Smartphone-Supported Automated Malaria Parasite Detection

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Outline

- Background on malaria diagnosis
- Our deep learning based App for malaria parasite detection
  - On thin blood smears
  - On thick blood smears
- Experimental results
- Conclusion
Malaria is a life-threatening disease.

According to the 2017 WHO malaria report, an estimated 216 million malaria cases worldwide were detected in 2016, causing approximately 445,000 deaths.

There are several techniques for malaria diagnosis:

- **Rapid Diagnostic Test (RDT)**
  - Species-specific
  - Not quantitative
  - Stay positive after treatment

- **Microscopy**
  - Gold standard: Quantitative
  - Less expensive
  - Time taken for manual diagnosis: 10-30 minutes
Background (2/2)

Thin smear
- differentiate parasite species
- detect parasite development stages
- automatic parasite counting

Thick smear
- detect the presence of parasites
We are developing an Android smartphone app for malaria parasite detection.
Available in Google Play.
Methods (2/4) -- Our NLM Malaria Screener App

NLM Malaria Screener

Start a New Session

Database

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**Result**

- **Current**
  - Cells: 168
  - Infected Cells: 2
- **Total**
  - Cells: 168
  - Infected Cells: 2

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**Result**

- **Current**
  - Cells: 219
  - Infected Cells: 12
- **Total**
  - Cells: 387
  - Infected Cells: 14

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**Result**

- **Current**
  - Cells: 255
  - Infected Cells: 14
- **Total**
  - Cells: 642
  - Infected Cells: 28

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**Summary Report**

- **Patient ID**: 5
- **Initial**: SJ
- **Gender**: Male
- **Age**: 42

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**Slide Info**

- **Slide ID**: 1
- **Site**: Chittagong Hospital
- **Time**: 3/28/2017, 2:41
- **Parasitemia**: 126004 Parasites/μL

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**Patient Info**

- **Patient ID**: 5
- **Gender**: Male
- **Initial**: SJ
- **Age**: 42

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Next
For thin blood smears:

- We customize a CNN classifier for parasite detection based on
  - 7 convolutional layers
  - 2 max-pooling layers
  - 3 dense layers.
For thick blood smears:

- We propose a customized CNN model for parasite classification. Our customized CNN model consists of three convolutional layers, three max-pooling layers, two fully-connected layers and a softmax classification layer.
Experimental results (1/3) - Data

- Images were acquired at Mahidol-Oxford Tropical Medicine Research Unit (MORU), Bangkok, Thailand.
- Manually annotated by an experienced parasitologist
- Thin blood smears: 1200 images from 200 patients
  - Annotated 213,000 cells
- Thick blood smears: 1818 images from 150 patients
  - Annotated 84,961 parasites
  - Annotated 35,036 WBCs
Experimental results (2/3) – Thin blood smears

- Evaluation on thin blood smears is performed based 10-fold cross-validation;
- The accuracy of our customized CNN model in discriminating between parasites and distractors in thick smears is 94.53%;
- Evaluation on thick blood smears is performed based 5-fold cross-validation;
- The accuracy of our customized CNN model in discriminating between parasites and distractors in thick smears is 93.32%.
Experimental results (3/3) – Thick blood smears

- **Ground-truth Parasites**
- **True Preselected parasites**
- **False Preselected parasites**
Conclusion

- Deep learning is an accurate and reliable model for malaria parasite classification on both thin and thick blood smears
- A trained CNN classifier can be run efficiently on a mobile device

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Thanks for your attention!