RMK ENGINEERING COLLEGE

(An Autonomous Institution)

R.S.M Nagar, Kavaraipettai -601 206,Gummidipondi Taluk, Thiruvallur District.

PROJECT

A Novel Method For Handwritten Recognition System

DONE BY

TEAM ID:PNT2022TMID15787

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1.INTRODUCTION

1.1 Project Overview:

The handwritten digit recognition is the ability of computers to recognize human handwritten digits. It is a hard task for the machine because handwritten digits are not perfect and can be made with many different flavours. The handwritten digit recognition is the solution to this problem which uses the image of a digit and recognizes the digit present in the image.

1.2 Purpose:

Handwritten character recognition is one of the practically important issues in pattern recognition applications. The applications of digit recognition include in postal mail sorting, bank check processing, form data entry, etc.

2.LITERATURE SURVEY

2.1 Existing Problem:

Author(s)	Method/Algorithm Used	Datasets used	Result	Limitations
Dan ClaudiuCiresan et al. [1]	Simple Neural network and back propagation	MNIST	0.7% error rate i.e. 99.1 percent accuracy	Higher processor required ,High cost, Time consuming
HyeranByun et al. [2]	SVM	MNIST	97.3% accuracy on Test data	Accuracy rate is low to test on our own data
Li Deng et al. [3]	Neural network (after distortion)	MNIST	0.4-0.6% error rates 99.2	--lack of accuracy due to absence of convolution networks
AyushPurohit et al. [4]	Hill climbing algorithm for handwritten character recognition.	MNIST	93% accuracy on upper case letters.	Unable to identify distorted data
Vineet Singh et al. [5]	PCA Principal component analysis.	MNIST	98.39% accuracy rate	Consumes more training time
PoojaYadav et al. [6]	Back-propagation neural network	MNIST	96% accuracy	Requires large memory
L. Bottou et al. [7].	Baseline Linear Classifier, LeNet 1, Le Net 4, Large fully connected multi network	NIST	1)92.2% 2)98.3% 3)98.9% 4)98.4%	Much complex networks with high computation time.
Mahmoud M. Abu et al. [8]	CNN, DNN	Random MNIST (shuffled)	98.5% 98.6%	Shuffled dataset provide less accuracy and consumes time
Xuefeng Xiaoa et al. [9]	Baseline LeNet-5	CASIAHWDB1.0 CASIA-HWDB1.1	1)97.3% 2)99.1%	High Computation time

2.2 References:

[1]Kusumgupta ,"A comprehensive review on handwritten digit recognition using various neural network approaches", international journal of enhanced research in management & computer applications, vol. 5, no. 5, pp. 22-25, 2016.

[2] Ishani Patel, ViragJagtap and OmpriyaKale."A Survey on Feature Extraction Methods for Handwritten Digits Recognition", International Journal of Computer Applications, vol. 107, no. 12, pp. 11-17, 2014.

[3] Y LeCun,"COMPARISON OF LEARNING ALGORITHMS FOR HANDWRITTEN DIGIT RECOGNISATION".In:International conference on Artificial Neural networks, France, pp. 53–60. 1995.

[4]FaisalTehseen Shah, Kamran Yousaf,"Handwritten Digit Recognition Using Image Processing and Neural Networks", Proceedings of the World Congress on Engineering, vol., 2007.

[5]Viragkumar N. Jagtap , Shailendra K. Mishra,"Fast Efficient Artificial Neural Network for Handwritten Digit Recognition", International Journal of Computer Science and Information Technologies, vol. 52, no. 0975- 9646, pp. 2302-2306, 2014.

[6]Saeed AL-Mansoori,"Intelligent Handwritten Digit Recognition using Artificial Neural Network", Int. Journal of Engineering Research and Applications, vol. 5, no. 5, pp. 46-51, 2015.

2.3 Problem Statement Definition:

Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically. Because of the progress

in the field of science and technology, everything is being digitalized to reduce human effort. Hence, there comes a need for handwritten digit recognition in many real-time applications. MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. this image is analyzed by the model and the detected result is returned on to UI.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas:

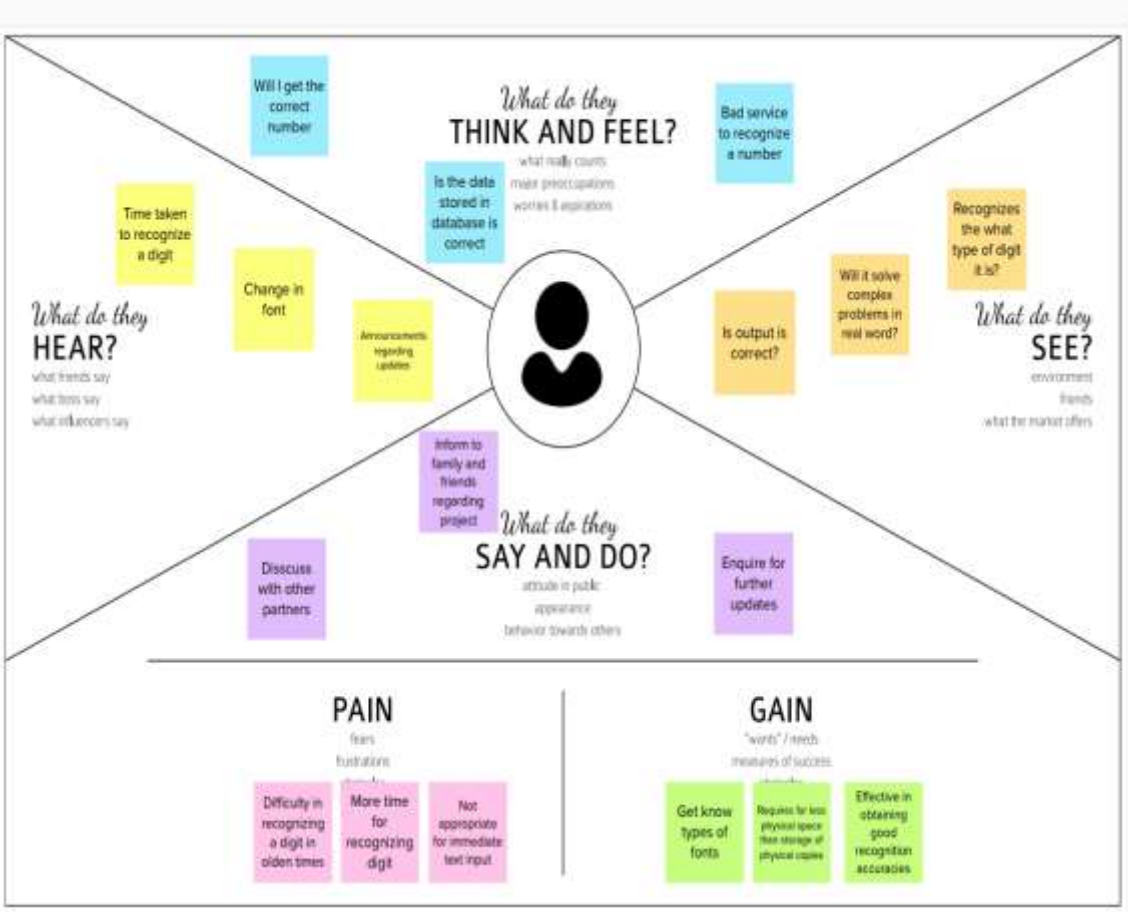


Figure 1: Empathy map.

