A NOVEL METHOD FOR HANDWRITTEN DIGIT RECOGNITION SYSYTEM

1. INTRODUCTION :

Handwritten character recognition is one of the practically important issues in pattern recognition applications. The main purpose of this project is to build an automatic handwritten digit recognition method for the recognition of handwritten digit string s. To accomplish the recognition task, first, the digits will be segmented into individual digits. Then, a digit recognition module is employed to classify each segmented digit completing the handwritten digit string recognition task. The applications of digit recognition include postal mail sorting, bank check processing, form data entry, etc. The heart of the problem lies within the ability to develop an efficient algorithm that can recognize handwritten digits and which is submitted by users by the way of a scanner, tablet, and other digital devices.

1.1 Project Overview:

Handwritten digit recognition is the process to provide the ability to machines to recognize human handwritten digits. It is not an easy task for the machine because handwritten digits are not perfect, vary from person-to-person, and can be made with many different flavors. This approach examines an image containing scanned text or handwritten characters and attempts to recall them using a variety of algorithms. The primary applications of OCR are recognized handwritten characters. First, we'll read images of handwritten digits from the MNIST dataset, which is extremely well arranged, and try to figure out which digit each image represents. For this, we will be using artificial neural networks (i.e., CNN) which is considered to be the best for the purpose. Artificial neural networks are similar to the neural network of the human brain which is a set of I/O units that are linked together (i.e., neurons) where each connection has a weight associated with it, and each relation has a weight associated with it. We may choose to use ANN to build statistical models from massive datasets. This paradigm assists us in comprehending image classification. These neurons are split between three layers, Input layer receives inputs and passes it to other layers. The number of input neurons is approximately the same as the number of functions. Hidden layer applies various convolutions and transformations to the inputs before passing them further. The weights are updated as the network is conditioned to be superfluous predictive and precise. Small random numbers, such as 0 to 1, are often used to initialize neuron weights. The output neuron is the predicted feature in the output layer.

1.2 Purpose:

The handwritten digit recognition is the capability of computer applications to recognize the human handwritten digits. It is a hard task for the machine because handwritten digits are not perfect and can be made with many different shapes and sizes. The handwritten digit recognition system is a way to tackle this problem which uses the image of a digit and recognizes the digit present in the image.

2.LITERATURE SURVEY:

2.1 EXISTING PROBLEM:

As we know there is no computer which can beat the level of the human brain. So due to these inefficiencies in computers we use artificial neural networks to make them somehow efficient like humans. Human brain easily processes and analyzes images. Brain automatically identifies and recognizes the elements and features of images. Image processing is a field which deals with enabling machines to do such tasks that our brain can do with images.

Nowadays we see that technology is increasing repeatedly and many options are available to perform Handwritten digit recognition. But CNN plays a very crucial role in many image processing applications. CNN is used for detection of data loss (fault) and accuracy of the application. In paper we have shown use of deep learning with others such as CNN using TensorFlow, Keras, OpenCV. These algorithms are used widely by researchers as experiments for theories of machine learning. Many researchers are using this technique other than machine learning algorithms such as SVM, KNN, and RFC etc., they prefer to use CNN because it gives high accuracy in image classification, video analysis etc. Moreover, it is also used in sentiment recognition, researchers are going for more accurate modal and less error correction [2]. The CNN (Convolutional Neural Network) has brought a revolutionary change in the field of machine learning. Particularly in character recognition. In 2003, Simard et al. introduced a general CNN architecture for analysis of visual documents and the sophisticated training method of neural networks. According to the findings, DNN gives accuracy of around 98.85% but fails against CNN approach in team of time. An encoder network, a decode network, and a pixel-wise classification layer make up the segmentation. For decoding, the proposed approach used max-pooling indices, and the result was quickly observed as good results. This method was also analyzed with past existing techniques for more deep understanding.

