Malaria Detection using Deep learning Technique Application

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Abstract

The application transforms malaria diagnosis by utilising the capability of the deep learning algorithm known as the VGG19 model. The application uses convolutional neural networks (CNNs) to distinguish between parasitized and non-parasite cells by examining microscopic pictures of dyed red blood cells. This novel technology greatly lowers the margin of error associated with conventional diagnostic techniques while simultaneously speeding up the detection procedure. Its user-friendly interface makes it possible for researchers and medical professionals to get accurate results fast, enabling timely and efficient treatment. The application is proof of the potential of artificial intelligence to improve malaria detection and management.

1. Problem Statement

Malaria is a disease spread by mosquito bites from female Anopheles mosquitos. Humans become infected with many mosquito parasites as a result of bites. These include Plasmodium Oval, Plasmodium malaria, Plasmodium vivax, and Plasmodium falciparum.

According to the 2020 World Malaria Report [1], these parasites are responsible for an anticipated 229 million malaria infections and 409,000 deaths globally. Early diagnosis is critical for successful therapy. However, manually examining blood smears for malaria parasites takes time and requires great effort and expert people.

An app for malaria detection from blood smear images using deep learning techniques would be more efficient and valuable. Due to some great performance of deep learning techniques that can be:

- Compared to traditional techniques and feature based approaches, deep learning requires no segmentation or handmade features, delivering an end-to-end solution
- It can discover hierarchical features.

The main problem that can solved using this app is that the application would be accessible to healthcare workers, researchers, and individuals in identifying malaria infections in the regions where resources are limited.

2. Market /customer Need assessment

- The app should streamline the diagnostic process, reducing the time spent on manual microscopy or RDT interpretation.
- A user-friendly interface is essential, especially for field workers with varying levels of technical expertise. The app should work offline and sync data later in remote areas with limited connectivity.
- Seamless integration with laboratory workflows and patient management systems is crucial.
- Patients want an app that detects malaria early, allowing timely treatment and preventing complications.
- The app should be accessible to individuals in rural or underserved regions.
- Patients expect their health data to be handled securely and confidentially.
- Information about malaria prevention, symptoms, and treatment can empower patients.

- Health authorities need accurate data for surveillance and monitoring. The app should facilitate real-time reporting.
- Aggregated data can help track outbreaks, identify high-risk areas, and allocate resources effectively.

3. Target Specifications and Characterization

- Patients, healthcare providers, and field workers in malaria-endemic regions.
- Develop the app for both Android and iOS to maximize reach.
- Allow users to upload blood smear images on the application
- The app would identify malaria parasites (Plasmodium species) and classify the blood smear as either infected or uninfected.
- After analyzing the blood smear image, the app would provide an immediate risk assessment:
- "Infected" or "Uninfected."
- If infected, the app can offer additional information like Mild, moderate, or severe infection.
- Recommendation treatment like Antimalarial drugs, dosage, and duration.
- Security of user data and protect patient privacy.
- Locating nearby clinics or hospitals for further evaluation.
- Educate users about malaria prevention, symptoms, and treatment.

4. External Search:

- https://ceb.nlm.nih.gov/repositories/malaria-datasets/
- https://www.kaggle.com/datasets/iarunava/cell-images-for-detecting-malaria
- **https://www.mdpi.com/2100666**

[1] World Health Organization. WHO Malaria Policy Advisory Group (MPAG) Meeting: Meeting Report; April 2021; World Health Organization: Geneva, Switzerland, 2021.

5. Bench marking alternate products:

Microscopy:

Traditional Method: Examining blood smears under a microscope is the gold standard for diagnosing malaria.

Limitations: It needs experienced technicians, can take a long time, and there's a chance that a mistake by a person could result in false negatives.

Quick Diagnostic Tests (RDTs):

Usefulness: RDTs don't require laboratory space and are easy to use, yielding findings fast. - Challenges: They could provide false negative results and be less accurate than PCR or microscopy, particularly in situations when there is a low parasite density or hrp2 gene deletion.

High Sensitivity: Polymerase Chain Reaction (PCR) has a high degree of sensitivity and may identify even minute parasite concentrations.

Complexity: It is less accessible in field settings since it needs specialized workers and advanced equipment.

