Cotton Quality Classification System using Digital Images

Group Members:

Anand Kumar

Navesh Kumar

Introduction

Factors of cotton quality in industries

- Colour quality and particles: pure white, white, off white, yellowish, trash, bolls, and brackets.
- Moisture measurement: The amount of moisture in cotton.
- Ratio: The ratio of cotton and seed


image (1).jpg


image (2).jpg


image (3).jpg


image (4).jpg


image (5).jpg

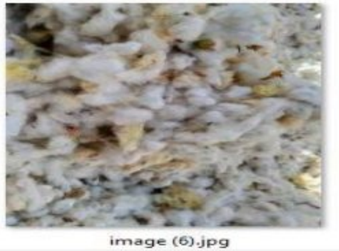


image (6).jpg


image (7).jpg


image (8).jpg

Continue

Cotton quality checking process in industries

- To measure the amount of moisture a sample of one kilogram of cotton is weighted then dried in air and again weighted.
- To check the colour quality, the experience is required by seeing the sample such as white, off-white, and yellowish.
- To estimate the ratio of cotton lint and cotton seeds a small table-sized ginning machine is used that separates cotton lint and seeds.

Literature review

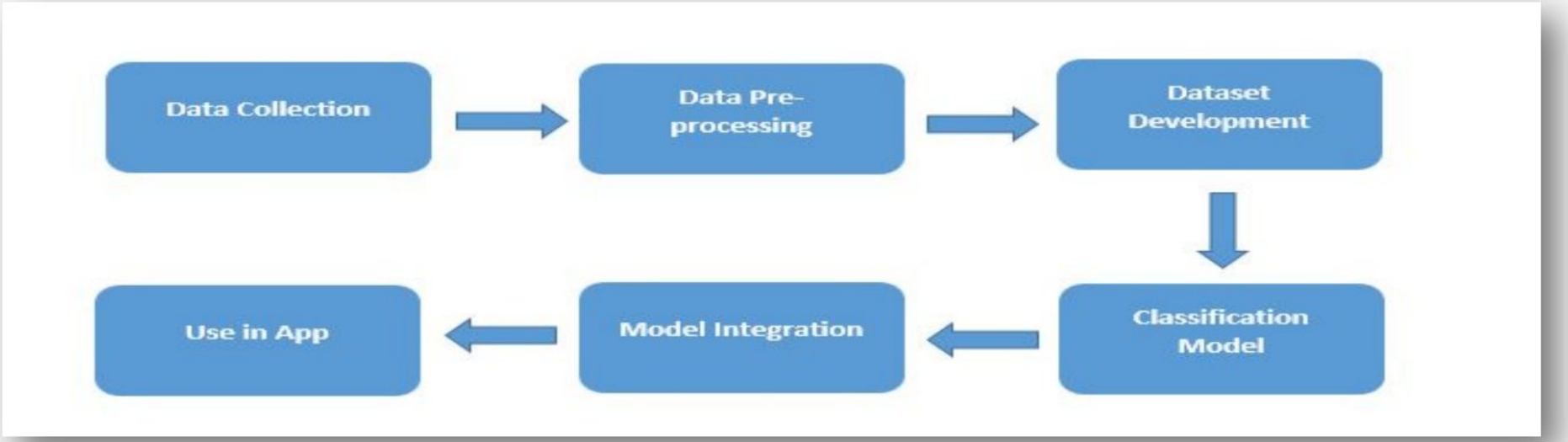
- The existing studies are focused only on cotton lint that are expensive and can be processed in chemistry laboratories.
- The classification of cotton quality is done manually based on the experience.
- There is digital moisture meter available to check the moisture of cotton fibre.
- There is table sized ginning machine available to estimate the ratio of seed and cotton.

Problem definition

- There is no system available to check the quality of cotton fibre in ginning factories.
- The available moisture meter is expensive and require frequent repair of needles.
- The available small ginning machine is time consuming in drying and ginning a sample.
- The dataset of cotton fibre images is not available that need to be developed.

Methodology

- Dataset collection
- Data pre-processing
- Deep learning based model
- Application development



Data collection

- The data include the different variety of cotton sample from all over Pakistan captured from four cities.
- The challenges faced during data collection include : capturing unique images having different features, travelling, permission issue for entry in ginning factories.
- Dimensions **4160x3120, 3000x4000**

City	Collected	Best	Better	Good	Bad	Worst	Ambiguous
Shahdadpur & Tando Adam	2967	143	449	958	722	180	490
Rohri	1051	0	0	94	480	102	217
Salephat	764	0	0	25	310	162	267

Data pre-processing

Data cleaning

- In this process, the blurred, shadowed, irrelevance object, and ambiguous images are removed to ensure the quality of the dataset for proper training of the model.

Continue

Data labelling

- In this process, the data has been labelled into five classes. This process is done under the guidance of quality checking expert from cotton ginning factory.

