Handwritten Digit Recognition Using Various Machine Learning Algorithms and Models

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ABSTRACT- Handwritten digit recognition is a technique or technology for automatically recognizing and detecting handwritten digital data through different Machine Learning models. In this paper we use various Machine Learning algorithms to enhance the productiveness of technique and reduce the complexity using various models. Machine Learning is an application of Artificial Intelligence that learns from previous experience and improves automatically through experience. We illustrate various Machine learning algorithms such as Support Vector Machine, Convolutional Neural Network, Quantum Computing, K-Nearest Neighbor Algorithm, Deep Learning used in Recognition technique.

KEYWORDS- Convolutional Neural Network, Support Vector Machine, HandWritten Digit Recognition, Artificial Intelligence, Deep Learning.

I. INTRODUCTION

Currently, Handwritten Digit Recognition is a pivotal concern in computer vision. Machine Learning technology makes a machine efficient to perform pattern or text recognition. In fact, the time complexity of current algorithms or models is very high because of contiguous accumulation and incremental development of handwritten digit sample collection of precision of identification [1].

The major concerns of handwritten digit recognition using machine learning models are illustrated as follow [2]:

- Handwriting patterns differ according to the speaker it is normally quite difficult to recognize even humankind handwritten digits as the writing types vary greatly.
- Similarities between handwritten digits, for instance six and four, that look the same based on writing style. Likewise, one and seven may look the same.

- There is no suitable and effective ideal Machine Learning model for handwritten digit recognition. Different researchers use different methods but there is no ideally suited model for recognizing handwritten digits.[9] In this paper topic is mainly focused on performance and consistency of machine learning models.
- Using defined image recognition patterns, the handwritten digits cannot be identified, since they are specific for various writers.

Machine Learning had mainly three type of learning as follows:

A. Supervised Learning
B. Unsupervised Learning
C. Reinforcement Learning

A. *Supervised Learning*

Supervised Learning in which model is trained with a labeled dataset. We have two variables one is input and other is output and we have to map from input to the output. Like input(x) and output(y).

y = f(x)

Example of Supervised Learning Algorithm:
- Naive Bayes
- Random Forest
- Linear Regression
- Support Vector Machine
- K-Nearest Neighbor
- Decision Trees

B. *Unsupervised Learning*

Unsupervised Learning in which you need to allow the model to work on unlabeled data, non-classified or categorized. In these we have only input data and to input we don't have output data, i.e. input variable(x) not have output variable.

Example of unsupervised Learning Algorithm:
- K-mean clustering
- Neural Network
- Multivariate Analysis
- Anomaly detection

C. *Reinforcement Learning*

Reinforcement learning is about sequential decision taking. To what output is dependent on current input and next input depends on previous output input.

Example of Reinforcement Learning algorithm:
- Positive

- Negative
- Markov Decision Process
- Q Learning

II. LITERATURE SURVEY

Year	Paper Title	Abstract	Analysis
IJTP[1]	Usage of Quantum K-Nearest Neighbor Algorithm to improve handwritten digit recognition	Study the efficiency of quantum computing using Grover Algorithm and K-Nearest Algorithm	Before this Algorithm time complexity was $12R$ after these algorithm complexity reduce to me O(kM2) for accuracy Algorithm - K- Nearest Neighbor
ICOASE[2]	A comparison of three classification algorithms for the identification of handwritten digits	Comparison of three classification algorithms In other terms Multilayer Perceptron (MLP), Naive Bayes(NB), and K-Star	After Evaluation for all algorithms on 46K instances with 10 cross validations for these K-star get highly accuracy of 82.36% follow by NB of 67.04% then MLP by 78.35%. Algorithm: K-Star
IJECE[3	Recognition of handwritten digits with classification of decision tree: A machine learning method	This paper tested the standard digital dataset from kaggle for recognition of handwritt-en digits using a machine learning algorithm decision tree. Accuracy will from 0 -9 digits	In these model is trained using decision tree algorithm with a standard dataset consist of 42K rows and 720 columns and from this model the accuracy came to be 83.4%. Accuracy for 0-9 digits as follows: 0 = 83.5%, 1 = 93.7%, 2 = 83.6%, 3 = 83.1%, 4 = 83.8%, 5 = 83.6%, 6 = 83.4%, 7 = 83.8%, 8 = 84.1%, 9 = 83.7% Algorithm: Decision Tree
IEEE[4	Development of a high precision handwritten digit recognition detector based on a Convolution-Neural Network	Determine accuracy and efficiency using Convoltion-al neural network with two layers on with 32 images and another with 64 images with some neurons on each layer.	After completion of training with dataset the accuracy of neural network was found to be 92.6% for training set and for test set it was 90.1%. Convolutional neural network is much accurate in-depth learning models and give excellence performance. Algorithm: CNN
MDPI[5	Improved Handwritten Digit Recognition Using Convolution-al Neural Networks (CNN)	It optimized various SGD algorithm to improve the efficiency of handwritten digit recognition. In these paper they explore the various option with stride size, kernel, padding number of layers and receptive. For testing MNIST dataset is used.	In these algorithm the learning rate in training parameter is of 0.01 and epoch count of maximum 4. The accuracy was achieved third layer Convolutional neural network was 99.76% and for fourth layer of (CNN) we highest accuracy rate for recognition of 99.76%. For MINST dataset the model of CNN with three layers with optimizer provided best accuracy of 99.89% Algorithm: Optimized CNN
IEEE[6	Strengthening Handwritten Digit Recognition with Two State Q-Learning	Using two Q state it's become very simple and easy to due to it required less parameter to optimize and easy to function on MNIST Digital dataset, USPS dataset and MATLAB dataset	Accuracy according to two Q state model as follows: 1. on MNIST dataset accuracy is 99.0% 2. on USPS dataset accuracy is 99.7% 3. on MATLAB digital dataset accuracy is 100.0%. Algorithm: Double Q Learning
JILSA[7]	MCS HOG features and handwritten digit recognition system based on SVM	The Histogram of Directed Gradient (HOG) with a Support Vector Machine (SVM) algorithm is used in this Multiple Cell Size (MCS) to identify digits from the MNIST digital dataset.	In experiment the 10 fold cross and independent test set is used for validation to determine accuracy and the accuracy for both was founded to be 99.26 % and 99.36% respectively Algorithm: SVM