In comparison with all these techniques application is more efficient as

- It makes use of artificial intelligence (AI), which may be able to identify malaria from blood pictures quickly and accurately.
- Scalability: The software can be readily scaled up and used in remote places without the requirement for specialized personnel, unlike microscopy and PCR.
- User-Friendly: Compared to sophisticated methods like PCR, an app with an intuitive user interface may be easier for medical professionals to use.
- Continuous Improvement: As more data is gathered and the model is further trained, the app's diagnostic skills can be further enhanced.

6. Applicable Regulations:

While developing an app for medical purposes, an app that includes the analysis of blood smear images using deep learning techniques for the detection of malaria. It is important to stick to some of the regulations that ensure patient safety, and data security, and it is according to healthcare standards. Some of the regulations that are applicable are:

- Accordingly, the app recommends medicine to the patients the government imposes rules following the" **Drugs and Cosmetics Act 1940**" in India.
- **Software as Medical Device (SaMD) Regulations**: In India, software used for diagnosis or treatment is considered a medical device and is subject to the Medical Device Rules, 2017. This involves getting certifications such as ISO 13485:2016 for quality management systems and ISO 14971:2019 for risk management of medical devices2.

7. Applicable constraint

- The apps should be designed to work on resource-constrained bias, especially in regions with limited access to high-end smartphones or computers.
- The app must be optimized to run efficiently on bias with varying processing capabilities.
- The app's memory footmark and storehouse conditions, as some bias may have limited RAM and storehouse space.
- Connectivity and Offline Operation Internet Access In areas with poor connectivity, the app should serve offline or with minimum reliance on the Internet.
- The apps should support multiple languages to feed to different regions' populations.
- Secure Data Transmission using encryption when transmitting sensitive data (e.g., patient information) to help unauthorized access.

8. Business model

- Provide a no-cost version of the application that includes fundamental functionalities such as symptom checker and access to health education resources. This tier serves as an introductory offer to the app's capabilities and helps in building a broad user base.
- Offer a value-added, subscription-based enhanced tier that boasts expedited diagnostic results, bespoke wellness advice, and comprehensive health monitoring features. This premium service caters to users seeking a more customized health management experience.
- Integrate carefully selected, nondisruptive advertisements within the application. Establish partnerships with advertisers in the health and wellness sector to ensure that the advertisements are pertinent and beneficial to the users.
- Leverage the data aggregated by the application to produce insightful reports detailing the patterns of diseases, treatment modalities, and health trends across different regions. These reports can be instrumental for health research and policymaking.
- Having strategic alliances with medical institutions such as clinics and hospitals to incorporate the application into their service offerings. In exchange, implement a model based on licensing fees or profit sharing.
- Explore avenues for obtaining financial support from public health departments, nonprofit organizations, or global health bodies. Such funding can bolster the app's development, especially during its nascent phase or when expanding into new territories.

9. Concept Generation

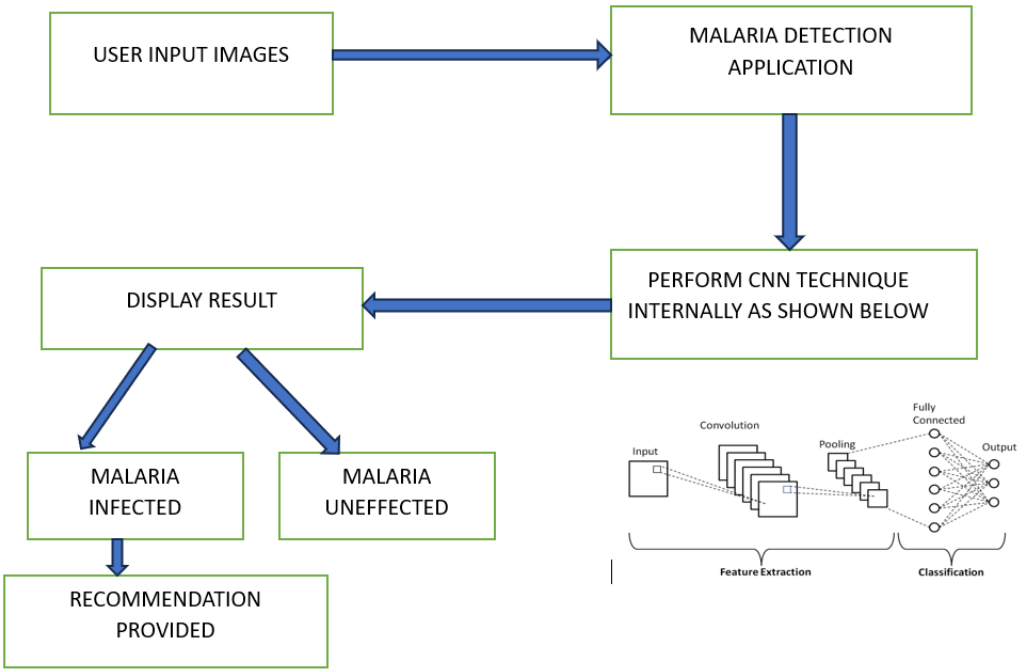
Acknowledge the difficulty in diagnosing malaria worldwide, particularly in areas with poor access to healthcare services. Choose the VGG19 model, renowned for its ability to identify images, to distinguish between healthy and contaminated blood cells. Create an intuitive app interface that medical professionals may use with little or no training. Incorporate functionalities like patient history tracking, result saving, and diagnosis-based health advice. Collaborate with organizations and healthcare providers to conduct field testing and validate the efficiency of the app.

