

**Project Report**



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**Report Title:**

**Enhancing Eye Disease Classification Accuracy Using CNN Architectures and Fine-tuning Strategies**

**Abstract:** This report presents an exploration into improving the accuracy of eye disease classification beyond the benchmark of 84% as outlined in the referenced paper <https://arxiv.org/pdf/2307.10501.pdf> Employing various Convolutional Neural Network (CNN) architectures and fine-tuning methodologies, this study investigates the impact of different model configurations on disease classification accuracy.

**Introduction:** The study aimed to build upon the existing research presented in <https://arxiv.org/pdf/2307.10501.pdf> which achieved an accuracy of 84% in disease classification using a specific CNN architecture. The primary objective was to investigate and implement diverse CNN architectures and fine-tuning strategies to surpass the established accuracy benchmark.

**Data Division for each Eye Disease:**

|  |  |
| --- | --- |
| **Eye Disease** | **Data mages available** |
| diabetic\_retinopathy | 1098 |
| Cataract | 1038 |
| Glaucoma | 1007 |
| Normal | 972 |

**Methodology:**

The research methodology encompassed several key stages:

1. **Dataset Utilization:** Utilized the same dataset as described in the referenced paper to maintain consistency in evaluation.
2. **Baseline Model Replication:** Replicated the baseline CNN architecture from the referenced paper.
3. **Exploration of CNN Architectures:** Experimented with different CNN architectures including SqueezNet, LeNet, Feedforward, DenseNet, and Metamodel.
   * **Results:** The LeNet model achieved an accuracy of 86%, outperforming other models.
4. **Fine-tuning Strategies:** Applied fine-tuning techniques such as layer adjustments and learning rate adjustments.
5. **Hyperparameter Tuning:** Conducted randomized search for optimal hyperparameters for each architecture and fine-tuning strategy.
6. **Training and Validation:** Models were trained using a defined train-test split or cross-validation strategy. Metrics like accuracy, precision, recall, and F1-score were monitored.
7. **Model Evaluation:** Compared the accuracy of different CNN architectures and fine-tuning strategies against the baseline model.

**Results:**

* The LeNet model emerged as the best performer, achieving an accuracy of **86%** in disease classification.
* Other models, including SqueezNet, Feedforward, DenseNet, and Metamodel, did not exhibit significant improvement over the **baseline accuracy of 84%.**

**Implementation Results and Comparisons**

**FIRST Attempt for CNN model**

**Table 1: Model Parameters**

| **Model** | **Total Parameters** | **Trainable Params** | **Non-trainable Params** | **Epochs** | **Optimizer** | **Loss Function** |
| --- | --- | --- | --- | --- | --- | --- |
| **Model 1** | 40146436 (153.15 MB) | 40146436 (153.15 MB) | 0 (0.00 Byte) | 10 | Adam | Categorical Cross entropy |
| **Model 2** | 123578564 (471.41 MB) | 123578564 (471.41 MB) | 0 (0.00 Byte) | 10 | Adam | Categorical Cross entropy |

**Table 2: Training Results**

| **Model** | **Final Training Loss** | **Final Training Accuracy** | **Final Validation Loss** | **Final Validation Accuracy** | **Test Loss** | **Test Accuracy** |
| --- | --- | --- | --- | --- | --- | --- |
| **Model 1** | 0.4457 | 0.8228 | 0.4961 | 0.8074 | 0.5944 | 0.7784 |
| **Model 2** | 0.4680 | 0.8069 | 0.4207 | 0.8474 | 0.5583 | 0.7986 |

**Testing Squeezenet Model:**

**Table 1: Model Parameters**

| **Model** | **Total Parameters** | **Trainable Params** | **Non-trainable Params** | **Epochs** | **Optimizer** |
| --- | --- | --- | --- | --- | --- |
| **Model 1** | 40146436 (153.15 MB) | 40146436 (153.15 MB) | 0 (0.00 Byte) | 10 | relu |
| **Model 2** | 724548 (2.76 MB) | 724548 (2.76 MB) | 0 (0.00 Byte) | 10 | relu |

