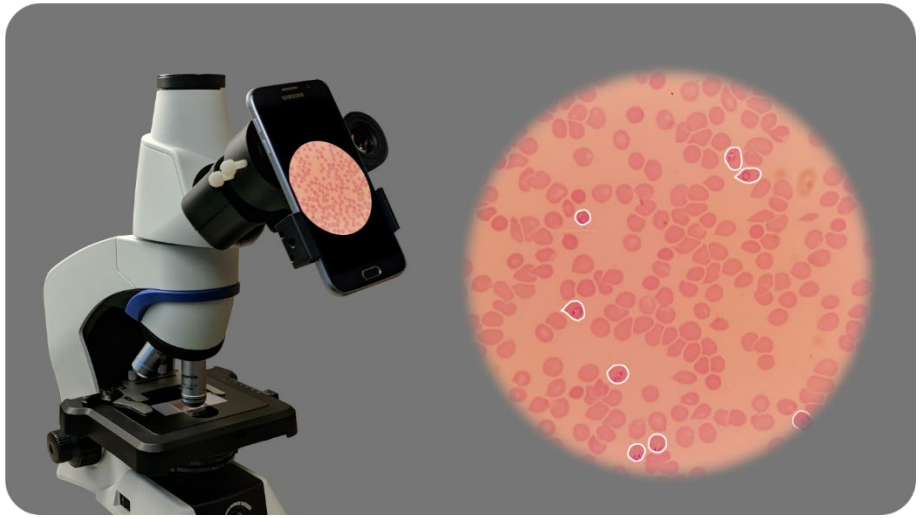
Automatic Blood Smear Analysis with Artificial Intelligence and Smartphones



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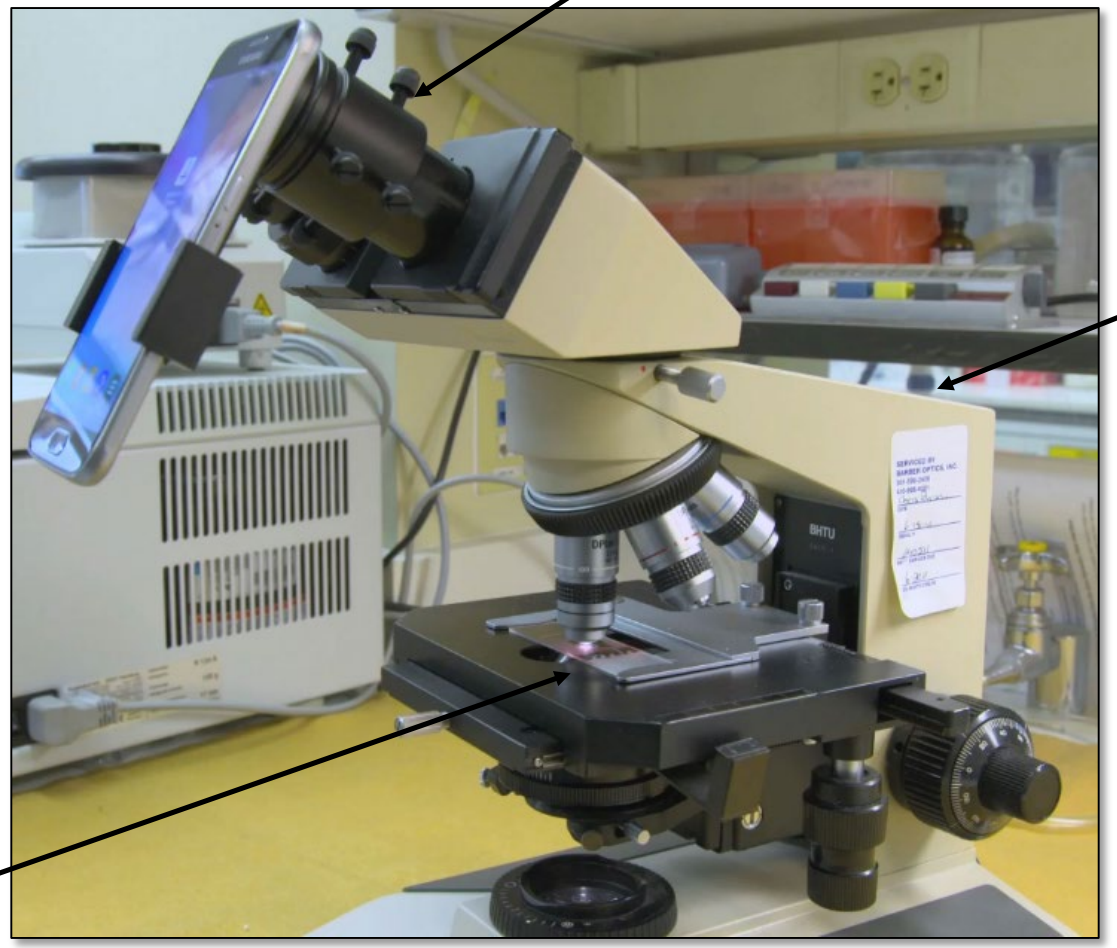
NIH U.S. National Library of Medicine
Lister Hill National Center for Biomedical Communications

