Executive summary-health category

Development of Robotic Microscopy for rapid and cost-effective malaria diagnosis

Malaria is one of the most serious public health challenges globally, despite current therapeutics having high efficacy rates when administered timely. Most concerning is that the fight against malaria has stalled. There were 230 million cases in 2015 (the baseline year of the global technical strategy for malaria 2016-2030) and 247 million cases in 2020. The barrier to malaria eradication is the lack of early diagnosis of the infected population. Current malaria diagnostics can be classified into three categories with specific strengths and weaknesses: 1) highly sensitive molecular-based techniques which use PCR. These are slow and demand the use of sophisticated equipment, expensive reagents, and a highly trained workforce; 2) Rapid Diagnostic Tests (RDTs) are relatively fast in comparison to optical microscopy but less sensitive (100-200 parasite μL^{-1}). Besides, the majority of them target the *Plasmodium falciparum* histidine-rich protein 2 *(pfhrp-2*) biomarker, and recent studies have shown the deletion of *pfhrp-2* which causes false negatives and threatens malaria control strategies. 3) Optical microscopy, the gold standard method for diagnosis. This involves examining stained blood smear samples under a microscope. It can detect up to 5-20 parasite μL^{-1}, however, the results vary significantly based on the expertise of the technician or health care provider, and it is labor and time intensive.

None of the three methods offers a definitive solution to early detection. Prompt treatment is crucial in preventing severe illness, complications, and deaths associated with malaria. To boost the fight against malaria, new approaches for diagnostics must be adopted to enhance the sensitivity, accuracy of detection besides being rapid and affordable. While research and development efforts are ongoing to improve and develop these and other malaria diagnostic methods, microscopy (the gold standard method for diagnosis) is likely to remain a vital tool in malaria diagnosis due to its proven effectiveness, cost-effectiveness, and established specialists in many malaria-endemic regions. Therefore, we think offering a solution within microscopy will likely offer a faster way to integrate new techniques in malaria diagnosis. Enhancing early screening and reducing the disease burden.

In this study, we propose to develop an affordable robotic configuration for imaging malaria by detecting the presence of hemozoin (Hz). Affordable, open-source, 3D-printed microscope like OpenFlexure microscope (OFM) will be modified to incorporate magneto-optic imaging capability. Leveraging on the magneto-optical physical properties of malaria pigment Hz, we will develop a phase-locked mode combining magneto-optical control, thus fully exploiting the Hz features to maximize sensitivity. To allow full automation of the detection assay, we will use a classification algorithm to accurately identify and categorize malaria-infected cells from the microscopy images. We can thus overcome the limitations of traditional microscopy and improve malaria diagnostics in terms of accuracy, efficiency, and accessibility.