2.2 REFERENCES:

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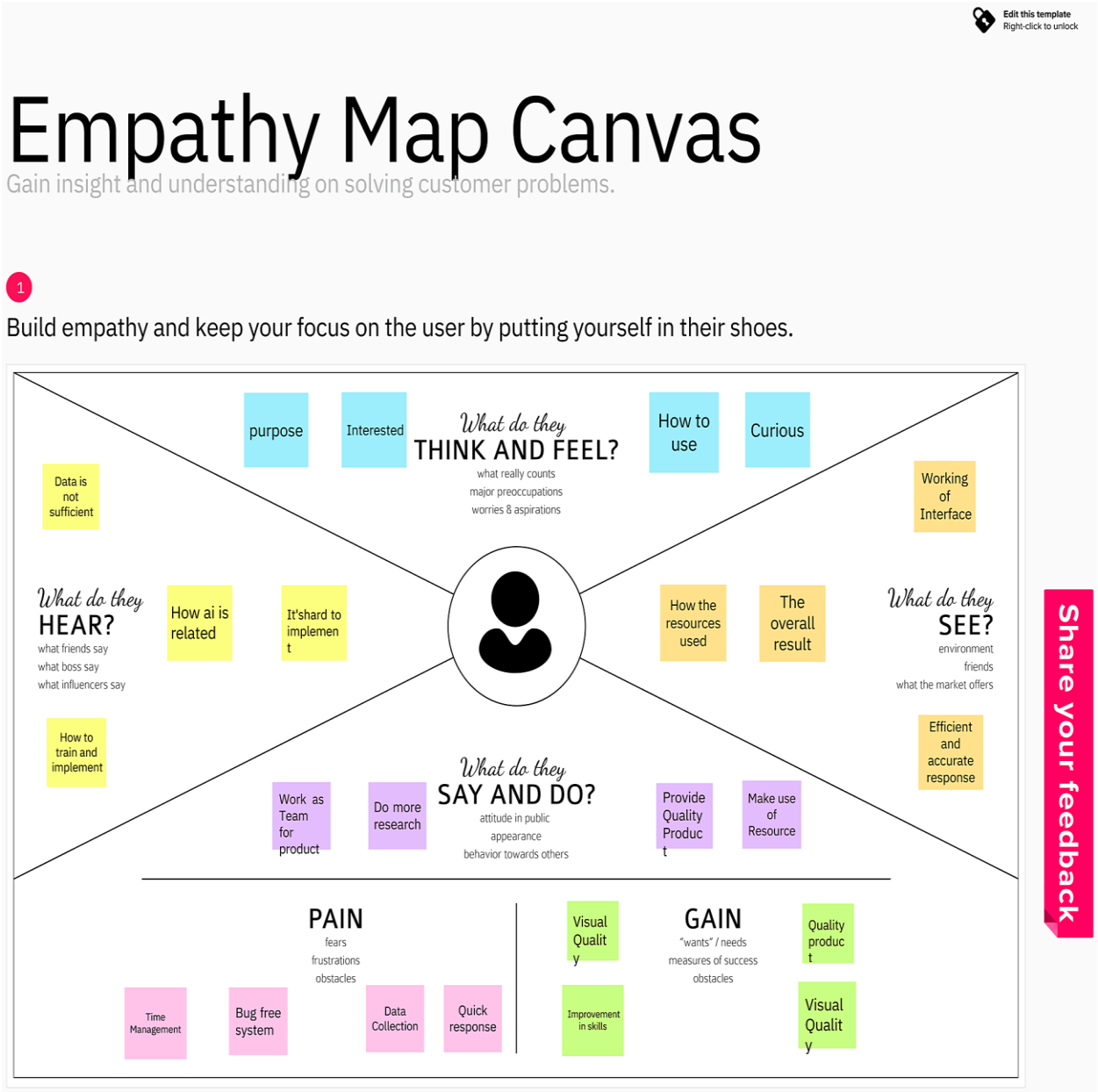
2.3 PROBLEM STATEMENT DEFINITION:

Handwriting recognition has been the main subject of research for almost the last forty years. This research work analyzes the behaviour of classification techniques (CNN) in a large handwriting dataset (MNIST) to predict a digit. Machine-learning techniques, particularly when applied to Neural Networks like CNN or ANN, have played an increasingly important role in the design of these recognition systems. Several methods have been developed in handwritten digit recognition and these methods have been classified into categories: knowledge-based methods, feature-based methods, template-based methods and appearance-based methods. Errors in Digit recognition cause severe problems like digits written on a bank cheque if recognized erroneously could result in unfortunate consequences.

