Deep Convolutional Neural Network Model for Optical Microscopic Automated Diagnosis of Plasmodium Falciparum Parasites in Sub-Saharan Africa.

Chikodili Ugwuishiwu 1, Charles Ikerionwu 2, Osondu Oguike 1, Izunna Okpala 3, Matthew Okoronkwo 1, Charles Nnadi 4, Ugochukwu Orji 1, Anthony Ike 5

1 Department of Computer Science, University of Nigeria, Nsukka, Enugu State, Nigeria. 2 Department of Software Engineering, Federal University of Technology, Owerri, Nigeria. 3 Department of Information Technology, University of Cincinnati, USA. 4 Department of Pharmaceutical and Medicinal Chemistry, University of Nigeria, Nsukka, Nigeria. 5 Department of Microbiology, University of Nigeria, Nsukka, Nigeria

INTRODUCTION

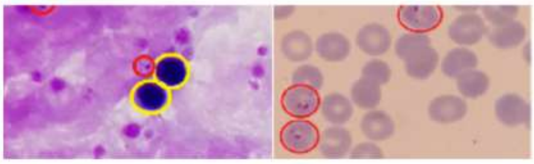
This work focuses on automating malarial diagnosis using machine learning method. Malaria is a life threatening disease caused by plasmodium parasites that is transmitted to humans through the bites of infected female Anopheles mosquitoes in the form of sporozoites [1]. Plasmodium falciparum is the most severe strain form of the disease among the five species of plasmodium parasites, and millions of people are infected annually, with a greater number of the infected population having a high risk of inevitable death, especially in the tropical zones of the world [2]. The standard practice in malaria diagnosis is a schematic examination of a blood smear under microscopy for the presence of the malaria parasite in the human red blood cells [3]. Popular traditional diagnostic approaches include nucleic acid sequence-based amplification, urine malaria tests, and saliva-based test for Plasmodium protein detection [4]. The traditional approach is time-consuming, highly tedious, and accuracy of result depends on the level of competence of the Parasitologists. This research is motivated by the effort to eliminate or minimize human expertise intervention in the malarial diagnostic process.

MAJOR GOAL

The research aims to adopt Deep Convolutional Neural Network (CNN) to locally generated, low-cost, portable optical microscopic blood films for automation of P. falciparum parasite detection in the red blood cells.

PROJECT DESCRIPTION AND METHOD

The researchers propose to source automated microscopic blood films (see figure 1, acquired with a digital camera or smartphone) from both private and public clinical parasitology laboratories within Nigeria. We would use the primary data to train our proposed model to predict and classify these blood films (erythrocytes) as infected or uninfected using the steps as described in figure 2. The work is at the stage of data collection and we hope to commence the actual research soon.



a) Thick blood smear b) Thin blood smear

Figure 1: Examples of thick and thin blood smears. Red circles are parasites and yellow circles are white blood cells [5].

Summarily, the proposed algorithm focus on the standard microscopic procedure of parasite identification through light microscopy inspection of stained blood smears, as recommended by the WHO. They goal to automate and classify infected and uninfected following the four steps depicted in figures.

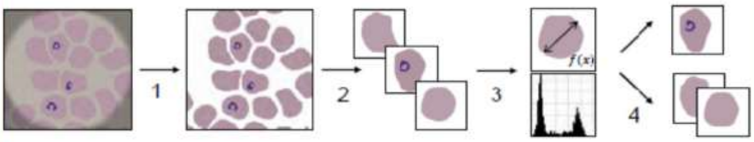


Figure 2: Schematic representation of the basic image analysis pipeline followed by most (traditional) automated malaria diagnosis algorithms, the numbers underneath the arrows refer to the four operations in this pipeline; 1) preprocessing, 2) segmentation, 3) feature extraction and 4) classification [6].

CONCLUSIONS AND IMPLICATIONS

The proposed model is expected to show that early detection of the malaria parasite has the potential to improve patient's survival through the application of deep CNN and as well reduces the involvement of trained human experts in malaria diagnosis process. Hence, the computational approach to malaria diagnosis helps to eliminate the limitations of the traditional approaches.

REFERENCES

[1] Afoma Mbanefo and Nirbhay Kumar. Evaluation of malaria diagnosticmethods as a key for successful control and elimination programs.Tropical Medicine and Infectious Disease, 5(2):102, 2020.

[2] Oboh, M. A., Singh, U. S., Ashmi, H. A., Ndiaye, D., Badiane, A. S., Ali, N. A., & Das, A. (2018). Molecular epidemiology and evolution of drug-resistant genes in the malaria parasite Plasmodium falciparum in southwestern Nigeria. Infection, Genetics and Evolution, 66, 222-228. 2018. 10.1016/j.meegid.2018.10.007.

[3] Shekar, G., Revathy, S., & Goud, E. K. (2020, June). Malaria detection using deep learning. In 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI)(48184) (pp. 746-750). IEEE.

[4] Courosh, M., Jaiswal, M., Delahunt, C., Thompson, C., Horning, M., Hu, L., ... & Bell, D.(2017). Computer-automated malaria diagnosis and quantitation using convolutional neural networks. In Proceedings of the IEEE international conference on computer vision workshops (pp. 116-125).

[5] Noor van Driel (2020). Automating malaria diagnosis: a machine learning approach Erythrocyte segmentation and parasite identification in thin blood smear microscopy images using convolutional neural networks, Master of Science Thesis. http://resolver.tudelft.nl/uuid:2db4839e-7c68-4536-895e-13e51821c9a9

[6] Yang, Feng & Poostchi, Mahdieh & Yu, Hang & Zhou, Zhou & Silamut, Kamolrat & Yu, Jian & Maude, Richard & Jaeger, Stefan & Antani, Sameer. (2019). Deep Learning for Smartphone-Based Malaria Parasite Detection in Thick Blood Smears. IEEE Journal of Biomedical and Health Informatics. PP. 1-1. 10.1109/JBHI.2019.2939121.