

IMPLEMENTATION AND EXPERIMENTAL VALIDATION OF THE MULTIMODAL INTELLIGENT DIAGNOSTIC SYSTEM FOR AUTOMATED DETECTION OF LEUKEMIA

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Abstract. The results of this work are aimed at developing the architecture of a biotechnical system for diagnosing acute forms of leukemia based on biomedical images. This system integrates the classification results and presents diagnostic information to clinicians. The system assists medical specialists by providing structured analysis results and highlighting potentially abnormal cellular structures in microscopic images. The interaction between the system modules forms a complete pipeline for biomedical image analysis, which allows for automated detection of leukemia. The system architecture provides the conversion of raw microscopic images into structured diagnostic results using a sequence of computational processes.

Key words: intelligent diagnostic system, microscopic images, detection of leukemia

Анотація. Результати даної роботи направлені на розробку архітектури біотехнічної системи для діагностування гострих форм лейкозу на основі біомедичних зображень. Ця система інтегрує результати класифікації та представляє діагностичну інформацію клініцистам. Система допомагає медичним спеціалістам, надаючи структуровані результати аналізу та виділяючи потенційно аномальні клітинні структури на мікроскопічних зображеннях. Взаємодія між модулями системи утворює повний конвеєр аналізу біомедичних зображень, який дозволяє автоматизовано виявляти лейкемію. Архітектура системи забезпечує перетворення необроблених мікроскопічних зображень на структуровані діагностичні результати за допомогою послідовності обчислювальних процесів.

Ключові слова: інтелектуальна діагностична система, мікроскопічні зображення, виявлення лейкемії

ACTUALITY

Based on the theoretical foundations and algorithmic methods presented in the previous chapters, this chapter focuses on the practical implementation and experimental validation of the proposed multimodal intelligent bioinformation system for the diagnosis of acute leukemia. The purpose of this stage of the research is to demonstrate how the developed diagnostic framework operates in real biomedical image analysis scenarios and to evaluate its performance in detecting pathological blood cells [1].

In clinical practice, the diagnosis of acute leukemia is traditionally performed through microscopic examination of peripheral blood or bone marrow smears by hematologists. Although this method remains the clinical standard, it requires considerable expertise and may lead to variations in diagnostic results due to subjective interpretation. In addition, manual microscopic analysis is time-consuming when large numbers of samples must be examined [2,3].

To address these challenges, the proposed intelligent diagnostic system integrates biomedical image processing techniques, machine learning algorithms, and expert decision-support mechanisms. The system automatically analyzes microscopic blood smear images and assists clinicians in identifying abnormal cellular structures associated with leukemia [4].

METHOD

The overall implementation framework of the diagnostic system is designed to transform raw biomedical images into structured diagnostic information through a sequence of computational modules. These modules include biomedical image acquisition, preprocessing, feature extraction, classification, and decision support. By integrating these modules within a unified architecture, the system enables automated detection of blast cells and supports the differentiation of pathological cells from normal blood cells.

The main objectives of the system implementation stage include:

- development of the integrated biomedical diagnostic system architecture;
- implementation of automated biomedical image processing pipelines;
- integration of biomedical image datasets into the diagnostic platform;

- validation of system performance through experimental evaluation.

ARCHITECTURE OF THE INTELLIGENT DIAGNOSTIC SYSTEM

Through the implementation of these components, the proposed diagnostic framework provides an automated tool for analyzing microscopic blood smear images and assisting medical specialists in the early detection of acute leukemia. The overall framework of the implemented intelligent biotechnical diagnostic system is illustrated in Figure 1, which presents the main functional modules and their interactions within the intelligent biomedical analysis platform.