Continue

Data is labelled by following standards provided by quality expert

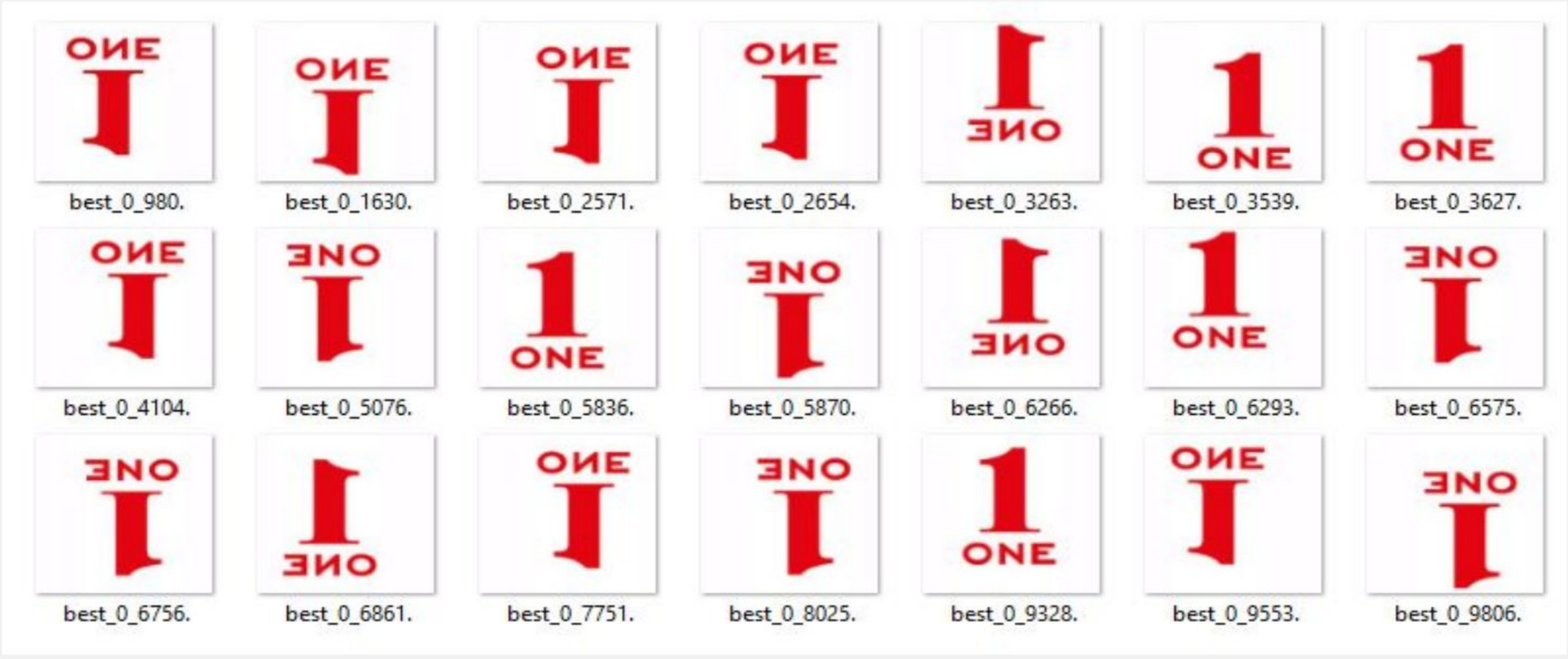
- Best: pure white, no brackets, open flowers
- Better: white, little brackets, no yellowish, open flowers
- Good: white, brackets, little yellowish, white debris allowed, little bolls, little black debris
- Bad: yellowish, black and white debris, bowls, rainy
- Worst: ungrown, yellowish, damaged crop, rainy, bolls

Continue

Data augmentation

- The reason behind applying data augmentation is unbalancing of data in different classes. The classes have been balanced by data augmentation techniques such as padding, cropping, horizontal, and vertical flipping on images.
- The challenge faced to select the technique that maintain the multiple features of particular class.

