

# ODOR RECOGNITION SYSTEMS A REVIEW

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## Abstract:

Biometrics, said as authentication and identification of individuals based on their uniqueness. When we see some biometrics such as using our hand for palm print and fingerprint detection, mouth for voice detection, eyes for iris or retina detection and finally face detection [1]. Latest technology has raised which are much more powerful and have better accuracy than the previous ones. Odor, vein pattern, heartbeat rate and ear design are available and from these “Odor Recognition “stand first with more than 85% accuracy, even when compared with fusion of biometrics.

Human body system sweats are unique and odor biometrics recognizes this as patterns and on equal match, it is verified. Body odors are featured with factors- stable over time regardless to diet or environmental factors such as pollution(or)external sources (lotions, soups, perfumes) does not affect the odor pattern and remains same always.

**Keywords — Uni-layered, multimodal, odor technology, odor characteristics, Electronic nose, artificial neural networks**

## I. INTRODUCTION

### OBJECTIVE:

Odor recognition is proposed to meet various needs that were not full filled by the present biometrics, here it is featured i.e., No physical user involvement with systems to verify, potential with rapid response rate, sense of uniqueness, reliable authentication, non-mask able by other deodorants (or) odors, stand-alone power (specific, constant, progressive, assurance). The ideology of using this biometric would satisfy the limitations of other biometrics and this paper consists the analysis done and a report of odor strength, stability, and comparative study on odor systems.

Biometrics are evolving all around the world for security and safety, based on individual uniqueness it has be possible to detect, identify, evaluate and is useful for privacy and safeguarding individual aspects or information. “Biometrics” is defined as measure of identification of individuals on their unique characteristics. When we consider a human being they might differ in talents, but sometime may be

similar.as we deal on physical entity we do not go by their talents but with their characteristics [3].

Physical, chemical and behavioral are determined based on expressing a character.

### A. Physical characteristics:

When we define this characteristic it may be present in an individual as physical character. That would be useful to determine a particular individual sometimes it unique, therefore beneficial

For let’s consider eyes for iris and retina identification, so on for face pattern, ear design, fingerprint are some.

### B. Chemical characteristics:

These characteristics are said to be chemical composition of individuals.

Body odor can be used as an authentication agent.

### C. Behavioral characteristics:

These characteristics are performed by individuals as unique; hence it is possible to identify an individual with their behavior.

Some are keystrokes/typing patterns, voice prints, and signature.

Biometrics uni-layered (set of only a one type of biometrics) or multimodal (combination of one or more biometrics) are used for higher accuracy and implement an ideal biometric system that achieves 100% accuracy.

- Unilayered – Biometrics which are of one single type and combined together to form an array of authentication systems, so that these able to achieve a lot rather than a single biometric. Higher accuracy is obtained when biometrics are combined of a single type, with reliability.
- Multimodal –Biometrics which is a combination of two or more types and formed as a single unit, so that ideal authentication can be achieved. Higher accuracy is obtained here such as face recognition systems when combined with other systems face-iris, face-speech, and face-fingerprint.

Body odor as a unilayered biometric is 85% accurate when compared to other biometrics from simpler – hand geometry, fingerprint, iris and retina recognition to higher accuracy rate-DNA recognitions [4].

The ideology of odor biometric is compared to dogs smelling their owner. We notice that the capability of dogs in sniffing are more when compared to humans, thus able to detect bombs in surroundings. The same concept is followed here to identify.

Every human exhibits odor, a chemical composition can be used to distinguish individuals. Odors of an individual belongs to them and there cannot be a duplication. Odor is divided as:

- Primary odor – It is primary as it is natural of individual. Not even change in diet or change in external environment can cause problem to it.
- Secondary odor –contains constituents of diet and external environment factors.
- Tertiary odor – this odor specifies other odors like scents, soap, body lotion.

In detecting odor of human being irrespective of gender, primary odor plays a major role. Odors present at the auxiliary region of an individual are the characteristic odor that can be used for identification. Here we know how the odor of a particular is evaluated by system of matching one pattern of odor to many odors, such that the resultant odor is the desired result. A database, such that it holds all the odors and during the matching process the resultant is considered as true, the system enables access.

## **II. LITERATURE REVIEW**

### **Title: “A Survey of Emerging Biometric Technologies”**

According to the paper “Biometrics are useful in field of authentication and identification with a greater accuracy rate”. New advancements in the technology field using of PIN, Passwords are developing problems of duplication, therefore considering a user involvement that limits to individual to access is better. Few such technologies that were developed are hand geometry, iris scan, face scan, voice scan and odor recognition. Some other interesting technologies that can be implemented would be using lips, ear, vein, heartbeat and retina [4].

