**CHAPTER 1**

**INTRODUCTION**

A developing era in the field of Computer Science Engineering is Digital Image Processing (DIP) and it has its branches in all the fields. One of the growing fields in it is the Medicinal part. DIP uses computer algorithms to perform image processing on digital images. The impact of digital images on modern society is so great, and image processing is a critical component in science. At present, the blood samples are taken to lab and processed with various substrates and the results are produced. Whereas this paper, a Biomedical – Computer Science based interdisciplinary work, applies the stain, makes the blood sample absorb the stain and then captures the image of it. Then it is digitally processed with software and the result is displayed immediately.

Haemocytometer is the device which is used in the labs to count the blood cells. A microscopic glass slide consists of a rectangular indentation which creates a chamber. A perpendicular line grid is etched in this chamber. It is possible to count the chamber of cells in a specific volume of fluid, and calculate the concentration of cells in the fluid. Physician views the haemocytometer using a microscope and count the blood cells using the hand counter.

Platelets are one of the blood cells that stops the bleeding in the body from blood clotting. Platelets can detect if any blood vessels are damaged. Red blood cells are also tiny blood cells that is also important in the health of human through carrying fresh oxygen throughout the body whereas white blood cells helps protect the body from infections. Complete Blood Count (CBC) involves blood testing to determine the healthiness of the major components of blood which are platelets, red blood cells and white blood cells. Abnormalities of result based from references of normal count of cells may indicate an underlying medical condition that needs further evaluation.

For this past few years, CBC counting is one of the most studied area of research due to accuracy problem. Laboratories in the hospital in the Philippines are still using the traditional method of counting blood cells. This was done in either manual method through hem cytometer or by automated method through flow-cytometer. In this study, it uses images of the blood to calculate the number of cells since research on medical images is new technology.

**ARTIFICIAL INTELLINGENCE:**

Artificial intelligence (AI) is the ability of a computer program or a machine to think and learn. It is also a field of study which tries to make computers "smart". As machines become increasingly capable, mental facilities once thought to require intelligence are removed from the definition. AI is an area of computer sciences that emphasizes the creation of intelligent machines that work and reacts like humans. Some of the activities computers with artificial intelligence are designed for include: Face recognition, Learning, Planning, Decision making etc.,

Artificial intelligence is the use of computer science programming to imitate human thought and action by analyzing data and surroundings, solving or anticipating problems and learning or self-teaching to adapt to a variety of tasks.

* **MACHINE LEARNING**

Machine learning is a growing technology which enables computers to learn automatically from past data. Machine learning uses various algorithms for building mathematical models and making predictions using historical data or information**.** Currently, it is being used for various tasks such as image recognition**,**speech recognition**,**email filtering**,**Facebook auto-tagging**,**recommender system, and many more.

Machine Learning is said as a subset of artificial intelligence that is mainly concerned with the development of algorithms which allow a computer to learn from the data and past experiences on their own. The term machine learning was first introduced by **Arthur Samuel**in **1959**. We can define it in a summarized way as: “Machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed”.

A Machine Learning system learns from historical data, builds the prediction models, and whenever it receives new data, predicts the output for it**.** The accuracy of predicted output depends upon the amount of data, as the huge amount of data helps to build a better model which predicts the output more accurately.

Suppose we have a complex problem, where we need to perform some predictions, so instead of writing a code for it, we just need to feed the data to generic algorithms, and with the help of these algorithms, machine builds the logic as per the data and predict the output. Machine learning has changed our way of thinking about the problem. The below block diagram explains the working of Machine Learning algorithm.

* **Deep learning**

In general, we will do two tasks all the time consciously or subconsciously, i.e., categorize what we felt through our senses (like feeling hot, cold mug, etc.)

And prediction, for example, predicts the future temperature based on the previous temperature data.

We do categorization and prediction tasks for several events or tasks in our daily life such as below:

Holding Cup of Tea/Water/Coffee etc., which may be hot or cold.

Email categorization such as spam/ not spam.

Day-light time categorization such as day or night.

Long-term planning of the future based on our current position and things we have – is called prediction.

Every creature in the world will do these tasks in their life, for example, consider animals like crow will categorize a place to build its nest or not, a bee will decide on some factors when and where to get honey, the bat will come during the night and sleeps during morning based on day and night categorization.

