Real Time Face Recognition System using Jetson Nano

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Abstract

This work aims to deploy an accurate face recognition system on a low cost, portable and reliable hardware. Nvidia Jetson Nano is a small size, portable and powerful computer to run Neural Networks. It uses an integrated 128-core Maxwell GPU for parallelization. The total power consumed by the device is less than 10 watts. Face recognition system consists of 2 steps, Face detection and Identification. Multi-Task Cascaded Convolutional Neural Networks (MTCNN) Model has been used for Face detection and VGG-Face has been used for Face Identification. The network is trained on VGG-Face dataset which consists of 2.6 million face images of 2,622 people. The system has achieved real time performance of upto 4 fps with an accuracy of 97.6% on Labeled Faces in the Wild (LFW) dataset.

Keywords: *Face Recognition, MTCNN, VGG-Face, Jetson Nano, TensorRT*

1. Introduction

A Face recognition system confirms the identity of an individual using their facial features. Facial recognition technology is in the limelight today more than ever, COVID-19 pandemic and several other diseases spread through contact from contaminated surfaces. Hence classical biometric systems based on password typing and fingerprints are unsafe especially in large spaces like offices, educational institutions etc. Face recognition technology is preferred in such cases because of its non-contact nature. Furthermore, facial recognition algorithms have very high accuracy rates and have very fast processing speeds. Significant advances in face recognition have occurred because of Artificial Intelligence technologies [1], previous research interests were mainly focused on face recognition under controlled conditions where simple classical approaches provided excellent performance. But with emergence of Deep Learning, the focus of research is on unconstrained conditions as it offers strong robustness against the numerous variations that can alter the recognition process

To run these Deep Learning based Face recognition algorithms a low cost, portable, low power powerful hardware is required, the hardware has to be affordable yet powerful enough to yield high throughput. For this task we have chosen Nvidia Jetson Nano as the hardware for our Face recognition system. NVIDIA Jetson Nano Developer Kit is [2] a small, powerful computer that runs multiple neural networks in parallel, it has a power consumption of less than 10 watts.

2. Literature Review

A large part of the literature in face recognition is focused on the development of algorithms that can accurately recognize faces. Some of the most widely used algorithms include Principal Component Analysis (PCA) [3], Linear Discriminant Analysis (LDA), and Fisherface [4], among others. More recent algorithms, such as Convolutional Neural Networks (CNNs) [5], have also shown promising results in face recognition.

The performance of face recognition algorithms is often evaluated using benchmark datasets, such as the Labeled Faces in the Wild (LFW) [6] dataset and the MegaFace dataset

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[7]. The evaluation metrics used for face recognition include recognition accuracy, processing time, and sensitivity to variations such as pose, illumination, and expression.

Jetson Nano has been shown to have real-time performance for face recognition, making it a popular choice for use in various applications. For example, in the study [8] the authors demonstrated the real-time performance of a face recognition system implemented on Jetson Nano. Several studies have compared the performance of Jetson Nano with other platforms for face recognition. For example, in the study [9] the authors compare the performance of Raspberry Pi and Jetson Nano for face recognition using various algorithms. They found that Jetson Nano outperformed Raspberry Pi in terms of recognition accuracy and processing speed. Jetson Nano has been integrated with various technologies to enhance its performance for face recognition. For example, in the study [10], the authors integrate Jetson Nano with OpenCV to improve the performance of a face recognition system. They found that the integration improved the accuracy of the system and reduced the processing time. These findings suggest that Jetson Nano is a promising platform for face recognition, with real-time performance and good accuracy. However, further optimization and improvement of algorithms is needed to overcome the limitations of Jetson Nano.

3. Research Methodology

Figure 1: Research Methodology

Facial recognition process typically involves the following steps: Capture and Pre-processing, Face Detection, Feature Extraction and Comparison.

Capture and Pre-processing: The first step is to capture an image or video of the person's face. The image or video is then pre-processed. This can involve cropping the image, converting it to grayscale, and normalizing the brightness and contrast.

Face Detection: Face detection is a computer technology used to identify and locate human faces in digital images or video frames. Face detection algorithms typically starts by searching for high-level features, such as eyes, noses, and mouths, and then uses these features to identify faces. The algorithm will then localize it by drawing a bounding box around the face. This can be done using techniques such as Haar cascades [11], HOG features [12], or deep learning-based object detectors.

Feature Extraction: Next, the facial features are extracted and represented as a set of numerical values, known as a feature vector. This can involve detecting facial landmarks, such as the corners of the eyes, mouth, and jaw line, and measuring their relative positions and distances.

Comparison: The extracted feature vector is then compared to a database of known faces, and the algorithm attempts to find a match. The comparison step typically involves calculating a similarity score between the input feature vector and each face in the database.

4. PROPOSED METHOD

4.1 FACE DETECTION USING MTCNN:

The Multi-task Cascaded Convolutional Networks (MTCNN) [13] is a popular deep learning framework used for face detection, alignment, and recognition. The method is based on cascaded neural networks, which are trained to perform several tasks in a sequence, allowing for a hierarchical and efficient approach. For the face detection task, MTCNN uses a multi-stage architecture to achieve high accuracy and speed.

In the first stage, a Proposal Network (P-Net) is used to generate candidate face boxes by proposing windows in the image. In the second stage, a Refine Network (R-Net) is used to further refine the face boxes and reject non-face regions. Finally, an Output Network (O-Net) is used to perform a face alignment and output a facial landmark points. These landmark points are then used to align the face and extract the face region from the image.

