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A LITERATURE REVIEW OF SCENT TECHNOLOGY AND ANALYSIS ON DIGITAL SMELL TO CAPTURE, CLASSIFY, TRANSMIT AND REPRODUCE SMELL OVER INTERNET

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ABSTRACT

The Digital Smell Technology deals about Capturing, Classification, Transmission and Reproducing smell over the Internet. To improve on the experience we've had over the last few decades, our literature survey focuses on "e-Smell", that can transfer odours over the internet. The research is still in its early stages, smell appears to be an unrecognised medium and a new channel in multi-media, but the mystery of smell, combined with technological advancement, allows for the measurement and reproduction of odours.This study explores, how in the Digital Smell Technology, the smell can be transmitted over the Internet as static or streamed data. The technology reveals concepts in scientific disciplines such as chemistry, artificial intelligence, machine learning, data science, photonics, and not limited to electronics engineering. The goal of this study is to identify the limitations of Digital Smell Technology as a whole and the e-Nose in particular. The digital detection of various odours, digital transmission and reproduction of smell is now illuminating this technology. Our literature survey focuses on various dimensions about olfaction with respect to ongoing research and future challenges in Digital Smell. This paper presents the evolution of digital smell technology using e-nose methodology since 1950's and discuss about the limitations of the existing e-nose mechanism and the lack of progression on capturing, transmission and reproduction of the smell.

Keywords: *Digital Smell Technology, Digital Scent Technology, e-Nose, Odour, Olfaction*

1. INTRODUCTION

Transferring smell over the internet is still not very popular or there isn't any structured technologies around to capture, classify, transmit and reproduce. The digital smell is generally a hardware and software combination. The role of hardware(sensor array) is to capture the smell and the software part will digitize it to create fingerprints for each distinct smell. Digital Scent Technology is a new field that aims to develop digital representations of smells that can be experienced via devices such as smartphones, tablets, and computers. We have been observe the recent happenings and trends in Digital Olfaction Society. This inspired us to review and research towards end-to-end smell communication. While we did experiment back in 2013, we understood that e-Nose used for Smell Classification using Pattern Matching or Pattern Recognition and however we felt there is a need for an research in Smell Capturing, which may be lead us to review with respect to Smell Communication.

Among the most recent advancements in Digital Smell Technology are:

i. Olfactory Display : Researchers have been working on developing olfactory displays, which are devices that can produce and release specific odours on programme. The use of micro-fabrication technique to create arrays of odor-releasing microcapsules, as well as the use of ultrasonic nebulization to generate smells, are two of the most recent developments in this field.

ii. e-Nose Technology : Another recent breakthrough is the use of electronic nose technology, which uses sensors to detect and analyse odours. These devices can generate digital "fingerprints" of distinct smells, which can then be saved in a database and used to identify or match smells in the future.

iii. Virtual Reality and Augmented Reality : Recent advancements have also been made in the use of digital scent technology in virtual reality (VR) and augmented reality (AR) applications. Researchers are investigating how to use VR and AR to create immersive and interactive experiences with realistic odours.
iv. Field of Medicine : Recent advancements in digital scent technology have focused on the medical field. By detecting volatile organic compounds in breath or urine, this technology could be used to diagnose and treat diseases such as cancer, asthma, and diabetes.
v. Artificial Intelligence : Artificial intelligence (AI) and machine learning (ML) are being used to analyse large datasets of digital scent information in order to create digital scent libraries that can be used for a variety of applications such as fragrance design, food and beverage development, and even security.

Digital Smell Technology is a developing field with numerous challenges to overcome. Recent advancements in this field indicate that it has the potential to change the way we perceive and interact with smells. Sharing the sense of smell are truly beneficial since those are strongly generated with individual memories, emotions, and everyday experiences[1]. When we consider the olfactory sense's ability to modulate human behaviours, it may have incredible properties. It plays important roles in the evolution of human habitat, food preparation, and, most importantly, social behaviour[2]. The ability to smell deteriorates with age, and women have a good smelling sense than men on average[3]. Human gustatory (taste) and olfactory(smell) systems both play important roles in enhancing one's daily life experiences via memory and emotions[4]. It's a wonder, how mammals are able to recognize and perceive 10,000 different odorants, and research focuses on how it is possible, the ability to have a sense of smell as acute as other mammals. Every creature's sense of smell has a unique perceptual range[19].

