Department of Information Technology
NBA Accredited

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UNIVERSITY OF MUMBAI

Academic Year 2022-2023

A Project Presentation on

Developing Real-time Digitization System using Deep Learning for Handwritten Documents

Submitted in partial fulfilment of the degree of
Bachelor of Engineering(Sem-8)

INFORMATION TECHNOLOGY

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1.Project Conception and Initiation

1.1 Abstract

- Devanagari is the most used script in India. The lack of use of this script in the digital space has held it back from being relevant and even popular. Younger generation is not using the script and gravitate towards English as it is easily available in the Digital format.
- The script however, is popular in the handwritten medium. There are no popular ways to digitize the Devnagari script in real-time.
- The most used way is by people. Human error is a factor in that method however.

1.2 Objectives

- **To make an app that digitizes handwritten Devanagari in real-time**. We plan on implementing that by using cloud services and hosting the model that we have developed on the cloud.
- **To convert the text into a digitally editable file format**. The CNN model that we will develop using python and keras [11] libraries along with segmentation using different classification techniques will be used to Digitize the file. Tensorflow [10] will be used to implement all of the backend code.
- **To enable users to use the app anytime, anywhere.** This will be done with the help of a flutter app that will serve as the front-end of the project.
- **To bring relevance back to the local languages in this digital age**. By having a method to digitize languages like Hindi and Marathi, the use of these languages can be promoted thus bringing relevance to them.

1.3 Literature Review

	Paper Title	Key Findings
1	Digitization of handwritten Devanagari text using CNN transfer learning – A better customer service support" (Pande, S. D., Jadhav, P. P., Joshi, R.Sawant, A. D., Muddebihalkar, V., Rathod, S., Gurav, M. N., & Das, S. (2022)	The Use of CNN can be used to classify, recognize and convert the handwritten into a digital format.
2	Devanagari Handwritten Character Recognition using fine-tuned Deep Convolutional Neural Network on trivial dataset (Deore, S.P., Pravin)	Construction and Optimization of the Neural Network for Character recognition which makes the backbone of our work.
3	Handwritten Devanagari Character Classification using Deep Learning (P. K. Sonawane and S. Shelke)	Improving the Accuracy of the neural network in less Epochs.

1.4 Problem Definition

- Most of the clerical work is done in India is done in English but that is just for the more urban areas. In rural areas the government offices still use the local languages. Most of them are handwritten.
- It takes more human effort and time to fill that information in the system. The factor of human error is also significant.
- The user wants to digitize a piece of document that is handwritten in the Devanagari script with the help of a mobile app.

1.5 Scope

- **Cross-platform application:** Use of flutter to make a cross-platform app.
- **Real-time conversion:** Unlike previous attempts, our app can do the conversion in real time.
- **Bigger Dataset to include more characters:** A bigger dataset is created to include more than 450 characters unlike the 46 in previous research.
- **Recognition of “Matras”:** Matras can be recognized due to the bigger dataset.

1.6 Technology stack

- Frontend :
  - Flutter 3.3.2
  - Dart 2.18.1
- Backend:
  - Python 3.11.7
  - libraries and packages used:
    - keras and tensorflow
    - teserract ocr
  - Cloud Storage : Google cloud

1.7 Benefits for environment & Society

- Reduces paper usage
- Promotes the use of local languages
- Increases accessibility to digital resources in local languages
- Reduces manual labor and errors in data entry
- Enables efficient storage and retrieval of data in digital format
- Encourages the use of technology in promoting cultural heritage and diversity
- Creates job opportunities for developers and technicians involved in the project.

