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HANDWRITTEN EQUATION SOLVER USING CNN

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Abstract - *Using CNN to create a robust handwritten equation solver is a difficult task in image processing. One of the most difficult challenges in computer vision research is handwritten mathematical expression recognition. The work is made more difficult by the fact that certain characters are segmented and classified. a collection of quadratic equations created by hand This study looks at quadratic equations as well as a single quadratic equation. These equations must be recognised and solved. Horizontal compact projection analysis is used for segmentation. We use both connected component analysis and integrated connected component analysis methodologies. Convolutional Neural Networks Characters are classified using a network. Each appropriate is required for the solution of the problem. Character string operation is used for detection. Finally, the results of the experiment show that the strategy we've described is quite effective. The goal of this project is to create a handwritten alphabet. Equation solver capable of dealing with a wide range of mathematical equations.*

Key Words: **Machine learning, Python, Handwritten Equation, Simplification, Pre-processing, Segmentation, Implementation, Recognition, CNN, Polynomial expressions, Image processing.**

1. INTRODUCTION

Arithmetic is utilized in basically every part of science, including physical science, designing, medication, and financial aspects. The investigation and perception of advanced archives is a critical scholastic subject today. OCR (optical person acknowledgment) can give further developed acknowledgment precision to English characters and digits in electronic books. In the field of PC vision, transcribed numerical articulation acknowledgment stays a troublesome assignment. The amendment pace of image division and acknowledgment can't meet its real prerequisites because of the two-dimensional settling gathering and fluctuated sizes. The initial phase in perceiving numerical articulations is to fragment and arrange the characters. In the field of PC vision, the convolutional neural network (CNN) is one of the most broadly utilized grouping models. Profound Convolutional Neural Network (CNN) inclining has exhibited brilliant execution in the fields of picture grouping, AI, and normal language handling lately. Perceive designs. CNN, most importantly othermodels, is truly outstanding. A penmanship acknowledgment framework's objective is to make an interpretation of manually written characters into designs that are machine meaningful. Vehicle tag recognizable proof, postal letter arranging, Check truncation framework (CTS) checking and recorded report conservation in archeological divisions, old archive robotization in libraries and banks, and different applications are among the generally normal. These fields manage enormous information bases, requiring fantastic acknowledgment precision, diminished processing intricacy, and predictable acknowledgment framework execution. Profound neural models are supposed to be more invaluable than shallow neural models. A convolutional neural organization is a type of profound neural network with applications in picture grouping, object acknowledgment, proposal frameworks, signal handling, normal language handling, PC vision, and face acknowledgment, among others. They are more proficient than their archetypes (Multi-layer perceptron (MLP), and so on) in light of the fact that they can consequently perceive the fundamental parts of a thing (here an item can be a picture, a written by hand character, a face, and so on) without any human oversight or collaboration. An exceptionally proficient CNN is the result of progressive component learning's solid abilities.

1.1 OBJECTIVE

1. To build a user interface for entering the object image that is straightforward to use.

2. The system should be able to process the mathematical expression in advance.

3. The system should be able to recognize text in the image as well as mathematical symbols.

4. The system should extract text from the image and display the mathematical expression's solution.

5. The primary goal is to learn how to create a CNN model for Mathematical Expression.

2. LITERATURE SURVEY

Some challenges connected to the topic of online mathematical expression recognition were examined by Ahmad-Montaser Awal et al(2010). Ha. et al. (1995, August) devised a system that can deduce mathematical expressions from the pictures of printed documents. They used 5 object-oriented methodology to explain the data abstraction for the hierarchical structure of the mathematical expression, which is presented in the form of an expression tree, in the development of this system. Using a feed-forward neural network approach, Pradeep et al. (2010) suggested a diagonal feature extraction technique for the handwritten character. For categorization, this technique employs diagonal, horizontal, and vertical features. A few papers on the recognition of mathematical expressions using convolutional neural networks are available online (CNN).

Azzeddine Lazrek, Widad Jakjoud International Conference on Multimedia Computing and Systems (ICMCS), 2011. "Segmentation approach of offline Mathematical symbols." The goal of this paper is to identify, extract, and segment the various mathematical symbols. Later on, this expression will be recognized.