Malaria Microscopy

- Accuracy depends on skill of technician
- Time consuming (10-30 minutes per slide); millions of tests per year worldwide

Using Artificial Intelligence to count cells and to detect parasites automatically.

NLM MalariaScreener – Smartphone App

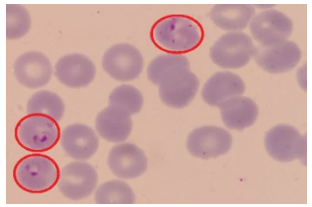


Big Training Data

P. falciparum

Thin smears:

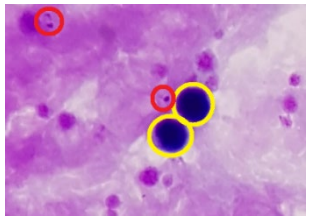
- ❑ 2508 images from 200 patients (150 infected / 50 uninfected)
- ❑ 1315 images with cell annotations
- ❑ 250,000+ red blood cells labelled



https://lhncbc.nlm.nih.gov/publication/pub9932

Thick smears:

- ❑ 2961 images from 200 patients
- ❑ 84,961 annotated parasites
- ❑ 62,148 annotated white blood cells



ftp://lhcftp.nlm.nih.gov/Open-Access-Datasets/Malaria/Thick_Smears_150.

P. vivax

Thin smears:

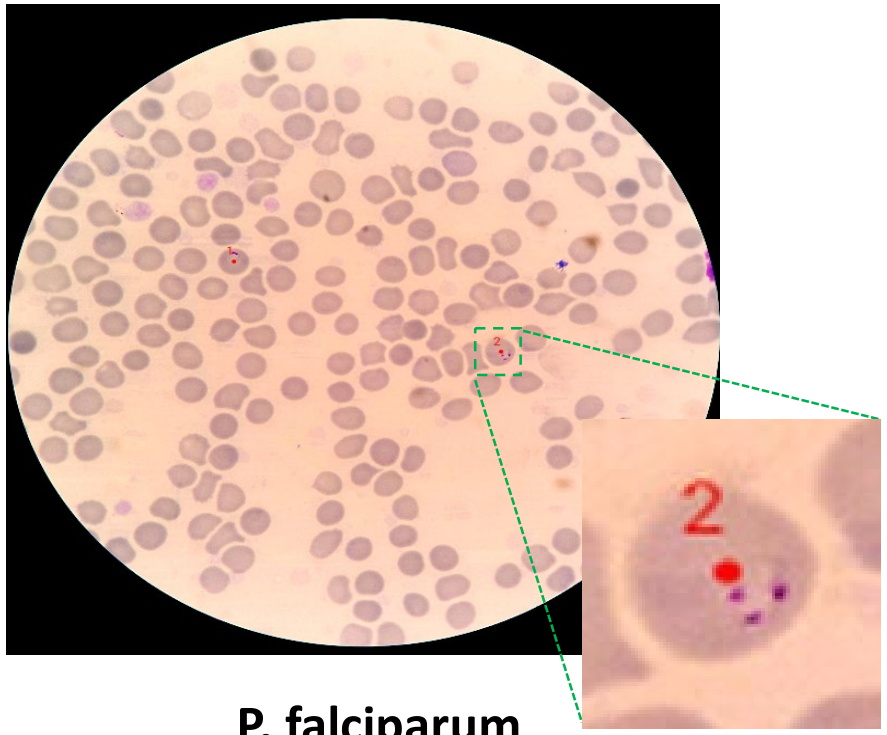
- ❑ 171 patients, 2567 annotated images
- ❑ 4336 infected cells