1.1 Correlation Between Scent And Smell

Smell

Smell, also known as Olfaction, the analysis and identification of airborne chemicals by sensory organs. There are two types of smells: good and bad. A smell is most general and neutral in terms. In terms of smell, every creature has a blind spot. Each creature's specific range of smell is only associated to its survival needs. People specific senses are constantly present in the air and do not require them to be actively sought or avoided.

Scent

A pleasant smell. Scent is generally good odour molecule, created using scientific methods, biological and/or chemical reactions. A Stench is used to represent an unpleasant smell, whereas Aroma, Fragrance, Essence, S*cent* are often used to describe sweet and pleasant smells.

These two terms Smell and Scent are not used interchangebly and has its own meaning within its context of this lierature survey.

1.2 Digital Scent Technology

Our study further involves investigating Digital Scent Technology based on classification by, i) End-To-End Communication(Capture, Classify, Transmit & Reproduce), and ii) An Electronic Odour Sensing System(e-Nose).

1.2.1 An electronic odour sensing system(e-nose)

In light of current technology, particularly in the areas of sensing devices and information processing, the electronic nose(e-Nose) is still under development, particularly in terms of sensitivity and smell estimates. Additionally, there is no clear correlation between sensor responses and odour. Electronic nose' ability to distinguish between distinct odours depends not only on their technology but also on the software used to interpret the raw data. It seems sense to focus objectives on technical factors since e-Nose measurement is instrumental and a multiple variant statistical analysis that relies on Pattern Matching methodology to perform discrimination and classification on the incoming sensor data. This is because human sensory smell measurement is specific and not repeatable(not reproduce).While e-Nose technology has many potential applications, such as in food and beverage production, medical diagnostics, and environmental monitoring, there are also some limitations to be aware of:

1. *Sensitivity* : Electronic nose sensors are not as sensitive as the human nose. A loss of

sensitivity in the distinctive classification or clustering of each odorant through automated identification
2. *Selectivity* : Sensor drift and the inability to provide absolute calibration, which compresses the sensor array's response and lowers sample-to-sample variations
3. *Interference* : Electronic nose sensors can be affected by environmental factors such as temperature and humidity, which can cause interference and the inability to obtain quantitative data in feature extraction pertinent to pattern recognition
4. *Complexity* : The association between analytical results and actual scent perception is not always straightforward, which is a disadvantage of pattern matching

This is the reason why digital smell technology has not advanced.

1.2.2 Key observations (end-to-end smell communication)

Scientists from various disciplines have been looking for a classification system to define a cognitive space and promote objective communication about odours for generations. There is a lack of tools for accurately equating and characterising odours, as well as predicting their degree of similarity. There is no default or standard device, to a large extent due to the complexity of the existing designs, lack of affordability, and the resultant inadequacy to the general people. None of these research focused on developing an end-to-end smell communication system.

2. THE DIGITIZATION OF SMELL

Sense of olfactory sensations is the first step in smell technology, where taste and smell are interrelated to one another. This unbelievable technology 'iSmell', is commenced by the authority in bioinformatics and genomics known as Dexter Smith and Joel Lloyd Bellenson[5]. The perfume manufacturing companies provided the fundamental mechanism for advertising their perfumes. Scent has been shown in cognitive-behavioral studies to elicit highly emotional associations and responses[6]. The procedure Digital Scent Technology(DST), shed lights on the interaction of conscious and neurobiological mechanisms, as well as the mechanisms by which fragrance elicits pleasure and reward. This is how Digital Scent Technology(DST) is known throughout the world.

