IEEE P2520.2.1
Machine Olfaction Devices and Systems used for General Outdoor Odor Monitoring
(SEN/SC/TMODS/OOM/2520.2.1)

Working Group Meeting Minutes
9 May 2022 / 10:00 AM – 11:00 AM (EDT) – check this time
WG Chair: Ehsan Danesh
WG Secretary: Cynthia Burham

1. Call to Order

The Chair called the meeting to order at (10:04) AM EDT. The Chair also announced that the meeting was being recorded for the purpose of preparing minutes.

2. Roll Call and Disclosure of Affiliation

Affiliation FAQs: http://standards.ieee.org/faqs/affiliation.html

The Chair directed participants to a Google Docs link in the Chat window:

https://docs.google.com/spreadsheets/u/2/d/1ydvTFKxRSYRrpT1CX-22zaNkETV4_aqD2NDVSoxxfk8/edit?ouid=114048767493602967276&usp=sheets_home&ths=true

Participants were asked to register for the meeting by placing an X at the intersection between the row including their name and the column including the meeting date. First-time participants and individuals whose information was not already listed within the Google document were instructed to include their name, affiliation and status under the appropriate columns at the bottom of the Google form. Participants were also asked to include their affiliations in parentheses after their name in the Chat window, if using the chat area. A few minutes were allowed for participants to access and complete the sign-in process. The Secretary added the attendance status of participants who did not complete their attendance status directly.

At least two (2) of the most recent four (4) WG meetings must be attended in order to maintain voting rights.

The participant information from the chat window and from the participant registration document has been merged and may be found in **Attachment A**.

3. Approval of Agenda

The Chair displayed the announced agenda, confirmed with the Secretary that a quorum existed, and proceeded with approval of the May 9th meeting agenda and the minutes for the WG Meeting held on March 14, 2022. Troy Nagle moved for approval of the March 14th WG Meeting minutes and the May 9th meeting agenda. Cynthia Burham seconded the motion. Both the agenda and minutes were approved without objection to unanimous consent. 15 voting members were required to be in attendance to achieve quorum. There were 17 voting members in attendance when approval was requested.

4. IEEE Patent & Copyright Policies

a. Call for Patents

https://development.standards.ieee.org/myproject/Public/mytools/mob/slideset.pdf

Per standard IEEE-SA WG meeting practice, the Chair reviewed the required policy regarding potentially essential patents. No one raised concerns for consideration.

b. Copyright Policy

https://standards.ieee.org/ipr/copyright-materials.html

Per standard IEEE-SA WG meeting practice, the Chair reviewed the required policy regarding copyrights. There were no questions or concerns.

5. Technical Presentation(s) and Discussion

The Chair presented a history of IEEE P2520.2.1: Machine Olfaction Devices and Systems used for General Outdoor Odor Monitoring and a review of the goals and approach of our WG. The presentation was followed by questions and a discussion addressing issues of interest and further clarifying how the WG might proceed.

a. *Presentation by Ehsan Danesh (WG Chair)*

Ehsan Danesh is Chair of the IEEE P2520.2.1 (Machine Olfaction Devices and Systems used for General Outdoor Odor Monitoring) Working Group. Dr. Danesh is founder and CEO of Adsentec LTD (https://www.adsentec.com), a company developing gas and air quality sensors and implementing within the internet of things (IOT) for smart applications. He is a gas sensor scientist and

researcher with multiple publications on the topic. Dr. Danesh may be contacted at: e.danesh@ieee.org

Dr. Danesh's presentation provided an overview of odour measurement standards for human panels and the approach the WG may wish to pursue for machine olfaction. A brief history of odour measurement was provided with a focus on developments in the 1970s and 80s surrounding the recognition and detection of 'nuisance' odors. Assessment methods implemented at the time were considered subjective in nature and a four-element odour pollution assessment and monitoring model was suggested to analyze odour episodes in environmental applications consisting of:

DURATION
FREQUENCY
ODOR INTENSITY
ODOR CHARACTER

Duration and frequency measure the length and regularity of exposure episodes, respectively and are fairly straightforward to collect. Odor intensity and character were more challenging to asses, requiring years of study before initial standardization in the European Union (EU) and United States. The most recent EU standard updates were released only a few months ago.

Dr. Danesh discussed perceived odours and the use of odour descriptors and vocabulary to train individuals to detect and describe an odour more objectively. He also explained the issues involved in developing an electronic nose because of the complications surrounding odour detection, particularly in a mixture. Generally, a human panel is required to review results. While effective characterization of a single compound using machine learning has been achieved, achieving the same result for mixtures is more difficult.

Pleasantness and offensiveness of an odour depend on intensity and detection above a suprathreshold. A fragrance that is pleasant at lower concentrations may become offensive at higher concentrations. Some odours are also offensive at very low concentrations. There are two procedures of analysis, one static and the other dynamic. An odour offensiveness scale with a range between -11 and +11 was explained. The Odor Intensity Referencing Scale (OIRS) ranging from 1 to 5 and using units in parts per million (ppm) of n-butanol was also mentioned. An article relating intensity to concentration was also discussed and the relationship explained to be a power law relationship: $I = kC^n$.

