Handwritten Character Recognition

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***Abstract*—Handwritten character identification is one of the most difficult patterns to recognize. This paper describes a strategy for recognizing handwritten characters that is both accurate and reliable. The method involves receiving data via motion and identifying the character by evaluating it among a huge number of handwritten characters. A camera can be used to detect motion. Data is trained in this method in order to get a reliable solution.Handwriting characters remain complex since different individuals have different handwriting styles. People still want to have Handwriting copies converted intoelectronic copies that can be communicated and stored electronically.The development is based on an artificial neural network, which is a field of study in artificial intelligence. The use of neural networks for recognizing Handwriting characters is more efficient and robust compared with other computing techniques. The paper outlines the methodology, design and architecture of the Handwriting character recognition system. *Index Terms*—Handwritten characters, predictions, pattern, recognition, motion detection, handwritten characters recognizer, webcam.**

I. Introduction

In today's digitized world, handwriting digits and character recognition are becoming increasingly important. In fields where high classification efficiency is required, various recognition systems have been developed or proposed. Handwriting letters, characters, and digits aids in the completion of more difficult tasks. In the field of image processing and pattern recognition, handwriting recognition has been one of the most fascinating and challenging research areas. Off-line and on-line handwriting recognition methods are the two most common types of handwriting recognition. In the recognition of handwritten characters, online methods have been shown to be superior to their off-line counterparts. Following recent advances in deep learning, it would be advantageous to construct a network that extracts reusable textual features. These features can then be used to train new models with less data on different, and sometimes more difficult, tasks. One of the goals of this research is to propose a network architecture for document processing that could be similar to AlexNet. Handwritten text recognition is no longer a major bottleneck in document analysis and processing systems. We require a method for training networks in days rather than weeks. MDL-STMs are more difficult to parallelize than convolutions. BLSTMs (bidirectional LSTMs) are faster as well, but they require a sequential input. BLSTM and convolutions are frequently used in the literature of neural networks to apply to language and images, respectively. Learned features that are good for text recognition, we believe, could be useful cues for addressing these issues [1]. The use of automatic processing systems in banks to process bank checks is a good example. The bank would have to hire a lot of people if it didn't have automated bank check processing systems. Biological neural networks can be used to inspire handwriting recognition systems. Individuals can recognize different Handwriting objects such as digits, letters, and characters thanks to the human brain. Humans, on the other hand, are biased, and can choose to interpret handwriting letters and digits in different ways. Computerized systems, on the other hand, are unbiased and capable of performing extremely difficult tasks. The main goal of this paper is to use the concept of Convolution Neural Network to develop a model that will be used to read handwriting digits, characters, and words from an image. Because of its ability to derive meaning from complex data, a neural network is the best choice for the proposed system.

II. Related Work

The goal is to use an HMM-based word recognition system to recognize a word and then verify it to produce a result. With a pre-processing stage, this handwritten recognizing system (HRS) includes segmentation and feature extractions. For this, a Man-Woman program and a neural network with artificial intelligence were created. Using convolutional neural networks and tensor flow. Megha Agarwal et al. attempted to improve the existing offline handwritten character accuracy method. Their goal was to create software that would take the least amount of time and produce high-quality results. The efficient method is similar to a computerized system. The coordinates of the pen movement by the handwriting automation systems are generally stored on electronic tablets. Pre-amplification, segmentation, attribute extraction, recognition, and post-processing are all steps in the ineffective method. Hidden Markov model (HMM) was employed for

segmentation. To calculate the closest data, the KNN algorithm and the Euclidean distance formula were used [2].

III. Methodology

Step by step approach of the handwritten character recognizer system.

A. Data-set Description

Handwritten character data sets are available. In the system, we use the MNIST dataset. The first 80% of the data is used for training, and the remaining 20% is used for testing.

B. Defining model calculate the accuracy

Data flows from one layer to the next in this model until it reaches the final layer. The flatten function is then used to convert the entire matrix into a single column. The dense layer takes the previous layer's output and passes it on to the next layer. The neural network's non-linearity is increased by using the rectified linear unit. The Softmax function converts values in the range of 0 to 1 and interprets the result as the probability of each class. The compile method is used to configure the learning process before training the model. After that, we calculated the accuracy prior to training and discovered that it was extremely low. Modelcheckpoint API is used to save our best model, and the fit function is used to train it. Modelcheckpoint API is used to save our best model, and the fit function is used to train it. We recalculate the accuracy and find that a large margin of error improves accuracy.

C. System Architecture

1) Video Capture: We defined the video camera through which our system will detect handwritten characters for motion detection. In our case, we used the (0) index, which is the web camera on our laptop, with Python's OpenCV library. OpenCV will capture the video, read it, and return the frame for each frame. We're converting the frame to HSV format because it's the most user-friendly. We used a blackboard, which is a type of whiteboard.

2) Object Detection: The most important aspect of motion detection is determining the object that will be used to generate motion. We're working with a blue-colored object. As noise, there could be a lot of blue objects in the background. So to define the area we will use findcontours() function where we are using $RETR\_EXTERNAL$ to detect the outermost contour of the blue object. Also for findcontours() function, we are using cv2.$CHAIN\_APPROX\_SIMPLE$ to avoid detecting all the points and save some memory. We want our system to choose the highest contour after finding the contours of the blue object. We're taking the highest contour so the camera can properly detect it. When a contour is discovered, a center is calculated from which to begin writing. To find the center, we use the popular moment calculation, which adds all of the pixels in the selected contour. The equation of the moments is:

$$m_{p,q} = \sum_{i=1}^{n} I(x,y) x^p y^q$$

Where I(x,y) is the value of image pixel at location (x,y) ,
p= x-order,
q=y-order.
From the above equation, we can find the center of the blue object by-

$$(X,Y) = (\frac{m10}{m00}, \frac{m01}{m00})$$

The writing will begin at the centroid and will be stored as points in a deque. The points will eventually connect to form a line, which will reveal the entire character. Because we used erosion, dilation, and morphology of morphological operations, as well as the kernel for smoothing, the drawing will be sharp and noise-free [3].

3) Blackboard Definition and Display: The image is then passed on to the models. When using prediction instructions, the maximum argument of indexes is used. The display is then initiated using the Opencv library's imshow() instruction, which takes the frame as an argument. We destroy all of the windows by pressing ENTER, which we declare by ASCII, after all of the writing and prediction is completed.

IV. Experimental result

The proposed system is capable of accurately recognizing all handwritten characters with high precision. There are no restrictions on how a character can be drawn or written in this system because it is user-dependent. This system consistently recognizes handwritten characters because it predicts a character based on the index's maximum argument. The handwritten characters were taken from the MNIST dataset, which is a large database of handwritten digits that is frequently used to train image processing systems.

V. Conclusion

After training and testing the system, the accuracy of selected data was over 90%, which was an impressive result.

A. Challenges

It was not easy to achieve the desired result. Getting data from MNIST and processing it in a specific way to achieve the highest accuracy was difficult. Because the frame shows the continuously generating images where the drawing is done and the blackboard displays those images, we had to build a frame and a blackboard separately.

B. Limitations

We've assigned a specific color to each object in the system. The one with the largest contour area will be chosen by the system. If the contour area of the object is insufficient, the system will detect it and choose the highest contour area.

C. Future Work

The handwritten character recognition system is a significant achievement in and of itself. This system's ability to recognize a person's gender and age will be a game-changer. The accuracy rate is greater than 90%.

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