ProjectDesignPhase-IProposedSolution

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| Date | 19September2022 |
| TeamID | PNT2022TMID01551 |
| ProjectName | Project-ANovelMethodforHandwrittenDigit  RecognitionSystem |
| MaximumMarks | 2Marks |

ProposedSolution:

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| **S.No.** | **Parameter** | **Description** |
| 1. | ProblemStatement(Problemtobesolved) | Handwriting recognition is one of thecompelling research works going on becauseevery individual in this world has their ownstyle of writing. It is the capability of thecomputer to identify and understandhandwritten digits or characters automatically.Because of the progress in the field of scienceand technology, everything is being digitalizedto reduce human eﬀort. Hence, there comes aneed for handwritten digit recognition in manyreal-time applications. MNIST data set is widelyused for this recognition process and it has70000 handwritten digits. We use Artificialneuralnetworkstotraintheseimagesandbuilda deep learning model. Web application iscreated where the user can upload an image ofa handwritten digit. this image is analyzed bythe model and the detected result is returnedontoUI. |
| 2. | Idea/Solutiondescription | HANDWRITTENdigitrecognitionistheabilityofa computer system to recognize thehandwritten inputs like digits, characters etc.from a wide variety of sources like emails,papers,images,lettersetc. |

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|  |  | HerecomestheuseofDeepLearning.Inthe  past decade, deep learning has become the hottool for Image Processing, object detection,handwrittendigitandcharacterrecognitionetc.A lot of machine learning tools have beendeveloped like scikit-learn, scipy-image etc. andpybrains, Keras, Theano, Tensorﬂow by Google,TFLearn etc. for Deep Learning. These toolsmake the applications robust and thereforemore accurate. The Artificial Neural Networkscan almost mimic the human brain and are akey ingredient in image processing field. Forexample, Convolutional Neural Networks withBack Propagation for Image Processing, DeepMind by Google for creating Art by learningfromexistingartiststylesetc.. |
| 3. | Novelty/Uniqueness | The first layer of the architecture is the Userlayer. User layer will comprise of the peoplewhointeractswiththeappandfortherequiredresults.  The next three layers is the frontendarchitectureoftheapplication.Theapplicationwill be developed using Bootstrap which is theopen source platform for HTML, CSS andJavaScript. The application is deployed in thelocalhostwhichisshownonthebrowser.  Through the app, the user will be able touploadpicturesofthehandwrittendigitsandconvertitintothedigitalizedform.  The one in between the database and viewlayer is the business layer which is the logicalcalculations on the basis of the request fromtheclientside.Italsohastheserviceinterface.  Thebackendlayerconsistsoftwodatasets:Training Data and Test Data. The MNISTdatabase has been used for that which isalready divided into training set of 60,000examplesandtestof10,000examples. |

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| 4. | SocialImpact/CustomerSatisfaction | As with any work or project taken up in thefieldofmachinelearningandimageprocessingwe are not considering our results to beperfect. Machine learning is a constantlyevolving field and there is always room forimprovement in your methodology; there isalwaysgoingtobeanothernewapproachthatgives better results for the same problem. Theapplication has been tested using threemodels: Multi-Layer Perceptron (MLP),Convolution Neural Network (CNN). With eachmodel we get a diﬀerent accuracy of theclassifierwhichshowswhichoneisbetter. |
| 5. | BusinessModel(RevenueModel) | Theresultsoftrainingthenetworkisstoredin  .npz format so that whenever a user tries torecognize the digit, the application does not gointo the training loop again. For classification,we have used logistic classifier, softmaxfunction, one hot encoding, cross entropy andloss minimization using mini batch gradientdescent.ThesearesomeofthebasicsofNeuralNetwork which are required to process theoutput from the network and display in theformtheusercanunderstand. |
| 6. | ScalabilityoftheSolution | An implementation of Handwritten DigitRecognition using Deep Learning has beenimplemented in this paper. Additionally, someof the most widely used Machine Learningalgorithms i.e. CNN using Tensorﬂowhave beentrained and tested on the same data to draw acomparisonastowhywerequiredeeplearningmethods in critical applications likeHandwritten Digit Recognition. In this project,we have shown that using Deep Learningtechniques,averyhighamountofaccuracycan |

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|  |  | beachieved.UsingtheConvolutionalNeural  NetworkwithKerasandTheanoasbackend,Iam able to get an accuracy of 95.72%. Everytoolhasitsowncomplexityandaccuracy.  Although, we see that the complexity of thecode and the process is bit more as comparedto normal Machine Learning algorithms butlookingattheaccuracyachieved,itcanbesaidthat it is worth it. Also, the currentimplementationisdoneonlyusingtheCPU  .Thus we settled on classifying a givenhandwritten digit image as the required digitusing three diﬀerent algorithms andconsequentlytestingitsaccuracy.Infutureweare planning to further explore the topic torecognizepeople’shandwriting. |