3.2 Ideation & Brainstroming :

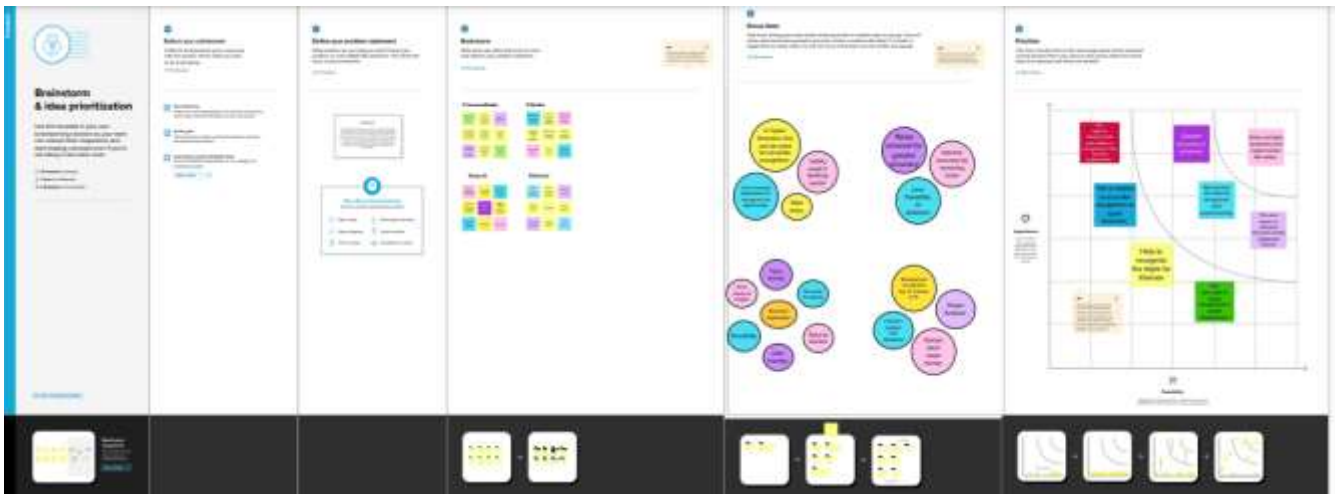


Figure 2: Ideation and Brainstroming.

3.3 Proposed Solution:

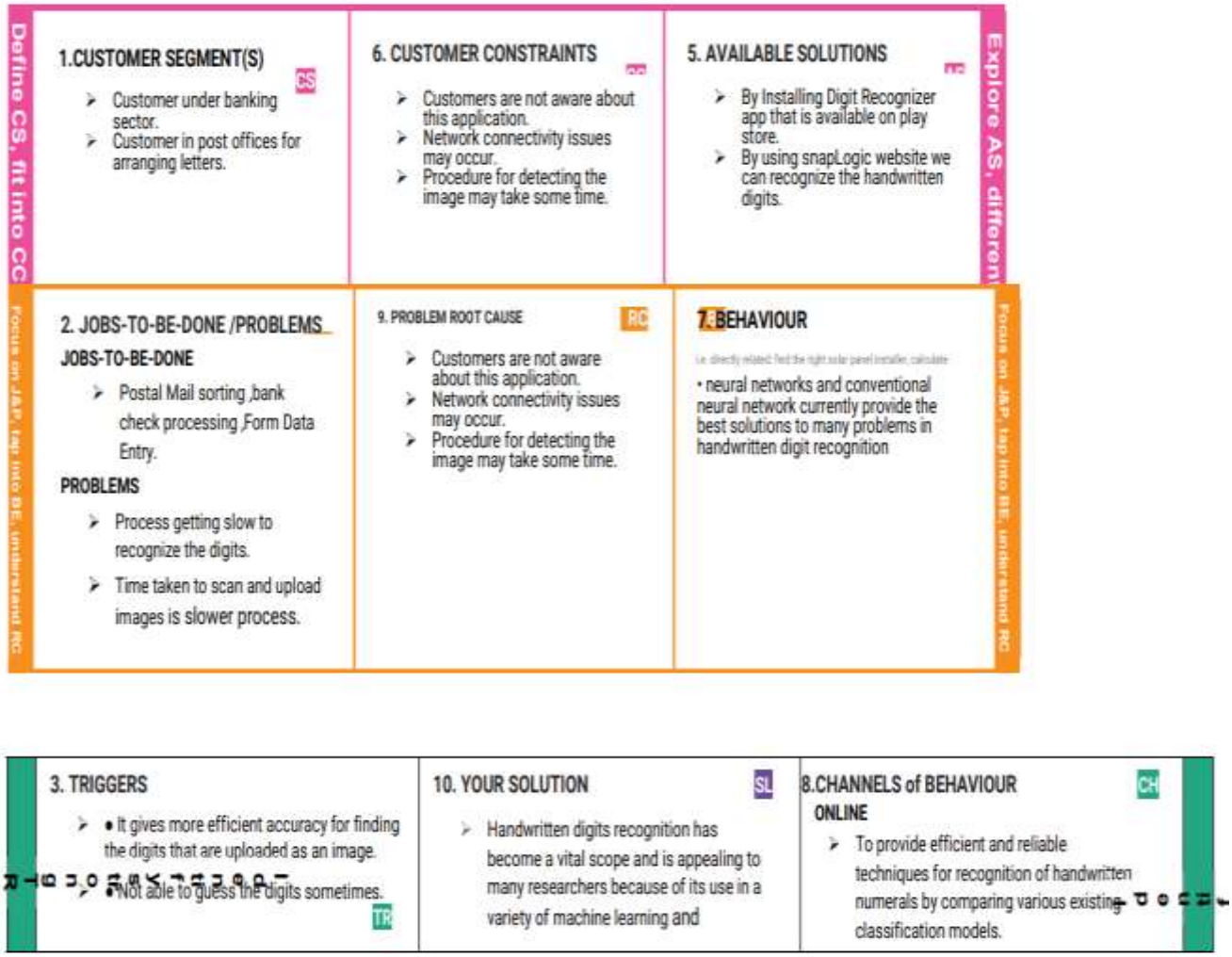
S.NO	Parameter	Description
1.	Problem Statement (Problem to be solved)	**Statement:** The handwritten digit recognition is the capability of computer applications to recognize the human handwritten digits. **Description:** It is a hard task for the machine because handwritten digits are not perfect and can be made with many different shapes and sizes.
2.	Idea / Solution description	1. It is the capability of a computer to fete the mortal handwritten integers from different sources like images, papers, touch defences. 2. It allows user to translate all those signature and notes into electronic words in a text document format and this data only requires far less physical space than the storage of the physical copies.