2. Project Design

2.1 Proposed System

- **Real time :**

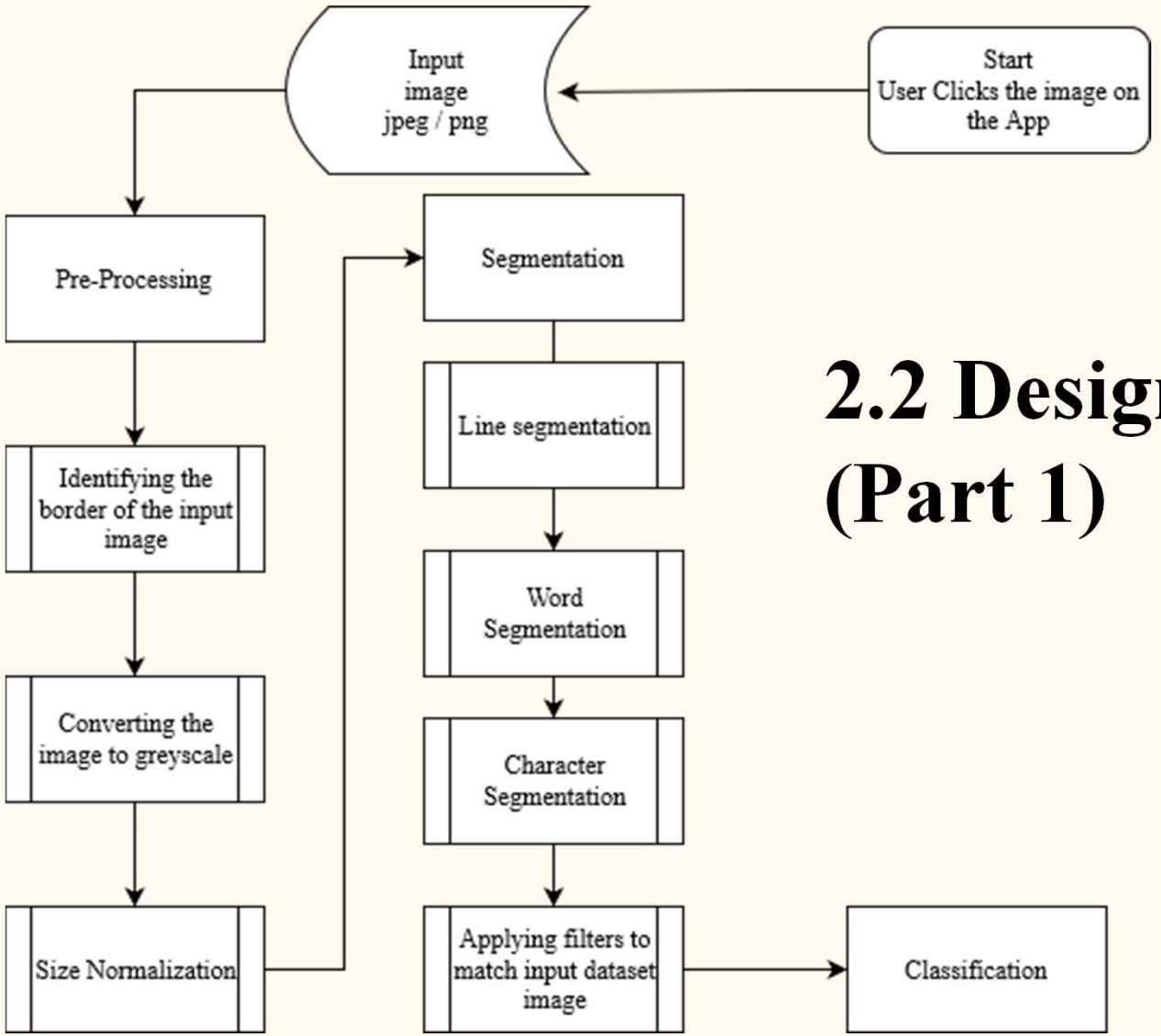
  We have made the whole system real-time.