10. Concept Development

- Develop a user-friendly interface that allows users to easily upload images and view results. Conduct user experience testing with a focus group of potential users, such as healthcare workers, to gather feedback on the app's usability and functionality.
- Add additional features based on user feedback, such as the ability to track patient history, integrate with electronic health records, or provide educational resources about malaria.
- Validate the accuracy of the app through clinical trials and verify that it meets all regulatory requirements for medical devices.
- Conduct a thorough market analysis to understand the competitive landscape, potential pricing strategies, and the best channels for distribution.

- Refine the business model to ensure sustainability. This could include finalizing the subscription model, advertising strategy, and partnerships with healthcare providers.
- Prepare for the launch of the app by developing a marketing strategy, setting up customer support, and ensuring the infrastructure is in place to handle user data securely and efficiently.

11. Final prototype



The final prototype of the malaria detection app should encapsulate the following features and functionalities, ensuring accuracy, usability, and impact:

- Clean and Intuitive design: A simple, user-friendly interface that guides users through the app seamlessly.
- Multilingual Support: Ensure the app can be used by speakers of various languages.
- Secure Login: Users can create accounts or log in securely.
- Personalized Profiles: Users can track their test history, receive notifications, and manage preferences.
- Image Analysis: Users can capture and upload images of blood smears or RDT results.
- Machine Learning Algorithms: The app analyzes images using VGG technique to detect malaria parasites.
- Rapid Results: Provide results within minutes, reducing the time for diagnosis.
- Offline Mode: The app works without internet connectivity, crucial for remote areas.
- Data Synchronization: When online, sync data with a central server for reporting and analysis.

- Symptoms and Prevention: Include information on malaria symptoms, prevention, and treatment.
- Health Tips: Provide personalized health advice based on test results.
- Data Sharing: Integrate with local health systems for reporting and surveillance.
- Health Worker Access: Allow healthcare professionals to access patient data securely.
- Data Encryption: Ensure user data is encrypted during transmission.
- Consent Management: Obtain user consent for data collection and sharing.
- User Feedback: Collect feedback to improve the app continuously.
- Scalable Architecture: Design the app to handle a growing user base.
- Regular Updates: Plan for ongoing maintenance, bug fixes, and feature enhancements.

12. Product details

How does it work?

The malaria detection application works by processing the blood smear image, given as input from the user. Then on the provided image, the app would apply CNN techniques like VGG19 after that delivers results and if the person is malaria-infected it gives recommendations accordingly.

Data Sources

It takes a variety of data from healthcare. The deployment of the internal model uses a dataset from Kaggle. The dataset contains 2 folders

- Infected
- Uninfected
  And a total of 27,558 images.