3.	Novelty / Uniqueness	Accurately recognize the digits rather than recognizing all the characters like OCR.
4.	Social Impact / Customer Satisfaction	1.Artificial Intelligence developed the app called Handwritten digit Recognizer. 2.It converts the written word into digital approximations and utilizes complex algorithms to identify characters before churning out a digital approximation.
5.	Business Model (Revenue Model)	1. This system can be integrated with traffic surveillance cameras to recognize the vehicle's number plates for effective traffic management. 2. Can be integrated with Postal system to identify and recognize the pin-code details easily.
6.	Scalability of the Solution	1.Ability to recognise digits in more noisy environments. 2.There is no limit in the number of digits it can be recognized.

3.4 Problem Solution fit:

Project Title: A Novel Method for Handwritten Digit Recognition System
Team ID: PNT2022TMID15787

Project Design Phase-I - Solution Fit Template



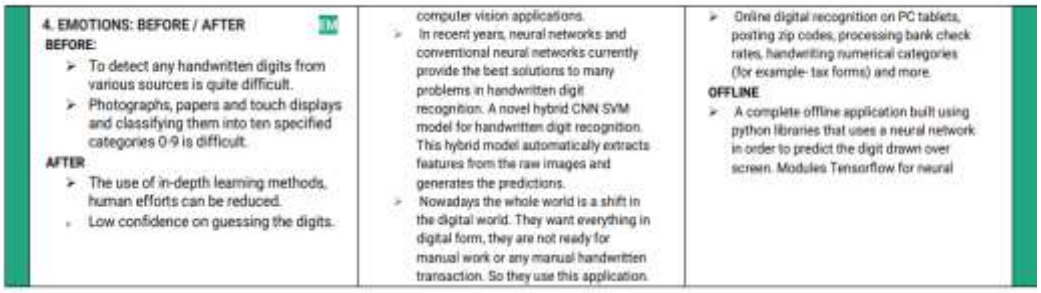


Figure 3: Problem solution fit

4.REQUIREMENT ANALYSIS

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Sub Requirement (Story / Sub-Task)
FR-1	Image Data: Handwritten digit recognition refers to a computer's capacity to identify human handwritten digits from a variety of sources, such as photographs, documents, touch screens, etc., and categorise them into ten established classifications (0-9). In the realm of deep learning, this has been the subject of countless studies.
FR-2	Website: Web hosting makes the code, graphics, and other items that make up a website accessible online. A server hosts every website you've ever visited. The type of hosting determines how much space is allotted to a website on a server. Shared, dedicated, VPS, and reseller hosting are the four basic varieties.
FR-3	Digit Classifier Model: To train a convolutional network to predict the digit from an image, use the MNIST database of handwritten digits. Get the training and validation data first.
FR-4	Cloud: The cloud offers a range of IT services, including virtual storage, networking, servers, databases, and applications. In plain English, cloud computing is described as a virtual platform that enables unlimited storage and access to your data over the internet.
FR-5	Modified National Institute of Standards and Technology dataset: The abbreviation MNIST stands for the MNIST dataset. It is a collection of 60,000 tiny square grayscale photographs, each measuring 28 by 28, comprising handwritten single digits between 0 and 9.

4.2 Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	One of the very significant problems in pattern recognition applications is the recognition of handwritten characters. Applications for digit recognition include filling out forms, processing bank checks, and sorting mail.
NFR-2	**Security**	1) The system generates a thorough description of the instantiation parameters, which might reveal information like the writing style, in addition to a categorization of the digit. 2) The generative models are capable of segmentation driven by recognition. 3) The procedure uses a relatively.
NFR-3	**Reliability**	The samples are used by the neural network to automatically deduce rules for reading handwritten digits. Furthermore, the network may learn more about handwriting and hence enhance its accuracy by increasing the quantity of training instances. Numerous techniques and algorithms, such as Deep Learning/CNN, SVM, Gaussian Naive Bayes, KNN, Decision Trees, Random Forests, etc., can be used to recognise handwritten numbers
NFR-4	**Performance**	With typed text in high -quality photos, optical character recognition (OCR) technology offers accuracy rates of greater than 99%. However, variances in spacing, abnormalities in handwriting, and the variety of human writing styles result in less precise character identification
NFR-5	**Availability**	