The goal of our work is to create a model that will be able to recognize and classify the handwritten digits from images by using concepts of Convolution Neural Network. Though the goal of our research is to create a model for digit recognition and classification, it can also be extended to letters and an individual's handwriting. The major goal of the proposed system is understanding Convolutional Neural Network, and applying it to the handwritten digit recognition system by working on the MNIST dataset. There have already been significant advancements in this area of research previously. We have tried to form a model around the Conventional Neural Network with MNIST as our dataset so that the model has high accuracy and has been trained and tested on a large dataset. We shall also consider developing a robust test harness for estimating the performance of the model and then exploring improvements to the model. With high accuracy rates, the model can solve a lot of real-life problems.

3.IDEATION & PROPOSED SOLUTION:

3.1 EMPATHY MAP CANVAS:



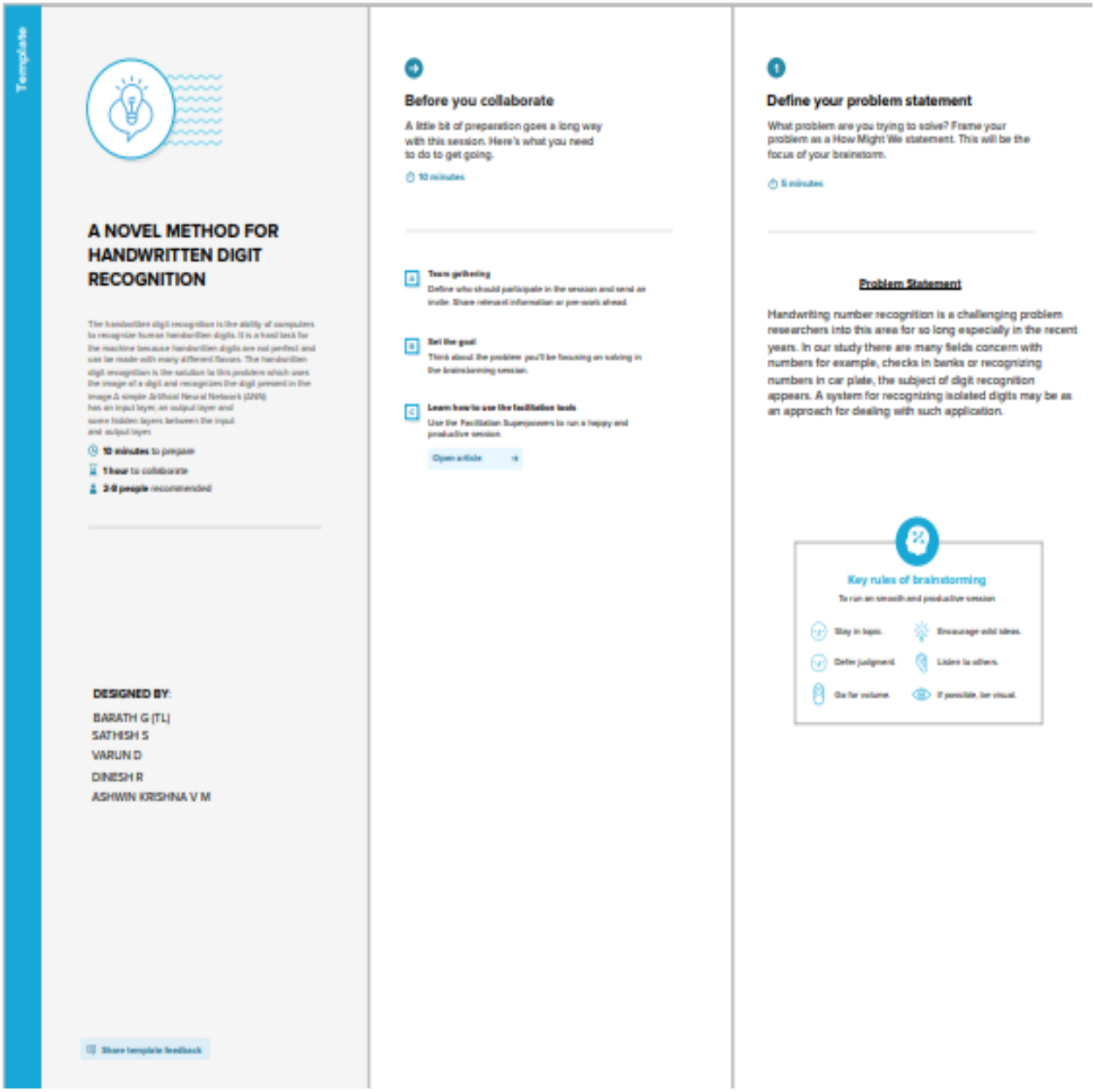
3.2 IDEATION & BRAINSTORMING:

