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Detection of Plasmodium Parasites from Images of Thin Blood Smears using Artificial Neural Networks

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Abstract

Despite all the efforts of all associations and health organizations around the world, the infections and deaths from the malaria disease are remain high, especially in the developing countries. Accurate and correct diagnosis of malaria helps in getting the appropriate treatment. This paper contains a design for automatic diagnostic system for malaria using Artificial Neural Networks (ANNs). Different image samples negative and positive were collected, and then ANN was designed and trained on it. The ANN type was Elman network and it achieved excellent performance in the test.

1. Introduction

Malaria is one of the biggest problems that threat the public health in the world, especially in the developing countries. The World Health Organization’s World Malaria Report for the year 2012 showed that there were about 207 million cases of malaria and 627 cases of deaths. The death ratio in Africa alone was nearly 91%. The organization's report for the year 2013 indicates that there were about 3.4 billion people live in areas that Infected with malaria [1].

Keywords: Malaria Parasite; ElmanNetworks; Graphical User Interface (GUI), Computer Aided Diagnosis (CAD).

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The World Health Organization recommends confirming a high-quality malaria diagnosis before starting treatment [2]. Diagnosis of malaria is usually done using a microscope and / or antigen-based rapid diagnostic tests (RDT) [3,4], but the microscope is the most widely used in the diagnosis [5].

Microscopic examination results accuracy depends on the skill of the person doing the examination and the parasite levels in the blood [5]. Drop in these factors leads to a wrong diagnosis, which undermines confidence in the health care systems and contributes to the body's resistance to drugs [6].

Computer Aided Diagnosis (CAD) can be useful in helping laboratory doctor and ensuring get a high accuracy diagnosis. Hirimutugoda et. al [7] were designed a three layer Back-propagation neural network for classify malaria, Thalassemia and other abnormalities in the blood. The classification accuracy was about 86.54%. Daniel Maitethia [8] was developed a system based on ANNs for diagnosing malaria using microscopic images of stained blood samples. Classification accuracy of 95.0 % was achieved.

2. Methods

The main aim of this work is to design an automatic diagnostic system for malaria parasite detection using Artificial Neural Networks (ANNs), since it have high capability in pattern classification and recognition. So it was used here for recognizing samples that contain malaria parasite from that clear from it. The block diagram in figure1 below shows the diagnostic steps that were considered.

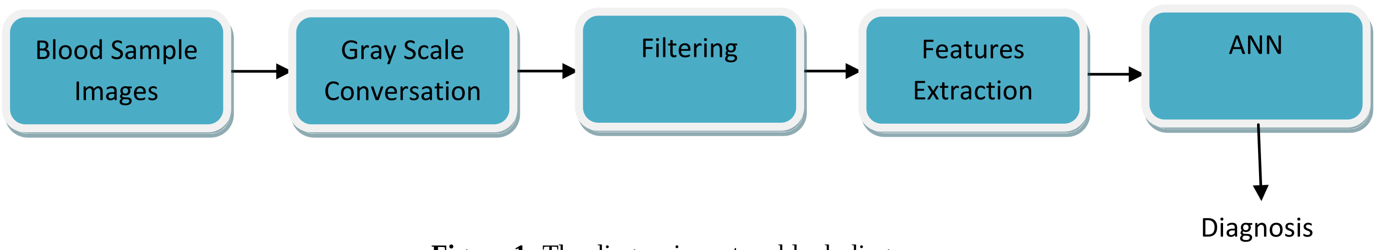

Figure 1: The diagnosis system block diagram

A dataset from different medical online databases and for different parasite life stages were collected, and then divided to training and testing data. The number of the total samples is 110 samples, 80 samples for training and 30 samples for the test. Figure 2 shows some of the samples.

Then each sample was pre-processed, features extracted using Harlick features [9], and used to complete the training data file for the neural network. The type of ANN which used here is Elman neural network with three layers and 10 neurons in the hidden layer. Figure 3 shows the designed network and Figure 4 shows the network performance during the training stage.