Data augmentation sample



Actual image

Augmented image


best_0_730..jpg


best_0_1201..jpg


best_0_1318..jpg


best_0_1626..jpg


best_0_1840..jpg


best_0_2055..jpg


best_0_2138..jpg

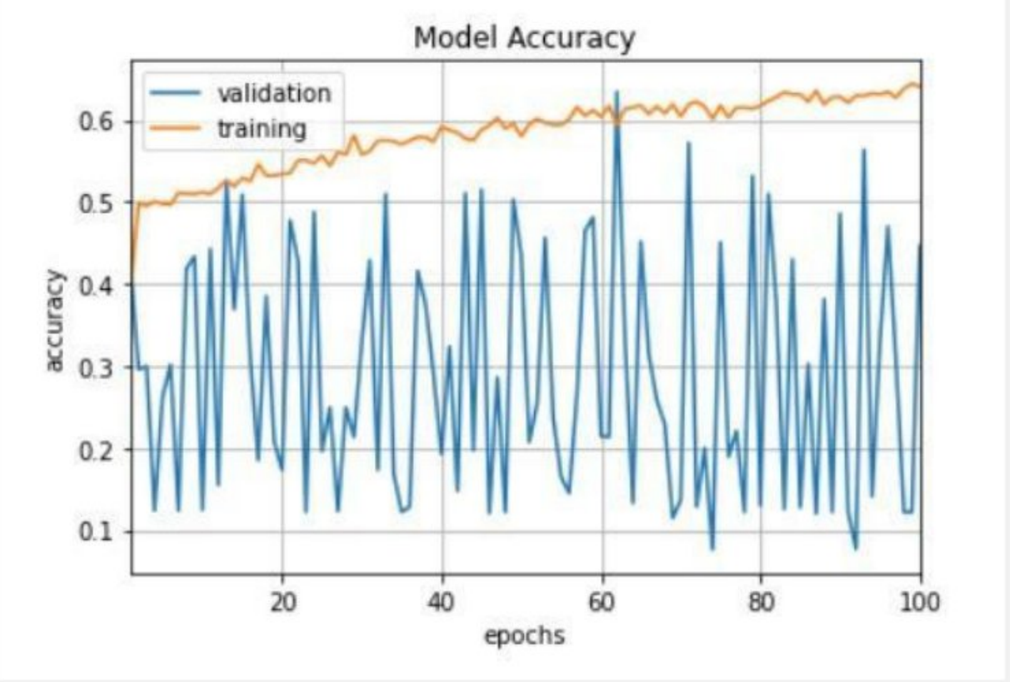

best_0_3555..jpg

Classification deep learning model

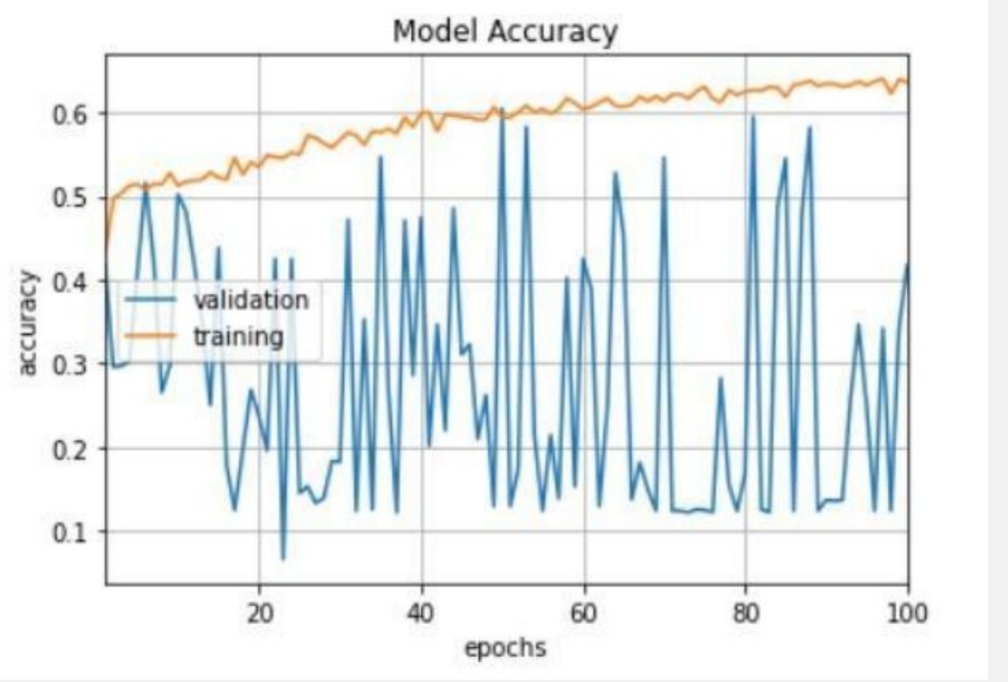
- The model has been trained by applying transfer learning on pre-trained models by freezing the layers.
- The training has been performed on different models that are InceptionV3, VGG16, Vgg19.
- The optimizers that have been applied on the model are Adam, RMSprop, SGD.
- The developed dataset has been used in the classification model to train, test, and validate the model.
- The distribution among 10000 images is defined as 5000 for training, 2000 for validation and 3000 for testing.