5.PROJECT DESIGN

5.1 Data flow Diagrams:

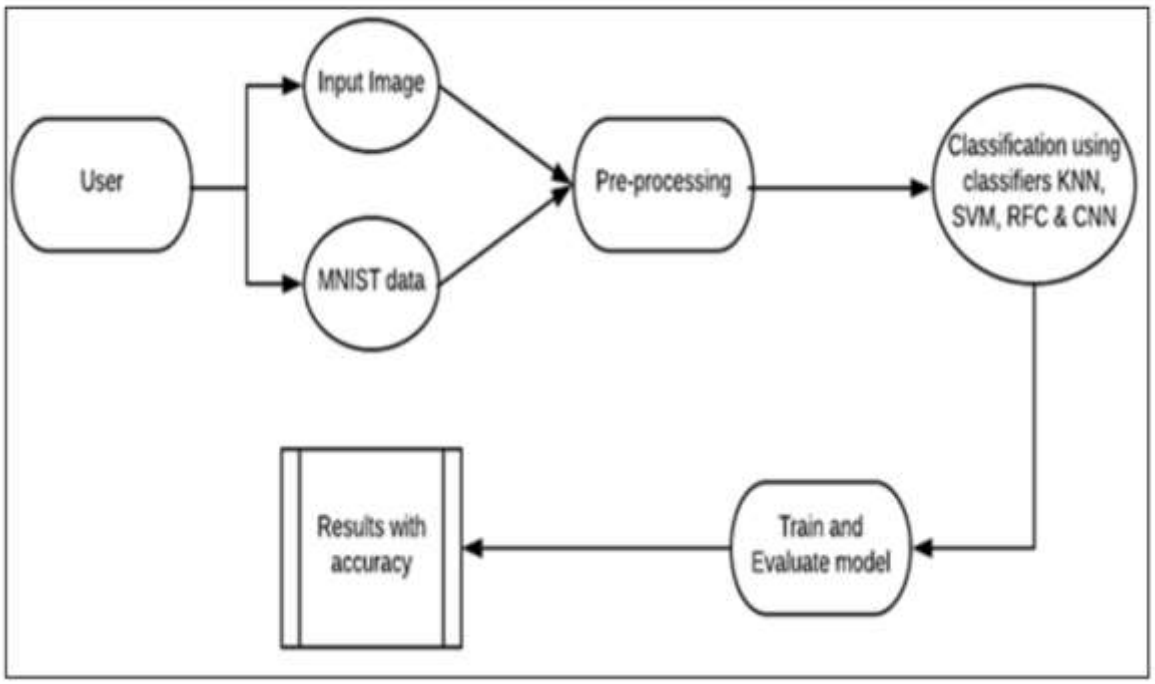


Figure 4: Data flow diagrams

5.2 Solution & Technical Architecture:

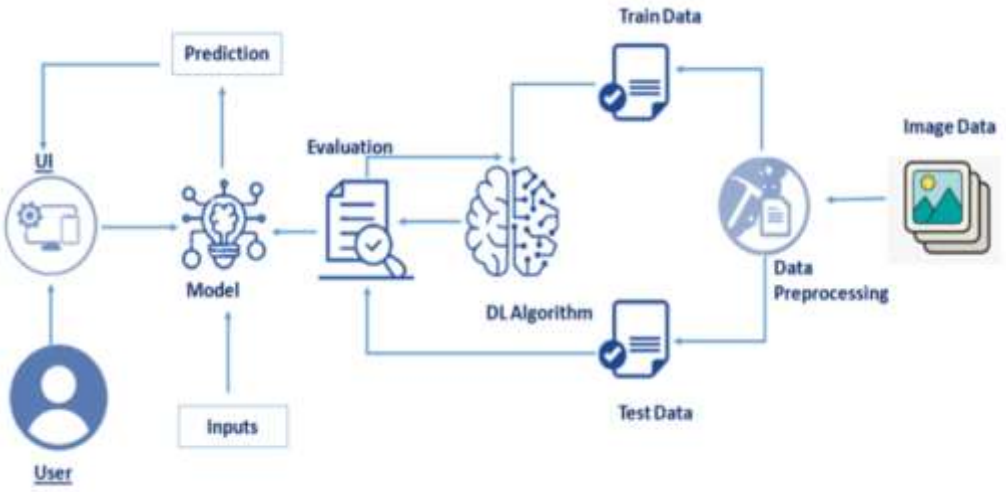


Figure 5: Solution and Technical Architecture

5.3 User Stories:

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Home	USN-1	As a user, I can view the guide and awareness to use this application.	I can view the awareness to use this application and its limitations.	Low	Sprint-1
		USN-2	As a user, I'm allowed to view the guided video to use the interface of this application.	I can gain knowledge to use this application by a practical method.	Low	Sprint-1
		USN-3	As a user, I can read the instructions to use this application.	I can read instructions also to use it in a user-friendly method.	Low	Sprint-2
	Recognize	USN-4	As a user, In this prediction page I get to choose the image.	I can choose the image from our local system and predict the output.	High	Sprint-2
	Predict	USN-6	As a user, I'm Allowed to upload and choose the image to be uploaded	I can upload and choose the image from the system storage and also in any virtual storage.	Medium	Sprint-3
		USN-7	As a user, I will train and test the input to get the maximum accuracy of output.	I can able to train and test the application until it gets maximum accuracy of the result.	High	Sprint-4
		USN-8	As a user, I can access the MNIST data set	I can access the MNIST data set to produce the accurate result.	Medium	Sprint-3
Customer (Web user)	Home	USN-9	As a user, I can view the guide to use the web app.	I can view the awareness of this application and its limitations.	Low	Sprint-1
User Type	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Acceptance criteria**	**Priority**	**Release**
Customer (Mobile user)	Home	USN-1	As a user, I can view the guide and awareness to use this application.	I can view the awareness to use this application and its limitations.	Low	Sprint-1

		USN-2	As a user, I'm allowed to view the guided video to use the interface of this application.	I can gain knowledge to use this application by a practical method.	Low	Sprint-1
		USN-3	As a user, I can read the instructions to use this application.	I can read instructions also to use it in a user-friendly method.	Low	Sprint-2
	Recognize	USN-10	As a user, I can use the web application virtually anywhere.	I can use the application portably anywhere.	High	Sprint-1
		USN-11	As it is an open source, can use it cost freely.	I can use it without any payment to be paid for it to access.	Medium	Sprint-2
		USN-12	As it is a web application, it is installation free	I can use it without the installation of the application or any software.	Medium	Sprint-4
	Predict	USN-13	As a user, I'm Allowed to upload and choose the image to be uploaded	I can upload and choose the image from the system storage and also in any virtual storage.	Medium	Sprint-3

6.PROJECT PLANNING & SCHEDULING

6.1 Sprint planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	P.Jeevana Reddy
Sprint-1	Login	USN-2	As a user, I can log into the application by entering email & password	1	High	P.Dharani
Sprint-2	Upload Image of digital document	USN-3	As a user, I can able to input the images of digital documents to the application	2	Medium	Navya.N
Sprint-2	Prediction	USN-4	As a user, I can predict the word	1	Medium	P.Sindhu

Sprint-3	Upload Image of Handwritten document	USN-5	As a user, I can able to input the images of the handwritten documents or images to the application	2	High	P.Jeevana Reddy
Sprint-3	Recognize text	USN-6	As a user, I can able to choose the font of the text to be displayed	1	Medium	P.Dharani
Sprint-4	Recognize digit	USN-7	As a user I can able to get the recognised digit as output from the images of digital documents or images	1	Medium	Navya.N
Sprint-4	Recognize digit	USN-8	As a user I can able to get the recognised digit as output from the images of handwritten documents or images	2	High	P.Sindhu

6.2 Sprint Delivery Schedule:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	2	6 Days	24 Oct 2022	29 Oct 2022	2	29 Oct 2022
Sprint-2	2	6 Days	31 Oct 2022	05 Nov 2022	2	05 Nov 2022
Sprint-3	2	6 Days	07 Nov 2022	12 Nov 2022	2	12 Nov 2022
Sprint-4	2	6 Days	14 Nov 2022	19 Nov 2022	2	19 Nov 2022