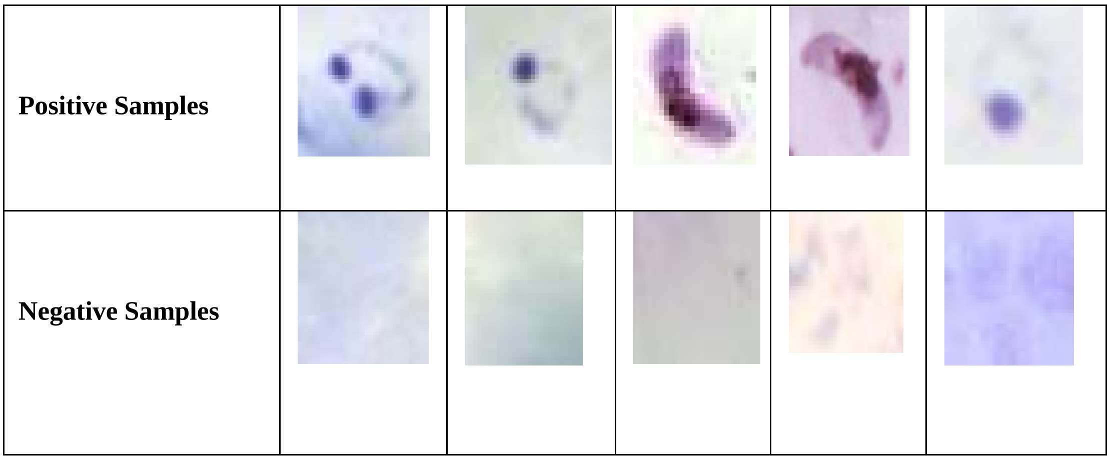

Figure 2: Training samples

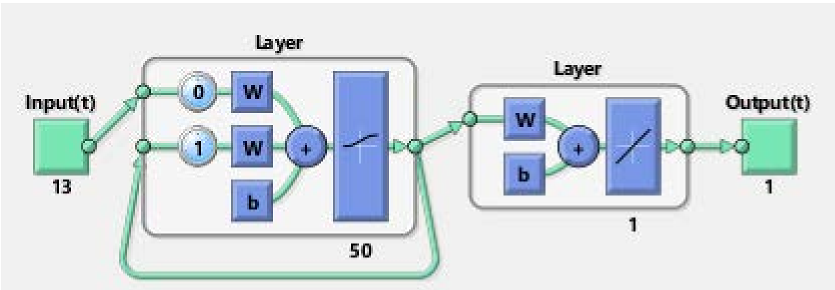

Figure 3: The designed Elman network architecture

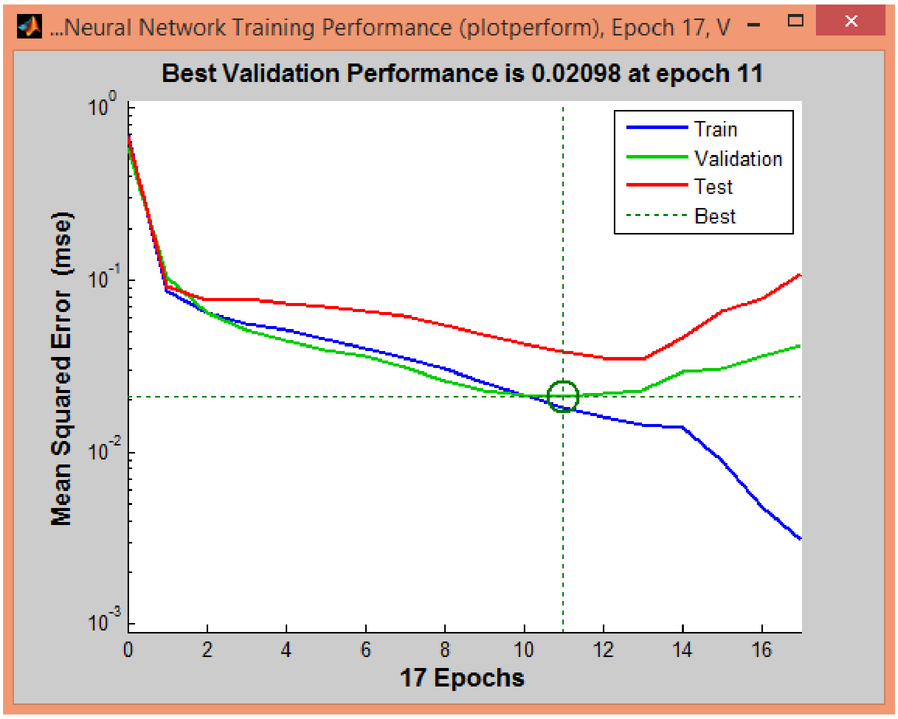

Figure 4: The network performance error during the training

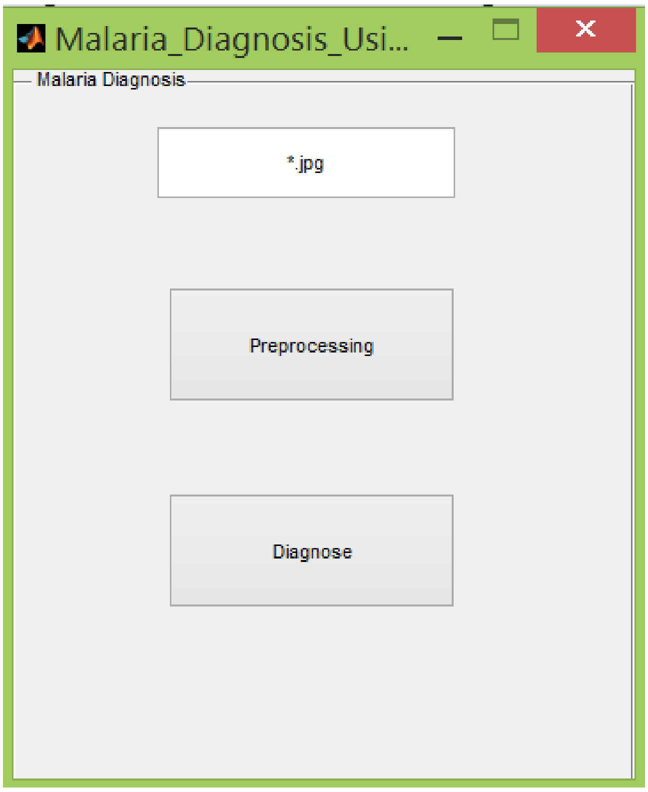

Figure 5: The diagnosis system GUI

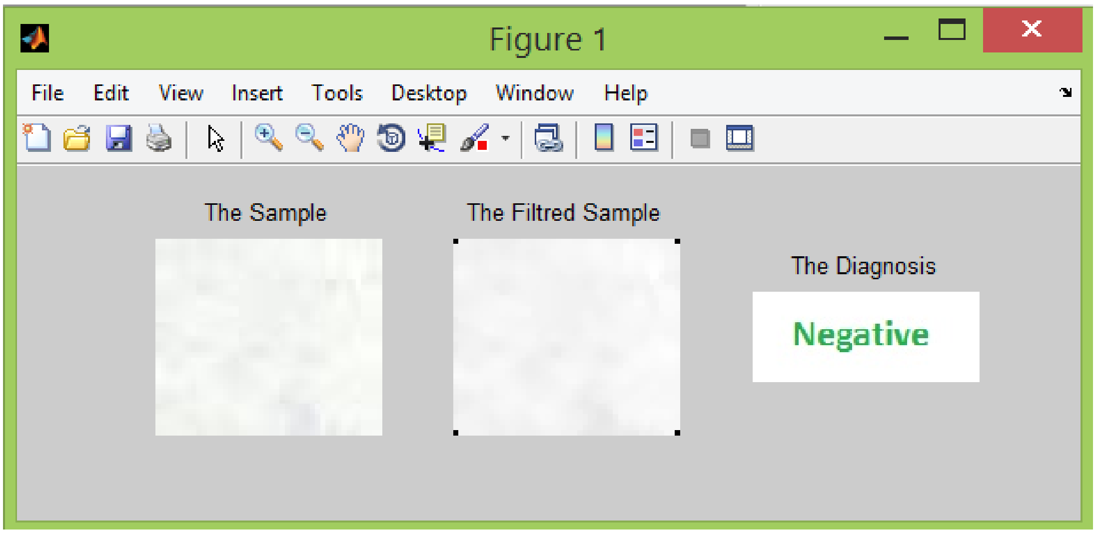

Figure 6: Real execution result for a negative sample

3. Results and Discussion