Data to be published

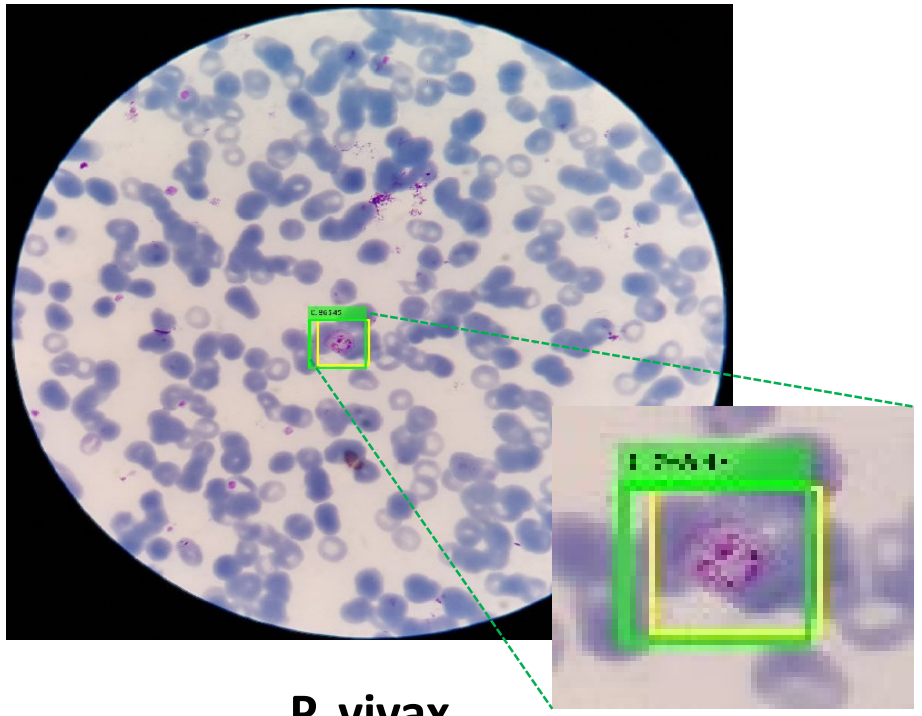
Thick smears:

