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Sweat Analysis and Its Role in Identification

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Abstract

Some methods of identification are already established like finger prints and DNA profiling but these types of evidence may not be always present or the procedure is costly or time consuming. For identification purposes additional biometric modalities are always being researched and body odour is another such biometric modality which is being researched but still it is under the process of development. In addition to identification purposes body scent analysis may help in diagnosis of diseases, crime scene investigations, search of human bodies and deception at security check points. The sweat analysis is carried out by different methods but many of them do not have real time applications as they are very time consuming, bulky and require especially trained persons to handle. Keeping in view these limitations research is being carried out to produce an instrument which can remove these short comings and in this direction E nose has been developed but still it has a lot of limitations. Attempt is being made to develop a real time E nose which may be as accurate as the nose of the dog and such type of instrument will have a big commercial use and carries a lot of financial potential.

Keywords: Sweat analysis; Scent detection; Human scent evidence; Odour signatures; Mechanical dog; E-nose

Introduction

There are many biometric modalities for identification of persons. Recognition by fingerprints and DNA profiling are better than lip prints, foot prints, iris pattern, voice, gait and handwriting but no single system is perfect and every system has its own limitations therefore these methods are used in combination. In addition to these factors body odour is one such biometric modality which has been less researched as compared to others and it has its own strengths and weaknesses [1].

There are various theories about production, collection and using of human scent as a source of identification [2]. Usual source of scent comes from the skin so it must be from one of the secretions of the skin [3]. In addition to skin this odour can also emanate from breath and excreta of person [4]. Microbiota present on the skin is also responsible for the smell of the person [5] and mosquitoes are attracted to the person by this smell. As there are different bacteria on different persons causing different scents that is why mosquitoes are attracted in a different way to different persons [5].

Since a long time dogs are being used for identification of human beings by use of human scent to differentiate one human being from another by various investigation agencies; and based upon this theory an idea originated to develop a mechanical dog [6].

In 1924 Löhne conducted experiments on the power of humans to smell sweat from different parts of the body and concluded that humans can differentiate sweat from different parts of the body but not differentiate sweat from different individuals and he concluded that there must be something in sweat which dogs can differentiate but humans cannot differentiate [7].

In experiments conducted on dog and human beings it was observed that there is a common substance in sweat from different regions of the body which a dog can identify and this substance has individual characteristics and this substance is fat soluble but not water soluble; and does not alter on different days [6]. The substances by which dogs identify the human beings are volatile with very high volatility, are chemically stable and relatively dense as compared to air and relatively not soluble in water [8]. It was observed in a study that there is persistence of human scent in a controlled environment even after three months [9].

These volatile organic compounds (VOC) in sweat help in identification. There are three types of odours and out of primary, secondary and tertiary odours of human primary odours help in identification or uniqueness of the individuals [10]. Primary scent is genetically controlled and is not affected by diet and environment where as secondary scent is affected by these changes. Tertiary scent is from outside sources like products used for skin care and cosmetics [2].

There are three types of glands in skin i.e. eccrine, apocrine and sebaceous glands and discarded epithelial cells which secrete the organic material on the skin but hey made a hypothesis that it is the sebum from sebaceous glands which could be the source of smell most probably as it secretes fat soluble substances and is present in most parts of the body and is rapidly formed after it is cleaned with baths but eccrine and apocrine glands can give a cue to the emotional condition of the individual [6].

Individual scent is genetically controlled and is different even in the blood relatives but might be confusing in the twins [11] but can be identified if scent of both twins were given to dogs before the

experiment. "It seems that the chemical composition of sebaceous gland and other skin products shows more striking species differences among mammals than that of any other organ or organ product [3]." There are chemical substances that differ in sweat of mammals (may be squalene) but there can be different proportions of chemicals (wax alcohols and fatty acids) which can give a characteristic smell to an individual.

Minimum concentration of substances which a human can smell is 10-13 mg/ml and same may be true for dogs but some things which a human cannot smell can be smelled by dogs [12]. Usually 200 micrograms of sebum are produced per minute and 20 micrograms of scent is transferred to air per minute and to the dog available concentration on an average will be 10-13 mg/ml of the air and usually is effective for a dog up to 100 yards [3]. Dogs can even detect cancers of various tissues like lungs, breasts, prostate and ovary, melanoma of skin by smelling surgically extracted tumors, urine and exhaled breath [13]. Dogs can also scent the human remains and find hidden or buried dead bodies or their remains [14]. Dogs can also scent the human blood and help to find hidden weapons having blood on it. They can detect blood on different surfaces and under different situations and environments [15]. Such canines are usually tested and certified for human remains detection certificate which is evaluated every two years [16].