III. ALGORITHM SURVEY

We used various Machine Learning algorithms and various models to get best accuracy by testing and training with various digital datasets.

1. K-Nearest Neighbour is a basic algorithm for classification. It is a kind of supervised learning and mainly focused on pattern recognition and detection for intrusion detection

2. K-Star is also called as instance base classifier. This recognition is done by comparing instances of index of pre recognized or classified sample [2].

3. Decision tree [3] is a kind of supervised algorithm for learning and it is mostly used for a problem like classification and solving problems of recognition. [8]In these model we break problem in data by making decisions like a questions in form of 0 and 1.
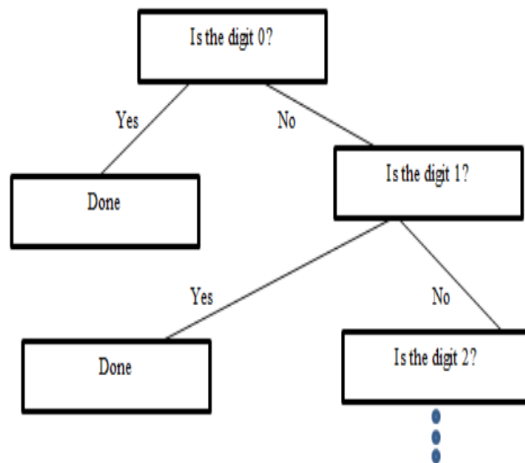

Fig 1: - Decision tree

4. Convolutional Neural Network (CNN) [4] constitutes a type of deep neural network. Some advantages of its are Hidden feature extraction and other is local field and share weights. [5] In deep learning CNN improves the research computer vision and practical improvement and performance. [10],[13]It consists of three layers' Input layer, Hidden layer and classification layer.
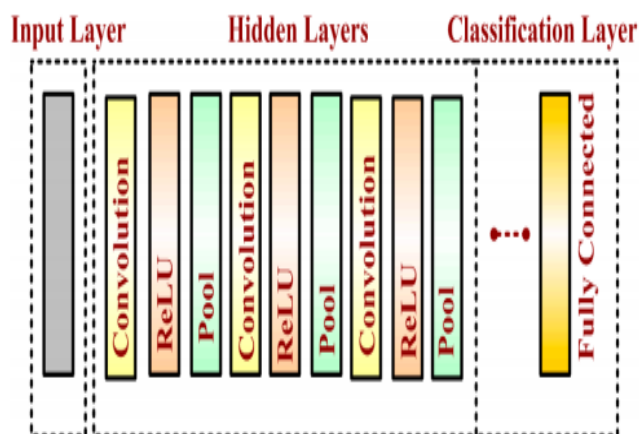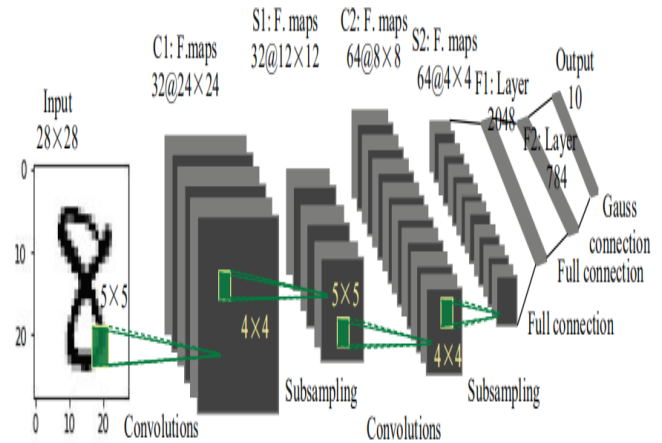

