1. Introduction

1.1 Purpose

The purpose of this document is to provide a comprehensive and detailed specification for the development of an application aimed at assisting medical professionals in the accurate diagnosis of acute lymphoblastic leukemia (ALL).

Acute lymphoblastic leukemia (ALL) is a type of cancer that affects the blood and bone marrow. It is the most common type of cancer in children, and accounts for about 30% of all childhood cancers. ALL is caused by a mutation in the DNA of a white blood cell, which causes the cell to grow and divide uncontrollably.

The diagnosis of ALL is typically made by a combination of blood tests and bone marrow biopsies. However, these tests can be difficult to interpret, and there is a risk of false positives and false negatives.

This software application is designed to help improve the diagnosis of ALL by using convolutional neural networks (CNNs) to **analyze pathological images of individual cells**. CNNs are a type of machine learning algorithm that are specifically designed for image recognition. They have been shown to be very effective at identifying patterns in images, and they have been used to diagnose a variety of diseases, including cancer.

1.2 Scope

The scope of the application encompasses the processing and analysis of pathological images of individual cells obtained from practictions through microscopic imaging techniques. It will focus on automating the classification process to identify leukemic cells accurately. By utilizing convolutional neural networks, the application will harness the power of deep learning algorithms to extract intricate patterns and features associated with leukemic cells, enabling medical professionals to make informed and timely diagnostic decisions. The application will not involve the diagnosis or treatment of patients but will serve as a valuable tool in assisting medical professionals with their expertise and judgment.

1.3 Intended Audience

The primary audience for this document includes:

- The software development team responsible for designing, developing, and implementing the application.
- Medical professionals specializing in hematology and oncology who will utilize the application as a diagnostic tool in their clinical practice.
- Stakeholders involved in the development and implementation of the application, such as healthcare administrators, and regulatory bodies.

2. Overall Description

2.1 Product Perspective

The application will be a web based system designed to seamlessly integrate with existing manual procedure. It will serve as a specialized module, receiving input images from the medical practioner and providing accurate classification results. The application will function independently, without requiring any modifications. It will provide a convenient and efficient tool for medical professionals to aid in the diagnosis of acute lymphoblastic leukemia.

2.2 Product Features

Image preprocessing: To ensure optimal classification accuracy, the application will employ advanced image preprocessing techniques. These techniques will include noise reduction algorithms to eliminate unwanted artifacts, contrast adjustment to enhance subtle features, and image enhancement methods to improve the visibility of relevant structures. The application will strive to enhance image quality while preserving important diagnostic details.

- Convolutional neural network training: The application will utilize a deep learning approach by training a convolutional neural network (CNN). The CNN will be trained using a comprehensive dataset of labeled pathological cell images, encompassing a wide range of leukemic and regular cells. The training process will involve the extraction of distinguishing features and the fine-tuning of network parameters to achieve robust and accurate classification.
- Cell classification: Leveraging the trained CNN, the application will perform efficient and reliable cell classification. It will analyze individual cells within the input images and categorize them as either leukemic or regular cells based on learned patterns and characteristics. The classification results will be generated promptly, enabling medical professionals to make timely and informed decisions regarding diagnosis and treatment plans.
- User interface: The application will feature an intuitive and user-friendly interface, designed to streamline the workflow of medical professionals. The interface will allow users to easily upload cell images acquired from microscopy equipment, initiate the image preprocessing and classification processes, and visualize the classification results. Furthermore, the application will facilitate data management, allowing users to organize and access patient information, review past analyses, and export data for further analysis or archival purposes.

2.3 User Classes and Characteristics

Medical professionals: The intended users of the application will primarily consist of medical professionals specializing in hematology and oncology. These users will possess a comprehensive understanding of leukemia and its diagnosis, as well as the underlying principles of microscopy imaging techniques. They will have the expertise to interpret the classification results provided by the application accurately. The application will augment their diagnostic capabilities and streamline their workflow, enabling them to make well-informed decisions efficiently.

2.4 Operating Environment

The application will be compatible with desktop and laptop computers, ensuring flexibility and accessibility. It will support multiple operating systems, including Windows, macOS, and Linux, to accommodate a wide range of user preferences and

setups. To ensure optimal performance, the application will require a minimum hardware configuration, such as an Intel Core i5 processor, 8 GB of RAM, and 500 GB of storage. These hardware requirements will ensure smooth operation and allow for efficient processing and analysis of cell images, contributing to a seamless user experience.

3. Assumptions, General Development, and Deployment

3.1 Assumptions

- It is assumed that the input pathological cell images will be obtained through standard microscopy imaging techniques and will be of sufficient quality for accurate analysis and classification.
- The labeled dataset used for training the convolutional neural network (CNN) will be carefully curated, ensuring accurate labeling and representation of different cell types.
- It is assumed that the application will receive necessary support and collaboration from medical professionals and domain experts to ensure the relevance and accuracy of the diagnostic outcomes.
- The application assumes the availability of appropriate computational resources to support the training and inference processes of the CNN, such as sufficient computing power, storage capacity, and memory.

3.2 General Development

- The development of the application will follow an iterative and incremental approach, allowing for continuous feedback and refinement throughout the development lifecycle.
- Agile development methodologies, such as Scrum or Kanban, will be employed to promote flexibility, collaboration, and rapid iterations.
- The application will undergo rigorous testing at various stages of development, including unit testing, integration testing, and validation against known datasets, to ensure functionality, accuracy, and reliability.
- Continuous integration and continuous deployment (CI/CD) practices will be adopted to facilitate automated builds, testing, and deployment of the application, ensuring a streamlined and efficient development process.
- The development of the application will leverage the Django framework as the backend technology stack.
- TensorFlow and Keras, two popular deep learning frameworks, will be utilized for the development and training of the convolutional neural network (CNN).
- The application will employ MySQL as the database management system for storing and managing relevant data, such as user information, image metadata, and classification results.
- The frontend design of the application will be developed using a combination of Vanilla JavaScript, HTML, and the Tailwind CSS.

3.3 Deployment

- The application will be deployed as a web application that can be deployed on desktop or laptop computers.
- Detailed installation instructions will be provided to guide users through the setup process and ensure a smooth deployment experience.
- The application will support popular operating systems, including Windows, macOS, and Linux, to accommodate a wide range of user environments and preferences.

- Compatibility with image file formats will be ensured, allowing seamless integration with existing infrastructure and workflows.
- Adequate documentation, including user manuals and troubleshooting guides, will be provided to assist users during the deployment and usage of the application.