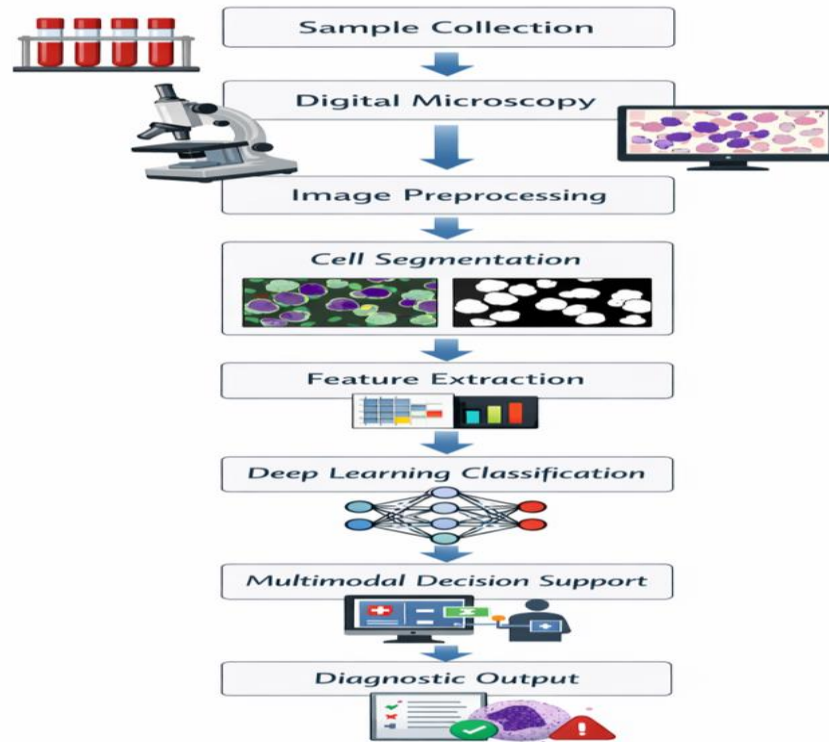


Figure 1 - Systems workflow of the proposed multimodel intelligent biotechnical diagnostics system

The proposed intelligent diagnostic system for acute leukemia was implemented as a modular biomedical information processing platform designed for automated analysis of microscopic blood smear images. The system architecture integrates several functional modules responsible for different stages of biomedical image analysis and diagnostic inference.

The architecture of the system follows a layered design that enables efficient processing of biomedical image data and facilitates integration of different computational methods. Each module performs a specific function within the diagnostic workflow while maintaining interaction with other modules through well-defined data interfaces.

The main components of the system architecture include the following modules:

BIOMEDICAL IMAGE ACQUISITION MODULE

The biomedical image acquisition module is responsible for obtaining microscopic blood smear images from digital microscopy systems. These images serve as the primary input data for the diagnostic platform. The acquired images contain detailed morphological information about blood cells that can be used for detecting pathological abnormalities.

IMAGE PREPROCESSING MODULE

The preprocessing module performs several operations aimed at improving image quality and preparing the data for further analysis. Typical preprocessing operations include noise reduction, normalization, and enhancement of image contrast. These operations help reduce variations caused by imaging conditions and improve the visibility of cellular structures.

FEATURE EXTRACTION MODULE

The feature extraction module analyzes the processed images and extracts relevant morphological and structural characteristics of blood cells. In this system, deep learning–based feature extraction techniques are

employed to capture hierarchical representations of cellular patterns. These features provide essential information for distinguishing between normal blood cells and pathological blast cells.

CELL CLASSIFICATION MODULE

The classification module uses machine learning algorithms to analyze the extracted features and determine the probability that a given cell corresponds to a blast cell associated with acute leukemia. The classification model produces diagnostic predictions that form the basis for further clinical interpretation. The final stage of the system architecture is the decision support module. This module integrates the classification results and presents diagnostic information to clinicians. The module assists medical specialists by providing structured analysis results and highlighting potentially abnormal cellular structures within the microscopic images. The interaction between these modules forms a complete biomedical image analysis pipeline that enables automated leukemia detection. The system architecture ensures that raw microscopic images are transformed into structured diagnostic outputs through a sequence of computational processes. The architecture of the proposed intelligent diagnostic system is illustrated, which demonstrates the relationships between the major system modules and the flow of biomedical image data through the diagnostic pipeline.

CONCLUSIONS

The results of this work are aimed at developing the architecture of a biotechnical system for the diagnosis of acute forms of leukemia based on biomedical images. This system integrates the results of classification and presents diagnostic information to clinicians. The system supports additional medical specialists, providing structured analysis results and detecting detected abnormal cell structures in microscopic images. The interaction between the system modules creates a complete pipeline for the analysis of biomedical images, which allows for the automated detection of leukemia. The system architecture provides the conversion of raw microscopic images into structured diagnostic results using the complexity of computational processes.

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