- **Hindi and Marathi:**

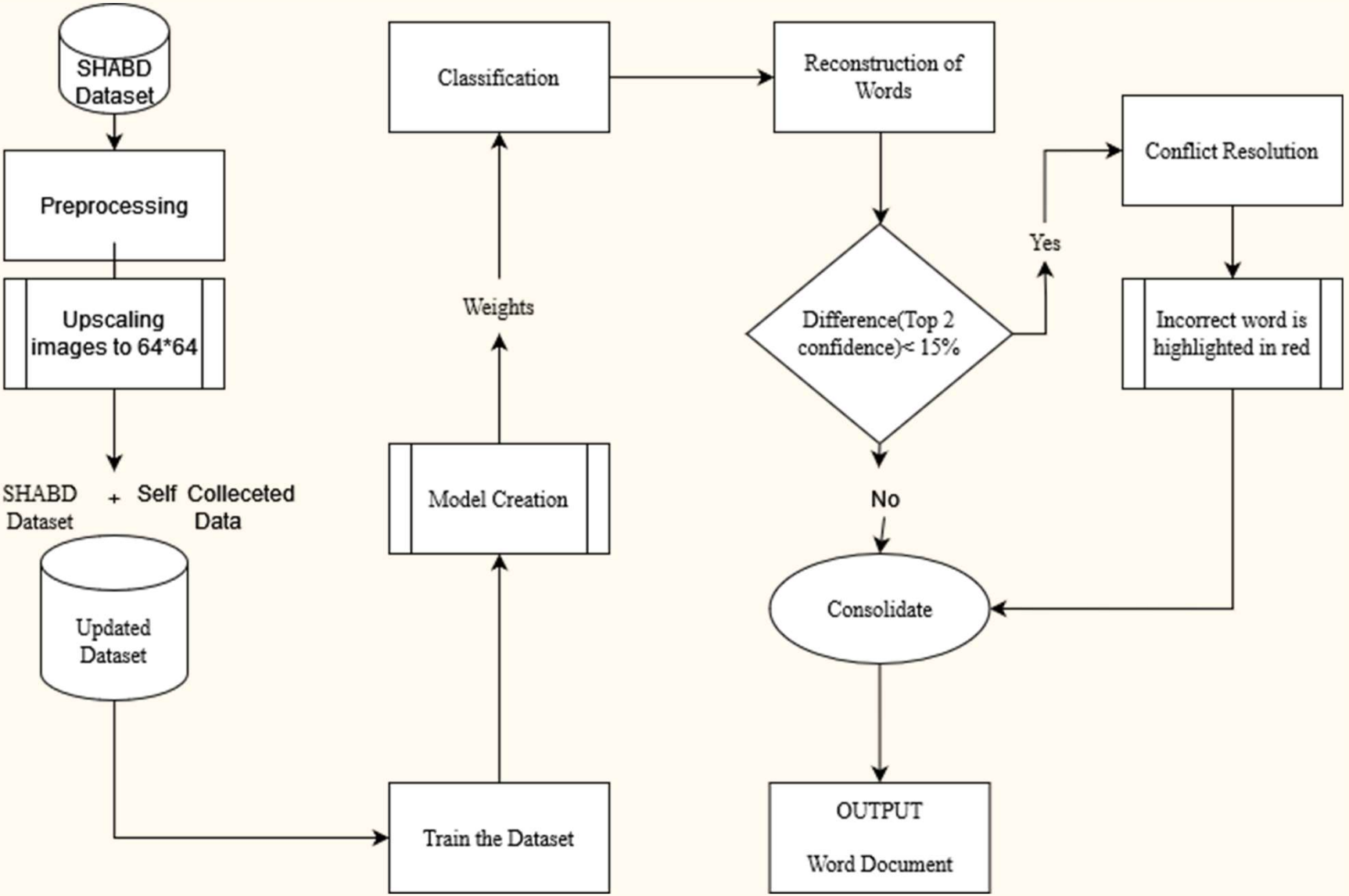
  The app works on Hindi and Marathi Language as they share the same script.

