Leukemia Detection using an improved method with k-means

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*Abstract***— Leukemia, commonly known as “blood cancer” is a fatal and serious disease. It is caused by irregular WBC cell division. To provide proper treatment to the patient, we must detect the issue in its early stages. This can be done in a multitude of ways, both manual, like cell culturing, and digital methods like taking microscopic images of the person’s blood cells and passing them through some automated image processing method. Our algorithm uses k-means clustering algorithm to segment out WBCs, followed by a traditional method to detect the RBCs. Digital methods yield early results compared to manual methods and can allow the patients to take proper steps before the cancer advances to later stages. Our algorithm detects acute lymphocytic (or lymphoblastic) leukemia and has an accuracy rate of greater than 95% using this method.**

*Keywords*— **Leukemia detection, acute lymphocytic leukemia, Image processing, k-means, filtering, Image de-noising.**

1. **INTRODUCTION**

Image processing has been used in the recent times to employ multiple techniques in order to assist people at certain tasks. As such, it finds great usage in the medical field where time is a precious resource, and can result in the life or death of an individual.

Leukemia is the term used for the cancer of blood cells. It has four major types: Acute Lymphocytic Leukemia (ALL), Acute Myelogenous Leukemia (AML), Chronic Lymphocytic Leukemia (CLL) and Chronic Myelogenous Leukemia (CML). It can be manually detected by cell culturing but that process is time consuming and requires professionals to determine the outcome as the classification is done manually under a microscope.

Digital image processing does not require neither trained professional nor expensive lab equipment nor long amounts of time. Using this, we can detect leukemia by just inputing an microscopic image of the blood smear of the person and the algorithm will automatically determine the presence of leukemia.

We considered several algorithms to achieve our goal but finalized on using the k-means algorithm and other feature extraction processes to get our results.

1. **PROCESS OVERVIEW**

For our research, we collected multiple microscopic images of blood smears from both healthy individuals and leukemia affected individuals. This formed the reference for computing the results for the implementation. Then we ran several image segmentation and other image preprocessing methods to remove the background noise and extract out the WBCs and RBCs.

First, the image is resized to better suit our algorithm. Then we extract the “saturation” component of the image. This gives us a 2-D matrix to work with. When k-means segmentation is performed on this 2-D matrix, using 3 clusters, the WBCs are highlighted in a color that separates it from the RBCs and other background components. The resulting image is converted to HSV color model. The components of the resultant image, hue, saturation and intensity, are then subtracted from each other. Upon performing several permutations of this process, we found that the difference between the intensity and saturation components provides greater distinction of WBCs. The resultant image is then filtered out for noise and is used as a mask to extract and count the WBCs.

To extract the RBCs, a different approach was carried out as their overlapping nature and color prevented them from being picked up properly by k-means. To overcome this issue, we converted the image to a binary image and cleared up the background noise. The white portions were then dilated and any ring-shaped or deformed portions were filled up to turn them into disks. The image was passed through a circle finding algorithm to count the number of circular objects. This gives us an estimate of the number of the total cells in the blood smear. We can get the number of RBCs by subtracting the number of WBCs from the number of total cells.

We calculated the ratio of WBCs to RBCs of the images in our dataset to get an estimate of the threshold of healthy and leukemia affected cells. Using that data, we applied a check on the ratio of WBC to RBC of the sample to determine whether the sample shows signs of acute lymphocytic leukemia or not.

