A New On-line Signature Verification by Spatio-Temporal Neural Network

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Abstract— **In this paper, a new on-line signature verification system using neural network is presented. The proposed system is based-on a newly developed Spatio-Temporal Artificial Neuron (SPAN),which is well adapted for the verification of Spatio-Temporal patterns. In this model, the strokes of a signature generated by a digitizing tablet is presented in form of a sequence of spikes corresponding to displacement of the stylus. The STAN has the capability to process continuous asynchronous Spatio-Temporal data sequence and compares them with the help Hermitian distance. The architecture of the proposed system is based on two modules : preprocessing and classification. The second module is based on neural architecture ,which has STANs as their neurons. This module is based on an adaptation of the RCE algorithm .Our database includes 400 genuine signatures , 200 random forgery and 200 skilled forgery signatures that were collected from a population of 40 human subjects. Our signature database consist of the samples with about 100% size difference that are recognize thoroughly. Our verification system has achieved a false acceptance rate (FAR) of 7.5% and a false rejection rate (FRR) of 12.81%. Advantage of this method is using spiking neural network by Spatio-Temporal coding, using properly from signature's temporal feature, high speed of training and testing , using the less features in recognition and verification of signature, signature recognition in different size, the easy method with low expenses , not needing to any preprocessing such as rotating, transmit , normalization, filtering and no local limitation in digitizing tablet.**

Index Terms— **On-line Signature Verification , RCE Spatio-Temporal Neural Network , Spatio-Temporal Complex Coding**

I. Introduction

Biometric authentication methods including voice and fingerprint identification, face recognition, retina scan and signature verification are becoming increasingly popular for applications ranging from access control to restricted areas to fraud prevention in financial transaction. Signature verification is of particular importance as it is the only widely accepted method for endorsing financial transactions.

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An important advantage of the signature over other biometric is its long standing tradition in many commonly encountered verification tasks. It has been used for decades in civilian applications while other methods(e.g., fingerprints) still have the stigma of being associated with criminal investigation. In other words, signature verification is already accepted by the general public.

Handwritten signature verification can be divided into Online and Offline verification. On-line verification refers to a process where the signer uses a special pen called a stylus to create his/her signature that produces measurement such as pen location, speed, and pressure. Off-line verification is concerned with the verification of a signature made by a normal pen. Various different approaches to both classes have been proposed. For literature surveys, see [1,2].

Recently a neuron model called Spatio-Temporal Artificial Neuron (STAN) has been developed [3-4], while emulates some of the aspects of the biological neuron. Its main feature is its capability to simultaneously handle the spatial as well as the temporal position of an event in a given sequence of events. This feature makes it suitable for applications which process data in which temporal positioning is also important [5-6].

In our solution we didn't use any preprocessing which includes : filtering, normalization, resampling etc individually or as a set of them [7-8]. It is worth nothing that our purely neural solution is particularly in eresting from point of view of speed, cost and the simplicity of putting up the system together.

In the rest of this paper, we are first going to present the ST coding on which our system is based . Then we explain our system which includes data acquisition , preprocessing, verification of signatures and give some experimental results.

II. Spatio-Temporal Coding

Consider a sequence of asynchronous events. An event is represented as an impulse x whose spatial and temporal aspects are simultaneously taken into account by coding it in the complex domain. In polar coordinates (η,φ) the magnitude η gives the amplitude and the angle φ gives the temporal position of the impulse from a reference point.

$$x = \eta e^{i\varphi} \text{ where } \tan(\varphi) = \mu_T \tau \text{ hence } x = \eta e^{+i \arctan(\mu_T \tau)} \quad (1)$$

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