- **Direct download:**

  The file once digitized is downloaded in the system



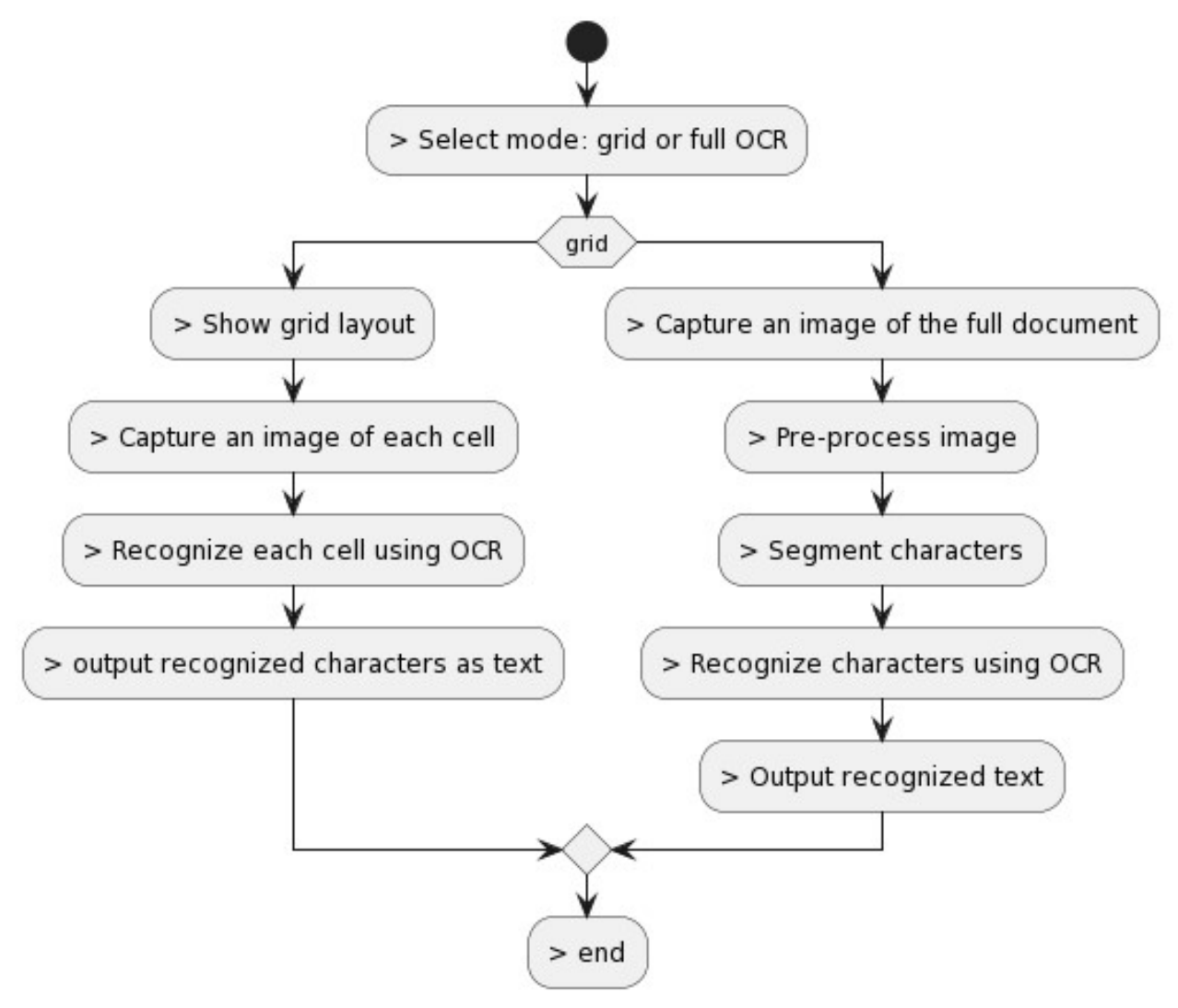
2.2 Design(Flow Of Modules) (Part 1)


SHABD Dataset
Preprocessing
Upscaling images to 64*64
SHABD Dataset + Self Colleceted Data
Updated Dataset
Train the Dataset
Model Creation
Weights
Classification
Reconstruction of Words
Difference(Top 2 confidence)< 15%
Yes
Conflict Resolution
Incorrect word is highlighted in red
No
Consolidate
OUTPUT
Word Document