Implementation and testing

AlexNet through scratch: SGD



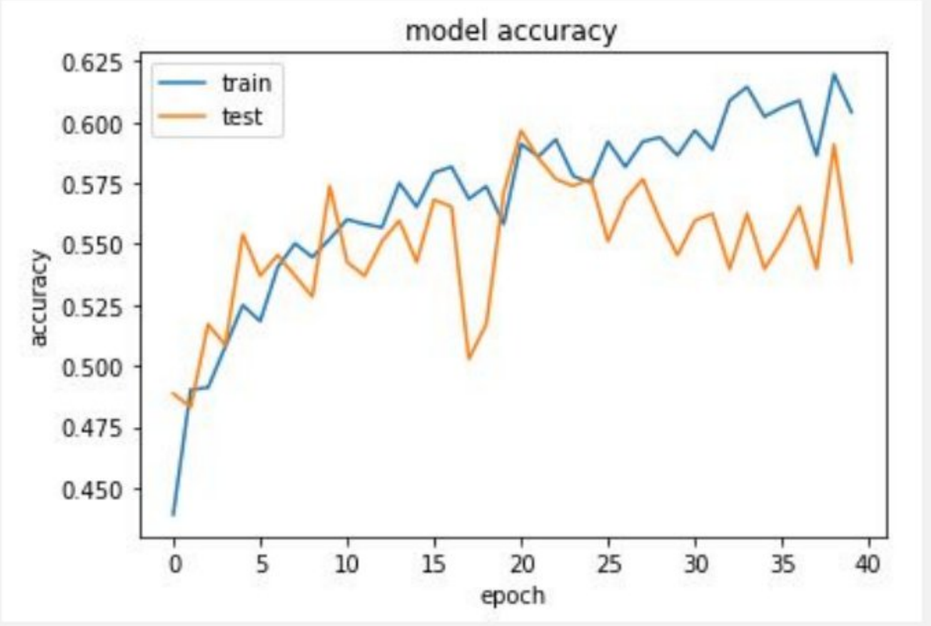
Constant learning rate

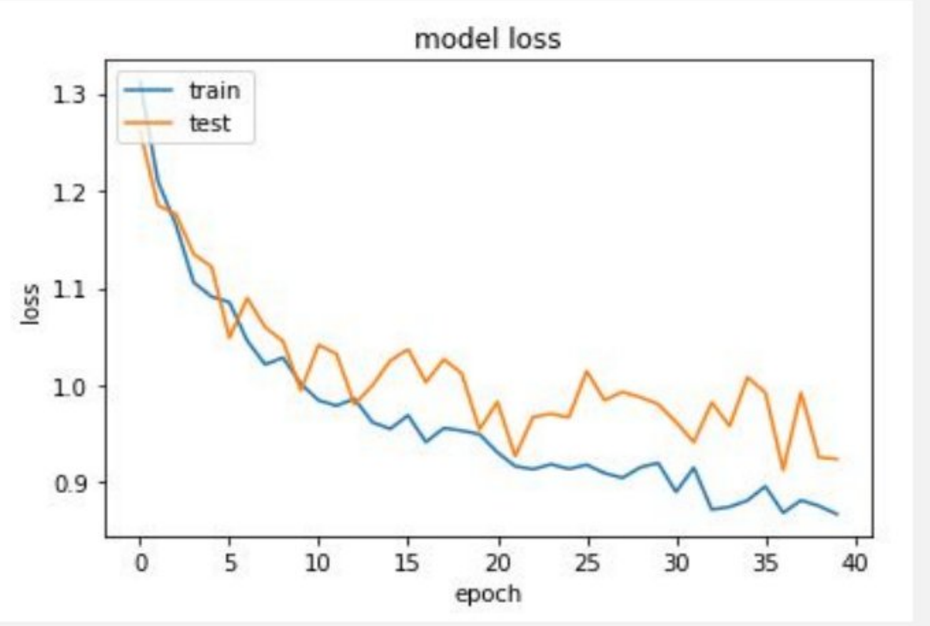


Time base decay

Continue

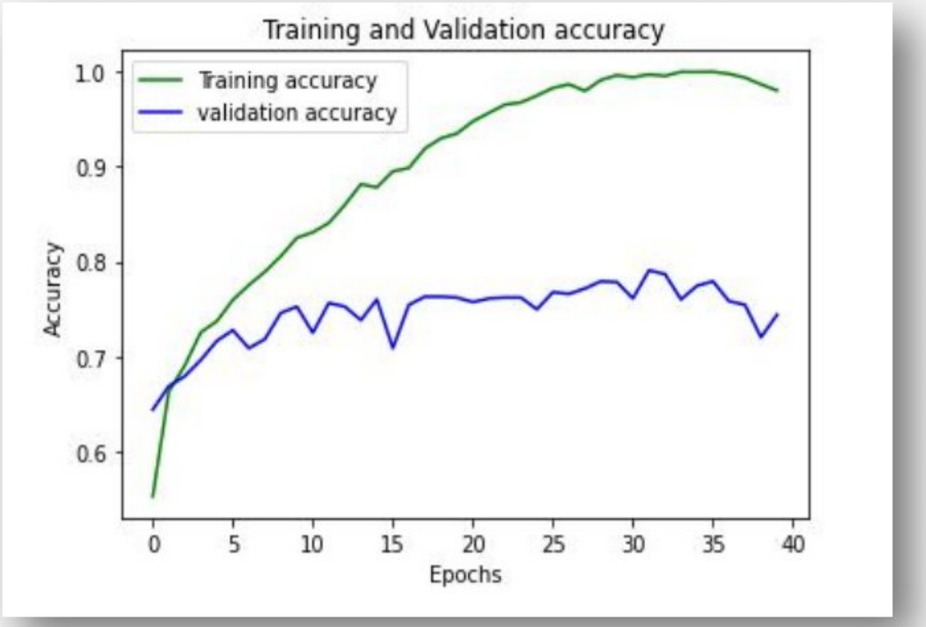
InceptionV3 on unbalanced dataset: SGD

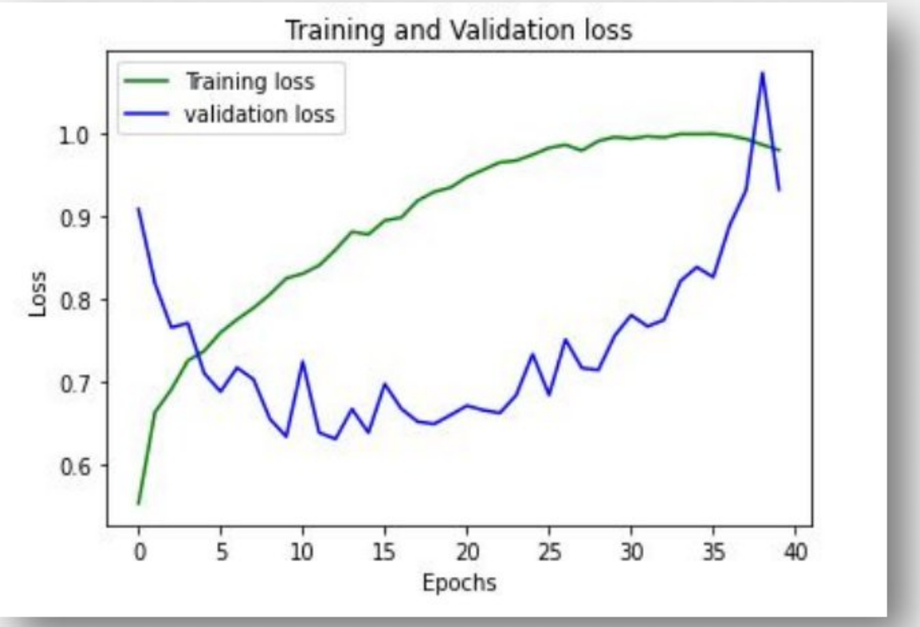




Continue

Transfer learning using inceptionV3: Adam

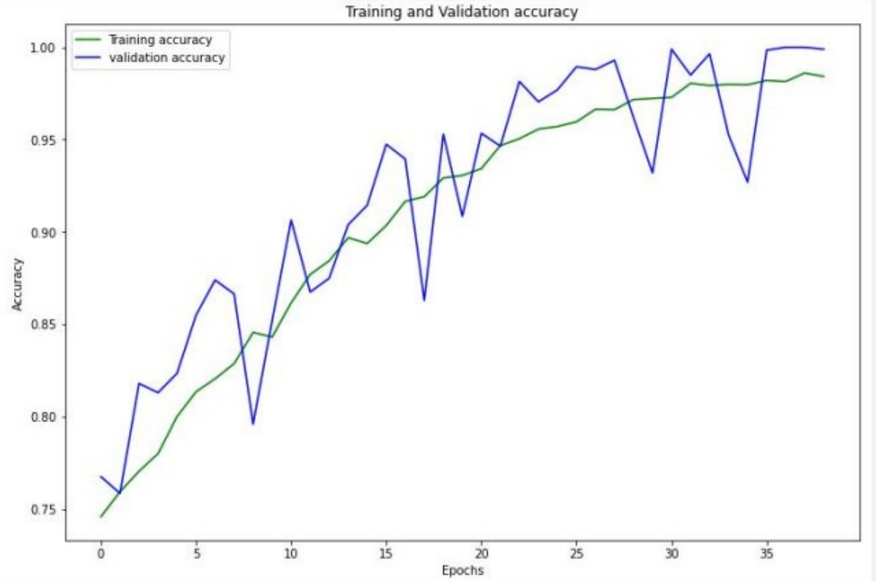


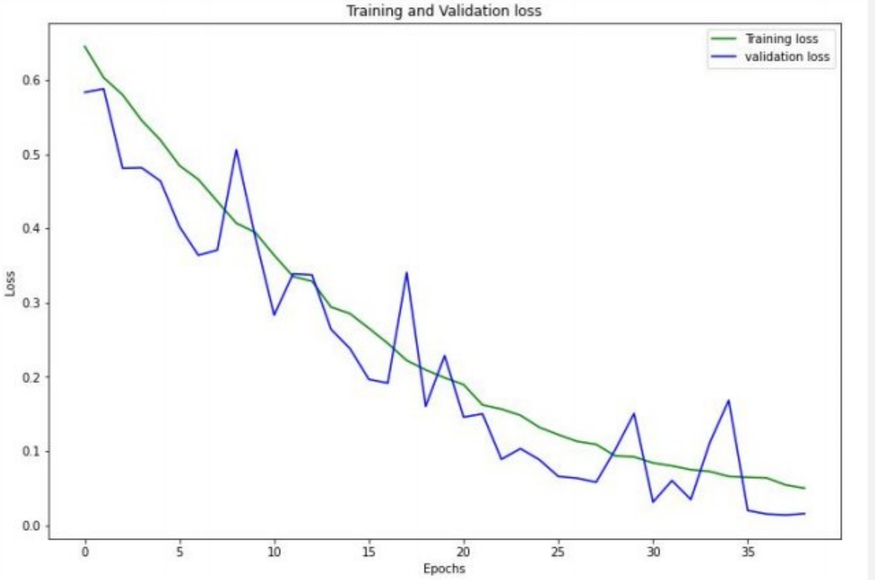



```
Evaluate on test data
750/750 [==============================] - 135s 180ms/step - loss: 0.8831 - accuracy: 0.7597