Saturation component

Compare ratio to determine the result

Calculate ratio of

WBC to RBC

K-means

Extract WBCs

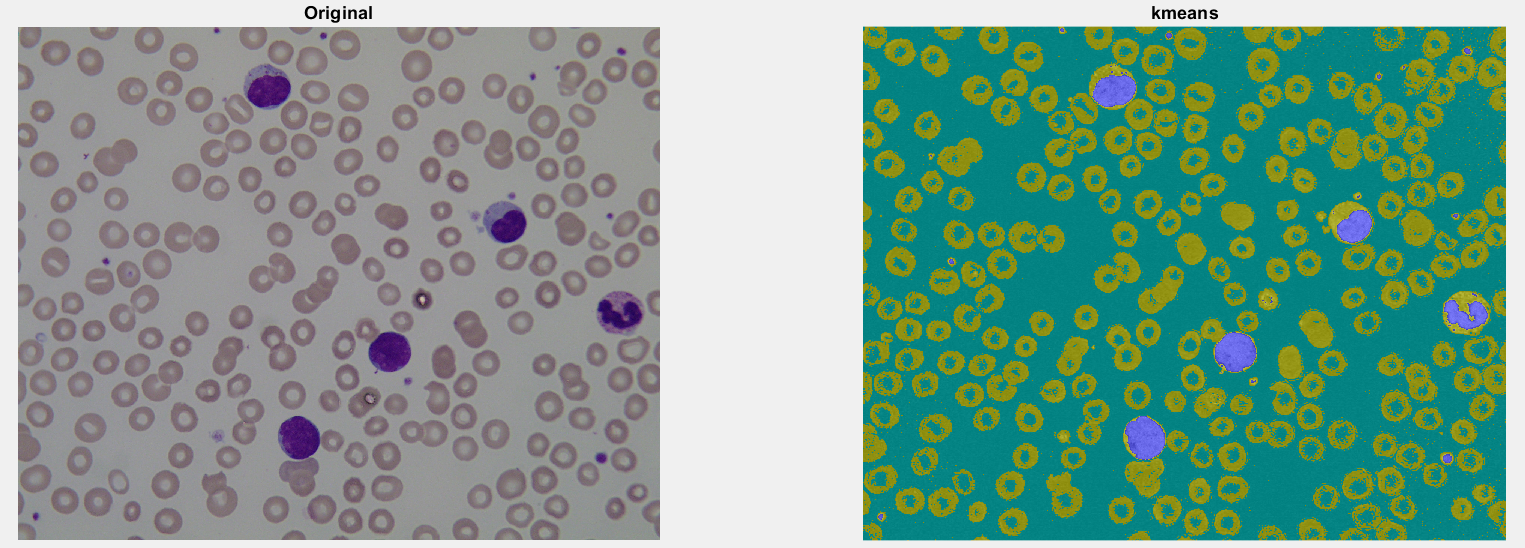
Adjustments to

count cells

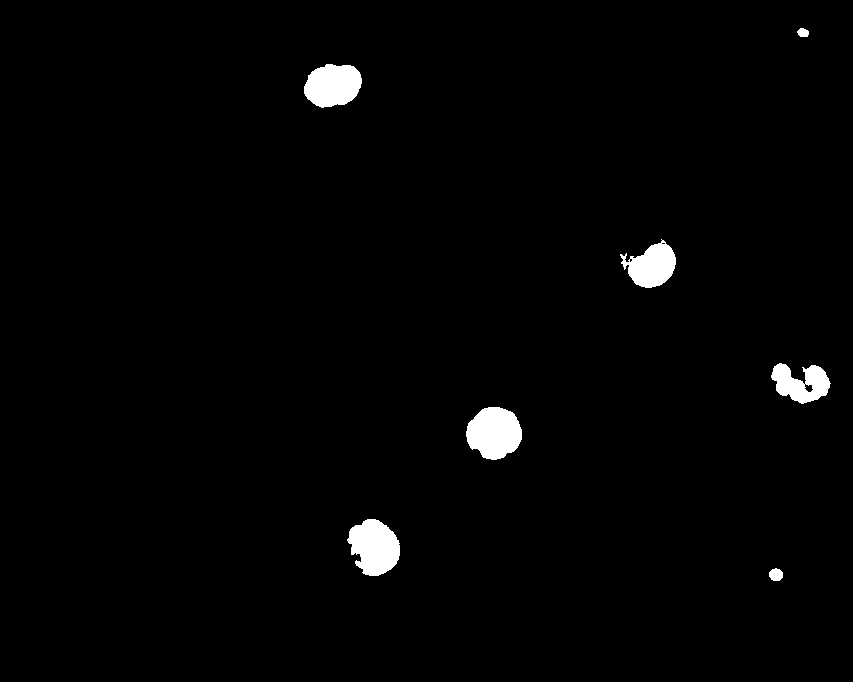
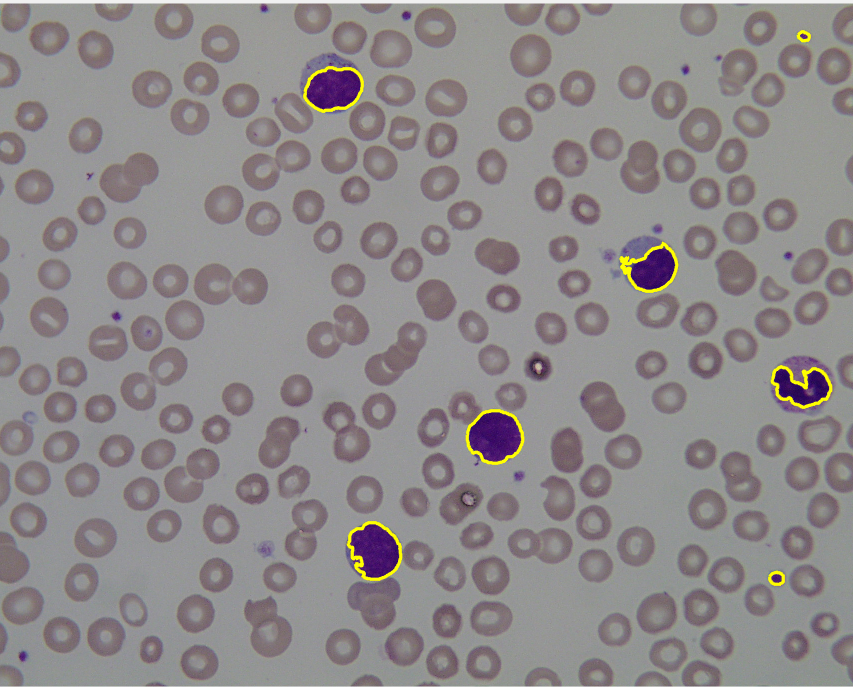
Extract total cells