2.1 Background

Early in the 1950's, Hans Laube designed the Smell-O-Vision[7], a system which liberated smell during the projection of a film so that the crowd can "smell" what was happening in the movie. Unfortunately, the scent-releasing apparatus interrupted hissing noises, lag in receiving scents, and imbalance of smells throughout the theatre were all result the technology poor. 'Sensorama'(1960) is the first digital smell sensor device, equipped with several sensor actuators that result in sound, wind, smell, and vibration. In this system, the user needs to be seated in front of a display screen, which is equipped with several sensory actuators. This concept of layering sensory stimuli to supplement a simple cinema granting make provision for today's "virtual reality" experiences[25]. An interesting formulation motivates several researchers in the field, the mammalian olfactory system involves a model nose where an olfactory system is conceivably achieved besides the highly specific resistors[8]. The smell/ odour classification[9, 24] is based on Empirical, Primary, and Statistical Methods. Empirical is one based on feelings that smell invokes; Primary is a number of reference smells and finally statistical, method of structuring a large set of olfactory data.

For their experiment, the Japanese firm "K-Opticom" created a special unit called Kaori web in 2004 that consisted of six different cartridges for different smells in their internet cafes[10]. During the year 2004, Sandeep Gupta an indian originator designed a new prototype called scent-producing device at CES 2005[11]. One step ahead, a technology called the 'Taste Screen'comforts users to lick monitors through flavor cartridges[12]. This sprinkles the chemical flavor on a screen based on the index. Specific flavor enhancers agent combinations replicate a flavour appropriate to the user's task. Trisenx's 'Scent-Dome' (2005) launched a website emitting scents[13]. A scent cartridge with 20 different scents, can mix the scents in any proportion to create unique odours. The flavour disperse from the top of the cartridge, but doesn't intact direct to user's Data Visualizations and VR Applications. The first olfactory e-mail 'Aroma Geur' (NTT Communications, 2007), the technology layed a path creating an ambient smell while listening to the radio[14]. The aromatherapy fragrance, the first smelling mobile phone was introduced, 'Sony Ericsson SO701i' (2008), with 8 different fragrances.'The Virtual Cocoon', a virtual headset that sprays scents on the wearer's nose and flavors

directly in the user's mouth. It is a virtual reality headset which simulates all the five senses to provide experiences from the real world[15].

The digital gustatory actuating system, an advanced technology that stimulates taste sensations digitally in humans, which people can taste and sense sensations digitally through the web remotely[16], [34]. This stimulation involves electrical and thermal simulations through the tongue, by applying a small pulse of current that could generate taste sensations on taste buds. The gustatory system incorporated with magnetic stimulation activates both smell and taste sensations. The system is able to simulate sourness and saltiness digitally. The author focuses on two aspects w.r.t, i) the control system that stimulates taste sensations, ii) actuating these sensations by combining electrical and thermal stimulators. The Japanese researchers invented the so-called "the Smelling Screen"[17] in early 2013. As odour concentration and distribution increase near the location of the fictitious odour source, the sensor response value rises until it reaches unity when the sensor is exposed to clean air. Studies have begun to untangle some of the secrets influencing the physiology of these senses' functions, as well as the roles they play in food choice, health, and social interactions, over the last several decades[18]. Digital Scent Technology a new chapter in IT Industry[14], briefs an introduction about various dimensions of the process of olfaction, ongoing researches, challenges that researcher face in digitizing smell and transmission over the internet. A digital delivery system of scent for video game application[33], system delivers the sense of smell in video game applications to individual gamers for a more immersive video game experience(gunfire and burning rubber).