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

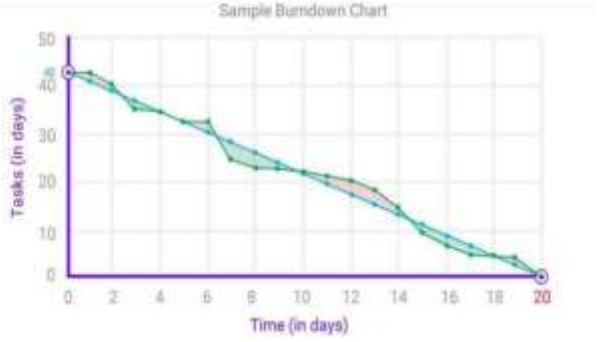
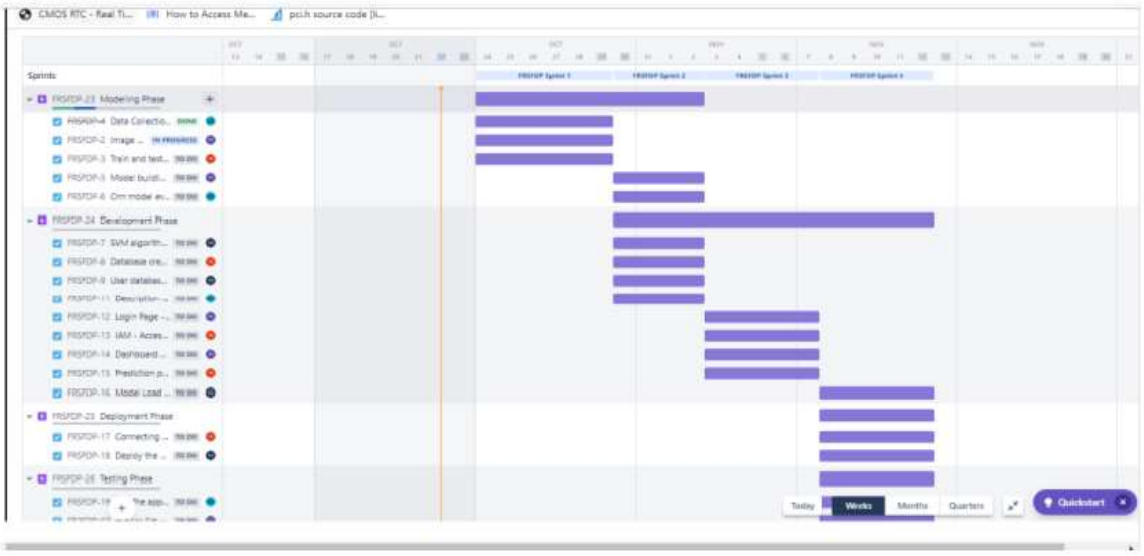


Figure 6: Sample Burndown Chart

6.3 Reports from JIRA:



7.Coding and Solutioning

7.1 Feature-1

Index.html

```
<html>

<head>

  <title>Digit Recognition</title>


  <meta name="viewport" content="width=device-width">

  <!-- GoogleFont -->

  <link href="https://fonts.googleapis.com/css2?family=Prompt:wght@600&display=swap" rel="stylesheet">

  <link href="https://fonts.googleapis.com/css2?family=Varela+Round&display=swap" rel="stylesheet">

  <link href="https://fonts.googleapis.com/css2?family=Source+Code+Pro:wght@500&display=swap" rel="stylesheet">
```

```
  <link
href="https://fonts.googleapis.com/css?family=Calistoga|Josefin+Sans:400,700|Pacifico&dis
play=swap" rel="stylesheet">

  <!-- bootstrap -->

  <link rel="stylesheet"
href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css"
integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T"
crossorigin="anonymous">

  <link rel="stylesheet" type= "text/css" href="static\css\style.css">

  <!-- fontawesome -->

  <script src="https://kit.fontawesome.com/b3aed9cb07.js"
crossorigin="anonymous"></script>


  <script src="https://code.jquery.com/jquery-3.3.1.slim.min.js" integrity="sha384-
q8i/X+965DzO0rT7abK41JStQIAqVgRVzpbzo5smXKp4YfRvH+8abtTE1Pi6jizo"
crossorigin="anonymous"></script>

  <script src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.14.7/umd/popper.min.js"
integrity="sha384-
UO2eT0CpHqdSJQ6hJty5KVphtPhzWj9WO1clHTMGa3JDZwrnQq4sF86dIHNDz0W1"
crossorigin="anonymous"></script>

  <script src="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/js/bootstrap.min.js"
integrity="sha384-
JjSmVgyd0p3pXB1rRibZUAYoIIy6OrQ6VrjIEaFf/nJGzIxFDsf4x0xIM+B07jRM"
crossorigin="anonymous"></script>

  <script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs@latest"></script>


</head>


<script>

  function preview() {

    frame.src=URL.createObjectURL(event.target.files[0]);

}


    $(document).ready(function() {

        $('#clear_button').on('click', function() {
```

```
            $('#image').val('');
            $('#frame').attr('src','');
          });
        });

</script>

<body>
  <section>
  <h1 class="welcome">IBM PROJECT

  <div id="team_id">TEAM ID : PNT2022TMID15787</div>
  </h1>
  </section>
    <section id="title">
    <h4 class="heading">Handwritten Digit Recognition</h4>
    <br><br>
        <i><b>This website is designed to predict the handwritten digit.
         </b></i>
    <p>
      Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically. Because of the progress in the field of science and technology, everything is being digitalized to reduce human effort.Hence, there comes a need for handwritten digit recognition in many real-time applications.MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. This image is analyzed by the model and the detected result is returned on to UI.</p>

  </section>

  <section id="content">
```

```
        <div class="leftside">
        <form action="/predict" method="POST" enctype="multipart/form-data">
        <label>Select a image:</label>
        <input id="image" type="file" name="image" accept="image/png, image/jpeg" onchange="preview()"><br><br>
          <img id="frame" src="" width="200px" height="200px"/>
          <div class="buttons_div">
            <button type="submit" class="btn btn-dark" id="predict_button">Predict</button>
            <button type="button" class="btn btn-dark" id="clear_button">  Clear  </button>
            </form>
          </form>
          </div>
        </form>
        </div>
  </section>
</body>
</html>
```