**Table 2: Training Results**

| **Model** | **Loss Function** | **Final Training Loss** | **Final Training Accuracy** | **Final Validation Loss** |  | **Test Loss** | **Test Accuracy** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Model 1** | Categorical crossentropy | ~0.558 | ~80.69% | ~84.74% |  | ~0.558 | ~79.86% |
| **Model 2** | Categorical crossentropy | ~1.386 | ~23.95% | ~27.61% |  | ~1.386 | ~27.61% |

**Testing LENET Model:**

**Table 1: Model Parameters**

| **Model** | **Total Parameters** | **Trainable Params** | **Non-trainable Params** | **Epochs** | **Optimizer** | **Loss Function** |
| --- | --- | --- | --- | --- | --- | --- |
| **LeNet 1** | 4255256 (16.23 MB) | 4255016 (16.23 MB) | 240 (960.00 Byte) | 15 | Adam | Categorical Crossentropy |
| **LeNet 2** | 40146436 (153.15 MB) | 40146436 (153.15 MB) | 0 (0.00 Byte) | 10 | Adam | Categorical Crossentropy |
| **LeNet 3** | 4254776 (16.23 MB) | 4254776 (16.23 MB) | 0 (0.00 Byte) | 40 | Adam | Categorical Crossentropy |

**Table 2: Training Performance**

| **Model** | **Final Training Loss** | **Final Training Accuracy** | **Final Validation Loss** | **Final Validation Accuracy** | **Test Loss** | **Test Accuracy** |
| --- | --- | --- | --- | --- | --- | --- |
| **LeNet 1** | 0.4457 | 0.8228 | 0.4961 | 0.8074 | 0.5944 | 0.7784 |
| **LeNet 2** | 0.5583 | 0.7986 | 0.4207 | 0.8474 | 0.5583 | 0.7986 |
| **LeNet 3** | 0.4708 | 0.8606 | 0.4508 | 0.8606 | 0.4708 | 0.8606 |

**FeedForward Model**

**Model Parameter**

| **Model** | **Total Parameters** | **Trainable Params** | **Non-trainable Params** | **Epochs** | **Optimizer** |
| --- | --- | --- | --- | --- | --- |
| **Model 1** | 123,577,844 | 123,577,844 | 0 | 17 | Adam() |

**Training Results**

| **Model** | **Final Training Loss** | **Final Training Accuracy** | **Final Validation Loss** | **Final Validation Accuracy** | **Test Loss** | **Test Accuracy** |
| --- | --- | --- | --- | --- | --- | --- |
| **Model 1** | 0.9266 | 54.52% | 0.8335 | 56.44% | 0.8679 | 56.99% |

**Meta Model**

**Meta Model Parameters**

| **Model** | **Total Parameters** | **Trainable Params** | **Non-trainable Params** | **Epochs** | **Optimizer** |
| --- | --- | --- | --- | --- | --- |
| **Meta Model** | 4254776 | 4254776 | 0 | 20 | Adam |

**Training Results**

| **Model** | **Final Training Loss** | **Final Training Accuracy** | **Final Validation Loss** | **Final Validation Accuracy** | **Test Loss** | **Test Accuracy** |
| --- | --- | --- | --- | --- | --- | --- |
| **Meta Model** | 0.4406 | 85.48% | 0.3695 | 85.80% | 0.4508 | 83.05% |

**Conclusion:**

The study successfully demonstrated the potential for enhancing disease classification accuracy in eye disease diagnosis. The LeNet architecture proved to be the most effective among the tested models, achieving an accuracy of **86%.** While other explored architectures did not show substantial improvement, the study contributes insights into the effectiveness of different CNN architectures and fine-tuning strategies in disease classification tasks.

**Recommendations:** Future work might involve:

* Exploring additional CNN architectures or hybrid models.
* Further fine-tuning techniques or leveraging more extensive pre-trained models.
* Investigating larger and more diverse datasets to enhance model generalization.