Zouaoui Abderaouf 2014 global conference on computer applications and research "licence plate character segmentation based on horizontal projection and linked component analysis" (wscar). A license plate segmentation method for Algerian cars is proposed in this paper. The proposed system is separated into two parts: first, the license plate is identified from the input image, and then the characters from the license plate are segmented.

Catherine Lu Karanveer Mohan "Recognition of Online Handwritten Mathematical Expressions Using Convolutional Neural Networks," Catherine Lu Karanveer Mohan cs231n project report Stanford 2015. We delve more into the challenge of identifying handwritten mathematical statements, which we also chose as the subject of our CS221 final project.

Pooja Kamavisdar, Sonam Saluja, Sonu Agrawal " A Survey on Image Classification Approaches and Techniques," worldwide Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 1, January 2013 Various categorization strategies are taken into account in this study; Decision Tree (DT), Support Vector Machine (SVM), and Fuzzy Classification are all examples of artificial neural networks.

Nicholas E. Matsakis The Massachusetts Institute of Technology published "Recognition of Handwritten Mathematical Expressions" in May 1999. In this paper, I will describe an online 6 method for converting a handwritten mathematical expression into an equivalent expression in a typesetting command language such as TEX or MathML, as well as a feedback- oriented user interface that can make errors more tolerable to the end user because they can be corrected quickly.

3. ARCHITECTURE

Convolutional layer, pooling layer, completely connected input layer, fully connected layer, and fully connected output layer are all layers in the CNN design.

1. Convolutional layer: The backbone of any CNN working model is the convolutional layer. This layer is where the images are scanned pixel by pixel and a feature map is created to define future classifications.

2. Layer for pooling: Pooling is also known as data down sampling, in which the total dimensions of the photos are reduced. Each feature's information from each convolutional layer is condensed to only include the most essential data. The creation of convolutional layers and the use of pooling is a continuous process that may require multiple iterations.

3. Fully connected input layer: The flattening of the images is also known as the fully linked input layer. The previous layer's outputs are flattened into a single vector.

4. Fully connected layer: When it's time to compute after the feature analysis, this layer applies random weights to the inputs and predicts a suitable label. Fully connected

5. Output layer: The CNN model's final layer stores the results of the labels determined for classification and assigns a class to the images.

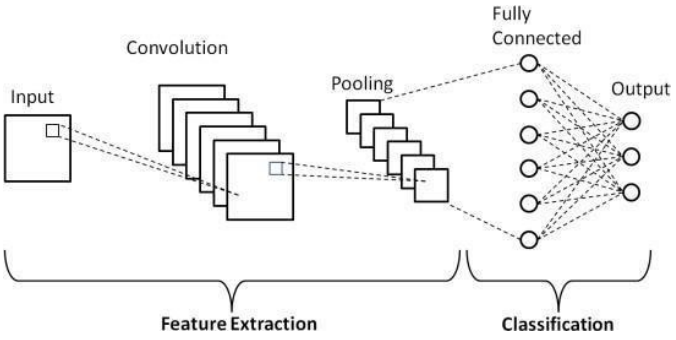

Fig -1: Feature Extraction and Classification of CNN

4. METHODOLOGIES

4.1 Methodologies Explanation: First, noise from the original input image is reduced using our proposed method by binarizing it. Then, from the input image, we utilize compact horizontal projection to segment each line of equation. Then, for subsequent processing, we treat each segment of thesegmented image as a full image. We then look for certain characteristics in the form of related components for each line of equation image. After that, each segmented character is fed into a convolutional neural network model for character categorization. The resulting character, which is CNN's output, is then utilized to create a character string that looks like the original equation.

4.2 Dataset preparation

The preparation of the dataset is the most important aspect of this project. The borders of characters like the English numeral, alphabet, and mathematical symbol can all be accurately defined. As a result, we begin by preparing the dataset with the highest priority given to its edges, i.e., illumine the edges. We created our own datasets and used a modified version of the NIST dataset for digits, which is similar to the popular MINIST dataset. For the training of the network, we use 2000 data items for each category. And in the majority of cases, our network training was accurate to the tune of 98.5 percent. We used a 32x32 grey level image in our dataset.

