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| **Gesture Recognition Model** | | | | | |
| **Process** | **Model** | **Model Details** | **Configuration** | **Results (Train Accuracy, Validation Accuracy)** | **Analysis and Decision** |
| **1. Initial Setup** | Model – 0 | Basic CNN (Conv3D) | 7 Images, 80x80, Batch Size = 128/64 | Generator Error | Kernel crashes with high batch sizes. **Decision**: Reduce batch size to <= 64. |
| **2. Baseline Model** | Model – 1 | CNN (2 Conv3D Layers) | 7 Images, 80x80, Batch Size = 32 | 1.0, 0.7734 | Severe **overfitting** observed. **Decision**: Add Batch Normalization (BN) and Dropout to address overfitting. |
| **3. Regularization** | Model – 2 | CNN (2 Conv3D Layers + BN, Dropout) | 7 Images, 80x80, Batch Size = 32 | 0.933, 0.6797 | Overfitting reduced, but low validation accuracy. **Decision**: Increase dataset size to 20 images for better learning. |
| **4. Improved CNN** | Model – 3 | CNN (2 Conv3D Layers + BN, Dropout) | 20 Images, 80x80, Batch Size = 32 | 0.6295, 0.5625 | Underfitting observed. **Decision**: Add an additional Conv3D layer to improve learning capacity. |
|  | Model – 4 | CNN (3 Conv3D Layers + BN, Dropout) | 20 Images, 80x80, Batch Size = 32 | 0.9554, 0.7344 | Improved accuracy. **Decision**: Test larger image sizes (120x120) to capture more features. |
|  | Model – 5 | CNN (3 Conv3D Layers + BN, Dropout) | 20 Images, 120x120, Batch Size = 32 | 0.9435, 0.7344 | Larger images did not improve accuracy significantly. **Decision**: Explore sequential architectures. |
| **5. CNN+RNN** | Model – 6 | LSTM + CNN (3 Conv2D Layers + BN, Dropout) | 20 Images, 80x80, Batch Size = 32 | 0.9911, 0.7969 | High accuracy but computational cost increased. **Decision**: Try GRU instead of LSTM for reduced complexity. |
|  | Model – 7 | GRU + CNN (3 Conv2D Layers + BN, Dropout) | 20 Images, 80x80, Batch Size = 32 | 0.9836, 0.8594 | Best balance between high training and validation accuracy. **Decision**: Test with larger datasets. |
| **6. Larger Dataset** | Model – 8 | CNN (3 Conv3D Layers + BN, Dropout) | All 30 Images, 120x120, Batch Size = 32 | 0.9315, 0.5156 | Significant drop in validation accuracy. Model instability observed. |
|  | Model – 9 | LSTM + CNN (3 Conv2D Layers + BN, Dropout) | All 30 Images, 80x80, Batch Size = 32 | 0.994, 0.7812 | Validation accuracy improved slightly but no significant gains. |
|  | Model – 10 | GRU + CNN (3 Conv2D Layers + BN, Dropout) | All 30 Images, 80x80, Batch Size = 32 | 0.9911, 0.8047 | Slight improvement in validation accuracy. **Decision**: Continue with Experiment 7 as the final model. |
| **7. Transfer Learning** | Model - 11 | MobileNetV2 + GRU | All 30 Images, 80x80, Batch Size = 32 | 1.0, 0.7266 | Severe **overfitting** with increasing validation loss. **Decision**: Reject this approach. |
| **8. Final Model & Saved Model** | Model 7 | GRU + CNN (3 Conv2D Layers + BN, Dropout) | 20 Images, 80x80, Batch Size = 32 | 0.9836, 0.8594 | Selected as the **final model** due to best balance of high accuracy, stability, and computational efficiency. |
| Final Model Details | GRU + CNN | Filename: model\_init\_2024-12-0114\_40\_59.989714/model-00030-0.05919-0.98363-0.57175-0.85938.keras | Parameters: 12,69,989 | Efficient and accurate for deployment. Further testing recommended on unseen data and hyper parameter optimization. |