test loss, test acc: [0.8830617070198059, 0.7596666812896729]
Generate predictions for 3 samples
predictions shape: (3, 5)
```

Continue

Transfer learning using inceptionV3: RMSprop

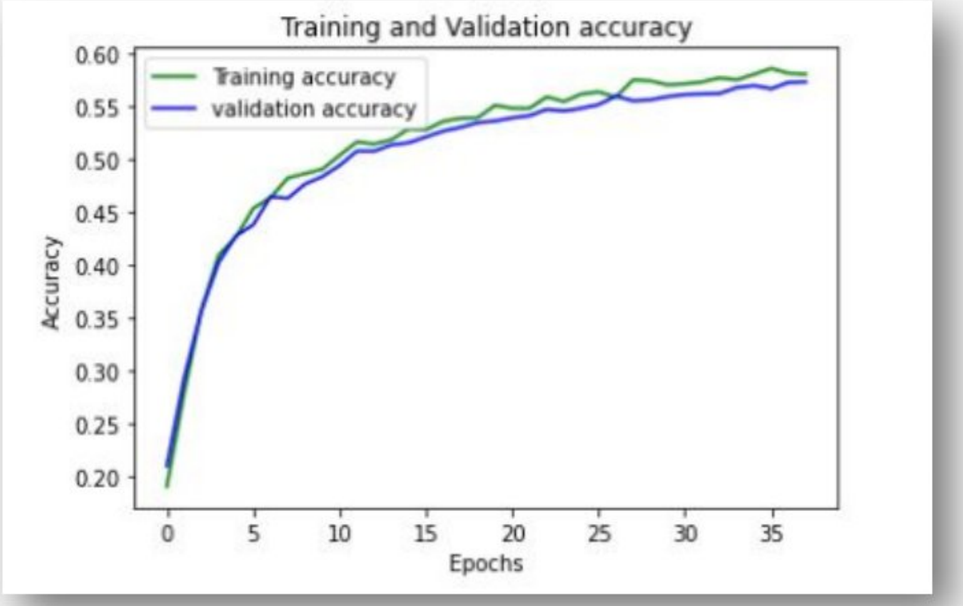


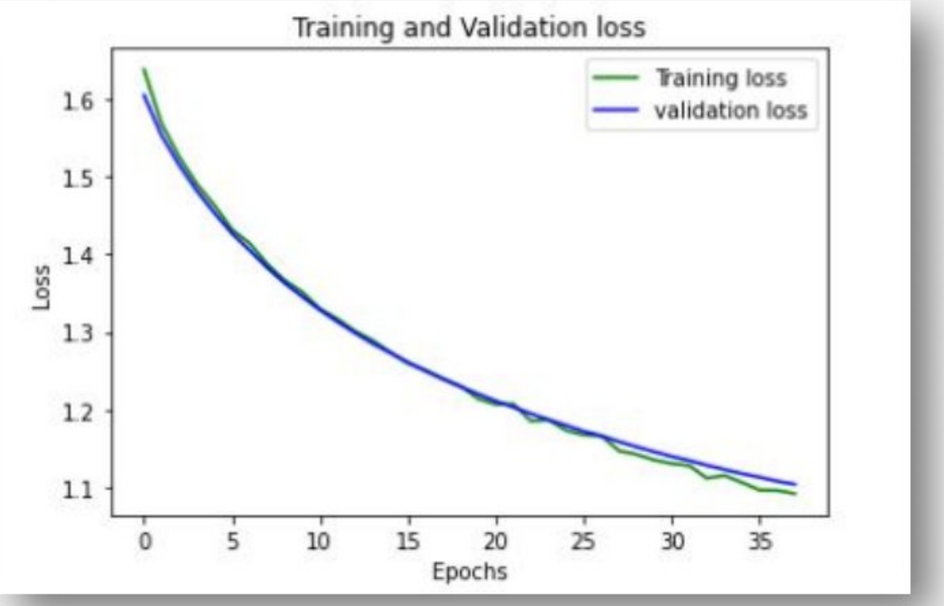



```
Evaluate on test data
750/750 [==============================] - 128s 169ms/step - loss: 0.0137 - accuracy: 1.0000
test loss, test acc: [0.0136647317558527, 1.0]
Generate predictions for 3 samples
predictions shape: (3, 5)
```