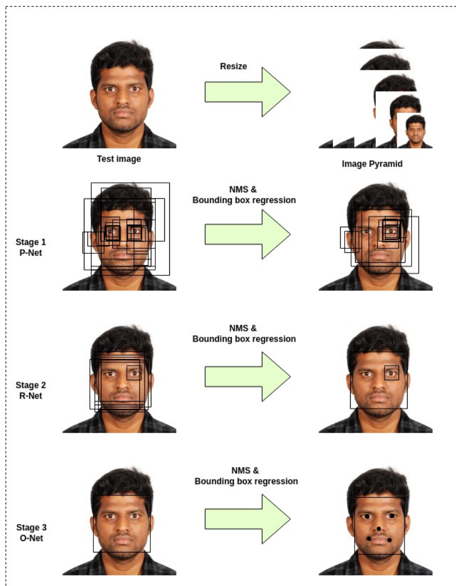

Figure 2: Face detection using MTCCN

The MTCNN framework has proven to be effective in a variety of real-world applications and has achieved high accuracy and efficiency in comparison to other traditional face detection methods. On the popular WIDERFACE dataset [14], MTCNN has been reported to have an accuracy of over 97%. In our work, MTCNN will be used to perform the initial face detection and alignment, allowing for the subsequent use of deep learning models for face recognition.

Figure 3: Face detection even when the person is not looking at camera

4.2 VGG-FACE NETWORK

*Visual Geometric Group (*VGG)-Face [15] is a deep neural network architecture that has been trained to identify faces in digital images and videos. It is built on the VGGNet architecture, which is a deep convolutional neural network that has been proven to be very effective for image recognition tasks.

The VGG-Face architecture has been trained on 2.6 million face images of 2,622 people. It is capable of extracting rich and complex features from an image, which can be used to classify the faces of individuals. The VGG-Face architecture has been evaluated on several benchmark datasets and has achieved impressive accuracy rates, outperforming many other popular face recognition models.

For example, it has achieved an accuracy of over 97% on the Labeled Faces in the Wild (LFW) dataset, which is a benchmark dataset for face recognition algorithms. This high accuracy rate makes VGG-Face a strong choice for face recognition applications, such as facial recognition systems, face verification systems, and biometric authentication systems.

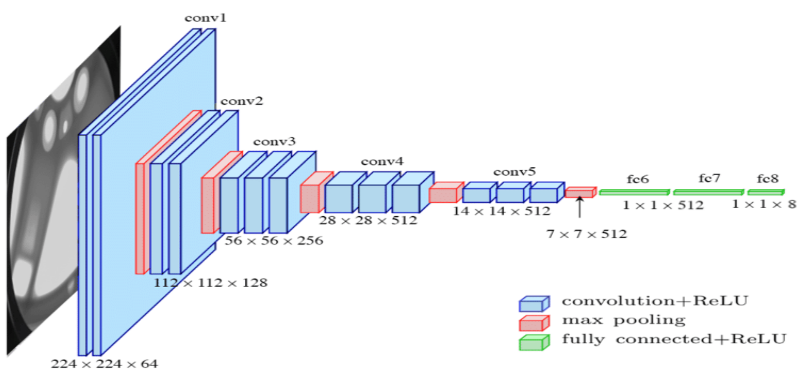

Figure 4: VGGNET ARCHITECTURE

5. RESULTS AND DISCUSSIONS

Figure shows the experimental setup used. A low-cost webcam is used to capture the images. Jetson Nano 2 GB is used to run the MTCNN and VGG-Face models. These models are accelerated to give high throughput by using NVIDIA TensorRT libraries.

Figure. 5: Experimental Setup

It was seen that the Face recognition system was able to detect and classify the persons successfully under partial mask scenarios also. The accuracy of facial recognition remained unaffected under different conditions such as lightning, and the distance from the camera.

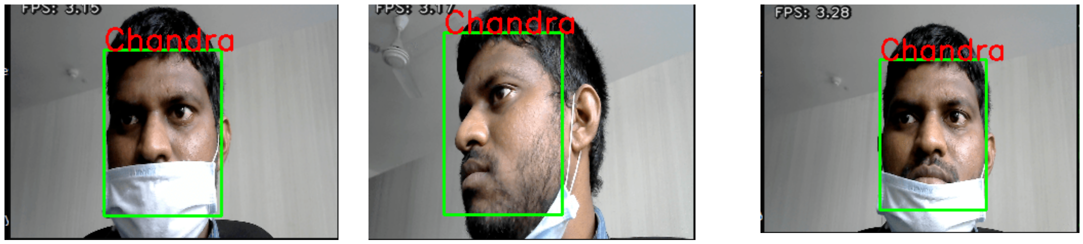

Figure 6: Face detected even with partial Mask.

6. Conclusions

A cost effective and accurate Face recognition system has been developed by using Deep Learning models available in literature. We were able to get real time performance on a very low-cost hardware by utilizing the NVIDIA TensorRT optimization libraries. We successfully demonstrated the model's efficiency even with partial mask scenarios. Although this system has limitations for very large user database as the Jetson nano has limited processing power, memory and storage capacity. More powerful alternatives are in development by NVIDIA to provide low cost and highly powerful GPU edge systems, and these need to be tested in future.

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