Ideation:

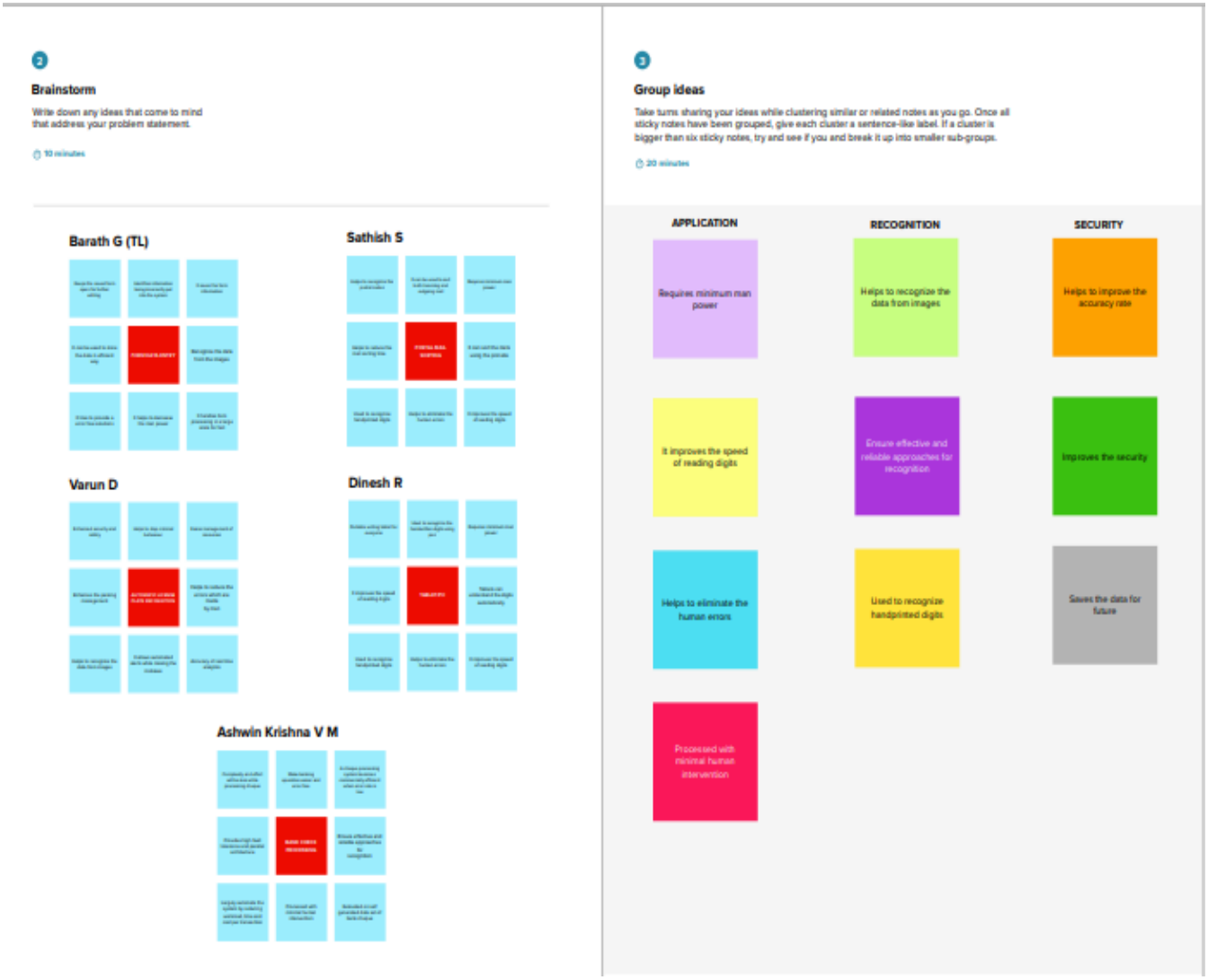
Who does the problem effect?	**Individuals:** It is used for those who want to extract numbers from the written document **Organisations:** It is useful for the people which are dealing with courier services for recognizing the pincodes , phonenumbers
What are the boundaries of problem?	It has been demonstrated that raw data entering with no subsequent verification processes has an error rate as high as 4%. That means that for every five entries made, there are two mistakes.
When does the issue work?	Data entering by hand takes numerous time. 10,000 to 15,000 keystrokes per hour is a decent rate for entering data from paper documents. Complex facts that require understanding before entry would slow down the process even more. Thus, it would take an experienced operator between eight and 10 minutes to enter 400 units of data, which is unsatisfactory when the volume of data is considerable.
Where does the issue work?	According to 55 percent of the employees questioned, gathering, uploading,and syncing data is the manual data input process that is least productive. Delivering Updates 32 percent of staff members believe that maintaining status updates and other information takes time away from more beneficial work
Why is it important to fix the problem?	Data entry can be significantly sped up by automation, especially when numerous data from several sources needs to be combined into one format.Redirecting valuable human time and effort to more useful and enjoyable tasks would increase work satisfaction and help retain employees.
What solution to solve the issue?	We solve this problem by creating automated digit recognition software using neural networks with high accuracy and precision