Continue

Transfer learning using inceptionV3: SGD

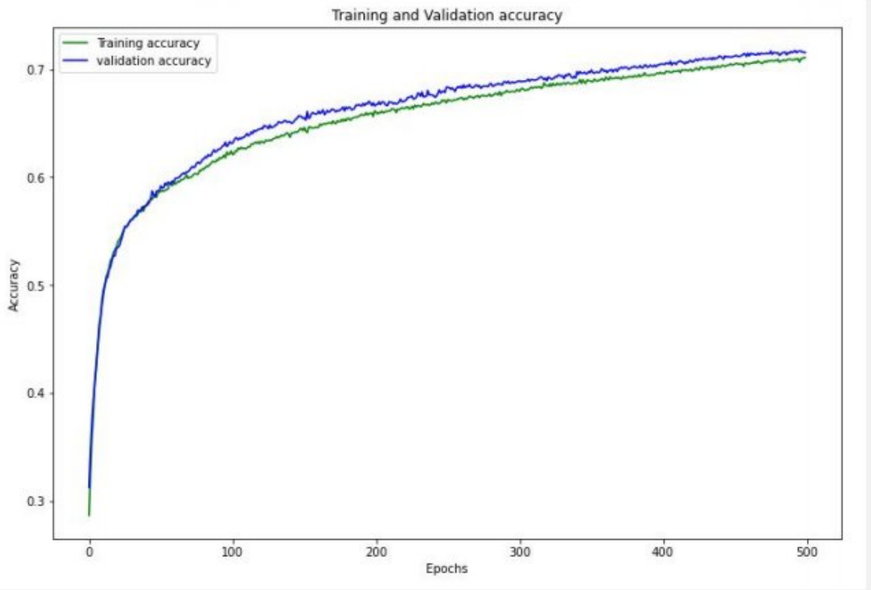


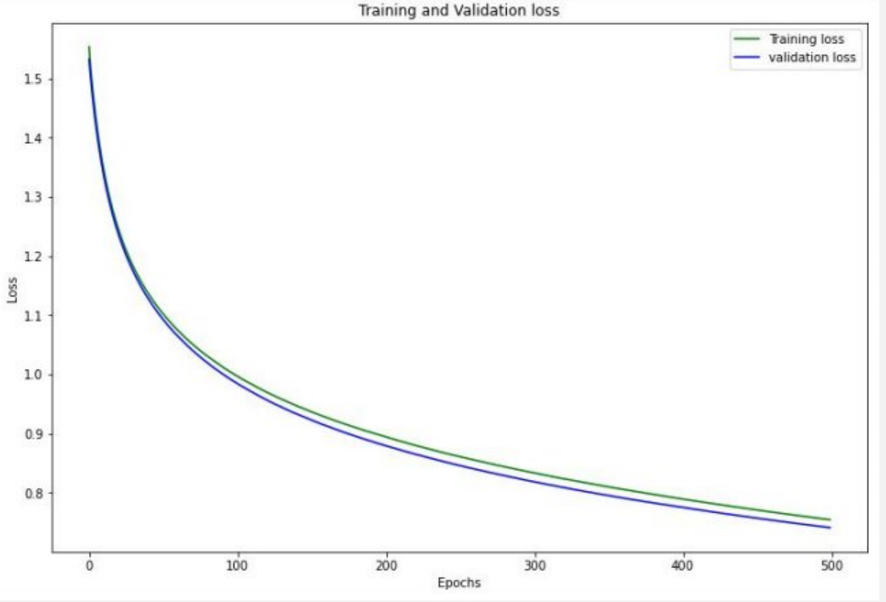



```
Evaluate on test data
750/750 [==============================] - 122s 163ms/step - loss: 1.1020 - accuracy: 0.5737
test loss, test acc: [1.1019608974456787, 0.5736666917800903]
Generate predictions for 3 samples
predictions shape: (3, 5)
```

Continue

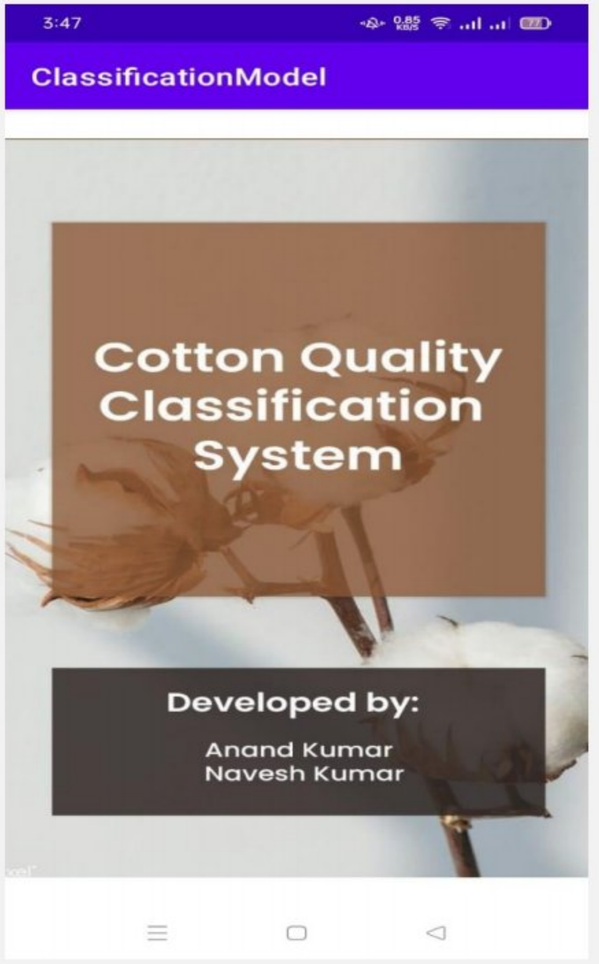
Transfer learning using inceptionV3: RMSprop