3. OLFACTORY COMMUNICATION

In more technical terms, smell not only transmits information, it carries sensations. While eating, odourant molecules from food entered the olfactory area via the retro nasal route, where they were processed and integrated in specialised areas of the neocortex alongside taste sensations, way that results in flavours[2],[4]. A smell carries more information, where air molecules act as a medium and smell as the message. Odours can be digitalized and reproduced using gas sensors, artificial noses, and digitally controlled scent diffusers. Odour can carry information such as emotions, warnings, and memories, as well as genetic information in the form of body odour or pheromones. As a result, odour can be defined as a medium[14]. Scentgraphy is the process of generalising the scent of specific paintings. The camera collects data about the environment (picture). Through the rubber pipe, all scent "inks" are blended. The atomizer bottle is used to discharge a portion of the mixed liquids, which can immediately produce the scene or picture smell[19]. Each creature's specific range of smell is only associated to its survival needs. People specific senses are constantly present in the air and do not require them to be actively sought or avoided. The compounds that are linked to the survival of creatures are usually the ones that trigger sensual reactions. A scent generator that is synced with other multimedia information gives audiences a stronger sense of immersion, and a multi-modal interaction is realised through the spray of scents[26]. Production of printed aromatic and gustative information[27], transforms signals received from the processing unit into olfactory documents that can, in turn, be stored and preserved as scented texts on thin layers of a gustative medium. In role of web enabled Digital Scent Technology, the author highlights, three functional key areas, i)the digital scent, ii)iSmell and iii)the smell synthesizer and the importance of virtual reality that sends and trade smells electronically. The scent synthesisers[29] are connected to a PC and can be programmed to emit a small amount of smell vapours into the environment, which is enough to recognize the smell. The role of aroma-content congruence[30], analyzes how the addition of ambient scent to a VR experience affects digital pre-experiences in a service context. The embodied VR devices, together with pleasant and congruent ambient scents, enhance sensory stimulation, which directly influence affective and behavioral reactions.

4. ODOUR CLASSIFICATION

There are seven categories of classification of smell(Carl Linnaeus,1764), i) Aromatic, ii) Fragrant, iii) Ambrosial, iv) Alliaceous, v) Hircine, vi) Repulsive and vii) Nauseous. In this classification[20], the smell can be scaled to pleasant, unpleasant, and both. Classifications based on statistical methods[21],[22] apply multidimensional methods to large sets of olfactory data, that is, classic semantic descriptions, descriptions emphasizing similarities between odors and odor profiles featuring estimation of the intensity of each feature. Although many researchers have attempted to develop classification systems to aid in "differentiation, recognition, and identification," the majority of them have actually pursued different goals without asserting them explicitly. The odour classification relies on self-organizing maps, with models for

artificial neurons and interactions derived from the framework core's base structures. In order to achieve meaningful results, researchers must first carefully address and define the features of odour systems[22], [24].

5. ODOUR CHARACTERIZATION

According to Fraunhofer IBP[40], An odour-active substance depends on the scaling of volatile organic compounds (VOC) is distinguished by an odour threshold, where the concentration perception of an odour is coupled with the olfactory receptors and its quality. The analytical methods (chemical sensors and pattern recognition) were used competently in the characterization of human body odour for the diagnosis of VOC, particularly in the recognition of chromatographic peaks related to different chemical compounds[41]. Sensory descriptive analyses were performed, yielding the overall aroma active compounds identified by AEDA as well as differences in the characteristic aroma intensity of four different yeast extract samples using phenolic, animal, fermented, sulphurous, floral, caramel, green, roasted, and fatty notes attributes[42]. The current theory of Odour Activity Values(OAV) is that simultaneous chemical and sensory analysis can reveal the identity of aromatic compounds responsible for the distinctive smell of marijuana[43]. Odourant chemicals have two properties that influence olfactory characterization and/or perception: intensity and quality. Furthermore, this study examines odour characterization using an e-Nose with an array of gas sensors and odour reproduction over the last few decades[44].

6. ISMELL, A PERSONAL SCENT SYNTHESIZER

California-based Digiscents Inc.,1999 developed iSmell personal scent synthesizer[10], a USB-powered device that smells at the appropriate time which permits the scent to be transmitted/ reproduced from the web. This technology transforms odor in the form of digital codes, then recreates the aroma from a palette of 128 chemicals stored in a cylinder/cartridge. Each indexed smell is coded and digitized into a web. The personal scent synthesizer at the receiver's end recreates the smell of aroma, and the air cannon discharges the smell in the form of scent. A concept of Digital Scent/Smell Technology[28], gives an introduction to an evolution of virtual reality w.r.t virtual theatre that comprises electronic hand gloves, advanced smell, multipoint sound framework, controllable seats, and 3d googles. The Digital Scent Technology works in fusion with olfactometer and e-Nose technology. It also deals with one's emotional intelligence ability to understand, interpret, and respond through virtual reality. Irrespective of the industry, Digital Scent Technology aims in an effective and intellectual way, enhances technology aids, provides emotional intelligence of existence. A JavaScript code smell detection technique called JSNOSE[31], combines static and dynamic analysis to detect smells in client-side code. An Affective Mood Booster Robot Based on Emotional Processing Unit(AI)[32],aims to propose certain behaviors of the robot in order to generate positive emotional interaction towards the user. The robot would generate relevant smell accordingly by digital scent technology.