Brainstorming:

Step 1: Team Gathering, Collaboration and Select the problem statement



Step 2: Brainstorm, Idea Listing and Grouping



Step 3: Idea Prioritization

4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

3.3 Proposed Solution

The model has successfully built a Python deep learning project on handwritten digit recognition app. We have built and trained the Convolutional neural network which is very effective for image classification purposes. After creating the Web API , Input is been provided through image and the digit is been recognized.

4. REQUIREMENT ANALYSIS:

4.1 Functional Requirement:

The functional requirement for the proposed solution are:

FR NO.	FUNCTIONAL REQUIREMENT	SUB REQUIREMENT(story/subtask
FR1	The product essentially converts handwritten digits to digital form.	The user is first asked to draw a number on the canvas, and the model that is built is then utilised to compare the data and provide an output in digitalized form.
FR2	Recognizing the handwritten digit and displaying.	Recognizing the handwritten digit and displaying
FR3	Import dataset file directly to the program from a command that will download the dataset from its website. Save the dataset file in the same directory as the program	Installing packages and applications.
FR4	Build a Neural Network with a number of nodes in the input layer equal to the number of pixels in the arrays	NIL
FR5	Activating the Neural Network	Packages – tensorflow

4.2 Non- Functional Requirements:

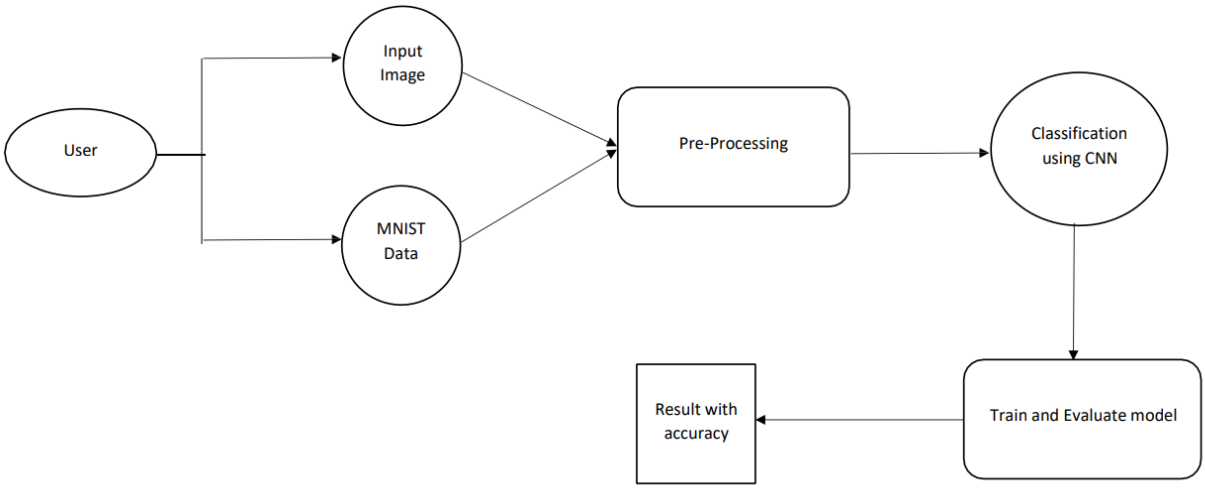
The non-functional requirements of the proposed solution

