Here in this case study, all important steps required to build the two models, namely 3D CNN and a stack of 2D CNN + RNN have been followed. Different functions have been created to execute different activities like cropping and resizing of the images, to plot images, normalizing of the images, generator of data and labels in batch, for compiling the model, for saving the model, for training of the model, for convolutional 3D model and a stack of 2D CNN and RNN etc.

Here results are shared in tabular format as shown below.

Mainly training categorical accuracy and validation categorical accuracy have been considered in the results. Three types of normalization methods studied here. In experiments 1 to 6, 9 & 10 and 13 & 14 type-1 normalization has been used, in experiments 7, 11 & 15 type-2 and in experiments 8, 12 & 16 type-3 normalization method used respectively.

|  |  |  |  |
| --- | --- | --- | --- |
| **Experiment Number** | **Model** | **Result** | **Decision + Explanation** |
| **1** | **Conv3D** | categorical accuracy = 0.78  validation categorical accuracy = 0.79 | Training and validation losses decreased continuously with the increase in epoch. Accuracy for both is near about 80%, which is in good range. |
| **2** | **Conv3D** | categorical accuracy = 0.796  validation categorical accuracy = 0.81 | Here the 1st kernel size was increased compared to the experiment 1, accuracy of the result is marginal better than the same from experiment 1. **This is the best case among all.** |
| **3** | **Conv3D** | categorical accuracy = 0.476  validation categorical accuracy = 0.436 | Here increase in 1st two kernels size with increase in batch size reduced the accuracy for training and validation both. |
| **4** | **Conv3D** | categorical accuracy = 0.46  validation categorical accuracy = 0.19 | Here increase in 1st kernel size with decrease in the 4th kernel size and with same batch size as in experiment 3, reduced the accuracy for validation more than the training. Showing some sort of overfit of the training data. |
| **5** | **Conv3D** | categorical accuracy = 0.6  validation categorical accuracy = 0.625 | Here on the experiment 1 case, l2 regularizer has been used, but this approach is not producing result better than the experiment 1. |
| **6** | **Conv3D** | categorical accuracy = 0.31  validation categorical accuracy = 0.23 |  |
| **7** | **Conv3D** | categorical accuracy = 0.423  validation categorical accuracy = 0.44 | In this case all the parameters are same as in experiment 1 except here type 2 normalization technique has been used. But results are not good. |
| **8** | **Conv3D** | categorical accuracy = 0.74  validation categorical accuracy = 0.77 | In this case all the parameters are same as in experiment 1 except here type 3 normalization technique has been used. But results are not as good as in experiment 1. |
| **9** | **Conv2D + RNN** | categorical accuracy = 0.18  validation categorical accuracy = 0.25 | LSTM model. Very low accuracy. |
| **10** | **Conv2D + RNN** | categorical accuracy = 0.25  validation categorical accuracy = 0.25 | LSTM model. All parameters are same as in exp.9, but here considered batch normalisation for lstmgrulayers and dropouts for convlayer. Training accuracy slightly increased. |
| **11** | **Conv2D + RNN** | categorical accuracy = 0.32  validation categorical accuracy = 0.1 | LSTM model. All parameters are same as in exp.10, except type 2 normalisation method has been used here. |
| **12** | **Conv2D + RNN** | categorical accuracy = 0.15  validation categorical accuracy = 0.2 | LSTM model. All parameters are same as in exp.10, except type 3 normalisation method has been used here. |
| **13** | **Conv2D + RNN** | categorical accuracy = 0.38  validation categorical accuracy = 0.36 | GRU model with low accuracy. |
| **14** | **Conv2D + RNN** | categorical accuracy = 0.37  validation categorical accuracy = 0.18 | GRU model. All parameters are same as in exp.13, but considered here batch normalisation for lstmgrulayers and dropouts for convlayer. Training accuracy is same as in exp.13, but validation accuracy has decreased, show indicating overfitting with training data. |
| **15** | **Conv2D + RNN** | categorical accuracy = 0.31  validation categorical accuracy = 0.21 | GRU model. All parameters are same as in exp.13, except type 2 normalisation method has been used here. |
| **16** | **Conv2D + RNN** | categorical accuracy = 0.4  validation categorical accuracy = 0.25 | GRU model. All parameters are same as in exp.13, except type 3 normalisation method has been used here. Accuracy on the training data has improved here compared to the last 3 GRU models, but validation accuracy has decreased, show again indicating overfitting with training data. |

Experiment 2 with Conv3D is the best model, as accuracy with training and validation both are equal or greater than 80%.