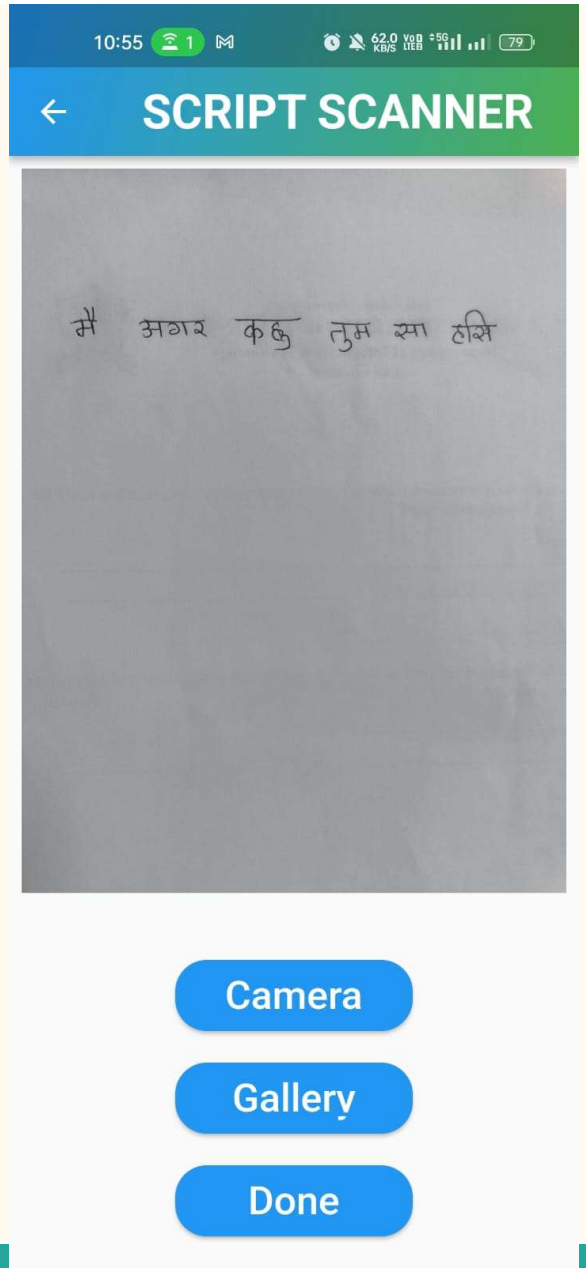
2.3 Description Of Use Case

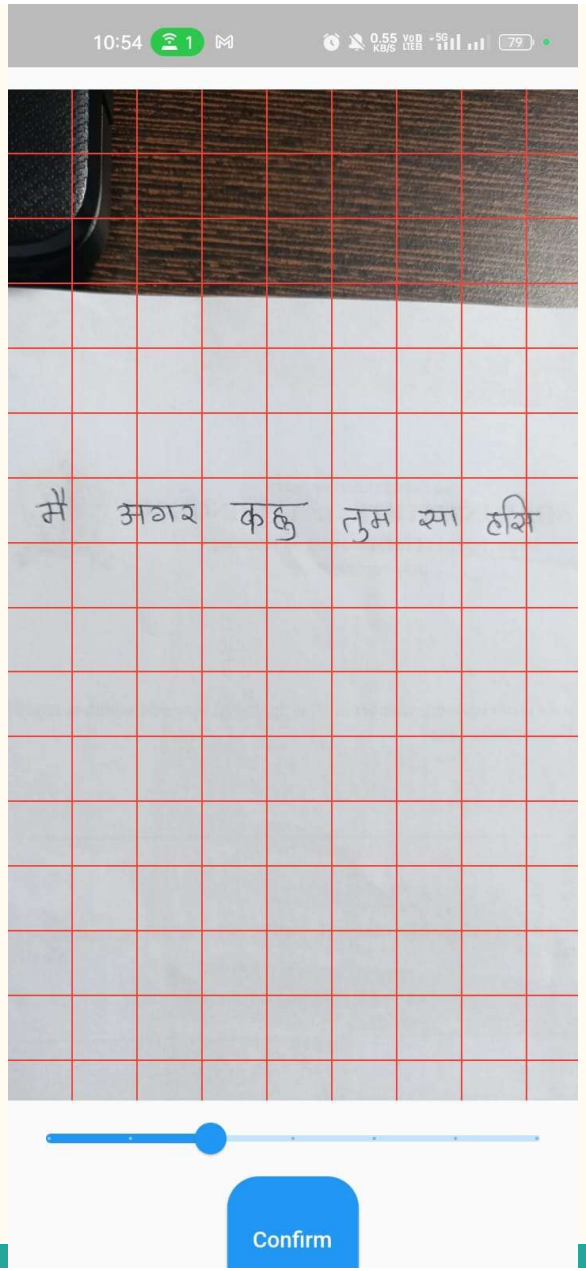
- The use case involves the process of digitizing handwritten Devanagari script in real-time using an app.
- The user uploads an image of the document containing the Devanagari script in real-time. The image is pre-processed, and the characters are segmented.
- The character recognition model analyzes and recognizes the characters.
- The recognized characters are output as text in digital format.
- The app provides the user with two options, grid and full OCR, to choose from.