### **Title: “A brief history of electronic noses. Sensors and Actuators”**

According to the paper the development of a human nose to a typical agent in detecting an individual through means of odor was the basic idea and with this the development of electronic nose began. The reason of such development was basically to develop an electrically usable system with array of sensors to identify an individual with their characteristics. Further advancements in the technology from past 30 years would conclude an intelligent access approach of E-nose. Some applications and future applications are mentioned to understand the growth of it [6].

### **Title: “Perfume and flavor identification by odor sensing system using quartz-resonator sensor array and neural-network pattern recognition”**

According to the paper the development of sensor system in field of neural networks with use of array of sensors and a neural network pattern recognition that is able to identify various odors in a multilayered odor at a rate faster than a normal sensing system. Usage of perfumes or scents would not affect any individual odor; thus the system is able to obtain a high success rate during the process. The future advancements of artificial neural networks would deploy more adverse effect on detecting an odor and identify various odors simultaneously when combined with gases [7].

This biometric depends on odor of an individual, the region that surrounds consist the odor that is utilized. The odor is spread across the region through air as a medium which pushes the odor throughout the body of individual. When we see the odor that an individual owns is by the effect of bacteria on dead cells of the body.as a result of this the smell due to bacteria decomposing the dead cells influence an odor to environment. This in turn is used here as an agent to detect or identify an individual [6].

An odor biometric view:

1. Sensing Sniffer
2. Metal Oxide Semiconductor system
3. Chromatography
4. Computation
5. Validation
6. Authentication

### III. REPRESENTATION OF A MODIFIED TRADITIONAL ODOR RECOGNITION SYSTEMS WORKING

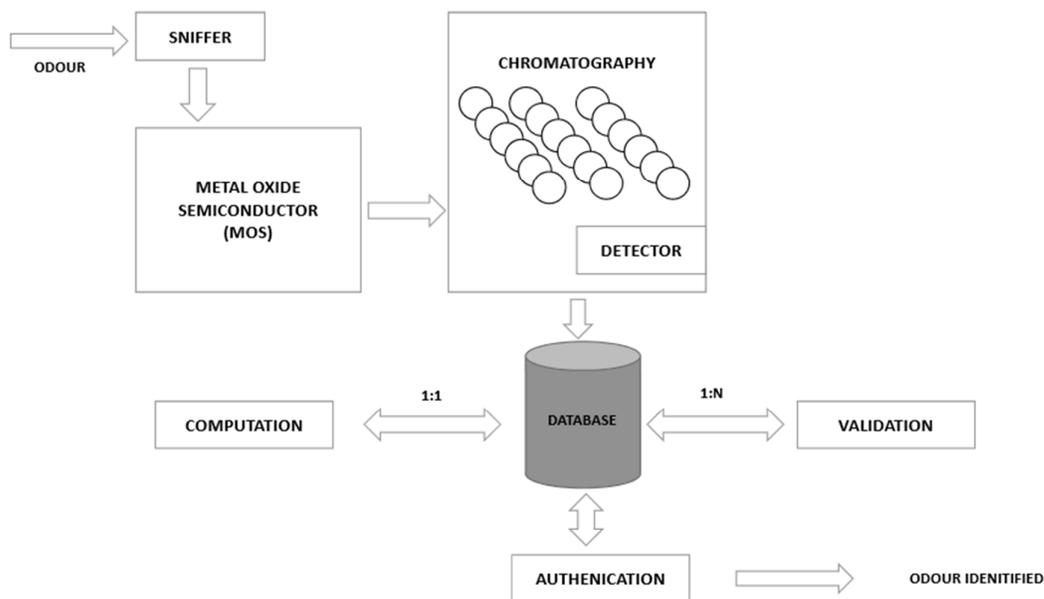


Figure 1: Working of odor biometric system (Modified)

1. Sensing Sniffer –The odor from the individual surrounding is sucked through a pump and this covers the current of warm air in it.
2. Metal oxide semiconductor systems –When the odor is acquired into the system, it gets reacted

with the volatile compounds. The sensor acts in determining the change in electrical properties. The pre-processing of odor pattern occurs here and is passed to the next phase, this is said as feature extraction (Figure 1). The extracted odor

is let to pass through a chamber to determine the odor classification.

3. Chromatography –The feature is passed through many columns in the chamber and quality and composition of odor is detected. This composition holds an odor pattern it is converted into a digital form to identify the match in the database (Figure 1).
4. Computation – One to many comparisons occurs and each patterns are called and on a match the computation process terminates. If no, then the odor pattern is stored into database for future recognition (Figure 1).
5. Validation –One to one comparison occurs, since the odor is computed, it is a necessary factor to validate the existing odor pattern to new odor pattern arises (Figure 1). If the odor is exact to the existing odor then decision is made as correct, if not exact then decision is wrong then validation said to be is completed.
6. Authentication –The odor is recognized with the estimate of what type odor it is and it allows the access control to the individual to whom the odor belongs. On the completion the odor authentication the odor biometric has successfully identified the individual with the body odor (Figure 1).