Let us visualize these tasks categorization and prediction, and they will look alike as in the below image; for categorization, we are doing categorization between cats and dogs by drawing a line through data points, and in the case of prediction, we draw a line through data points to predict when it will increase and decrease.

1. **Categorization**

In general, to categorize between cats and dogs, or men and women, we don’t draw a line in our brains, and the position of dogs and cats is arbitrary for illustration purposes only, and it is needless to say the way we categorize between cats and dogs in our brains is much complex than drawing a red line as above.

We will categorize between two things based on shapes, size, height, looks, etc., and sometimes it will be difficult to categorize with these features such as a small dog with fury

And a newborn cat, so it is not a clear-cut categorization into cats and dogs.

Once we are able to categorize between cats and dogs when we are children, then onwards we are able to categorize any dog or cat even we didn’t see it before.

2. **Prediction**

For prediction based on the line, we draw through data points if we are able to predict where it is most likely to go upward or downward.

The curve is also a prediction of fitting new data points within the range of existing data points, i.e., how close the new data point is to the curve.

The data points which are in red color in the above image (right side) are examples of both within and beyond the range of existing data points, and the curve attempts to predict both.

Finally, both task categorization and prediction are ended at a similar point, i.e., drawing a curvy line from data points. If we are able to train the computer model to draw the curvy

Line based on data points we are done with, then we can extend this to apply in different models such as drawing a curvy line in three-dimensional planes and so on.

The above thing can be achieved by training a model with a large amount of labeled and unlabeled data, which is called deep learning.

**2.1. ALGORITHM**

**1. OpenCV**

OpenCV tutorial provides basic and advanced concepts of OpenCV. Our OpenCV tutorial is designed for beginners and professionals.

OpenCV is an open-source library for the computer vision. It provides the facility to the machine to recognize the faces or objects. In this tutorial we will learn the concept of OpenCV using the Python programming language.

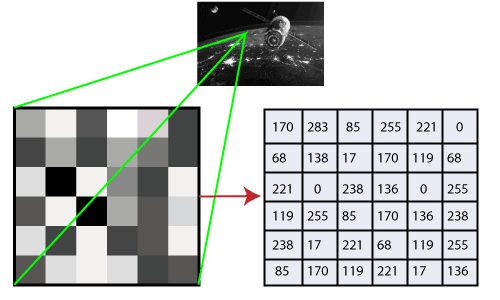
Our OpenCV tutorial includes all topics of Read and Save Image, Canny Edge Detection, Template matching, Blob Detection, Contour, Mouse Event, Gaussian blur and so on.

OpenCV is a Python open-source library, which is used for computer vision in Artificial intelligence, Machine Learning, face recognition, etc.

In OpenCV, the CV is an abbreviation form of a computer vision, which is defined as a field of study that helps computers to understand the content of the digital images such as photographs and videos.

The purpose of computer vision is to understand the content of the images. It extracts the description from the pictures, which may be an object, a text description, and three-dimension model, and so on. For example, cars can be facilitated with computer vision, which will be able to identify and different objects around the road, such as traffic lights, pedestrians, traffic signs, and so on, and acts accordingly.

Human eyes provide lots of information based on what they see. Machines are facilitated with seeing everything, convert the vision into numbers and store in the memory. Here the question arises how computer convert images into numbers. So the answer is that the pixel value is used to convert images into numbers. A pixel is the smallest unit of a digital image or graphics that can be displayed and represented on a digital display device.



The picture intensity at the particular location is represented by the numbers. In the above image, we have shown the pixel values for a grayscale image consist of only one value, the intensity of the black color at that location.

**2.** **Tkinter Frame Work**:

Python provides various options for developing graphical user interfaces (GUIs). Most important are listed below.

* **Tkinter** − Tkinter is the Python interface to the Tk GUI toolkit shipped with Python. We would look this option in this chapter.
* **wxPython** − This is an open-source Python interface for wxWindows
* **JPython** − JPython is a Python port for Java which gives Python scripts seamless access to Java class libraries on the local machine

There are many other interfaces available, which you can find them on the net.

## Tkinter Programming

Tkinter is the standard GUI library for Python. Python when combined with Tkinter provides a fast and easy way to create GUI applications. Tkinter provides a powerful object-oriented interface to the Tk GUI toolkit.

