A Hybrid Model for Retinopathy of Prematurity Stage III Disease Diagnosis

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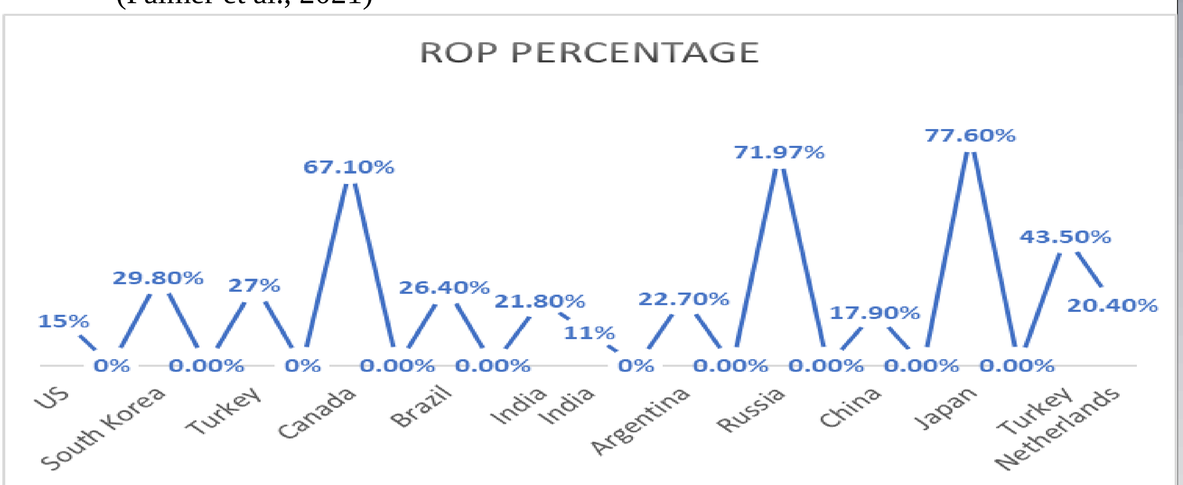
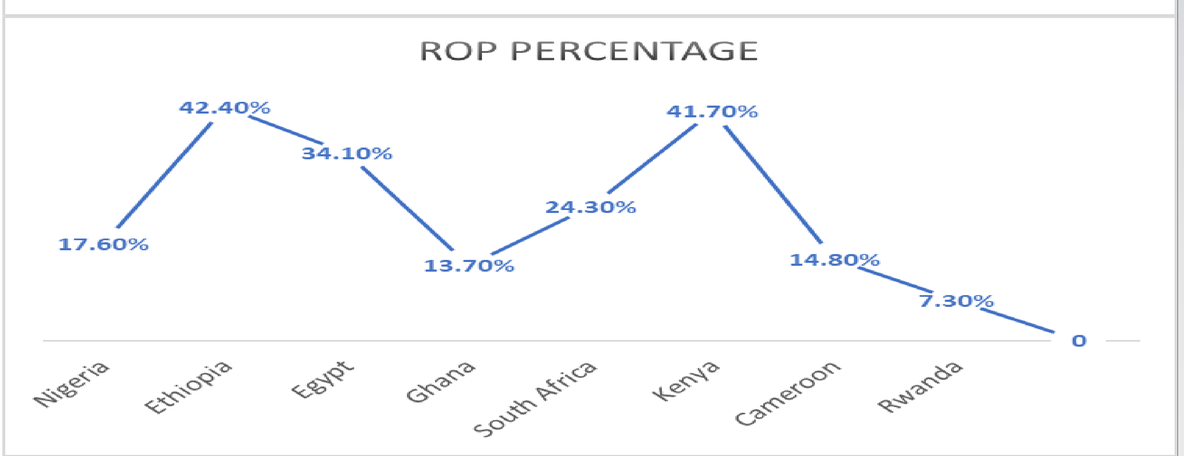
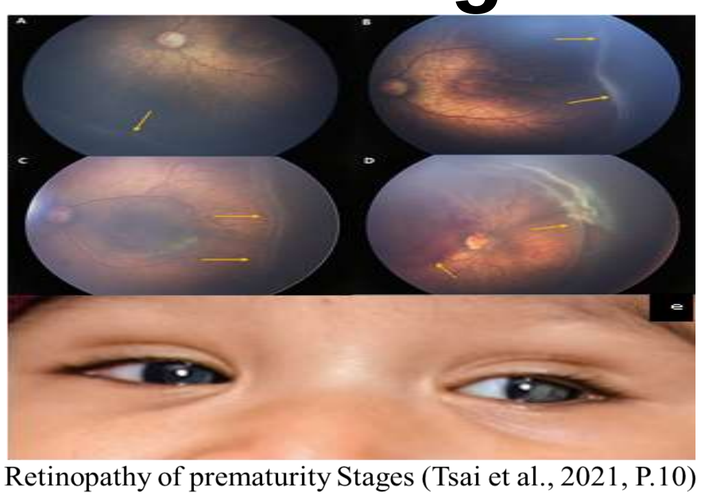
Introduction

- 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)



