A Hybrid Model for Retinopathy of Prematurity Stage III Disease Diagnosis

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Introduction

- Retinopathy of Prematurity (ROP) is an eye disease which affects newborn babies born after thirty-two weeks and or with a weight of less than 1.5kg (Palmer et al., 2021).
- A CNN containing 5 pretrained convolutional layers was built into blocks of five, with one pooling layer, three fully connected layer and a run of 20 epochs. Adam optimizer was used to manage the model weights.

Methodology

ROP Stages

Retinopathy of prematurity Stages (Tsi et al., 2021, P.10)

CNN Architecture

Image labelling and Resizing

- Open CV library was applied to resize images to sizes of 224x224 pixels.

Data Augmentation

- TensorFlow library was used to perform data augmentation.
- Image rotation range was set to 2, width shift to 0.05, height range shift to 0.05
- Zoom range to [0.85,1.15]. Vertical and horizontal flipping was enabled and set as “True” and fill mode set to nearest.
- Images used for training, testing and validation were randomly selected at a ratio of training=0.80, Testing=0.10, Validation=0.10 as shown in Table 1.

Table 1. ROP dataset for model training and testing.

<table>
<thead>
<tr>
<th>Disease Stage</th>
<th>Training Dataset</th>
<th>Testing Dataset</th>
<th>Validation Dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2</td>
<td>1232</td>
<td>154</td>
<td>154</td>
</tr>
<tr>
<td>Stage 3</td>
<td>1464</td>
<td>183</td>
<td>183</td>
</tr>
</tbody>
</table>

Results

- We customized the VGG19 and the S-Net models and compared their results with our model.
- Our model had the highest disease classification accuracy as shown in Table 2

Table 2. Model Comparison

<table>
<thead>
<tr>
<th>Model</th>
<th>Accuracy</th>
<th>Specificity</th>
<th>Sensitivity</th>
<th>Precision</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid model</td>
<td>92.8%</td>
<td>94.6%</td>
<td>97.3%</td>
<td>97.3%</td>
<td>0.98</td>
</tr>
<tr>
<td>VGG19</td>
<td>91.2%</td>
<td>97.5%</td>
<td>97.7%</td>
<td>90.8%</td>
<td>0.98</td>
</tr>
<tr>
<td>S-Net</td>
<td>88.2%</td>
<td>89.5%</td>
<td>95.6%</td>
<td>93.4%</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Conclusions

- This work accurately managed to diagnose the symptoms of ROP stage 2 and 3 however the following challenges were encountered:
  - Device inconsistency and low-quality images
  - Model training images, there is need for more images
  - Imbalanced data, we had to seek more images from a hospital in Kenya

References


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