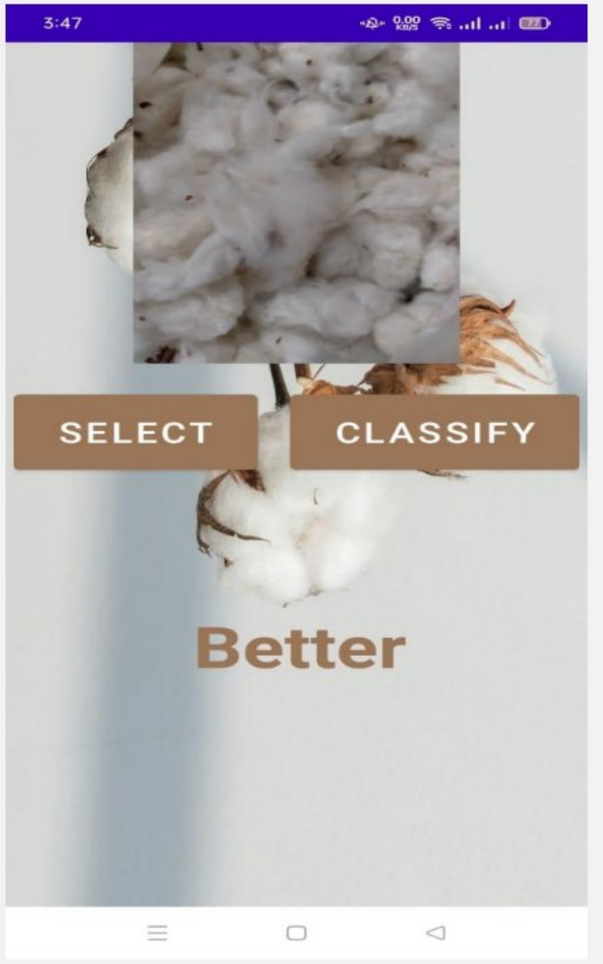


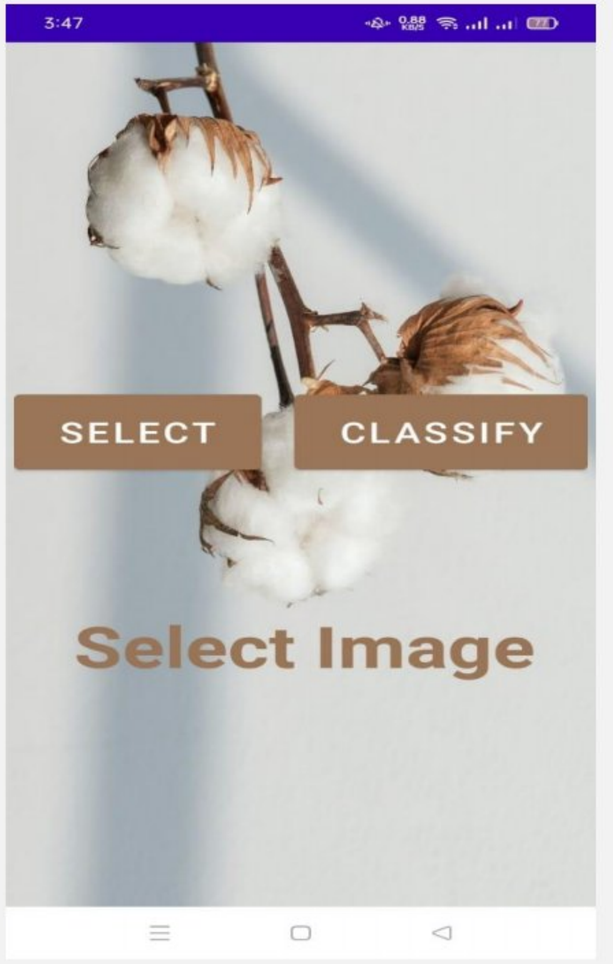



```
Evaluate on test data
750/750 [==============================] - 143s 191ms/step - loss: 0.8763 - accuracy: 0.6577
test loss, test acc: [0.8762544989585876, 0.6576666831970215]
Generate predictions for 3 samples
predictions shape: (3, 5)
```

