Malaria Parasite Detection: Automated Method Using Microscope Color Image

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ABSTRACT

Healthcare Delivery Systems are becoming overloaded in developing countries like India and China. It is imperative that more efficient and cost-effective processes are employed. One such requirement is the automatic detection of malaria parasites in stained blood smears. Malaria is a mosquito-borne infectious disease. Each year Malaria kills between one and three million people. The most conventional and gold standard test for the confirmation of the Malarial diagnosis is the peripheral blood smear examination. The paper investigates and develops an automated malaria diagnostic system based on the color image processing using Hue, Saturation & Intensity (HSI) model. The algorithm is designed to identify only parasites inside red blood cells (erythrocytes) to avoid false positive results. The workflow process has enabled practical tele-pathology by allowing e-collaboration between lesser skilled technicians in rural areas and experts in urban areas, cutting down the total turnaround time for diagnosing malaria from days to minutes.

Keywords: Hue-Saturation-Intensity-Histogram, Image Segmentation, Malaria Parasites, Microscopic Image Analysis, ROI

1. INTRODUCTION

The healthcare industry in India which comprises of hospital and allied sectors is projected to grow 23% per annum to touch US$ 77 billion by 2012 from the current estimated size of US$ 35 billion (Rs. 1610 Billion) in 2009. The central and state governments are responsible for the provision of primary healthcare in the country. A spending of 1% of the GDP (effectively about Rs. 1050 per capita) on public health is not only dismally low but most of the expenditure is on staff salaries leaving little for facilities, drugs and other consumables. There are always more patients than can be looked after and more healthy people to be monitored in order to minimize the risk of being ill. Hence intelligent systems are always necessary for increasing efficiency in healthcare sector. Using information technology efficient systems of healthcare delivery can be created to improve the quality of healthcare and make it more affordable.

Globally, 247 million clinical episodes of malaria are estimated to occur every year. Malaria impacts 109 countries and territories around the world caused by four species of parasites and transmitted by multiple mosquito
vectors. In addition to its health toll, malaria puts a heavy economic burden on endemic countries and contributes to the cycle of poverty people face in many countries. For example, it is estimated to have in Africa alone contemporaneous costs of at least US$12 billion per year in direct losses (e.g. illness, treatment, premature death), but many times more than that in lost economic growth.

The estimated economic loss due to malaria in India from 1990-1993 is $506.82 million to $630.82 million (Sharma, 1996c). India has spent up to 25% of its health budget on malaria control from 1977-1997, and starting in 1997, India planned to spend $40 million on malaria control, a 60% increase from the previous year. This expenditure is part of a five year program aimed to target 100 districts where 80% of all P. falciparum cases occur (Jayaraman, 1997). According to Dhingra et al. (1998), 70-80% of the malaria control money in India is spent on insecticides.

Considering that malaria is a dreaded infection prevalent mostly in economically backward regions, an automated system for detection of malaria parasites in peripheral blood smear will be very useful. Such a system also reduces the workload of medical experts and improves the turnaround time for test reports.

Our objective is to provide a cost effective means by which routine blood test for malaria parasite detection may be automated. Specifically, the system should be affordable, practical and usable in current day rural environments and locations where mass screening is done. As such, some of the important aspects to be addressed are:

- a) The system should be usable by technicians in diagnostic laboratories / hospitals.
- b) Response times should be quick enough to cater to practical needs of the diagnostic laboratories.
- c) Absence of an obvious indication of malaria to be indicated clearly.
- d) Possible presence of an indication of malaria to be flagged by the system for further analysis by an expert – thereby optimizing expert’s time.

Our objective is not to replace an expert but to optimize the usage of valuable time on patients where expert’s opinion is crucial. This paper discusses briefly about malaria disease, covers the current methods of malarial diagnosis with a comprehensive literature survey, describes the techniques and methods used for this research, tabulates the results followed by discussions on the results achieved and finally provides insights to future research work.

2. MALARIA

Malaria is an infectious disease caused by a parasite, Plasmodium, which infects red blood cells. Malaria is a febrile illness characterized by fever, flu-like illness including shivers and related symptoms. C. Laveran in 1880 was the first to identify the parasites in human blood. In 1889, R. Ross discovered that mosquitoes transmitted malaria.

All the clinical features of malaria are caused by the erythrocytic schizogony in the blood. The growing parasite progressively consumes and degrades intracellular proteins, principally hemoglobin, resulting in formation of the ‘malarial pigment’ and hemolysis of the infected red blood cell (RBC). This also alters the transport properties of the red cell membrane and the red cell becomes more spherical and less deformable.

Four species of malaria that affect human beings are Plasmodium Falciparum, Plasmodium Vivax, Plasmodium Ovale and Plasmodium Malariae. Of the four common species that cause malaria, the most serious type is Plasmodium falciparum malaria. It can be life-threatening. Clinical symptoms that identify malarial risk suggest malaria as a diagnosis. The classic and most used diagnostic test for malaria is the blood smear on a microscope slide that is stained (Giemsa stain) to show the parasites inside red blood cells. Other tests based on immunologic principles exist; including RDTs (rapid diagnostic tests) and polymerase chain reaction (PCR) tests.
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