Binary image

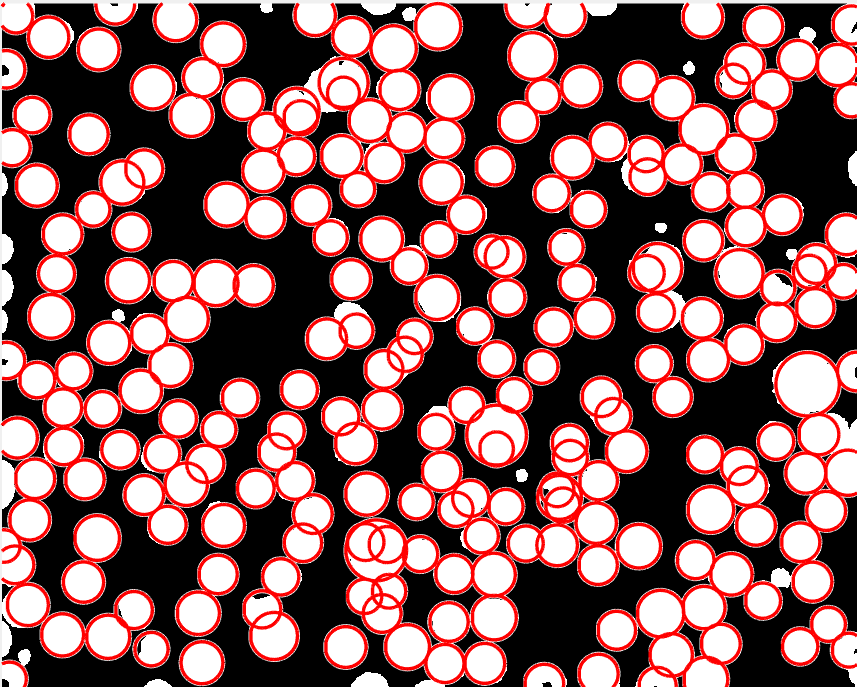
Input Image



*Figure 1 –* Original image vs k-means segmented image

*Figure 2 –* Mask for WBCs *Figure 3 –* WBCs extracted out



*Figure 4* – Total cells

1. **LIMITATIONS**

* k-means remains to be unreliable without proper color contrast to differentiate the WBC. So the smears need proper pigmentation before being processed.
* Can only be used to detect acute lymphocytic leukemia.

1. **FUTURE WORK**

* A manual interface is suggested to choose the most appropriate mask for extracting WBCs. During our research, some samples had other alternatives for determining the mask (like difference between Hue and Saturation). As the algorithm cannot always determine the best mask for the task, a manual input may be necessary to procure more accurate results.
* A shape detection algorithm, with a database detailing the shapes of deformed WBCs, can be used in conjunction with this algorithm to detect other forms of leukemia.

1. **CONCLUSION**

This paper suggests a relatively simple algorithm to detect the presence of leukemia using blood smear samples. The proposed system has been tested with over 108 images and has been able to detect leukemia with great efficiency. Images are converted to HSV model to optimize the efficiency of the algorithm. The algorithm can be further refined using techniques mentioned in the “Future Work” section.

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