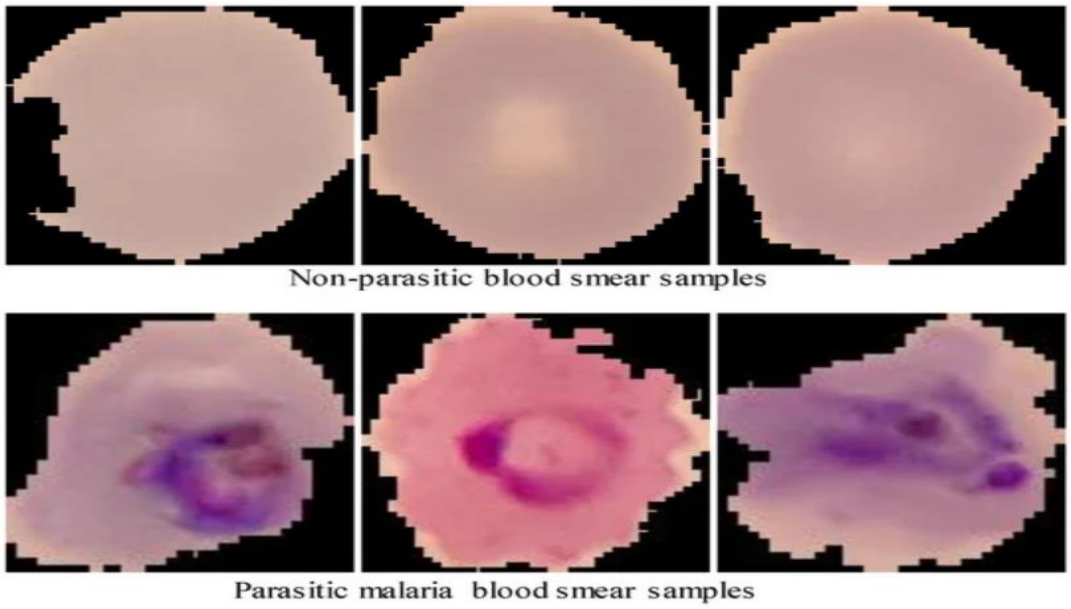


Fig 1. Images from dataset

Algorithms, Framework, Software, etc. needed:

The malaria detection application uses deep learning techniques such as CNN like VGG19. The frameworks like Keras and Flask are used The application is designed to be scalable and user-friendly.

Team required to develop:

- Mobile App Developers
- Blackened Developers
- Data Scientist
- UI/UX Designer

What does it cost?

This is a basic rough estimation

- Developing the core functionality, including image processing algorithms, user interface, and offline capabilities: ₹10,00,000 to ₹20,00,000.
- Creating and training deep learning models for accurate parasite detection: ₹5,00,000 to ₹10,00,000.
- Ensuring data security, privacy, and compliance with regulations: ₹2,00,000 to ₹5,00,000.
- Rigorous testing and bug fixing: ₹2,00,000 to ₹4,00,000.
- Launching and promoting the app: ₹1,00,000 to ₹3,00,000.
- Ongoing maintenance and feature enhancements: ₹1,00,000 to ₹2,00,000 per year.

13. Code implementation

```
# import the libraries as shown below

import numpy as np
from glob import glob
from PIL import Image
import matplotlib.pyplot as plt
from tensorflow.keras.models import Model
from tensorflow.keras.models import Sequential
from tensorflow.keras.models import load_model
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.vgg19 import VGG19
from tensorflow.keras.applications.resnet50 import preprocess_input
from tensorflow.keras.layers import Input, Lambda, Dense, Flatten,Conv2D
from tensorflow.keras.preprocessing.image import ImageDataGenerator,load_img
```

```
prediction = Dense(len(folders), activation='softmax')(x)

# create a model object
model = Model(inputs=mobilnet.input, outputs=prediction)
```

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator

train_datagen = ImageDataGenerator(rescale = 1./255,
                                   shear_range = 0.2,
                                   zoom_range = 0.2,
                                   horizontal_flip = True)

test_datagen = ImageDataGenerator(rescale = 1./255)
```

```
training_set = train_datagen.flow_from_directory('../input/cell-images-for-detecting-malaria/cell_images/cell_images',
                                                 target_size = (224, 224),
                                                 batch_size = 32,
                                                 class_mode = 'categorical')
```

```
test_set = test_datagen.flow_from_directory('../input/malaria-dataset/Dataset/Test',
                                            target_size = (224, 224),
                                            batch_size = 32,
                                            class_mode = 'categorical')
```

```
# loading the model

# model=load_model('./model_vgg19.h5')
```

```
[ ] # Taking random image and will see what our model predicts.

img=image.load_img('../input/malaria-dataset/Dataset/Test/Parasite/C39P4thinF_original_IMG_20150622_105803_cell_108.png',target_size=(224,224)
img
```

```
if(a==1):
    print("Uninfected")
else:
    print("Infected")
```

14. Conclusion

The user-friendly interface and user-centered design of the app guarantee a smooth experience while meeting the needs of its wide range of users. The software stands out in the market thanks to its cutting-edge features, which offer original answers to problems that arise in the real world. The app is a solid resource for customers who need efficiency and responsiveness because of its consistent performance and fast response times. All things considered, the software would benefit its users by increasing productivity and providing convenience at their fingertips.