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Pattern Recognition In Air-Written Handwriting Using Artificial Intelligence And Machine Learning Methodology

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ABSTRACT

In pattern recognition applications, Handwritten Character Recognition is a significant challenge. This proposed approach aims to enhance readers' understanding of the information by utilizing Machine Learning and Python. These technologies make it easier to recognize human handwriting and classify the characters into a digital format with near-human-level accuracy. The focus of this paper is on predicting real-time handwritten characters in the air. It presents an innovative method for online handwritten character detection, intending to provide an effective and reliable approach for recognizing handwritten characters.

Keywords: Handwritten character recognition, Artificial Intelligence (AI), Machine Learning (ML), Deep Learning.

INTRODUCTION :

Machine learning and deep learning play crucial roles in computer science, artificial intelligence, and their various applications. These technologies have significantly reduced human effort in many industries. Handwritten character recognition (HCR) has gained popularity since the early days of machine learning and deep learning, making it a well-practiced field. HCR can be achieved through two primary methods: online and offline recognition. Online handwritten recognition systems capture input in real time. In contrast, offline handwritten recognition works with scanned images of handwritten text. Offline recognition is generally more challenging, as it involves analyzing and understanding handwriting from images. Converting handwritten information into a readable format simplifies the process and enhances comprehension. HCR involves devices or computers that accept input in the form of handwritten text from various sources, such as photographs, scanned documents, or direct input via touch screens. The goal is to interpret this input as text, which has a wide range of applications.

OBJECTIVE :

The handwritten character recognition system proposed here is an innovative method for detecting handwritten characters online. Its primary objective is to deliver an effective and reliable approach to recognizing handwritten text. This system provides a comprehensive understanding of machine learning and deep learning algorithms used in handwritten character recognition. Additionally, it offers insights into the algorithms that efficiently perform character recognition tasks. Key goals include evaluating the recognition accuracy of various machine learning and deep learning algorithms on real sets of handwritten characters, as well as analyzing how preliminary image processing affects recognition accuracy. Finally, the system assesses the feasibility of using these algorithms to address technical challenges related to processing handwritten characters. The system employs pattern matching to convert handwritten letters into corresponding text or commands in real-time. The main aim is to translate handwritten characters into formats that machines can read and process.

SCOPE OF STUDY :

The scope of this project is focused on handwritten character recognition through the application of machine learning (ML) algorithms that utilize feature extraction and image preprocessing techniques. The aim is not only to enhance current recognition performance but also to achieve the highest reliability in handwritten character applications. Handwritten character recognition is important across various fields, including online handwriting recognition on computer tablets, the recognition of zip codes on mail for postal sorting, and the processing of numerical entries on hand-filled forms, such as tax documents. The primary goal of a handwriting recognition system is to convert handwritten characters into machine-readable formats. This technology has both professional and commercial applications, as well as practical uses in everyday life. It can be particularly beneficial for visually impaired individuals. Additionally, handwritten character recognition can simplify complex tasks, making life easier for many users. Its popularity spans from beginners interested in deep learning and machine learning to experienced practitioners in the field.

PROBLEM DEFINITION :

Human beings are increasingly seeking smarter ways to work, often by using compatible devices. In terms of handwriting, rather than relying solely on exceptional handwriting skills, we can implement systems and models that enhance handwriting recognition. As new ideas and technologies emerge daily, machines are being developed to mimic human behavior. However, some human characteristics remain difficult to replicate. Handwriting continues to hold significant importance in our lives, although it varies greatly from person to person. Sometimes, human readers struggle to read and recognize handwritten text. Developing a system for identifying and detecting handwritten characters could be beneficial for various applications. Numerous research opportunities exist in this area, utilizing various technologies and algorithm-based techniques to advance recognition methods. Instead of using multiple devices for deployment, reducing the number of necessary devices is recommended. This approach eliminates the need for typing altogether. Handwriting recognition is recognized as a major challenge in fields such as pattern recognition (PR) and computer vision (CV). Since handwriting differs greatly among individuals, it is often difficult to identify handwritten characters or words. One of the primary challenges in such systems is the distortion, irregularity, and variability of handwriting patterns. Handwriting also plays a crucial role in forensics, including criminal investigations, DNA testing, and questioned document examinations (QDEs). By minimizing the need for human intervention, this system could accelerate the overall process and reduce burdens on individuals.