FR NO.	NON FUNCTIONAL REQUIREMENT	DESCRIPTION
NFR1	Usability	System design should be easily understood and user friendly to users. Furthermore, users of all skill levels of users should be able to navigate it without problems

NFR2	Security	The system should automatically be able to authenticate all users with their unique username and password
NFR3	Performance	Should reduce the delay in information when hundreds of requests are given.
NFR4	Availability	Information is restricted to each users limited access
NF	Scalability	the system should be able to handle 10000 users accessing the site at the same time

5.PROJECT DESIGN:

5.1 Data Flow Diagrams:

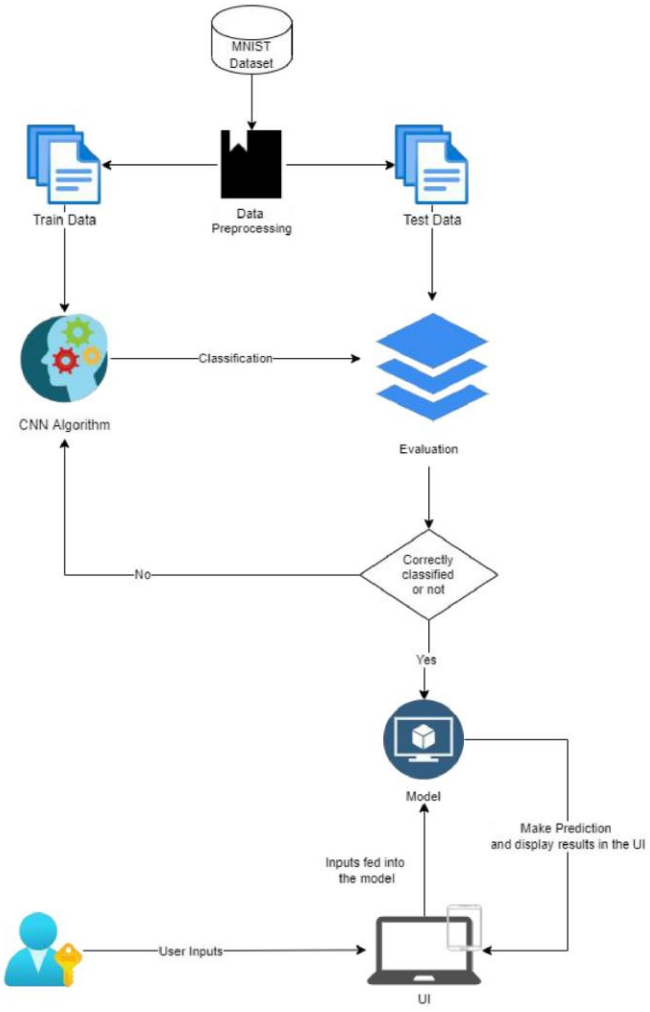


5.2 Solution & Technical Architecture:

Solution :

S.NO	PARAMETER	DESCRIPTION
1.	Problem Statement (Problem to be solved)	A Novel Method for Handwritten Digit Recognition System

2.	Idea / Solution description	The proposed solution is to classify the digits which is in handwritten format by using CNN based model and this model can be trained by using MNIST database which contains 60,000 training samples and 10,000 test samples.
3.	Novelty / Uniqueness	To classify the image datasets by using CNN, which provides efficient solution compare to other methods. Here ANN algorithm is used for voice recognition which helps blind people.
4.	Social Impact / Customer Satisfaction	Users no need to use external dependencies or devices to recognize the digits, this process can be done through our mobile phones.
5.	Business Model (Revenue Model)	1. Input module 2. Image processing module 3. Segmentation module 4. Feature extraction module 5. Data set training module 6. Classification module
6.	Scalability of the Solution	The accuracy of the result for the training data set is 99.98%, and 99.40% with 50% noise by using MNIST. Even we can improve this model to achieve the better results by training different types of datasets.