Creating a GUI application using Tkinter is an easy task. All you need to do is perform the following steps −

* Import the *Tkinter* module.
* Create the GUI application main window.
* Add one or more of the above-mentioned widgets to the GUI application.
* Enter the main event loop to take action against each event triggered by the user.

**LITERATURE SURVEY**

# **[1] TITLE:** Blood Cell Count using Digital Image Processing

**AUTHOR:** [Varun D Dvanesh](https://ieeexplore.ieee.org/author/37086531163); [Priya S. Lakshmi](https://ieeexplore.ieee.org/author/37542093300); [Kandluri Reddy](https://ieeexplore.ieee.org/author/37086531633); [Abirami S Vasavi](https://ieeexplore.ieee.org/author/37086531456)

**DESCRIPTION:**

# The basic aim of this paper is to find the RBC and WBC count using Digital Image Processing (DIP) from blood smear images captured through a compound microscope. This paper presents a method to digitally analyze the image of blood cells and find the RBC and WBC count values from the blood smear microscopic images. Plane Extraction of the microscopic images is done followed by edge detection and morphological filling operation. Circular Hough transform is performed for RBC count, whereas boundary is detected for WBC. The obtained results of the experiment are compared with lab reports and an accuracy of 91% is achieved for RBC while an accuracy of 85% is obtained for WBC.

# **[2] TITLE:** Implementation of Blood Cell Counting Algorithm using Digital Image Processing Techniques

# **AUTHOR**: [Vilas B. Inchur](https://ieeexplore.ieee.org/author/37088637490); [L. S. Praveen](https://ieeexplore.ieee.org/author/37086473273); [Preetham Shankpal](https://ieeexplore.ieee.org/author/38551370800)

# **DESCRIPTION:**

# Blood is a connective tissue with cellular components like RBC, WBC, and platelets. If the blood cells are below the standard range it leads to varies health diseases and hence proper blood cell counting technique plays importance in the pathology department. The most widely used method for counting blood cells is the microscopic technique which gives better results however, it takes more time to count the number of blood cells. Blood cell count using a digital image processing technique can be considered to automate the microscopic method and minimize the time taken by the conventional method. In this paper, a digital image processing technique is proposed to accurately count all the blood cells in a given slide with maximum accuracy. A method such as morphological operator, texture-based classification method and Circular Hough Transformation (CHT) used to count the RBC which gives accuracy around 90%. Similarly, Morphological Operator, Vegetation method, and Texture Object-Based classification are implemented to count the WBC and Platelet. However, Texture Object-Based classification method gave 100 % accuracy compared to Morphological Operator and Vegetation method. From the results discussed in this paper conclude that for RBC count using Circular Hough Transformation gives better result and WBC, platelets count using the Texture Object-Based classification method gives better results.

# **[3] TITLE**: An automatic red blood cell counting method based on spectral images

# **AUTHOR:** [Jingyi Lou](https://ieeexplore.ieee.org/author/37086085665); [Mei Zhou](https://ieeexplore.ieee.org/author/37085702586); [Qingli Li](https://ieeexplore.ieee.org/author/37403670300); [Chen Yuan](https://ieeexplore.ieee.org/author/37086089029); [Hongying Liu](https://ieeexplore.ieee.org/author/37085401657)

# **DESCRIPTION:**

# Blood cell analysis, including blood cell counting, is the key point for modern pathological study as well as medical diagnosis. Taking into account both resources and environment of the medical research, analyzing blood cells under the microscope, instead of dedicated blood cell analyzer, provides a more intuitive and convenient way for research uses. This paper aims to provide a method to count red blood cells (RBCs) automatically by analyzing blood cell images collected from a microscopic hyperspectral imaging system. The classification algorithms-spectral angle mappings (SAMs) and support vector machines (SVMs) are used to segment blood cell image. In order to identify RBCs in the image, a standard RBC model has been built to match RBCs in the segmentation results based on SAM classification algorithm. RBC counting results are therefore obtained from the identification and the counting accuracy reaches about 93%. For the sake of higher precision, an improved algorithm, using segmentation results based on SVM classification algorithm to screen the previous matching results, is proposed and the counting accuracy increases to about 98% after applying the improved algorithm.

