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Fingerprint Classification using CNN for Forensic Analysis

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Abstract: *In forensic medicine, DNA fingerprinting for identification is becoming a necessary procedure. Analysing fingerprints left at the scene of a crime is one of the most critical parts of forensic analysis. Fingerprint analysis typically helps to connect the crime to a person who may have been present at the scene but can also be used to track a person's previous records; arrests, parole, and other details. Thus, it is required to create a fingerprint identification system. This work proposed a fingerprint identification system using deep learning for investigation purpose. The dataset for the fingerprint identification is downloaded from public domain and it contains fingerprint images of different persons. The algorithm used for the proposed fingerprint identification system is Convolutional Neural Network (CNN), which is a deep learning algorithm. The algorithm extracts feature from the input data and features is used to identify person.*

Keywords: CNN, Fingerprint image , Image processing

I. INTRODUCTION

Forensic evidence of fingerprint is the field of forensic expertise related to the inference of the identity of source from the examination of all the friction ridge skin, namely the fingers, the palms, the toes, the soles, and their marks. Fingerprint recognition technology has a long history which was mostly used for the identification of the criminals from a crime scene and judicial investigations. A fingerprint is an impression of a fingertip made on any plain or flat surface. Also, it can be said as an ink impression of the lines upon the fingertip which is further used for identification. A fingerprint consists of ridges and valleys. Ridges are the dark area of the fingerprint and valleys are the white area between the ridges.The artificial intelligence technology, especially the image technology based on deep learning, has opened a new mode of fingerprint identification algorithm. The fingerprint identification technology based on deep learning uses image features instead of traditional minutiae feature, which changes the cognition of fingerprint recognition in the field of forensic science. The Convolutional neural networks (CNN) in deep learning are popular for image processing. Also, here the inputs are fingerprint images, therefore CNN can be used for identification. The proposed work is a fingerprint identification system based on Convolutional Neural network (CNN) for investigation purposes to identify the fingerprints in the crime scene.

II. LITERATURE SURVEY

Deep learning based RF fingerprinting for device identification and wireless security : Qingyang Wu, Carlos Feres, Daniel Kuzmenko, Ding Zhi, RF fingerprinting is an emerging technology for identifying hardware specific features of wireless transmitters and may find important applications in wireless security. In this study, the authors present a new RF fingerprinting scheme using deep neural networks. In particular, a long short-term memory based recurrent neural network is proposed and used for automatically identifying hardware-specific features and classifying transmitters. Experimental studies using identical RF transmitters showed very high detection accuracy in the presence of strong noise and demonstrated the effectiveness of the proposed scheme.

Deep learning based RF fingerprint identification using differential constellation trace figure : LinningPeng, Junqing Zhang, Ming Liu and Aiqun Hu , This paper proposes a novel deep learning based radio frequency identification method for internet of things terminal authentications differential constellation trace figure a two dimensional representation of differential relationship of single time series is utilized to extract RFF features without requiring any synchronization. A

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CNN is then designed to identify different devices using DCTF features. Compared to the existing CNN based RFF identification methods the proposed DCTF CNN possesses the merits of high identification accuracy zero prior information and low complexity.

III. PROPOSED SYSTEM

The artificial intelligence technology, especially the image technology based on deep learning, has opened a new mode of fingerprint identification algorithm. The fingerprint identification technology based on deep learning uses image features instead of traditional minutiae feature, which changes the cognition of fingerprint recognition in the field of forensic science. The Convolutional neural networks (CNN) in deep learning are popular for image processing. Also, here the inputs are fingerprint images, therefore CNN can be used for identification. The proposed work is a fingerprint identification system based on Convolutional Neural network .