4.3 Pre-processing

The procedure of changing and modifying the input image to make it suitable for recognition is known as pre-processing. Image enhancing techniques include the ones listed below.

1) Conversion of RGB to Gray-Scale Because character detection on a colored image is more difficult than on a gray-scale image, this colored image is first turned into a conventional gray-scale image and represented through a single matrix. If the grey bitmap is Y and the color bitmaps are R, G, and B, the formula is Y = 0.299R
+ 0.587G+0.114B.

2) Binarization Binarization is the process of converting pixel data into 0s and 1s by selecting a threshold value. In this study, 1s indicate black pixels and 0s represent white pixels in the horizontal projection computation. Binarization thresholds can be approved in two ways: overall threshold and partial threshold. Otsu's method is based on picture statistical properties and is 11 an overall threshold method. This strategy allows the computer to choose a threshold on its own.

3) Noise Reduction Noise refers to the presence of too many pixels in an image. Salt and pepper noise and Gaussian noise are two types of noise. Low pass filtering is used to remove Gaussian noise from the image, and Salt and Pepper noise does not need to be filtered because it is relatively low in comparison to Gaussian noise. For the sake of simplicity, we deleted all components that are less than 5 pixels in our proposed solution.

4.4 Segmentation

Image processing and computer vision applications frequently use segmentation to identify objects or other key information in digital images. Which is the division of one image into several parts. In our proposed method, segmentation is divided into two parts.

5. TECHNOLOGY

Data is collected first in our implemented approach. The data was then standardized. Normalization is divided into two parts: training data and testing data. The training data is then fed into a Convolution Neural Network, which treats each portion of the image as a complete image for processing. We then look for certain characteristics in the form of related components for each line of equation image. Each segmented character is then sent into a Convolutional neural network model, which is used to classify the character. The character obtained as a result of CNN is then utilized to create a character string that is similar to the original equation. The correctness of these characters is then checked. The answer is predicted by the prediction model, which is then delivered as an output. We eventually get the quadratics' solution for each correct detection. In Figure 2 block diagram of our implemented method is shown.

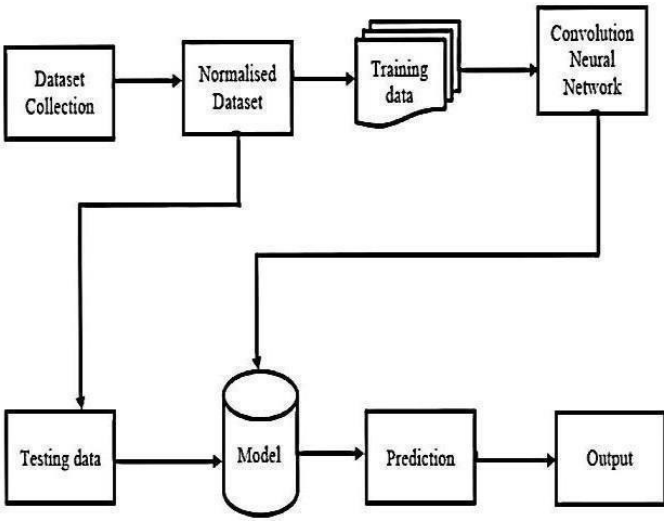

Fig -2: Block Diagram of Implemented System.

6. CONCLUSIONS

The focal point of this review was on perceiving manually written numerical quadratics. For acknowledgment, we think about single quadratics just as series of quadratics. Examine projections Each line of quadratics is fragmented utilizing a particular minimized flat projection. For character division, an associated part with a high achievement rate is utilized. For image acknowledgment like '=,' which is a solitary image blended in with two separate associated parts, a further developed form of associated part is used. The most troublesome part of arrangement is highlight extraction. Besides, penmanship is more diligently

to recognize on the grounds that to a few preset highlights. After effectively perceiving quadratics in any mix, we process the found condition to get the quadratics' answer. We usea string activity way to deal with get the worth of a, b, and c of every quadratic of the structure ay2+by+c=0 in this segment. At long last, we accomplished best in class execution in both the discovery and arrangement stages.

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