to become mature, infection-fighting cells. There are 2 main types of lymphocytes:

B lymphocytes (B cells):
    B cells help protect the body by making proteins called antibodies. The antibodies attach to germs (bacteria, viruses, and fungi) in the body, which helps the immune system destroy them.

T lymphocytes (T cells):
    There are several types of T cells, each with a special job. Some T cells can destroy germs directly, while others play a role in either boosting or slowing the activity of other immune system cells.