A Graphical User Interface (GUI) was designed using Matlab program to facilitate using the system. Figure 5 shows the GUI window for the system, while figures 6 and 7 show the execution results for two samples;

negative (no malaria parasite appearance) and positive respectively.

As it seen from figures 6 and 7; the obtained diagnosis from our system is matches the clinical results.

Finally the ANN performance ratio was calculated using the following equation:

$$Performance\ ratio\ \% = \frac{Correct\ Samples}{Total\ Samples} \times 100\%$$

The designed Elman network achieved a performance ratio of about 98% in the test.

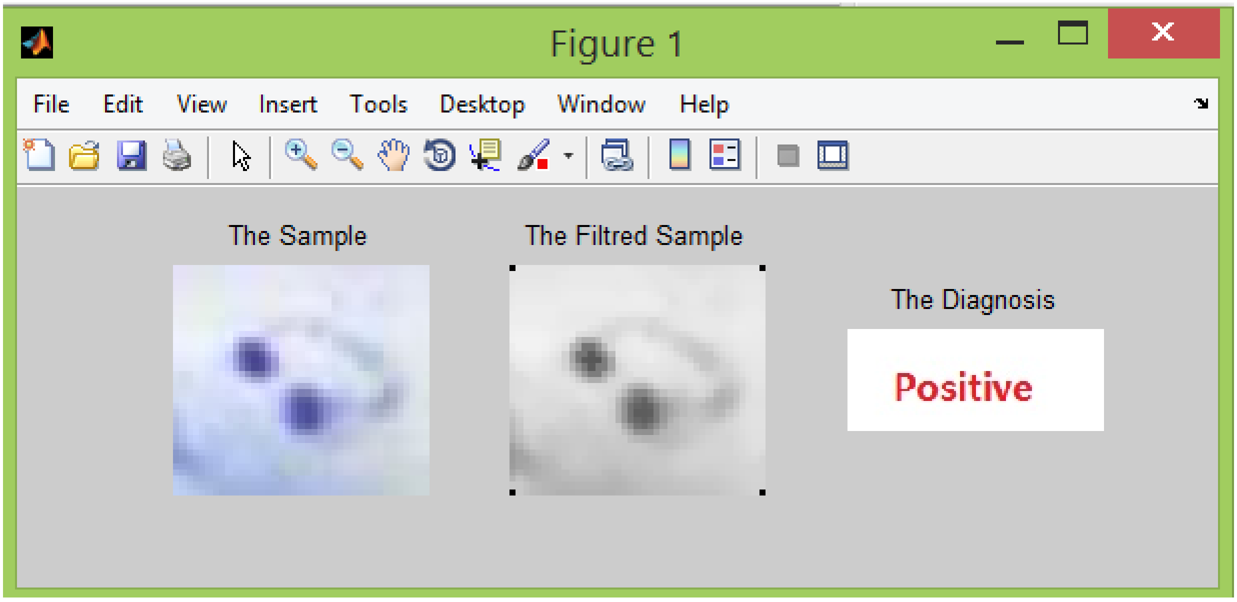

Figure 7: Real execution result for a positive sample

4. Conclusion

Artificial Neural Networks can be used sufficiently for the medical diagnosis purpose which may give very effective and intelligent laboratory devices. Our proposed ANN gives excellent results and can be used in real environment for malaria parasite detection in any of its life stages.

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