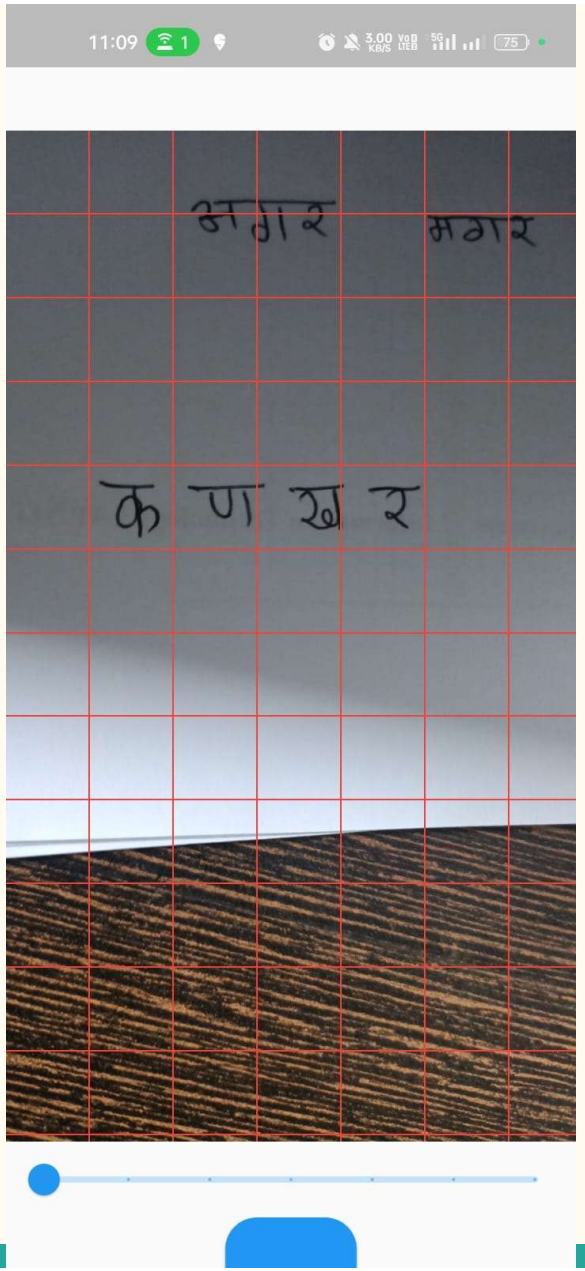
2.4 Activity diagram



3. Implementation


10:55
SCRIPT SCANNER
मैं अगर कहूं तुम सा हसि
Camera
Gallery
Done


10:54
मैं अगर कहूं तुम सा हसि
Confirm

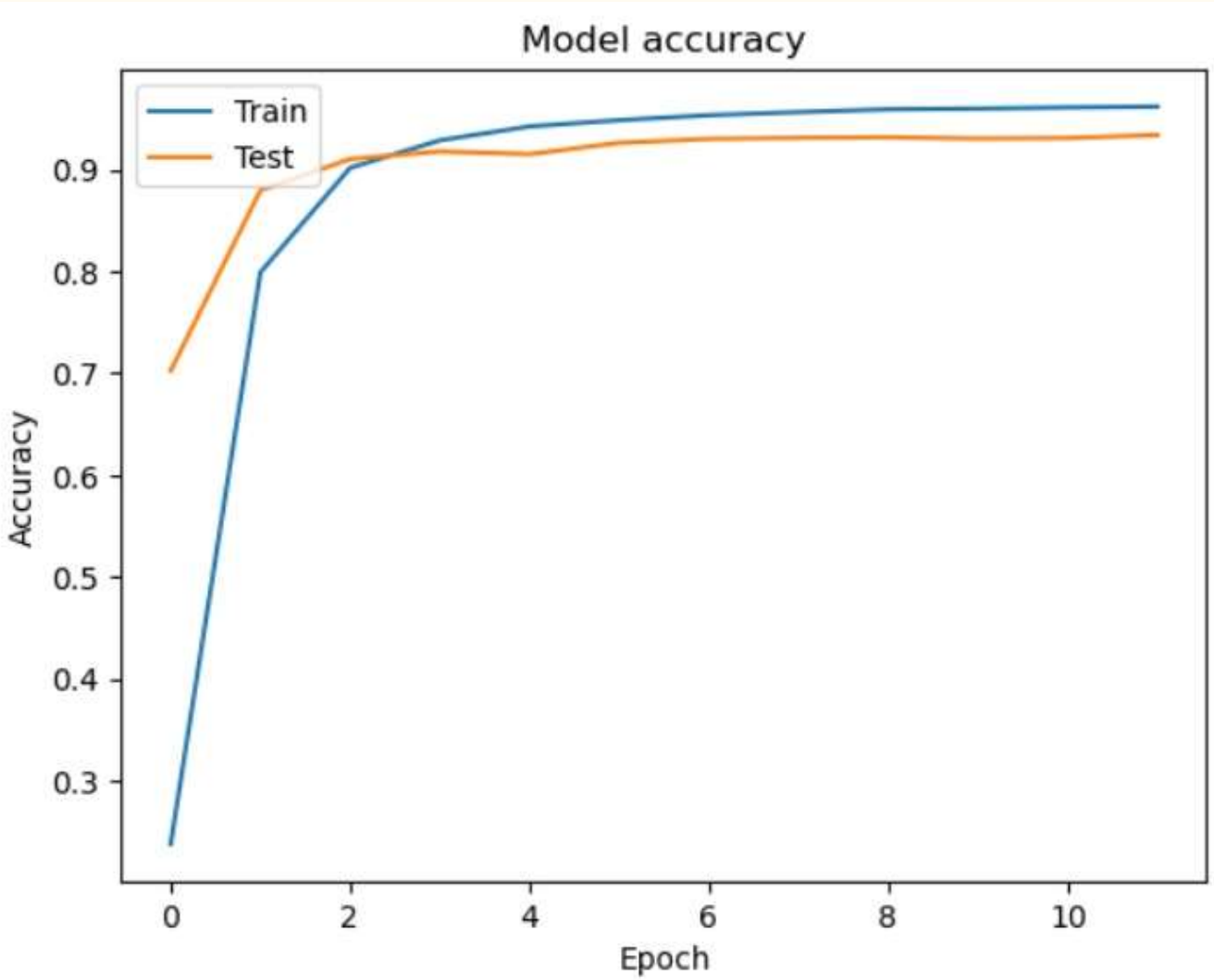

11:09
अगर मगर
क ण ख र

4. Testing

Test Case	Expected Result	Actual Result
1	Image uploaded successfully	Image uploaded successfully
2	Image is pre-processed correctly	Image pre-processing Success
3	Borders of image identified correctly	Borders not identified; image analysis incorrect
4	Image converted to greyscale successfully	Image converted
5	Image normalized to correct size	Image normalized
6	Noise removed from image	Noise still present, recognition accuracy reduced
7	Skew correction performed correctly	Skew correction failed; characters misaligned
8	Characters segmented accurately	Characters not segmented properly; recognition accuracy reduced
9	Character recognition accurate	Character recognition inaccurate, errors in output
10	Output text in correct digital format	Output in incorrect format, further processing required
11	Robust pre-processing handles various input images	Pre-processing fails on certain image types
12	Comprehensive database ensures accurate recognition	Database missing some characters, recognition accuracy reduced