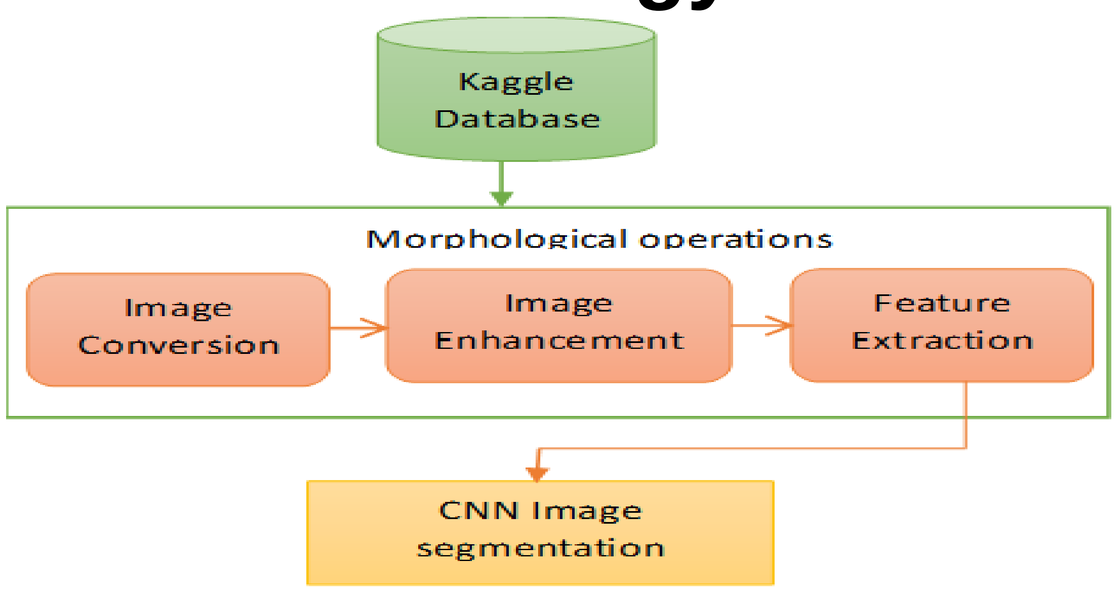


ROP Stages



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

Methodology



Data Set and Model Training

- Kaggle database 40 images with ROP stage II, 30 images with ROP stage III
- Private owned database of the eye Hospital in Kenya, we extracted 1500 images of ROP II and 1800 images ROP stage III.
- 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

CNN Architecture

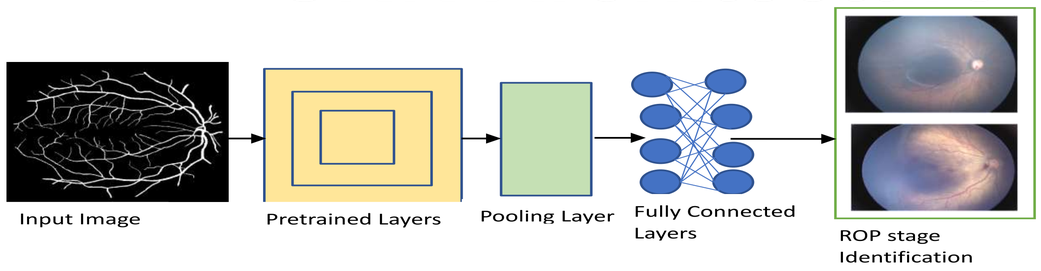


Image labelling and Resizing

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

Disease Stage	Training Dataset	Testing Dataset	Validation Dataset
Stage 2	1232	154	154
Stage 3	1464	183	183

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

Model	Accuracy	Specificity	Sensitivity	Precision	AUC
Hybrid model	92.8%	94.6%	97.8%	97.3%	0.98 %
VGG19	91.2%	97.5%	97.7%	90.8%	0.98
S-NET	86.2%	89.5%	95.6%	93.4%	0.89

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

1. Sabri, K.; Ells, A.L.; Lee, E.Y.; Dutta, S.; and Vinekar, A. (2022). Retinopathy of Prematurity: A Global Perspective and Recent Developments. *Pediatrics*. 2022. https://doi.org/10.1542/peds.2021-053924
2. Tsai, A.S.H.; Acaba-Berrocal, L.; and Sobhy, M. (2022). Current Management of Retinopathy of Prematurity. *Curr Treat Options Peds* 8, 246–261.2022. https://doi.org/10.1007/s40746-022-00249-8
3. Chan-Ling, T.; Gole, G.A.; Quinn, G.E.; Adamson, S.J.; and Darlow, B.A. (2017). Pathophysiology, screening, and treatment of ROP: a multi-disciplinary perspective. *Prog Retin Eye Res.* 62:77–119. 2018. https://doi.org/10.1016/j.preteyeres. 2017.09.002.
4. Agarwal, K.; and Jalali, S. (2018). Classification of retinopathy of prematurity: from then till now. *Commun Eye Health*. 31(101):S4–7. 2018.
5. Xu, S.; Liang, Z.; Du, Q.; Li, Z.; Tan, G.; and Nie, C. (2018). Systematic study on the prevention and treatment of retinopathy of prematurity in China. *BMC Ophthalmol*.18:44. 2018. doi: 10.1186/s12886-018-0708-3
6. Tsai, A. S.; Chou, H. D.; Ling, X. C.; Al-Khaled, T.; Valikodath, N.; Cole, E.; Yap, V. L.; Chiang, M. F.; Chan, R.; and Wu, W. C. (2021). Assessment and management of retinopathy of prematurity in the era of anti-vascular endothelial growth factor (VEGF). Progress in retinal and eye research, 101018.2021. Advance online publication. https://doi.org/10.1016/j.preteyeres.2021.101018

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