LITERATURE REVIEW :

Handwritten character recognition (HCR) is an ongoing area of research in artificial intelligence (AI), computer vision (CV), and pattern recognition (PR). Humans can easily understand various handwriting styles through their learning and intelligence. Machine learning (ML) and AI help replicate this ability in machines. When a computer performs handwriting recognition, it can gather and identify characters from photographs, touch display devices, paper documents, and other mediums. It then converts these characters into a machine-readable format, a process that falls under the category of Optical Character Recognition (OCR).

Before the widespread adoption of digital technologies, there was a growing interest in digitizing existing records and books. Digitized text allows for efficient operations such as searching and sorting, as it can be quickly processed for various tasks.

OCR is divided into two main categories: Printed Character Recognition (PCR) and Handwritten Character Recognition (HCR). PCR is comparatively easier to perform than HCR because there are significantly fewer printable fonts (like Calibri, Algerian, etc.) than there are unique handwriting styles, which are highly diverse. HCR can be further classified into Offline Recognition and Online Recognition.

Online Recognition occurs in real-time when characters are recognized as the user writes. In contrast, Offline Recognition involves recognizing characters from pre-existing documents using tools like cameras or optical scanners. Various image processing techniques and neural network models are commonly employed for these tasks.

"Air writing" refers to writing letters in open space using all six degrees of hand motion. In this method, a mask for the tracking object is created using the HSV color space, which is then refined through morphological processes. This approach allows users to select any color, shape, or material for tracking. The trajectory of the mask is tracked and visualized in a virtual window. A convolutional neural network (CNN) is used to recognize the air-written characters.

The Devanagari handwritten character dataset includes 36 different classes (from ka to kya), the MNIST dataset contains 10 classes (0 to 9), the English handwritten character dataset comprises 26 classes (A to Z), and the Devanagari handwritten digits dataset has 10 classes (0 to 9). Additionally, a custom dataset of air-written digits (0 to 9) with three examples from each class and contributions from 20 distinct individuals is utilized to test the CNN. The proposed system achieved accuracy rates of 99.75%, 99.73%, 99.13%, 99.97%, and 99.81% for isolated characters across these datasets.

METHODOLOGY :

The required data must be collected to design the model. The imported dataset needs to be analyzed, cleaned, and prepared for the analysis process. This process will return two tuples: one will contain the data and labels necessary for training, while the other will hold the data and labels required for testing.

Next, preliminary processing of the data should be conducted. This involves a series of steps to transform the dataset into a form that can be processed more easily and effectively. Various operations should be applied during this step, including reshaping the pixel intensities, converting them to a float data type, and normalizing the values so that they fall between 0 and 1. Reshaping is essential because the original labels and data are provided in deep learning (DL) format. Each image will have dimensions of 28x28 pixels, resulting in a total of 784 pixel intensities. After reshaping, these pixel intensities must be converted to the float32 data type. The normalization step aims to enhance processing efficiency. Once data preprocessing is complete, the model will be created. The next step involves compiling the model for learning and optimization. Afterward, the model will be fitted using the prepared data.

Building The Model

The model will utilize the background image drawn by the user in space and predict how the character will be illustrated based on that image. The main objective is to ensure that the model accurately forecasts most of the inputs. It makes precise predictions using letters from A to Z. The pip command, a package management tool created in Python, can be used to install any necessary packages. Initially, the model's accuracy will be lower before it is trained. To evaluate its performance in categorization, a scoring function is implemented. Accuracy is determined using only the testing data..

The Camera Used In Pattern Recognition

The foundation of the proposed model is based on the frames captured by a laptop or PC's webcam. The webcam starts recording video once the video capture object is created using the Python computer vision package, OpenCV. The virtual AI system receives these frames from the webcam. Several image processing operations are applied to the captured video. Erosion reduces the thickness of the boundaries of bright areas in the image. We specifically use morphology opening to eliminate noise, while morphology closing, which could remove noise from bright areas, is not utilized in this case. Dilation, on the other hand, increases the thickness of the boundaries of bright areas in the image. Writing in the air is performed using the tip of a finger, while the tips of two fingers are employed to signal the end of writing.

Option Section

By utilizing the tip of the specific finger identified with Media-Pipe and the corresponding coordinates of the fingers that are raised, we can determine which finger is up. Once we identify the raised finger, we can then execute the corresponding mouse function.