style.css

```
body{
  background:url("https://www.pexels.com/photo/turned-on-bokeh-light-370799/");
}
#clear_button{
  margin-left: 15px;
  font-weight: bold;
  background-color: #d3aa8f;
  color:black;
}
```

```
p{
  background-color: #d3aa8f;
  width: 900px;
  border: 5px solid #653c23e0;
  padding: 50px;
  margin: 20px;
}

#confidence{
  font-family: 'Josefin Sans', sans-serif;
  margin-top: 7.5%;
}

#content{
  margin: 0 auto;
  padding: 2% 15%;
  padding-bottom: 0;

}

.welcome{
   text-align: center;
   position: relative;
   color: honeydew;
   background-color:#602805e0;
   padding-top: 1%;
   padding-bottom: 1%;
   font-weight: bold;
   font-family: 'Prompt', sans-serif;
}
```

```
#team_id{
   text-align: right;
   font-size: 20px;
   padding-right: 3%;
}

#predict_button{
  margin-right: 15px;
  background-color: #d3aa8f;
  color:black;
  font-weight: bold;
}

#prediction_heading{
  font-family: 'Josefin Sans', sans-serif;
  margin-top: 7.5%;
}

#result{
  font-size: 5rem;
}

#title{
  padding: 1.5% 15%;
  margin: 0 auto;
  text-align: center;
}

.btn {+
```

```
    font-size: 15px;
    padding: 13px;
    background: #D5D8DC;
    border: 1px solid #888;
    margin-top: 20px;
    margin-bottom: 20px;
}

.buttons_div{
  margin-bottom: 30px;
  margin-right: 80px;
}

.heading{
  font-family: 'Varela Round', sans-serif;
  font-weight: 700;
  font-size: 2rem;
  display: inline;
}

.leftside{
  text-align: center;
  margin: 0 auto;
  margin-top: 2%;
  /* padding-left: 10%; */
}

#frame{
  margin-right: 10%;
}
```

```
.predicted_answer{
  text-align: center;
  margin: 0 auto;
  padding: 3% 5%;
  padding-top: 0;
  /* padding-left: 10%; */
}
p{
  font-family: 'Lucida Sans', 'Lucida Sans Regular', 'Lucida Grande', 'Lucida Sans Unicode', Geneva, Verdana, sans-serif;
  margin-top: 1%;
}
@media (min-width: 720px) {
  .leftside{
    padding-left: 10%;
  }
}
```

7.2 Feature-2

predict.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <title>Prediction</title>
    <link rel="stylesheet" type= "text/css" href= "static\css\predict.css">
</head>

<body>
    <div id="rectangle">
```

```
        <h1 id="ans">Predicted Number : {{num}}</h1>
    </div>
</body>
</html>
```

predict.css:

```
body{
    background-image:url("https://images.pexels.com/photos/5239797/pexels-photo-5239797.jpeg?auto=compress&cs=tinysrgb&w=1260&h=750&dpr=2");
    background-repeat: no-repeat;
    background-size: cover;
   }

   #rectangle{
    width:400px;
    height:150px;
    background-color: #1e1f1f;
    opacity: 0.8;
    border-radius: 25px;
    position:absolute;
    top:50%;
    left:50%;
    transform:translate(-50%,-50%);
   }