7. LIMITATIONS

The complexity of smells, the unpredictability of air flows, and the difficulty of managing timing and intensity are all fundamental issues with existing system. None of these research focused on developing an end-to-end smell communication system. There is neither a default or standard device, owing to the complexity of existing designs, the lack of accessibility, and the resulting inadequacy for the general public. The following tabular column(Table 1) shows, drawbacks to pattern matching, which is why there has been no progress in the Digital Scent Technology.

8. FINDINGS

The following are the fundamental issues identified, with conventional Digital Scent and e-Nose technology and the key limitations of interactions with virtual objects and the people.

i. Difficult in controlling the distribution pattern of odor molecules through the air

ii. There is no clear correlation between sensor responses and odour

iii. Ineffecient timing and distribution, while triggering odor during the projection of a film

iv. Odour molecules that linger long after they are no longer required, resulting in muddled or unwanted odours

v. Unsophisticated VR environments mechanisms to deliver odours to a

participant, causing discomfort in immersive experience and interrupting users

vi. Imbalanced odor index scale, from the logarithm transformations of odor concentrations

vii. The sensitivity of sensor membranes can be affected by strong temperature dependence

viii. Storage requirements, because the entire dataset must be available during recall, and computational cost

ix. Abnormal odours (e.g., perfume, alcohol, etc.) cause a strong sensor response, compromising the usual use of e-Nose for target odour analysis

9. OBSERVATION

Our prior work analysed the top down approach on analysing the electronic nose in general,on various sensing applications that has gathered momentum in the recent times, especially in smell classification[24]. In this study we have identified the limitations of Digital Smell Technology as a whole and the Pattern Matching of e-Nose in particular. e-Nose has major limitation, as it lacks in determining the identity, the concentration or the properties of an analyte with respect to Volatile Organic Compounds(VOC) and their quantification in the mixture. Since 2010, *Digital Olfaction Society (DOS), Tokyo, Japan,* initiated and aims at turning any odorous source into a digital media. Following the most recent advances in olfaction, our challenge is to apply this knowledge to innovative technology developing end-to-end communication that can not only capture odour, transfer them into digital data, transmit and restitute the original data. No such detailed literature survey since, Hans Laube invented the Smell-O-Vision. There are very limited literature survey or experimental papers available in reputed journals, that too in end-to-end smell communication[14], [28], [33], [36]. Our study is the first literature to the best of our knowledge which did a thorough literature on Digital Scent Technology or Digital Smell Technology for end-to-end communication.

10. CONCLUSION

This paper introduces the new Internet era, the Digital Smell and the Digital Scent Technology. In this literature survey, the limitations of e-Nose technology and Digital Olfactory Devices have been identified. A detailed study of e-Nose is conducted and proved that Pattern Matching won't be a good technique for end-to-end communication. Based on survey, we conclude that e-Nose technology must be re-invented for Digital Smell Technology to become in reality. The upcomming or future innovations should overcome these limitations, devloping End-to-End Digital Smell System, to i) Capture and Classify the smell ii) Transmission of smell over internet and iii) Reproduction of smell using synthesizer. The system should offer a rich multimedia experience for the user and one can view, hear and smell at the same time. In general the Digital Smell Technology (DST) is not only restricted with e-Nose, it's a technology to sense, transmit and re-produce a smell enabled digital media. For all these reasons the Digitization of Smell, remains a challenge.

COMPETING INTERESTS

I/We certify that we have NO affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. I/We have no conflicts of interest to disclose. The above information is true and correct, up to our knowledge.