Prediting Character

This is the final module. The model predicts words drawn in the air in real time. When a word or letter is drawn, the model simultaneously predicts the corresponding character. If a letter is drawn incorrectly, it can be erased by selecting the eraser option, which will remove that specific letter. After that, all detected points should be connected with a line. When you pass this image to the model, it will predict the alphabet.
On the resulting screen, the text "You entered:" will be displayed, along with a result window generated by the OpenCV library. The main goal of this module is to ensure that the model can accurately predict most of the drawn images or inputs. Shows the resulting window displaying the predicted alphabet, with the capability for users to draw characters in real-time.

SYSTEM ARCHITECTURE :

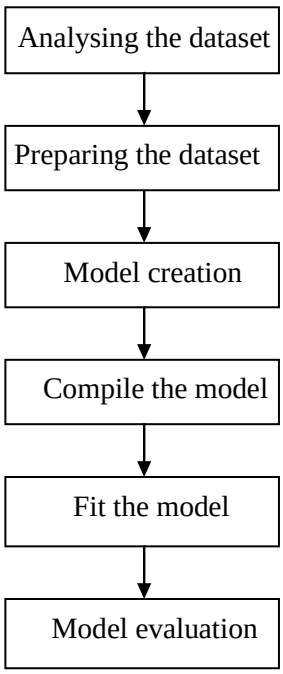

Figure7 .1: Structure of the model

Figure 7.1 The necessary data must be collected to design the model. Once the dataset is imported, it needs to be analyzed. Cleaning and preparing the dataset is essential for the analysis process. The analysis will return two tuples. A tuple is a built-in data type used to store data items within a single variable. One tuple will hold the data and labels required for training, while the other will contain the data and labels needed for testing.

Next, preliminary data processing should be conducted. This involves a series of steps to transform the dataset into a form that can be processed more easily and effectively. Various operations must be performed at this stage, including reshaping the data, converting pixel intensity values to the float data type, and normalizing the data so that the values fall between 0 and 1. Reshaping is a necessary step because the original labels and data are provided for deep learning (DL). Each image has dimensions of 28x28, resulting in a total of 784 pixel intensity values. After reshaping, the pixel intensities need to be changed to the float32 data type. Normalization is performed to enhance computational efficiency. Once the data is processed, the model is created. It must then be compiled for learning and optimization. After compilation, the model is fitted using the training dataset. Finally, the model is evaluated using the unseen test dataset.

FUTURE ENHANCEMENT :

Handwriting recognition has numerous applications. Recent technological advancements have made it more difficult for individuals to replace outdated equipment. There are several situations where people may not develop familiarity with typing on a keyboard. For instance, if a key is damaged, or if the keys are labeled in a language that the user only partially understands, it can be problematic. Additionally, with touch-enabled keyboards, locating each character can be time-consuming.

Adding a physical keyboard to portable devices can also be challenging. In the future, air-drawn character recognition may evolve to include sentence and paragraph recognition. Devices equipped with handwriting recognition software will have several advantages, including multilingual support, compatibility with various writing styles, and eliminating the need for a traditional keyboard. This technology will also enhance convenience for touch-enabled documents that were created by hand. Furthermore, the software can be expanded to include features such as translation and voice reading.

CONCLUSION :

Air-Drawn Character Recognition (ADCR) is a system that uses a camera and a fingertip, acting as a pen, to recognize the 26 letters of the English alphabet. To use the system, you first need to open your webcam. Instead of writing on paper or typing, you can draw letters or words in the air using one finger. The system uses two fingers to stop writing and make selections. When you open the webcam, a window appears that allows you to draw letters. This interface includes three different colors for drawing and an eraser, along with live predictions of the letters being drawn. To draw a letter, simply use one finger, and when you want to stop, show two fingers. For example, if you draw the word "ABC," the system will predict it as "ABC." The system is case-sensitive, meaning it distinguishes between uppercase and lowercase letters. The 'F' key on your keyboard is used to finalize the prediction of the word you have drawn, while the 'S' key can be used to search for the word on Google.

The ADCR system allows users to draw or write characters in the air and provides accurate predictions, increasing the flexibility of this recognition solution. Handwriting Character Recognition (HCR) is a crucial step in the broader fields of Artificial Intelligence (AI) and Computer Vision (CV).
This system can recognize handwritten characters from various sources, such as images, touch screen devices, and paper-based documents, transforming human-written letters into a machine-readable format. Optical Character Recognition (OCR) is a popular technique used in this context. The system has applications in advanced character recognition and greatly enhances the interface between humans and automated processes. Ongoing research focuses on developing new approaches and techniques to accelerate processing while improving precision rates in recognition tasks.

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