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
Methods (1/4) -- Our NLM MalariaScreener App

- We are developing an Android smartphone app for malaria parasite detection
- Available in Google Play
Methods (2/4) -- Our NLM Malaria Screener App

The NLM Malaria Screener app is designed to assist in identifying infected cells in a sample. The app provides a summary report and slide information for each analysis session. The process includes:

1. **Start a New Session**: Begin by selecting a new session to start the analysis.
2. **Database**: Access the database to store and manage patient information.
3. **Summary Report**: Review the patient ID, initial, gender, age, total cell count, infected cell count, and parasitemia. For example, with a total cell count of 642 and 28 infected cells, the parasitemia is 126604 Parasites/μL.
4. **Slide Info**: Check the slide ID, time, site, and any additional slide information.
5. **Patient Info**: Enter and save patient information, including gender and age.

The app provides a visual interface for analyzing samples, with results displayed in real-time. This tool is particularly useful in healthcare settings for rapid identification of malaria infection.
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
- 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!