MNIST Dataset
Train Data
Data Preprocessing
Test Data
Classification
CNN Algorithm
Evaluation
Correctly classified or not
No
Yes
Model
Make Prediction and display results in the UI
Inputs fed into the model
User Inputs
UI

TECHNICAL ARCHITECTURE

5.3 User Stories :

The user stories for the solution:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer	Application	USN-1	As a user, I can application by opening it easily.	I can download the application	High	Sprint-1
		USN-2	As a user, I will be given access to the canvas board to draw or write the number	I can access the canvas	High	Sprint-1
		USN-3	As a user, I can change the colour of the pen ink.	I can use the canvas pen	Medium	Sprint-2

6.PROJECT PLANNING AND SCHEDULING:

6.1 Sprint Planning & Estimation:

Sprint	Functional Requirement	Task
Sprint-1	Image Data	As a User need to collect the Image Data of Handly Written Images to train the model.
Sprint-2	Dash Board or Website	We using Python Flask Framework to create a dynamic Webpage to host our model (UI).
Sprint-3	Classifier Model	Using CNN Model for Image Classification.

Sprint-4	Cloud	Hosting the Organized appication in Cloud platform.

6.2 Sprint Delivery Schedule:

The backlog and sprint delivery schedule for the solution:

Sprint	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Story Points**	**Priority**	**Team Members**
Sprint-1	Data Collection & pre processing	USN-1	As a user, I can upload any kind of image with the pre-processing step is involved in it.	10	High	Varun D
Sprint-1		USN-2	As a user, I can upload the image in any resolution.	10	High	Sathis S
Sprint-2	Building the Machine learning model	USN-3	As a user, I will get a application with ML model which provides high accuracy of recognized handwritten digit	3	Medium	Dinesh R

Sprint-2		USN-4	As a user, I can pass the handwritten digit image for recognizing the digit.	2	Medium	Barath G, Ashwin Krishna V M

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-2		USN-5	As a user, I can get the most suitable recognized digit.	10	High	Varun D
Sprint-3	Building User Interface Application	USN-6	As a user, I will upload the handwritten digit image to the application by clicking a upload button.	8	Medium	Barath G
Sprint-3		USN-7	As a user, I can know the details of the fundamental usage of the application	2	High	Sathish S
Sprint-3		USN-8	As a user, I can see the predicted / recognized digits in the application	10	Medium	Dinesh R

Sprint-4	Train and deployment of model in IBM Cloud	USN-9	As a user, I can access the web application and make the use of the product from anywhere	20	Medium	Ashwin Krishna V M

6.3 Reports From JIRA:

7.CODING & Solutioning

7.1 Feature1

7.2 Feature2

7.3 Database schema

8.TESTING

8.1 Test Cases

8.2 User Acceptance Testing

9.RESULTS

9.1 Performance Metrics

10.Advantages & Disadvantages:

This approach has many advantages:

1. System not only produces a classification of the digit but also a rich description of the instantiation parameters which can yield information such as the writing style.
2. During the process of explaining the image, generative models can perform recognition driven segmentation.
3. The method involves a relatively small number of parameters and hence training is relatively easy and fast.
4. Unlike many other recognition schemes, it does not rely on some form of pre-normalization of input images, but can handle arbitrary scalings, translations and a limited degree of image rotation.

Disadvantages:

The disadvantage is that, it is not done in real time as a person writes and therefore not appropriate for immediate text input. Applications of offline handwriting recognition are numerous: reading postal addresses, bank check amounts, and forms.

11. Conclusion

Using Neural Network system, back-propagation learning, to recognize handwritten digits was very successful. An image, which contained 100 samples of each number, was trained and tested. The accuracy rate of recognizing the number was 96%. This accuracy rate is high. It gave different training and testing results every day for each numeral. It will need to take a close look at the system and should look for improvements for the future. From the net-file, the system was able to produce an image-file. This part will also need more improvements. Apart from the above problems and parts that need improvements, the overall recognition system was successful.

12.Future Scope

The task of handwritten digit recognition using a classifier has a great importance and use such as online hand writing recognition on computer tablet,recognize zipcodes on mail for postal mail sorting, processing bank check amount, numeric enteries informs filledup by hand and so on.

13.Appendix