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Table 1: Limitations of Existing Digital Scent Technology (DST)

S. No	Author & Year	Title of the Paper/ Book/ Conference	Device	Background	Limitations
1	Neeraj Kumar Parashar, Navneet Kumar, 2017	A Concept of Digital Scent/Smell Technology: An Underrated Technology	iSmell	An introduction to an evolution of virtual reality w.r.t virtual theatre that comprises electronic hand gloves, advanced smell, multipoint sound framework, controllable seats, and 3d googles	Limited interactions with virtual objects and people. Controls aren't always intuitive
2	Ibrahim Al-Bahadly, Aymen Reda, 2013	A Digital Delivery System of Scent for Video Game Application		A system composed of a fragrance generator adapted for use with video or computer game involving action stimulations in which the user is immersed in a virtual or near-virtual experience(gunfire and burning rubber)	Difficulty of controlling the distribution pattern of odor molecules through the air
3	Devashish Gosain, Mohit Sajwan, 2014	Aroma Tells a Thousand Pictures: Digital Scent Technology a New Chapter in IT Industry	Smell-O-Vision, Aroma Geur, Scent-Dome, Smelling Screen	The system concentrates on various dimensions of the process of olfaction, ongoing research, challenges that researchers face in digitizing smell and transmission over the internet	The technology used to trigger the release of aromas was unable to be effectively timed with the action on-screen, resulting in the release of the incorrect aroma at the incorrect time.
4	Nimesha Ranasinghe, Gajan Suthokumar, Kuan Yi Lee, Ellen Yi-Luen Do, 2014	Digital Flavor Interface	Digital Flavor Interface	The digital gustatory actuating system, an advanced technology that stimulates taste sensations digitally in humans, which people can taste and sense sensations digitally through the web remotely	Non-invasive brain stimulation may be harmful to humans if used for an extended period of time. More research is needed on the negative effects of transcranial magnetic stimulation on the human brain when used for extended periods of time.
5	Sorna Mugi Viswanathan, Revanth Rajan, 2020	Digital Scent Technology- A Critical Overview	E-nose, Scent Synthesizer, Scentography, K-Opticom	The Japanese firm "K-Opticom" created a special unit called Kaori web that consisted of six different cartridges for different smells in their internet cafes	The system is based on odour molecules that linger long after they are no longer required, resulting in muddled or unwanted odours.
6	Amin Milani Fard, Ali Mesbah, 2013	JSNOSE : Detecting JavaScript Code Smells	JSNose	A JavaScript code smell detection technique called JSNOSE, combines static and dynamic analysis to detect smells in client-side code. This automated technique can help developers to spot code that could benefit from refactoring.	The system does not deal with frameworks like jQuery. JSNOSE is dependent on the crawling strategy and execution time, which may affect the accuracy if certain JavaScript files are never loaded in the browser during the execution
7	Sudhanshu Jain, Deepshikha Bhargava, Ramesh	Role of Web Enabled Digital Scent Technology	Aroma-Jet, iSmell, Scent Synthesizers	The author highlights, three functional key areas, i)the digital scent, ii)iSmell and iii)the smell synthesizer and	Smell Synthesizer, operates at higher temperature requiring heaters, cross sensitivity and complex