   #ans{
 text-align: center;
 font-size: 40px;
 margin: 0 auto;
```

```
 padding: 3% 5%;
 padding-top: 9%;
 color: rgb(249, 240, 240);
}
```

8.Testing

8.1 Test Cases:

This report shows the number of test cases that have passed, failed, and untested.

Section Total	Total Cases	Not Tested	Fail	Pass
Home page	10	0	4	6
Predict page	20	0	15	5
Upload	7	0	2	5
result	6	0	4	2

8.2 User Acceptance Testing:

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved.

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

9.RESULTS

9.1 Performance Metrics:

Figure 7

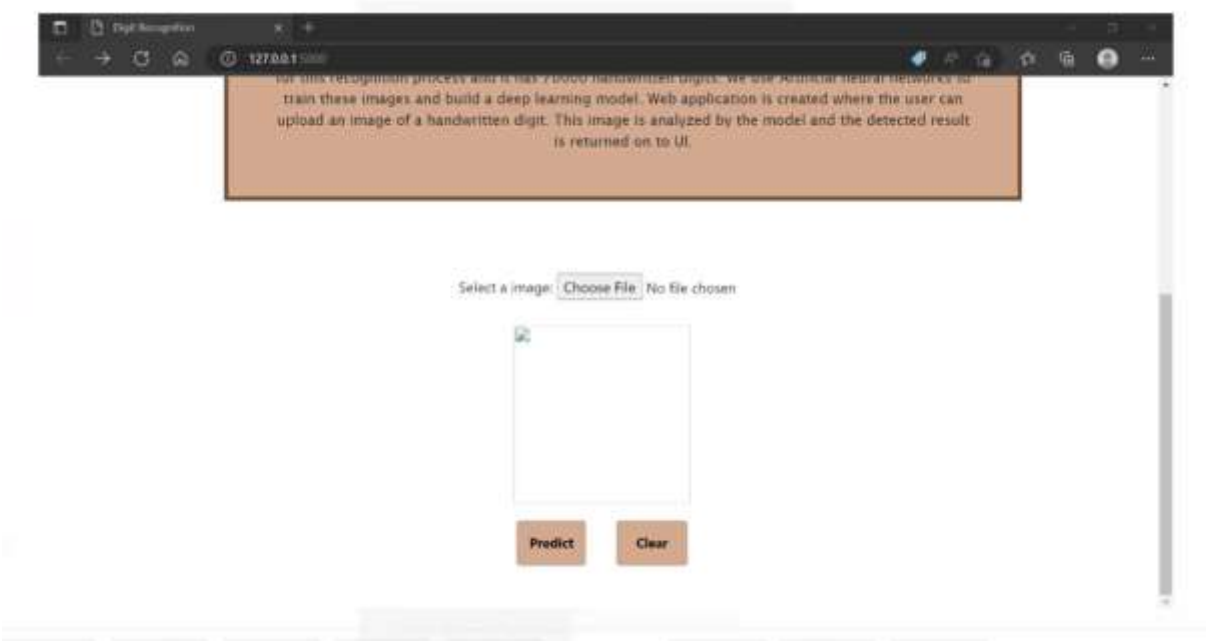


Figure 8

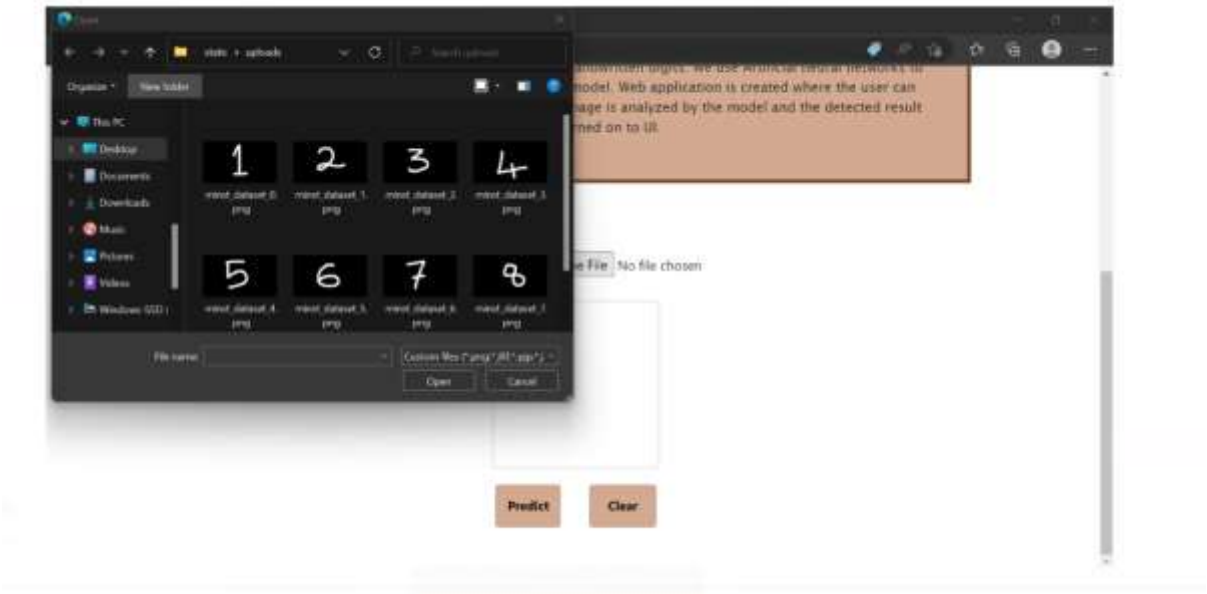


Figure 9

Figure 10

Figure 11

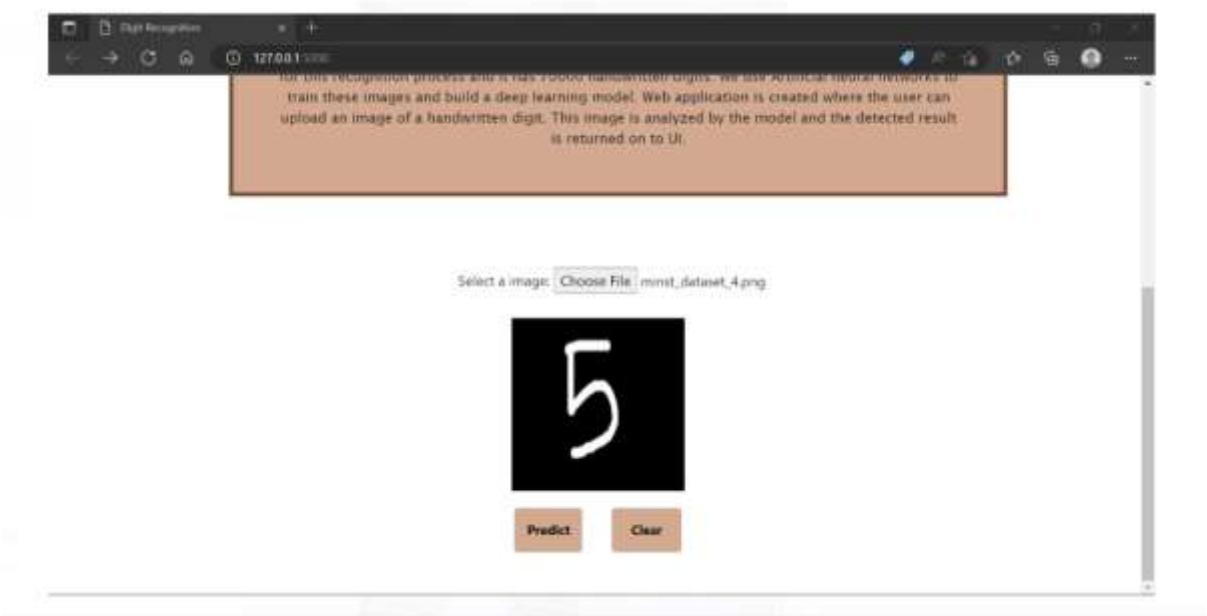


Figure 12

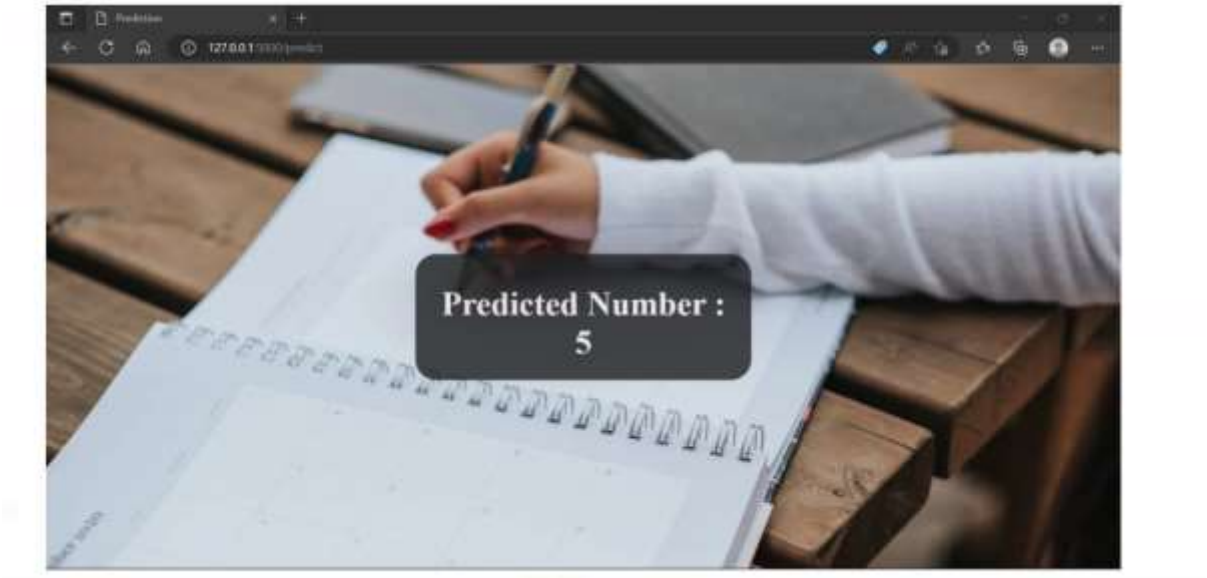


Figure 13

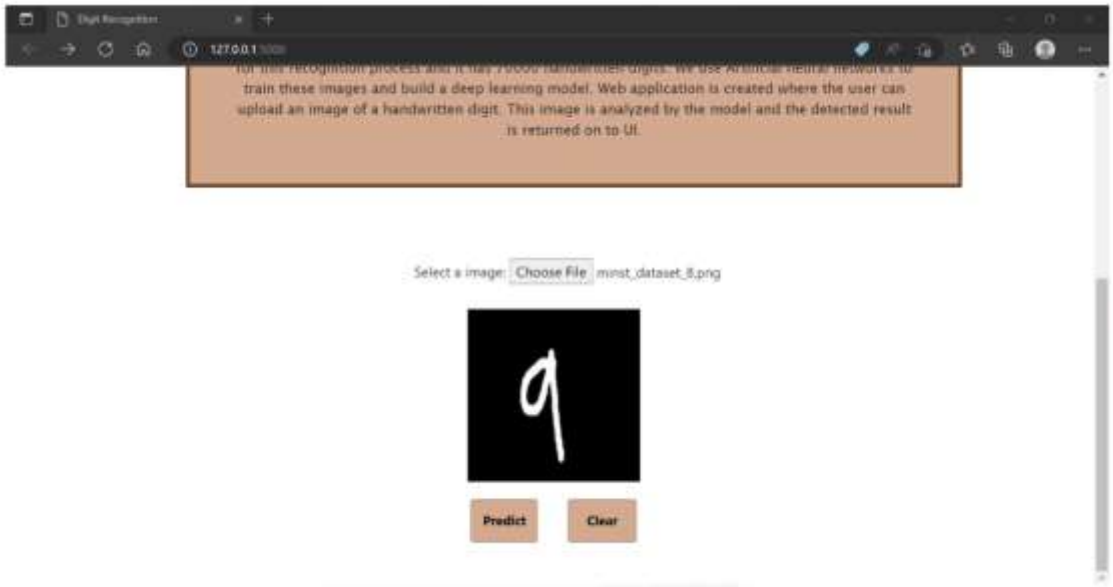


Figure 14

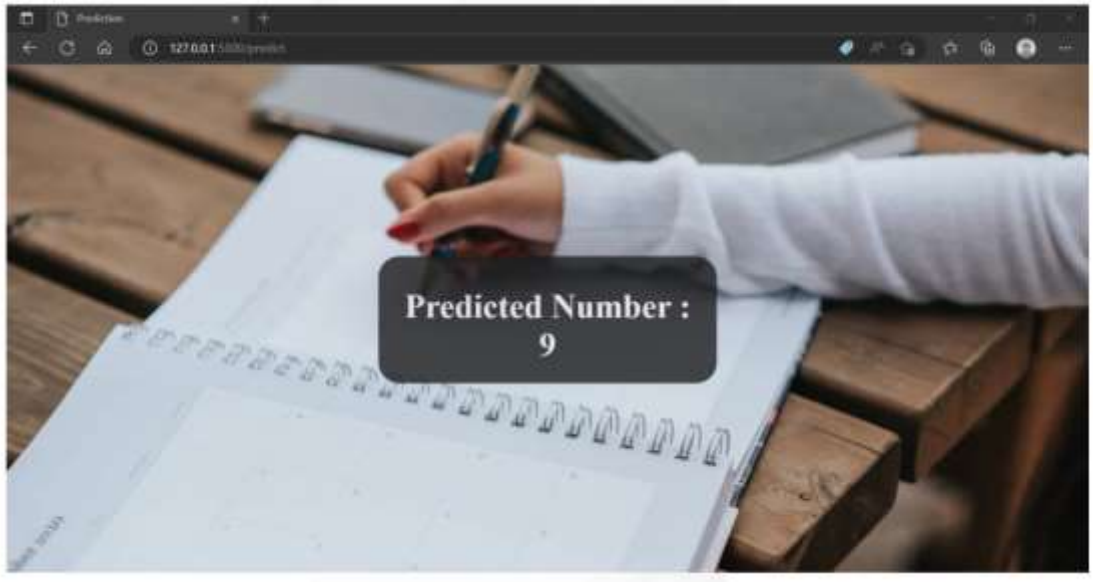


Figure 15

10.ADVANTAGES & DISADVANTAGES:

Advantages:

This approach has many advantages:

1) the 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) the 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 translations and a limited degree of image rotation.

5) Classification time is fast**.**

Disadvantages:

1) It is not done in real time as a person writes and therefore not appropriate for immediate text input.
2) Not always accurate.
3) Unique style of writing.
4) Poor images of text.
5) Does not model temporal relationship well.

11.CONCLUSION

In this project, the variations of accuracies for handwritten digit were observed for 10 epochs by varying the hidden layers. The accuracy curves were generated for the six cases for the different parameter using CNN MNIST digit dataset. The six cases perform differently because of the various combinations of hidden layers. The layers were taken randomly in a periodic sequence so that each case behaves differently during the experiment. The maximum and minimum accuracies were observed for different hidden layers variation with a batch size of 100. Among all the observation, the maximum accuracy in the performance was found 99.21% for 10 epochs in case 2, In digit recognition, this type of higher accuracy will cooperate to speed up the performance of the machine more adequately. However, the minimum accuracy among all observation in the performance was found 97.07% in case 6 Moreover, among all the cases, the total highest test loss is approximately 0.049449 found in case 3 without dropout and the total lowest test loss is approximately 0.026303 found in case 2 with dropout. This low loss will provide CNN better performance to attain better image resolution and noise processing. In the future, we plan to observe the variation in the overall classification accuracy by varying the number of hidden layers and batch size.

12.FUTURE SCOPE

In future, we explore and use different algorithms to classify different styles of digits with maximum accuracy and speed. The future development of the applications based on algorithms of deep and Artificial Intelligence is practically boundless. In the future, we can work on a denser or hybrid algorithm than the current set of algorithms with more manifold data to achieve the solutions to many problems.

13.APPENDIX

Source code:

app.py