Data acquisition in progress

Experimental results - Thin blood smears



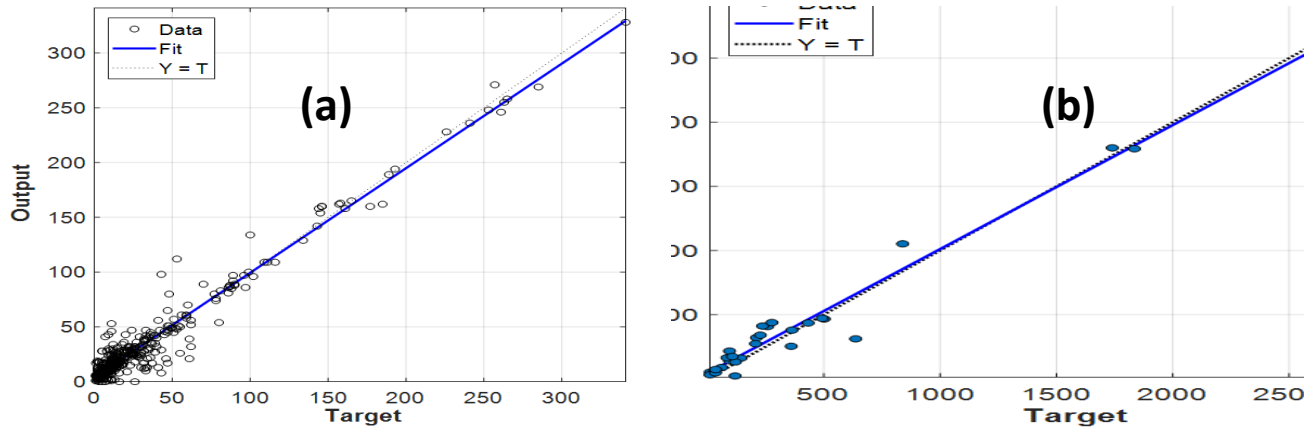
P. falciparum



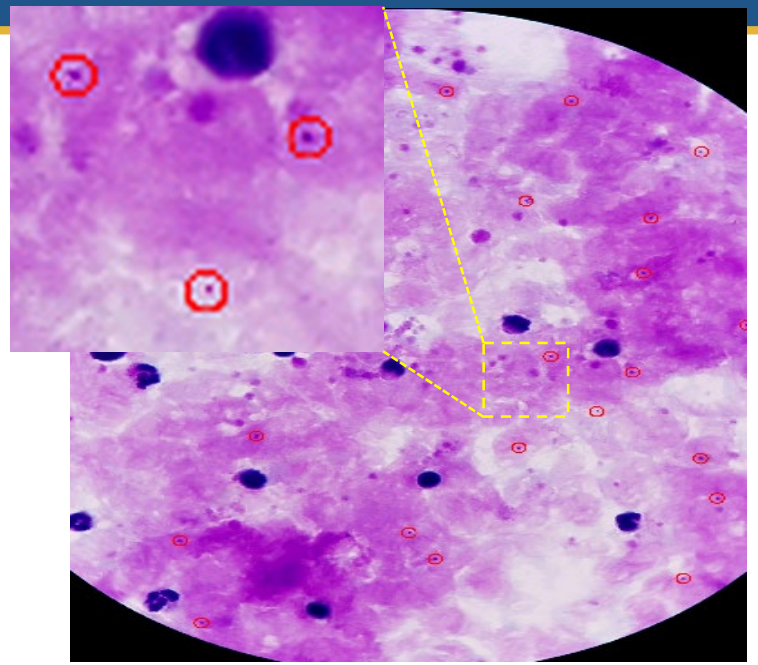
P. vivax

- Poostchi Mahdieh, et al., *Malaria parasite detection and cell counting for human and mouse using thin blood smear microscopy, Journal of Medical Imaging* 5, no. 4 (2018): 044506.
- Feng Yang, et al., *Cascading YOLO: Automated Malaria Parasite Detection for Plasmodium Vivax in Thin Blood Smears*, to be presented at SPIE Medical Imaging, Feb.18-20, 2020, Houston, USA.

Experimental results - Thick blood smears



Linear regression on image level (a) and patient level (b), Corr. Coef. > 0.98



P. falciparum

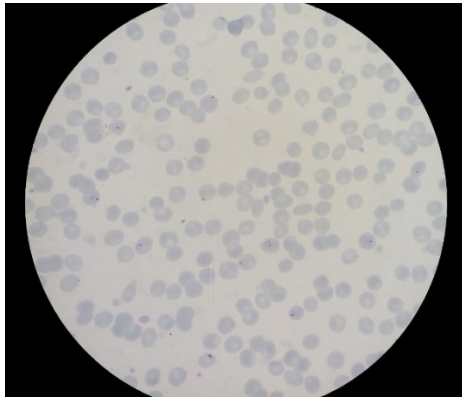
Evaluation on parasite patch level

Method	Accuracy	F1	Specificity	Sensitivity	Precision	AUC
Mean	93.46	93.40	94.33	92.59	94.25	98.39
Std	0.32	0.33	1.25	1.27	1.13	0.18

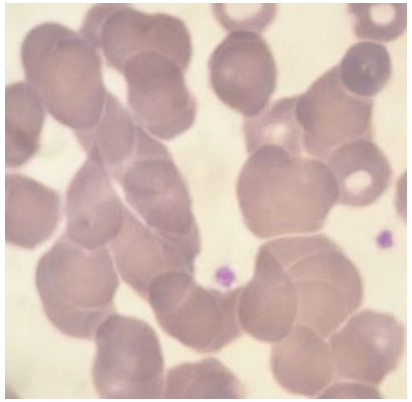
The average processing speed per image is around 10s on a Samsung Galaxy S6.

Feng Yang et al., ***Deep Learning for Smartphone-based Malaria Parasite Detection in Thick Blood Smears***, *IEEE journal of biomedical and health informatics*, IEEE J Biomed Health Inform. 2019 Sep 23. doi: 10.1109/JBHI.2019.2939121.