	Chandra Poonia, B Suresh Kumar, 2015			the importance of virtual reality that sends and trade smells electronically.	design. They rely on odor molecules, which hang around long after they are needed, resulting in muddled or unwanted odors
8	Xiaotian Sun, Kiyoshi Tomimatsu, 2019	Scentgraphy - Interactive Installation of Scent Communication	Scentgraphy	Scentgraphy project explored a way for computing, simulation, and telecommunication of odors by visual and olfactory conversion.	A lapse in timing, difficult to clear an odour in time for the next to waft freely
9	Carlos Flavián, Sergio Ibá ñez-Sánchez, Carlos Orús, 2021	The influence of scent on virtual reality experiences: The role of aroma-content congruence	Virtual Reality	This study analyzes how the addition of ambient scent to a VR experience affects digital pre-experiences in a service context	Simple VR environments, unsophisticated mechanisms to deliver odours to a participant (without the ability to switch rapidly between odours). Some of these advanced devices must be worn during the immersive experience, causing discomfort and interrupting users from the main experience
10	Nalini Dattaram Karmat, Vandana Navale, 2022	Artificial Smell	Smell-O-Vision Scent Energizer, Smell Synthesizer, iSmell, Scentography, Fabric Based Scent Sensors	This study discusses application areas of usage of perfumery and implementation of digital scent devices using Scent index that can identify different smells	Imbalanced odor index scale, from the logarithm transformations of odor concentrations, inefficiencies in yielding consistent set of values for odor reduction
11	B.Jebina Priscil, M.Anandhavalli, 2018	Digital Smell Technology	3d Glasses with Smell Speakers, Scentography,	Applications of Smell Technology, Current Challenges, Advancements and Researches happening in this domain	Adaption to timing of the distribution of scents; Health hazards of synthetic odours; The price is a considerable factor
12	Nimesha Ranasinghe, Kasun Karunanayaka, Adrian David Cheok	Digital Taste and Smell Communication	Digital Taste (gustatory) Actuating Device	This system introduces a new technology, allows people to share taste and smell sensations digitally with a remote person through existing networking technologies such as the Internet. This paper focuses on future aspects of such technology for remote smell actuation	The sensitivity of sensor membranes can be affected by strong temperature dependence and temporary or permanent solute adsorption.
13	Takamichi NAKAMOTO et.al., 2008	Reproduction of scent and video at remote site using odor sensing system and olfactory display together with camera	Tele Olfaction System	This study propose the new system for scent reproduction at remote site together with video. Users can sniff the smell in real time at the location away from the odor source, simultaneously watching a video around the	A lapse in timing could cause issues, and the scents were too diffuse to provide a satisfying experience.

				odor source.	
14	Eungyeong Kim et.al., 2012	Pattern Recognition for Selective Odor Detection with Gas Sensor Arrays	Odor Monitoring System	The aim of this study was to accurately classify an odor using pattern recognition in order to enhance the selectivity of gas sensor arrays.	Storage requirements, because the entire dataset must be available during recall, and computational cost, because the distance to all training examples must be computed for each unlabeled example (and sorted)
15	Y. Soudry et.al., 2011	Olfactory system and emotion: Common substrates		Human gustatory (taste) and olfactory(smell) systems both play important roles in enhancing one's daily life experiences via memory and emotions	Unlike in vision or taste, where receptors are linked to perception of different colours and tastes, the odorant receptors (ORs) linked to specific olfactory percepts are unknown
16	Xiaotian Sun, Kiyoshi Tomimatsu, 2019	Scentgraphy - Interactive Installation of Scent Communication	Scentgraphy	Every creature's sense of smell has a unique perceptual range. Each creature's specific range of smell is only associated to its survival needs.	Despite a plethora of behavioural studies demonstrating the impact of colour on various olfactory determinations, the neurophysiological basis for these cross-modal interactions remains unknown
17	Hyung-Gi Byun et.al., 2012	Implementation of Olfactory Interaction between Images and Smells	Scent Generator	Olfactory interaction between images and smells, analyzes various elements needed in olfactory display technology and propose an olfactory interaction model and define metadata for digital information of scent generator and how it can be used.	A lapse in timing could cause issues, and the scents were too diffuse to provide a satisfying experience. It was also difficult to clear an odour in time for the next to waft freely
18	Berg P. Hyacinthe, 2006	Apparatus and Methods for Production of Printed Aromatic and Gustative Information	Fragrance Cartridges	Production of printed aromatic and gustative information, transforms signals received from the processing unit into olfactory documents that can, in turn, be stored and preserved as scented texts on thin layers of a gustative medium.	In fact, oral experience derives from several different sensory systems, only one of which actually conveys information about taste (gustation) per se. The term taste is reserved for the limited range of gustatory sensations, that accompany eating.
19	Kathrin Kaeppler, Friedrich Mueller, 2013	Odor Classification: A Review of Factors Influencing Perception-Based Odor Arrangements		The odour classification relies on self-organizing maps, with models for artificial neurons and interactions derived from the framework core's base structures.	Gas sensors with high selectivity,dependabilityand cross-sensitivity to different odours are ideal. However, a new issue is that abnormal odours (e.g., perfume, alcohol, etc.) cause a strong sensor response, compromising the usual use of e-Nose for target odour analysis.