5. Result

- The proposed system has yielded favourable results on our machines. The accuracy obtained is on average 84% and validation accuracy of about 97%.
- Despite having to train a large number of classes, the results were favourable.
- The model is trained on 459 classes as opposed to 46 classes in [1] and is trained in an average of 4 hours.
- The model was trained on 3 different machines 2 of which had integrated graphics and one having a dedicated graphics card
- During the training process, the model's accuracy improves as the number of epochs
- increases.
- In our proposed system, a significant increase in accuracy during the first few
- epochs was observed, after which the accuracy growth plateaued.
- The validation accuracy also increased steadily during the initial epochs before stabilizing at around 97%.



This shows the accuracy of our CNN model as it runs for multiple epochs.

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 64, 64, 32)	896
conv2d_1 (Conv2D)	(None, 64, 64, 32)	9248
max_pooling2d (MaxPooling2D)	(None, 32, 32, 32)	0
dropout (Dropout)	(None, 32, 32, 32)	0
conv2d_2 (Conv2D)	(None, 32, 32, 64)	18496
conv2d_3 (Conv2D)	(None, 32, 32, 64)	36928
max_pooling2d_1 (MaxPooling2D)	(None, 16, 16, 64)	0
dropout_1 (Dropout)	(None, 16, 16, 64)	0
conv2d_4 (Conv2D)	(None, 16, 16, 128)	73856
conv2d_5 (Conv2D)	(None, 16, 16, 128)	147584
max_pooling2d_2 (MaxPooling2D)	(None, 8, 8, 128)	0
dropout_2 (Dropout)	(None, 8, 8, 128)	0
conv2d_6 (Conv2D)	(None, 8, 8, 256)	131328
conv2d_7 (Conv2D)	(None, 8, 8, 256)	262400
conv2d_8 (Conv2D)	(None, 8, 8, 256)	590080
max_pooling2d_3 (MaxPooling2D)	(None, 4, 4, 256)	0
dropout_3 (Dropout)	(None, 4, 4, 256)	0
flatten (Flatten)	(None, 4096)	0
dense (Dense)	(None, 512)	2097664
dropout_4 (Dropout)	(None, 512)	0
dense_1 (Dense)	(None, 256)	131328
dropout_5 (Dropout)	(None, 256)	0
dense_2 (Dense)	(None, 459)	117963

Total params: 3,617,771
Trainable params: 3,617,771
Non-trainable params: 0

- Our CNN model uses multiple Convolution layers.
- It also includes pooling and dropout layers.
- The output of the model is flattened.
- Multiple dense layers are used to obtain the final output.

6. Conclusion and Future Scope

Conclusion:

- Handwritten Devanagari text digitization is crucial for preserving information.
- Manual digitization is prone to errors and slow.
- Our approach offers high accuracy and minimal errors at a low cost.
- The approach covers a larger set of characters than previous studies.

Future Scope:

- Future improvements include recognizing consonant clusters and integrating with text-to-speech software.
- The approach can be extended to recognize handwritten text in other languages.
- The model can be integrated into mobile applications for on-the-go digitization.

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Paper Publication

Paper entitled "**Developing Real-time Digitization System Using Deep Learning for Handwritten Documents**" will presented at "**2023 International Conference on Contemporary Challenges in Science and its Engineering Applications (IC3SEA 2023)"** by "**Atharv Joshi", " Siddhesh Puranik", "Niranjan Ram", "Sonal Balpande", "Jayashree Jha".**

Thank You