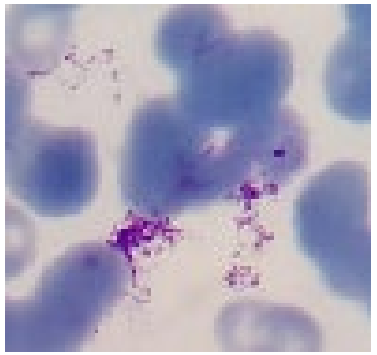
Challenges



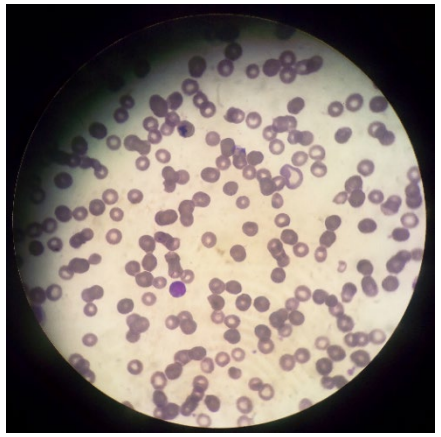
- Low image contrast



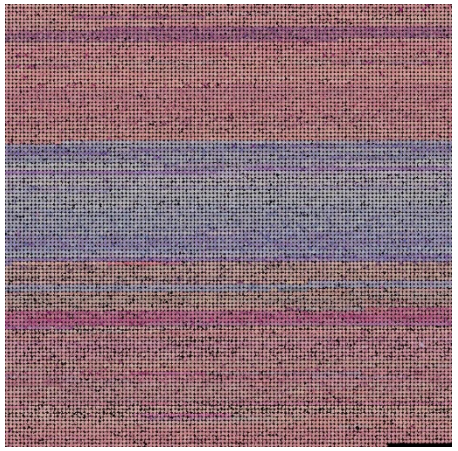
- Clustered cells



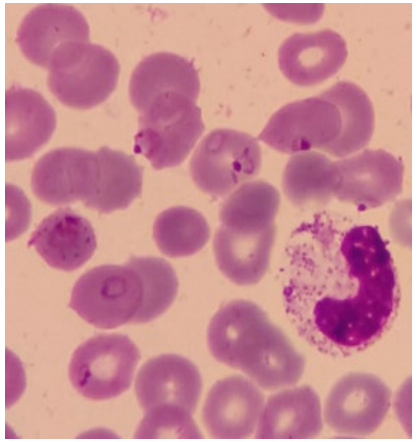
- Staining artifacts



- Uneven illuminations



- Staining variations

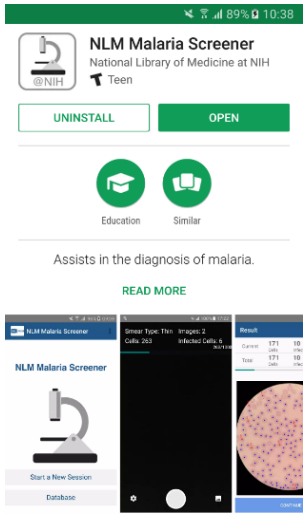


- Texture variations

Collaborate with us

1. Get equipment

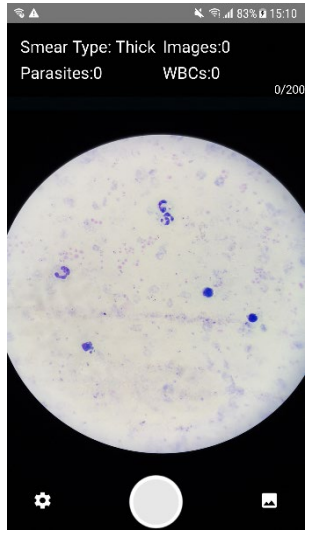
- Microscope with 100X objective lens
- Android smartphone with 12+ Mega Pixel camera.
- Adapter



2. Email us

- Email us to join the beta test group

hang.yu@nih.gov



3. Take images

- Uses the app to take images of 10+ thin or thick smears with manual counts.

*No personal data will be collected

Official app coming soon ***early 2020***!

Acknowledgment

- Md Amir Hossain
  Chittagong Medical College Hospital, Chittagong, Bangladesh
- Wendy O' Meara
  School of Medicine, Duke University, USA
  Moi University, Eldoret, Kenya
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  University of Veterinary and Animal Sciences, Lahore, Pakistan

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