# Ear Image Recognition using Hyper Sausage Neuron

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***Abstract-*. It is important to distinguish an individual from a group of other individuals to ensure information security an d integrity. One of human body parts that has distinguishable characterics is the ear. Prior attempts on identification of hum an ear image has been implementing statistical pattern recogni tion which focusing more on classification between sample sets . This research attempts to build a robust ear image recognitio n system using Hyper Sausage Neuron (HSN) that concetrates on cognition process rather than classification. A recognition s oftware has been built and tested to recognize ear images. Ear images presented into the software has its geometrical moment invariants extracted. These moments is then used to build a se ven dimensional feature vector which will construct a network of HSN of each individual it represents. Different ear images f rom the same individual is presented into the software to test i ts accuracy. The experiment result shows that ear recognition using HSN has better accuracy and faster training time than p revious recognition attempts using statistical pattern recogniti on.**

## BACKGROUND

Individual recognition have been proven to be useful in s ecuring information. It is important to distinguish an individ ual from a group of other individuals to ensure information security and integrity. Biometric is a method to recognize a person based on their certain physiology characteristics. It h as been previously explored and suggested as an authenticat ion method [1] [2]. One of human body parts that has distin guishable characterics is the ear. Compared to other body p art, such as face, ear has several advantages, namely that its shape does not change significantly throughout human life and that it is not easily affected by emotional change [3].

Prior attempts on identification of human ear using statist ical pattern recognition results in more than 90% accuracy[ 4] [5] [6]. However, in accordance to the nature of neural n etwork, these attempts are focusing on classifying and diffe rentiating the training samples. This nature made the recogn ition system may be weak to new, untrained sample. Thus, i f there is a new training sample to be added to the network, the whole network has to be re-trained to maintain its accur acy. Repeating these process can be time consuming with in creasing network and sample sets.

Hyper Sausage Network (HSN) is a part of biomimetic p attern recognition. It concentrated on the cognition process rather than classification of sample sets. Each sample is sep arated and has no connection to other [7]. Therefore, if ther e is an added sample, only a certain part needs to be trained. It also implemented the principal of homology-continuity ( PHC) [8]. HSN can be described as the basic covering unit of the training set. Its coverage in high dimensional space c onstructs a sausage like shape in feature space for covering the distribution area of the sampling points in the same clas s [9]. The HSN covering can be seen as a topological produ ct of a one-dimensional line segment and a two-dimensiona l super sphere [10].

As previous studies suggested, ear is a potential biometri c focus, but, previous attempts using statistical pattern reco gnition might be vulnerable to untrained data. HSN, on the other hand has a different cognitive process that is more rob ust to untrained data. This research attempts to build a robu st human ear image recognition system using HSN and com pare its result and training time to previous studies.

## CURRENT RESULTS

An ear image recognition software prototype has been bu ilt using Java programming language. The recognition uses Geometrical Moment Invariant (GMI) as its feature extracti on method. GMI is based on nonlinear combination of nor malized central moments. It has seven features that does not changed althought the image is translated, scaled, mirrored, and rotated [11]. It has been proven as an effective feature e xtraction method to

The recognition software has two main processes, namely , the training process and the recognition process. The softw are flow chart can be seen on Fig. 1. Both of the processes t akes binary human ear image as input. The training process results is then saved into external file containing HSN netw orks of each individual and their respective id, whereas the recognition process will show each input image owner id.

To test the accuracy of HSN in recognizing human ear im age, sample images from 25 individuals has been tested into the software. Sample images were taken from the AMI ear database. The images were collected and pre-processed by s caled, gray scaled, and thresholded into binary image as see n on Fig. 2. The pre-processing is done externally using ima ge editing software. Each individual is represented by 6 ima ges, 3 were used for training, and the other 3 were used to t est the recognition accuracy.

Experiment were conducted under 4 different configuration s based on different threshold's β value. Threshold value in HSN represents a sausage super sphere's radius. The value can be a static value, or derived from the sausage's characte ristic, which is the line segment width ($D_{ij}$) and a user-deter mined β value. Results of these experiments can be seen on Table 1. In this experiment, different threshold value does n ot affect th recognition result, but it significantly increase th e accuracy compared to static threshold value.

TABLE I
SUCCESS RATES OF DIFFERENT EXPERIMENT CONFIGURATION

| Threshold | Static (th = 1.000.000) | th = β * $D_{ij}$ | | |
|---|---|---|---|---|
| | | β = 0.4 | β = 0.75 | β = 0.9 |
| Success rate (%) | 90.67% | 97.33% | 97.33% | 97.33% |

The process of training and recognizing image were also timed. Training process of 25 individuals with each 3 sample sets was done in 0.125 sec, while the recognition process of 75 images takes 1.718 sec, averaging in 0.023 sec of each image.

TABLE II
COMPARISON OF THE SYSTEM TO OTHER STATISTICAL PATTERN RECOGNITION

| Recognition Method | Success Rate Percentage | No. Of training sample | Training time (s) |
|---|---|---|---|
| Hyper Sausage Neuron with GMI | 97.33% | 75 | 0.125 |
| Backpropagation with ZMI [4] | 96.67% | 75 | n/a |
| SOM with GMI [5] | 96% | 75 | n/a |
| SOM with Geometrical Feature [6] | 98% | 46 | 2.3 |

Compared to previous attempts on human ear identification in Table 2., the result is better than [4] and [5], while it is lower than [6]. But, the training time is significantly faster than it is of SOM.

Based on the current experiment result of the ear image recognition, HSN has shown a promising result and better processing time to prior attempt to ear image recognition. Future development of the system consist of dynamic addition of training sample, and different application of HSN threshold value.

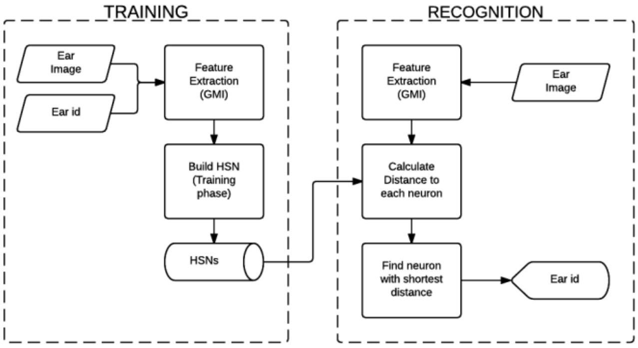


Fig 1. Ear Image Recognition with HSN software flow chart

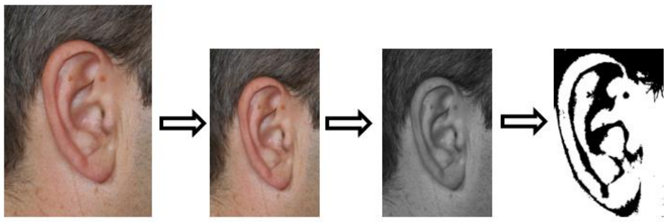

Fig 2. Ear Image Pre-process

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