#### IV. ODOR RECOGNITION SYSTEMS

Odor biometrics based on the structure are implemented as Electronic nose (using concept of human olfactory model) and Artificial Electronic Nose (using the concept of ANN-Artificial Neural Networks).

##### A. Human Olfactory Model (ELECTRONIC NOSE)



Figure 2: Electronic Nose [5]

Human nose is effective in determining odors and identifying the characteristics of odor through the receptors and olfactory nerve. The ability to smell is not as much powerful when compared to animals. Around 40 million olfactory nerves are present to determine even a slight traces chemical composition in the air. Variation of odors such that one part per trillion could be detected [8].

Human odor recognition systems are said to complicated ones and implementation of this as Electronic Nose was a challenging task. The mechanism of how brain works effectively in distinguishing the odor and knowing olfaction method are the aspects which lead to development of Electronic Nose (Figure 2) [7]. Olfaction method is divided as:

**1. Sniffing** – Odor is mixed to a uniform concentration so that similar scents are in one side and others of their similar type. And this is delivered to the mucus layer (present at the upper part of the nasal cavity). These are transferred to olfactory nerves and to thier olfactory receptor neurons [2].

**2. Reception** – Olfactory receptor neurons provides the binding of the odor molecules and are provided to olfactory receptor membrane through binding with proteins. During the chemical reaction of olfactory simulation, electrical stimulation is provided to olfactory bulb.

**3. Detection and Recognition** – Receptors at olfactory bulb provide the information to olfactory cortex, odor recognition takes place and olfactory cortex is able to recognize the specific odor. The messages of olfactory nerves are sent to brain, is associated with collection of signals sent by the olfactory nerves with specific odor. Brain detects the odor specific character and identifies what odor it is through the memory unit.

**4. Cleansing**

This process ends the olfaction process by breathing fresh air such that it removes the odor molecules from the olfactory receptors.

This mechanism of odor recognition is the base for implementing Electronic Nose; the function of electronic nose is the same way as a normal human nose function and detect the odor. Olfactory array of sensors are used as receptors, pattern recognizing systems, sensing systems and brain like a database for odor manipulation.

### **5. Sensors**

These are considered in a form of array so that combined form would be able to measure different property of the sensed chemical odor. Each sensor present is used to perform a specific operation and it is complicated in determining the proper pattern of odor [2].

### **6. Pattern recognition systems**

The main objective of an odor recognition system is to find the proper match of the odor from the entire database. The Enose (Electronic Nose) cannot have olfactory bulb unlike humans to detect odor, the automatic identification of odors through means of uniqueness in the pattern and clustering of each odor would be able to detect some odors which are stored in the database through computation and validation techniques. Recognition could be through several approaches –statistical, artificial neural networks, neuromorphic.

### **7. Sensing systems**

Odor specific character or pattern must be identified for the proper functioning of a Enose, the signal processing and pattern recognition systems are relatively solved by further divided this processes as feature extraction, odor classification based on odor pattern and decision making with the authentication of odor pattern with the database.

### **B. PROBLEM: NEED FOR ARTIFICIAL NEURAL NETWORKS**

Scientists have been working on usage of artificial neural networks for an issue that was detected in using olfactory system modal. The problem is stated as each individual are detected based on the unique odor, this is recognized and distinguishable “What is two or more user’s odor is given to detect whose odor

it belongs?” then it is impossible to answer without a mixed odor effect.

This effect is included in artificial neural networks where in an individual or many individual’s odor is randomly checked for the suitable odor and displayed for user to choose an option. Therefore, user has to choose one of the option for authentication. Using the concept ANN artificial electronic nose is implemented.

### **C. ARTIFICIAL ELECTONIC NOSE**

Artificial neural networks (ANN) are implemented in pattern recognition systems such that the layer of neural networks able to identify and determine the odor. To solve the problem that a raised with olfactory model Enose’s ,if odors are mixed ,two or more odors are present then analyzing of more odors or mixed odors would be a difficult task to perform[9].

In ANN we are able to solve this problem with higher accuracy rate and providing communication and understanding as how a humans are able to smell. They are useful in predicting the intensity of gas mixtures that comprises of different odor. Mixed odors are also been detected and analyzed. They are trained to be useful in detecting odors based on weak, distinct, and strong odors , so that in pattern recognition systems odor is identified as a perfect match.

Neuromorphic approach is based on building models of olfaction through biological methods and implement those using electronics. The olfactory system is implemented on neuromorphics are able to process including recording, remapping, signal compression and performs pattern identification, classification and recognition.

