Chapter 1

Introduction

Automated Sickle Cell Anaemia Detector (A.S.C.A.D.) is a software application that diagnoses 'Sickle Cell Anaemia' (drepanocytosis) from microscopic images of the patient's blood smear. It uses advanced image processing techniques to analyze the shape of 'Red Blood Cells' which are primary indicators of the disease. Our ultimate goal however, lies in automation of the pathological examinations, thereby expediting the process of differential diagnosis.

1.1   Description

A red blood cell in normal physiological condition, is circular in front view and bi-concave in side view. Sickle cell anaemia is a hereditary blood disorder which primarily presents itself with high propensity for red blood cells to assume a cresentic or sickle-like shape.

When the patient provides microscopic image of his/her blood sample to A.S.C.A.D, it uses edge detection algorithms to scan for the presence of abnormally shaped red blood cells in it. The A.S.C.A.D then proceeds to compare the ratio of normal RBC count to sickle shaped RBC count. A decision considering a threshold is then made to arrive at the conclusion to whether the patient is anaemic or not. The application also provides a detailed report of its result for further diagnostic purposes if required. It also provides appropriate recommendations based on it.

1.2   Problem Formulation

Sickle cell anaemia affects about 300,000 children born each year, of which, tropical regions, particularly sub-Saharan Africa, India and the Middle-East witness much higher epidemiological occurrence [1]. According to studies, about 8–22% of Indians have this disease most of which remains untreated, especially in rural backgrounds [2].

In sickle celled disease, the abnormally shaped RBCs have a lower haemoglobin function. This results in anaemia and other complications such as sickle cell crisis, haemolytic crisis, cholelithiasis, increased risk of infection, pulmonary hypertension, hypospleenism, renal failure, stroke and consequentially an increased risk of death. Many of these complications of can be mitigated and prevented to a large extent with vaccination, preventative antibiotics, blood transfusion, etc. Early detection of the disease thus becomes the pivotal antecedent in not only improving the patient's longevity but also the overall health standard of our nation.

1.3   Motivation

Despite onus being on detection of sickle celled disease, we are yet to see an automated screening test for it. Typically for a patient admitted in a medical environment, consideration of sickle cell anaemia as the likely cause depends on his symptoms, which usually varies in case of this disease. Furthermore, its confirmed diagnosis occurs only after an extensive and manual laboratorial examination of the patient's blood. As seen above, an outward manifestation of the disease to an extend that requires hospitalization, further prolonged by manual blood tests, are often needed before we even begin treatment of this already-fatal disease. In such cases, not only that the mitigation and prevention techniques are now out of question but also going forward, the impetus shifts from a preventive care to a suppressive treatment regimen. Thus an automated screening system and such a screening healthcare programme is imperative for us. This provided the motivation for developing A.S.C.A.D which allows simple, quick and inexpensive method of screening.

1.4   Proposed Solution

In U.K., new born babies are screened for sickle cell anaemia manually. Such a programme is more essential in India where the prevalence of the disease is much higher. But owing to the time and expenditure required in manual blood screening of every individual, such a practice is not followed in India.

A solution to this lies in the use of image processing. From a microscopic blood smear image, one can filter out all the components in the human blood other than the RBCs and determine a relative numeric value for each RBC that will help us in estimating its shape and decide whether it is normal or not. Thus, the software can be used to diagnose sickle cell anaemia from a microscopic image with high accuracy. A.S.C.A.D is such diagnostic software.

Microscopic Image Aquisition → Filtering & Enhancing → Processing → Metric Calculation → Decision Making
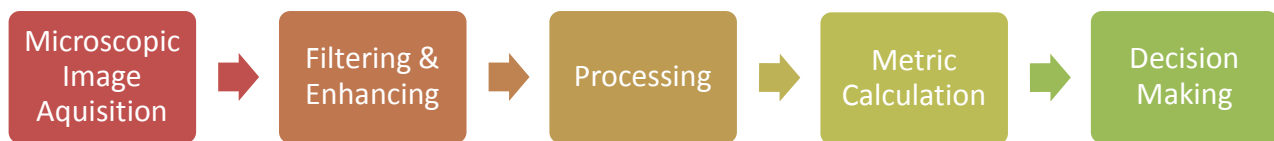
Fig 1.4.1 Proposed solution block diagram

A.S.C.A.D provides a solution that is not just fast and inexpensive, but also can be easily incorporated into routine blood-work performed at birth. It also expedites the diagnosis of sickle cell anaemia in adult patients, by circumventing the lengthy manual blood examinations. Additionally, it resolves the possibility of human-induced error that may occur during manual testing.

1.5   Scope of the project

The scope of the whole project will be solely on software domain. A.S.C.A.D will directly accept microscopic image as a file input. An arrangement that allows a microscope embedded with an image capturing device to directly feed real-time images would be the ideal use of A.S.C.A.D. However, integration of this software onto a microscope will be beyond the scope of this project owing to the local unavailability of such hospital-grade microscopes and unavailability of real-time anaemic patient and his/her blood to test on. Images from the internet will be used as experimental data to test the software.