Dogs can also smell the faecal matter in drains and based upon this water contamination of drinking water by drain water can be detected by dogs and based upon this quality of smell of dogs water was tested indicated by dogs to be contaminated turned out to be contaminated on testing of such waters [17]. There have been various challenges to the biological detectors of scent. Cost of training and maintenance of dogs is about US$ 5,000 per dog/year and their handler's working life for this is 6-8 years and they can work only for a limited period of the day [18]. Drawback of this is if handlers of canines have false beliefs there are chances that false positive results will be obtained for scent detection by dogs [19]. Sometimes canines give false indications resulting in huge loss to flight operators and airports [20]. The odour signatures are particularly helpful when no other evidence can be used as evidence but results depend upon a large extent to the training of the dogs and the experience of the dogs in scent detection [2] and there is need for standardization of the protocols to make it more valuable in courts [2]. SWGDOG practices will make the procedure more standard to be more valuable in various forensic scenarios and courts [2]. Samples of the volatile organic compound from the skin can be taken by rolling stir bar and samples were found to stable for 14 days by this method [21].

The volatile organic compounds can be evaluated by different techniques. In one study Axillary sweat odour has been analysed by Gas Chromatography (GC)/Mass Spectrometry (MS) after collecting samples by stir bar sorptive extraction method and there were reproducible GC-MS fingerprints and identified the chemical structure of 44 different compounds in the sweat of armpits [22]. Studies from upper back and forearms also reveal volatile organic compounds by using solid phase micro extraction and solvent extraction and about 100 compounds were identified and it was observed that VOC profile was same from upper back and forearm of same individual though there were notable differences. Two parts of the body share a considerable number of compounds but with quantitative and qualitative differences [23]. There are also quantitative changes with the change of age [23].

Based on GC Heracles flash gas chromatography electronic nose has been developed and marketed by Alpha MOS smell, taste and chemical profiling [24]. Based on GC and coupled with IMS FlavourSpec (R) has been developed to detect VOC of flavours and is said to vey user friendly [25]. Molecular odour detection services are provided using GC/MS and molecular detection can be done in very low concentration which can be up to the sub level of Parts per trillion (ppt) and this machine has a sniffer port also [26]. These are usually big machines and required trained persons to handle these machines. Easy to carry chemical sensor technology machines have also been developed which can detect chemical compounds in breath in diseases like Tuberculosis, diabetes and cancers [26].

In another study the volatile components were evaluated for their helpfulness in distinguishing odours of different persons by solid phase micro extraction gas chromatography and mass spectrometery [9] which was found to be useful for extracting, sorting out and analysis of human scent and these results were reproducible.

In addition to this ion mobility spectrometry (IMS) have been combined with GC and multi capillary columns (MCCs) and Gas sensor systems has also been used with GC. Optical sensors and absorbance spectroscopy and hyper-spectral imaging have also been used for VOC detection [14].

New technologies are developing in the form of E-nose which may provide complimentary technology to GC/MS technology14 in the short future. In the E-nose array of electronic sensors chemically detects components of odour like receptors in the nose and a mechanism for pattern recognition like brain interprets in the humans [27]. This whole thing is done by a chip of computer which has both sensors and processing components [27]. It is biomimickry which act on the principles of natural phenomenon.

In the E noses surface acoustic waves (SAW) sensor transducer is used to convert surface acoustic waves produced by VOC into electrical signals which is then detected by sensor microelectronics [28]. When VOC come into contact with chemically coated sensor transducers SAWs are produced [14].

Breakthrough is expected with E-nose for the detection of tuberculosis in India by detection of seven molecules in the breath like alcohol is detected and quantified by breath analysers [29].

In another study electronic nose [10] has been used to identify these odours. E nose has been used to differentiate smell of armpits of different persons by using metal oxide sensors with new hardware and software as gas sensors are affected by humidity. In this process they used humidity generators to mask the humidity of the samples [30]. It was also observed that deodorant does not affect the differentiation of two persons by E nose method and this has shown the way to development of body odour biometrics [30].

Array of nano-sensors have also been coated with various DNA oligomers which work as receptors to different odorants found in human breath e.g. Octanal, Decanal and Hexanoic acids. Nano-sensors were bases on single wall CNTs [31].

Others have used chemically sensitive array of sensors made up of conducting polymer films which react chemically with VOC and produce a pattern which is recognized by neural network hardware which also classify and quantify the pattern [32].

Conclusion

All these observations lead us to a conclusion that a machine may be developed which may work better than a dog in detecting odour of the body which may help in identification of the individuals which may be unique to every individual.

This can also be used in variety of circumstances in criminal investigations to locate the hidden dead bodies, their remains and weapons used in the offence. Further these can be used to screen for certain diseases particularly cancers of certain origins. These mechanical dogs with modifications may be also used to detect explosives and drugs also.

The need to develop machine is more apparent as sometimes false beliefs of canine handlers can give false positive results and this can be avoided if proper mechanical dogs are developed and with this handlers beliefs will not affect the outcome [19] but till date no such machine has been developed that can replace canines [14] though sufficient progress has been made in this regard.

The idea is to develop a small sized device which can function as mechanical dog or e-nose which should be portable, sensitive and affordable for the people/agencies using them and may not require very specialized and trained persons but may be used in routine by the investigating officers. It should be easy to use. It will also be used for variety of other reasons like non-invasive way of monitoring health and detecting cancers and diseases.

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