```
import numpy as np
import os
from PIL import Image
from flask import Flask, request, render_template, url_for
from werkzeug.utils import secure_filename, redirect
from gevent.pywsgi import WSGIServer
from keras.models import load_model
from keras.preprocessing import image
from flask import send_from_directory

UPLOAD_FOLDER = "static//uploads"

app = Flask(__name__)
app.config['UPLOAD_FOLDER'] = UPLOAD_FOLDER

model = load_model("models\mnistCNN.h5")

@app.route('/')
def index():
    return render_template('index.html')

@app.route('/predict', methods=['GET', 'POST'])
def upload():
    if request.method == "POST":
        f = request.files["image"]
```

```
        filepath = secure_filename(f.filename)
        f.save(os.path.join(app.config['UPLOAD_FOLDER'], filepath))

        upload_img = os.path.join(UPLOAD_FOLDER, filepath)
        img = Image.open(upload_img).convert("L")  # convert image to monochrome
        img = img.resize((28, 28))  # resizing of input image

        im2arr = np.array(img)  # converting to image
        im2arr = im2arr.reshape(1, 28, 28, 1)  # reshaping according to our requirement

        pred = model.predict(im2arr)

        num = np.argmax(pred, axis=1)  # printing our Labels

        return render_template('predict.html', num=str(num[0]))

if __name__ == '__main__':
    app.run(debug=True, threaded=False)
```

Github & Project Demo Link

Github:

https://github.com/IBM-EPBL/IBM-Project-25747-1659972090

Demo Link:

https://drive.google.com/file/d/1I7TZhpsZr0P_MSIouzE5AqTYTLbIr7i5/view?usp=share_link