ANN are standardized by the latest technology of array format, sensory system is the main objective and due to many sensors which perform as a neuron when compared. Each sensor acts as agent of input odor and other sensor for output odors, the left out sensors are coupled along with each other in processing and analyzing of odor patterns.

Human nose is capable of smelling certain odors but relatively is able to smell all odors, but the olfactory model does not sense a wide variety of odor

compounds. Hence ANN approach could solve this problem to certain extent but not fully as neural networks are to be trained to analyze an odor, if odor is not known then how it can identify it and recognize it. Therefore, research are undertaken and multilayered ANN odor systems are been developed to meet the odor compounds with mixed odors.

**D. COMPARISON**

Comparison Feature	Electronic Nose	ANN Nose	Electronic Nose
Technique	Olfaction Method	ANN Olfaction Method	
Detection	Uni-layered	Multilayered	
Sensing Unit	Sensors	ANN-neuromorphics ( an array of sensors)	
Accuracy Rate	Moderate	High	
Matching Rate	One at a time	Many at a time	
Availability	Lower range	Wider range	

**V. FEATURES OF ODOR RECOGNITION SYSTEMS**

1. No user physical involvement- User has no physical contact with the systems, odors are recognized when the user pass by or stands before the system. It is also able to recognize an individual at a distance when the contact of odor and system meet up.
2. Sense of uniqueness- Odor is a unique factor of all human beings and this acts a characteristic of each individual to be distinguishable. Therefore, odor recognition systems are implemented with keeping this point in mind.
3. 85% accuracy- Accuracy is the part of security; this system is able to achieve nearly 85% of accuracy factor in pattern recognition and identification of individuals when compared to other systems.

4. Rapid response rate- Responsive is the main objective if these systems are not able to compute the results, then it would not be considered. Therefore, rapid response is provided, if the odor is detected it's quickly validated in database and result is provided.
5. Non maskable- Masking of human odor is done external factors such as perfumes, deodorants, soaps, lotions. Even though it's masked, odor recognition systems are able to detect only the human odor and not anything else. It is an essential feature since change in our daily perfumes or lotions do not affect the natural odor and its pattern.
6. Reliable authentication- An authentication meets success only if it's believed that it will work without any defects and faults in it. These systems are reliable and we can believe that it will work efficiently.
7. Stand-alone power- These systems are classified on their power based on their working.
  - Specific
  - Constant
  - Progressive
  - Assurance

**VI. ADVANTAGES OF ODOR RECOGNITION SYSTEMS**

1. Reduce passwords usage and administration costs.
2. Reduces human efforts such remembering passwords and working of systems.
3. Automatic systems with reduced amount of user involvement.
4. Non maskable by any other odors, therefore it can be hacked or break in easily.
5. Effective response to other individuals, if odor does not then provide alerts.
6. Impossible to trick or change the odors.
7. Low error rate as it a rapid response system.
8. Systems alerts if any slight change or mishandle to system is done.

**VII. APPLICATIONS OF ODOR RECOGNITION SYSTEMS**

1. **Medical diagnostics**  
Daily usage application odors in breath can be useful to determine gastrointestinal problems,

sinus, diabetes, liver problems, wounds and infected tissues.

Can also be used to track glucose levels in diabetic patients, find ion levels in body fluids and detect tuberculosis issues.

## **2. Environmental applications**

Identification of hazardous and toxic wastes, determine fuel mixtures, detection of oils, and monitor factory emissions, test ground water odors.

## **3. Food industry**

In determining quality, inspection of food items during production. Controlling food items during cooking, checking of taste by smell. Verifying juices for natural tastes.

## **4. Pharmaceuticals**

To check if the existing drug that are stored does not gets expired if stored for a lot of time by monitoring its smell from the day to existing day a same. If change occurs, it alerts.

## **5. Perfumes**

Scents and deodorants are made using these systems for higher efficiency in production and useful in mass or huge production.

## **VIII. CONCLUDING REMARKS AND FUTURE ENHANCEMENTS**

Odor biometrics are becoming as a part of authentication around the world. Individuals are being identified without their involvement in providing access and safeguarding their personal information. This development has been found to be most accurate biometric till found yet among unilayered and multilayered systems.

Scientists are trying to identify an ideal working system which would never fail. Using a multimodal biometrics, it is possible but more than two are required to achieve it. Odor recognition systems are 85% accurate and user friendly, the rest 15% must be full filled and to do so it must be also user friendly. I consider fusion of odor with facial recognition systems for ideal authentication success.

Both face and odor are non-user involvement recognizers and if fusioned then it would provide an

ideal system recognizing face at a far distance and odor when coming closer to the systems. Therefore, authentication would be ideal with 100% accuracy as I guess.

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