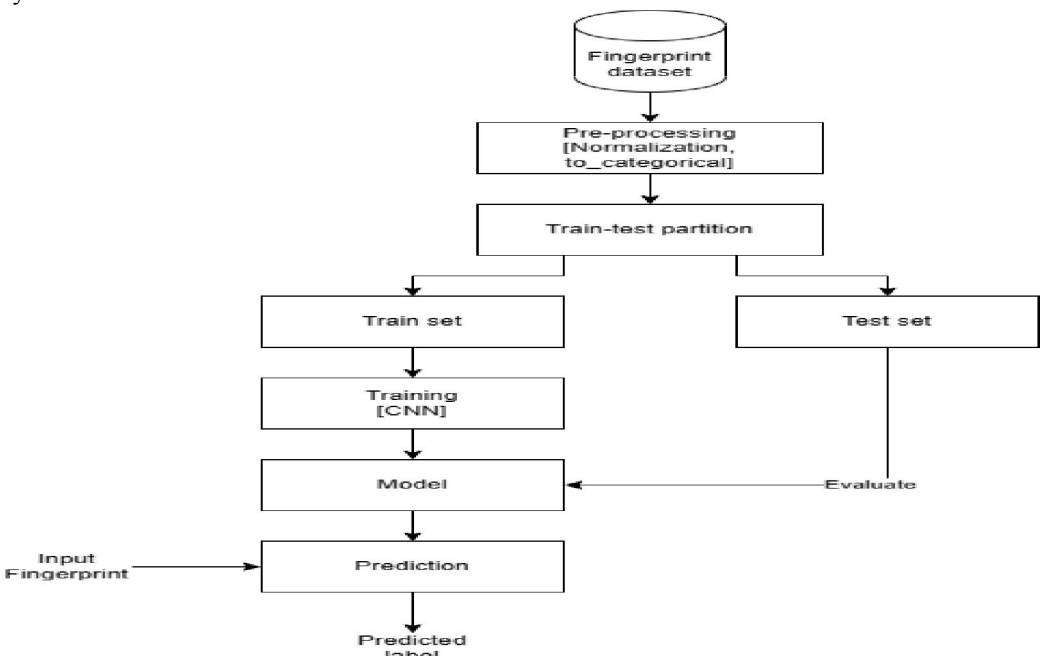

Figure 1. System Architecture

IV. METHODOLOGY

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving. Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. AI is an interdisciplinary science with multiple approaches, but advancements in machine learning and deep learning are creating a paradigm shift in virtually every sector of the tech industry. Artificial intelligence is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the most simple to those that are even more complex. The goals of artificial intelligence include mimicking human cognitive activity. Researchers and developers in the field are making surprisingly rapid strides in mimicking activities such as learning, reasoning, and perception, to the extent that these can be concretely defined. Some believe that innovators may soon be able to develop systems that exceed the capacity of humans to learn or reason out any subject. But others remain skeptical because all cognitive activity is laced with value judgments that are subject to human experience.

Deep learning

Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability, allowing it to

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"learn" from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy. Until recently, neural networks were limited by computing power and thus were limited in complexity. However, advancements in Big Data analytics have permitted larger, sophisticated neural networks, allowing computers to observe, learn, and react to complex situations faster than humans. Deep learning has aided image classification, language translation, speech recognition. It can be used to solve any pattern recognition problem and without human intervention.Artificial neural networks, comprising many layers, drive deep learning. Deep Neural Networks (DNNs) are such types of networks where each layer can perform complex operations such as representation and abstraction that make sense of images, sound, and text. Considered the fastest-growing field in machine learning, deep learning represents a truly disruptive digital technology, and it is being used by increasingly more companies to create new business models. Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition

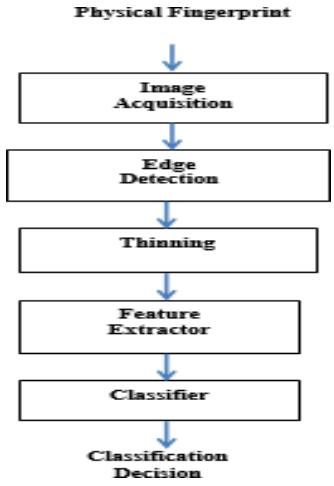

Figure 2. The Convolutional Neural Networks

CNN:

CNN approach realizes both the preprocessing and recognition phases, thereby increasing the overall performance of the system. Normalization eliminates noise and improves the feature quality of the fingerprint image. Segmentation technique isolates the fingerprint image from the background. Considering threshold value, binarization is applied and image is improved Gabor or similar type of filter. Next thinning process is applied on ridges. Finally, minutiae are determined with its positions and types. Directions of the complete ridges are analyzed to classify the fingerprint images. Unnecessary deformation such as cut, twig, circular and cross ridges occurs during thinning process. Elimination of these deformities is done by tracing bifurcation point based on angles between average and end points. Connection of cut ridges, removal of twig ridges, disconnection of cross ridges and moving a part of circular ridges are done using certain measures. Figure 1 represents the CNN system's workflow diagram. It describes the process flow from the identity provider (local cloud) and the service provider (remote cloud). The token obtained from the service provider can be used to obtain the resources list from service provider.

V. COMPARISON WITH PREVIOUS METHODS

Our work presented CNN based fingerprint methodology to enhance and match the fingerprints to improve the performance of a biometric authentication system. Some inference made by our study are, training sets and size should be minimal for matching problems when compared to classification problem. For instance, classification of whorls with refined statistical variations across to the network. Classification of whorls demands the need to expose the network to a large sample representative of whorl patterns across the total population with refined statistical variations. Matching mainly subtracts one image from the other. Hence concern is towards the variability of the difference. Applications

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consisting small databases have features that are favorable in exploring architecture and training of networks. An effort to solve matching problem using neural network is done. Testing larger samples, a general-purpose network is essential. It is notable that, trained network associated with only five different persons image pairs, simplifies well with larger data base.

VI. CONCLUSION AND FUTURE SCOPE

In this work, a fingerprint identification system is implemented using deep learning technique. Fingerprint is the most commonly used human feature in automatic detection of authenticity which deals with a very large number of databases. A high accuracy rate is very crucial in the classification and detection of fingerprints. In this work, Convolutional Neural Network is used for the implementation of the fingerprint identification system. The input is the fingerprint image and output are the identified person. The technology used for the implementation is python. The implemented system attains overall accuracy of 94%. Fingerprint classification and identification is a well-established field with numerous practical applications. The potential areas where a fingerprint classification and identification project could be useful is Law enforcement agencies use fingerprint classification and identification for criminal investigations, to identify suspects, and to solve crimes.

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