# **[4] TITLE:** An improved methodology for blood cell counting

**AUTHOR:**  [Hemant Tulsani](https://ieeexplore.ieee.org/author/37085535547); [Rashmi Gupta](https://ieeexplore.ieee.org/author/37085525102); [Rajiv Kapoor](https://ieeexplore.ieee.org/author/37285355000)

**DESCRIPTION:**

# In this paper, we present an approach for counting blood cells during blood smear test. The approach presented in this paper eliminates the major problem of overlapping cells while counting by segmentation using morphological watershed transformation and regional maxima computation providing high degree of accuracy. Simulation results of counting red blood cells (RBCs), white blood cells (WBCs) and platelets in blood smear test images are also presented. The simulations are done in MATLAB

# **[5] TITLE:** Detection and counting of blood cells using image segmentation: A review

# **AUTHOR:** [Dixit Kolhatkar](https://ieeexplore.ieee.org/author/37085878822); [Nisha Wankhade](https://ieeexplore.ieee.org/author/37085882502)

# **DESCRIPTION:**

# In medical field blood testing is considered to be one of the most important clinical examination test. In clinical laboratory counting of different types of blood cells is important for physician to diagnose the diseases in particular patient. Manual microscopic inspection of blood cells is time consuming and requires more technical knowledge. Therefore there is a need to research for an automated blood cell detection system that will help physician to diagnose diseases in fast and efficient way. Many researchers have done their research for counting blood cells using different methodologies. This paper reviews different methodologies that have been used for blood cell counting. The objective is to study these methodologies and identify future research direction in order to get more accuracy.

# **[6] TITLE:** Identification and red blood cell classification using computer aided system to diagnose blood disorders

**AUTHOR:** [Vasundhara Acharya](https://ieeexplore.ieee.org/author/37086291772); [Preetham Kumar](https://ieeexplore.ieee.org/author/37086289999)

**DESCRIPTION:**

# Red blood cell count plays a vital role in identifying the overall health of the patient. Mature Red blood cells undergo morphological changes when blood disorder exists. Automated and Manual techniques exist in the market to count the number of RBCs(Red blood cells). Manual counting involves the use of Hemocytometer to count the blood cells. The conventional method of placing the smear under a microscope and counting the cells manually leads to erroneous results and medical laboratory technicians are put under stress. Automated counters fail to identify abnormal cells. A computer aided system will help to attain precise results in less amount of time. This research work proposes an image processing technique to separate the Red blood cell from other components of blood. It aims to examine and process the blood smear image, in order to support the classification of Red blood cells into 11 categories. K-Medoids algorithm which is robust to external noise is used to extract the WBCs from the image. The granulometric analysis is used to separate the Red blood cells from White blood cells. Feature extraction is done to obtain the significant features that help in classification. The classification results help in diagnosing the diseases like Sickle Cell Anemia, Hereditary Spherocytosis, Normochromic Anemia, Iron Deficiency Anemia, Megaloblastic Anemia and Hypochromic Anemia within few seconds.

# **[7] TITLE:** Determination of blood components (WBCs, RBCs, and Platelets) count in microscopic images using image processing and analysis

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**DESCRIPTION:**

Blood is one of the most essential parts of the human body, and it comprises of the RBCs, WBCs, and Platelets. Complete blood count characterizes the condition of well-being. Hence, segmentation and identification of blood cells is very important. Up to this day, many hospitals and health centers still use the old conventional method which involves manual counting of blood cells. This technique is time-consuming and prone to erroneous outcomes. On the other hand, there are some costly machines like Hematology Analyzer, which health centers cannot afford. This paper presents a raspberry-pi based image analysis system that is designed to segment and count blood cells from microscopic images of blood using Hue, Saturation, and Value (HSV) thresholding method and connected component labeling, respectively. Detection and counting of RBCs, WBCs, and Platelets have been done on ten microscopic images. Statistical analysis was performed to compare the values measured by the proposed system to the actual complete blood count test result of each patient. It shows that the proposed system has a 90% and up accuracy with respect to the actual CBC tests result. In addition, an android application was also developed to aid the user, especially those who are in rural areas, in assessing the number of blood cells, and to send the results from GUI to a doctor or specialist through short message service (SMS) for remote diagnosis.