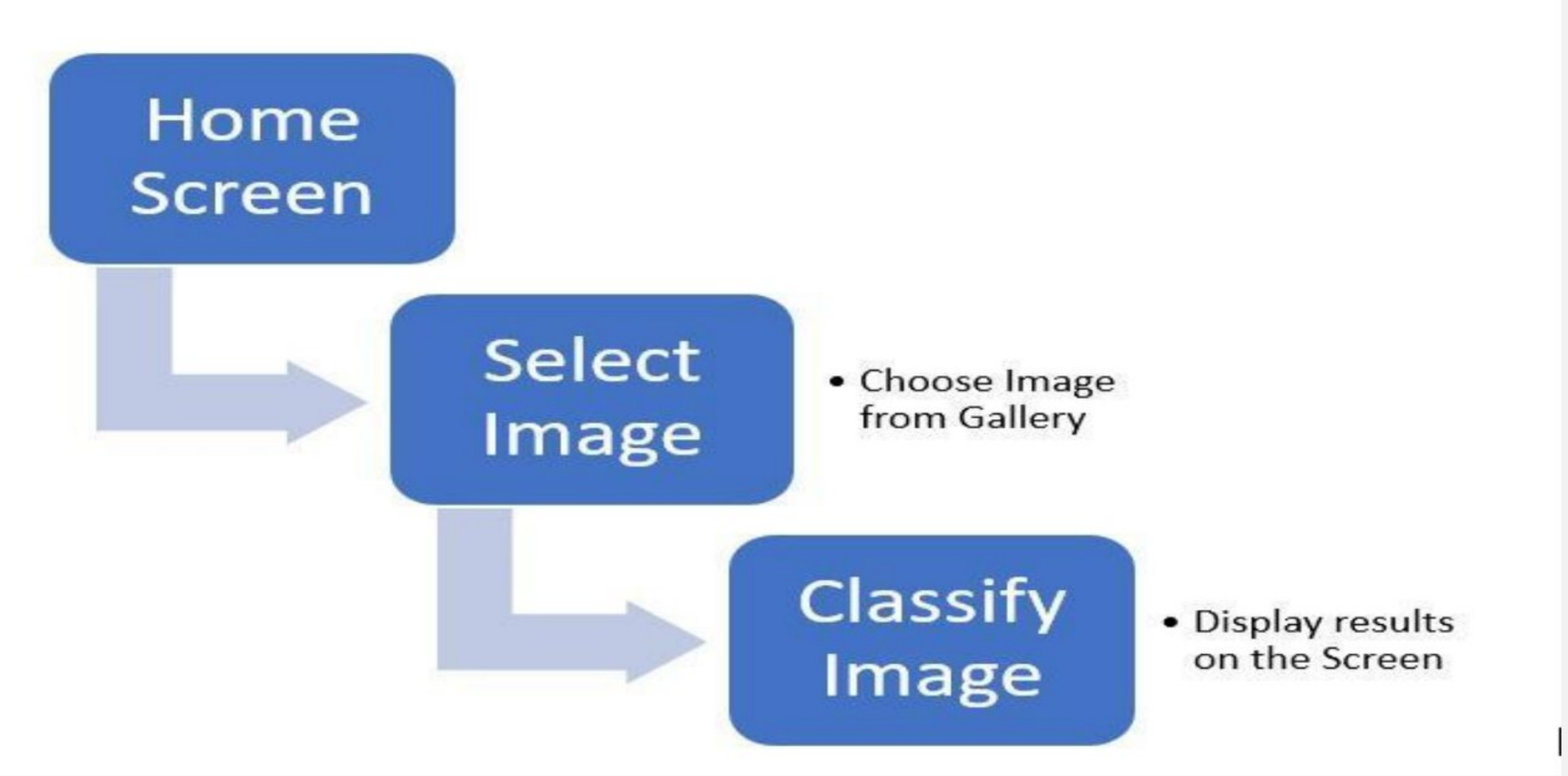
Android application







Flow diagram



Project milestones

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Data Collection	✓	✓	✓	✓	✓			
Dataset Development			✓	✓	✓	✓	✓	
SRS Document	✓	✓	✓					
SDS Document	✓	✓	✓					
Classification Model					✓	✓	✓	✓
Application Development								✓
System Testing							✓	✓
Final Thesis								✓

Conclusion and future work

- This system successfully automates the quality checking process of cotton. The remaining factors such as moisture and ratio will be future work.
- The future work of this system is proposed to design the hardware-based state-of-the-art cotton quality checking system for factory ginners that will be very much beneficial and innovative in the agriculture sector and ginning industries.

Work division

	SRS	SDS	Data Collection	Dataset Development	Classification Model	App	System Evaluation	System Testing	Thesis
Anand	✓	✓		✓	✓	✓	✓		✓
Navesh	✓	✓	✓	✓	✓		✓		✓
Factory Ginners							✓	✓	

References

1. Brownlee, J. "Gentle Introduction to the Adam Optimization Algorithm for Deep Learning." from https://machinelearningmastery.com/adam-optimization-algorithm-for-deep-learning/#:~:text=Adam%20is%20a%20replacement%20optimization,sparse%20gradients%20on%20noisy%20problems.

2. Delhom, C. and J. Rodgers (2016). Cotton Moisture—Its Importante, Measurements and Impacts. Proceedings of the 33rd International Cotton Conference Bremen, New Orleans, LA, USA.

3. Kurama, V. (2020). "Inception v3 Architecture." Retrieved 27-02-2022, 2022, from https://blog.paperspace.com/popular-deep-learning-architectures-resnet-inceptionv3-squeezenet/.

4. Matusiak, M. and A. Walawska (2010). "Important aspects of cotton colour measurement." Fibres & Textiles in Eastern Europe **18**(3): 80.

5. Rodgers, J., et al. (2014). "Cotton Fiber Moisture Measurements: A Comparative Evaluation." AATCC Journal of Research **1**(5): 24-33.

6. Sanghvirajit. "A Complete Guide to Adam and RMSprop Optimizer." from https://medium.com/analytics-vidhya/a-complete-guide-to-adam-and-rmsprop-optimizer-75f4502d83be.

7. Saxena, S. (2021). "Introduction to The Architecture of Alexnet." Retrieved 27-02-2022, 2022, from https://www.analyticsvidhya.com/blog/2021/03/introduction-to-the-architecture-of-alexnet/.

8. Shahbandeh, M. (2020). "Global cotton production 2019/2020, by country." Retrieved 16-April, 2021, from https://www.statista.com/statistics/263055/cotton-production-worldwide-by-top-countries/.

9.

Thank You