Fig 2: CNN Architecture

Fig 3: CNN Digit Recognition

5. Double Q Learning [6],[15] used features with huge dimensions along with sates and used in conventional reinforcement network based objects. It is also used for overestimated values. [11]Double Q Learning is faster and efficient then Q Learning.
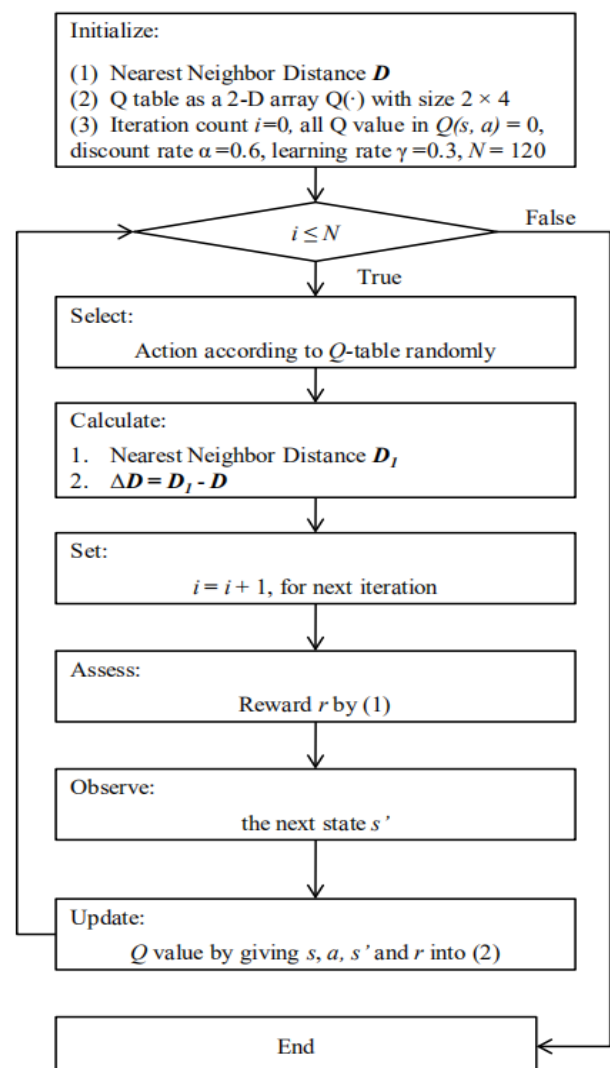

Fig 4: Double Q Learning Recognition algorithm

6. Support vector Machine (SVM) [7],[14] is a supervised type of machine learning. It is a more accurate classification tool. [12]It results in binary classification or regression challenges. It has capability to handle multiple categorical and continuous variable.
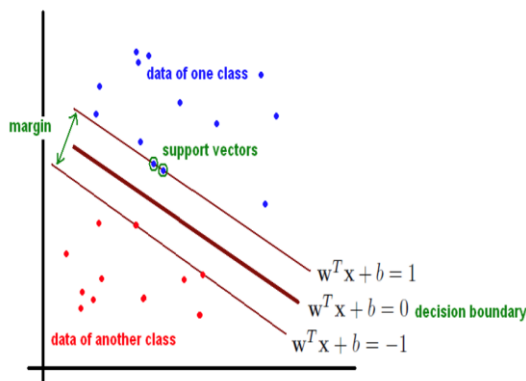

Fig 5: SVM Model

III. CONCLUSION

From the survey, it can be achieved that the Machine learning models and algorithms are very efficient to recognize or detect patterns with different writing style. Testing various algorithms gives results in terms of lesser the complexity more will be efficiency and accuracy for any digital data sets. According to survey we have founded that by using Convolutional neural network accuracy increase to the 99.89% accuracy most among all Similarly, Double Q learning algorithm also given high accuracy but in MATLAB dataset only. SVM also given accuracy of 99.36%. CNN produce most as it used layered architecture which improve the computer vision and follow a hierarchical model which work on making network and give fully connected layers so neuron get connect to each other and output is processed.

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