The ASTM standards to measure odor concentration were mentioned, as well. The detection threshold (DT) was defined as the number of dilutions needed to make an odor sample undetectable by a human panel. The recognition threshold (RT) was defined as the number of dilutions needed to make an odour sample faintly recognizable. The volume of odorless air over the volume of odorous air is the dilution factor (D/T), a dimensionless value. Measurement of DT and RT is in pseudo units of odour unit per cubic meter (OU/m^3).

Dr. Danesh reviewed the process generally used to train human panels to analyze field samples and some of the issues related to implementation of a human panel. The process of panel selection and training is relatively costly and time consuming. Panelists must have a 'normal' sense of smell and this sensitivity must by regularly tested and evaluated for consistency. The effects of emotional factors, health, visual cues, and weather conditions were also mentioned as factors that affect a panelist's sensitivity. Continuous measurement and implementation in remote or difficult to access areas are also costly issues to address. Dr. Danesh mentioned that detailed coverage on human panels was provided in an earlier presentation to the WG which may be accessed on the WG website.

Though e-noses mimicking human olfaction are a reasonable alternative, issues exist related to the ability of chemical and biochemical sensors to interpret odours similarly to the perception of an 'average' person. Some sensor types may not obtain sufficient resolution. There are many papers addressing methodologies to address the issues involved. Mathematical algorithms for data evaluation and various standards exist to assist in addressing this situation.

Dr. Danesh provided insight into the IEEE P2520 Standard series and clarified the roles of P2520, P2520.1, and P2520.2.1, the latter being the subject of outdoor monitoring being evaluated by the WG. The draft of the overarching guidelines being developed in another WG led by Dr. James Covington should be ready for approval by the end of 2022.

IEEE P2520.2.1 is still in progress with deadlines approaching in August 2022. Dr. Danesh reiterated the importance of selecting representative odorous mixtures (e.g., a mixture between 5 to 10 odours is suggested in the literature) against which e-nose sensors may be tested, performing initial olfactometric analysis of these samples, and developing samples at specific concentrations (to be used in cylinders, perm tubes, or a combination). When necessary, dilution

may be made from the representative mixture to obtain very low concentrations. The samples must be calibrated; methodologies exist to train against samples at known ratios to compare measured data to the ground truth. Slope, intercept, linearity, and error may be used in the usual way for evaluation of measurement precision and accuracy.

The necessity of human screening for representative sensitivity and reliability remains a factor. The WG must provide some general guidelines, sub-sections determining details of interest to their WGs such as the relevance to them of more specific effects of temperature and humidity on samples and evaluation. Dr. Danesh reiterated the importance of mixtures as representative odour samples and indicated that a single sensor might pass the standard test in a single-analyte evaluation process.

b. General Discussion:

During the discussion questions arose regarding what odours might be relevant for representation. Examples included: gas leak, forest fire, fresh road tar, chicken farm, paper mill, landfill, refinery, and wastewater. Landfill and wastewater odours have been discussed by the WG as particularly relevant. The point was reiterated that the WG goal should be to determine calibration and evaluation standards, including ranges, and more specific information regarding the sample being determined by the group conducting a study. Defining calibration and test procedures as well as training procedures were stated to be as important as the odours themselves. Implementing what information already exists toward this purpose is important.

Ideally, an odour sample is required for calibration and samples should include a mixture of at least three and preferably five or more compounds. Meeting attendees agreed that synthesizing landfill and other odours should be straightforward as an option.

A suggestion was made that the WG look to perfume and flavor manufacturers (e.g., International Flavors 7 Fragrances – IFF) for additional information and guidance. A request was made that any such manufacturers be brought to the attention of the WG in order to assess collaborative opportunities. A speaker from one of these sorts of companies may provide insight to the WG.

Humidity and temperature were discussed; including them in baseline determinations was stated to increase complications. It may be preferable to define for a controlled environment. However, humidity, in the case of some odours such as those produced by hog farms, may be a central element as certain essential compounds may not remain in gas phase at high humidity. Establishing ranges may assist in resolving these sorts of issues. Some compounds with very low concentrations or extreme humidity sensitivity may contribute enormously to a nuisance odour.

Points were mentioned regarding the necessity of including a human panel and confirmation through an independent lab.

The Chair indicated that materials relevant to the WG, including presentations, links, and documents may be found at the WG website:

https://sagroups.ieee.org/2520-2-1/

The Chair mentioned that subgroups creating a list of relevant chemicals and concentrations will be the focus of the WG over the next few months. Subgroups may be created to continue discussion outside the regular WG meeting as deemed necessary.

The next WG deadline is 7/8/2022 for initial standard draft V1.0 approval.

The Chair will present a poster of the WG effort at the 2022 Air Sensors International Conference (ASIC) on 12/4/2022 between 4:00 – 4:30 PM BST. WG members are invited to attend ASIC and the poster session/participate in discussion either in-person or virtually.

6. Approval of Agenda and Previous Meeting Minutes

The Chair received a motion from Troy Nagle, seconded by Cynthia Burham, to approve the May meeting agenda and the March WG meeting minutes. The motion passed without objection to unanimous consent. The number of voting members in attendance required for quorum was 15. There were 17 voting members in attendance.

7. Unfinished Business/Action Item Review

There was no unfinished business.

8. New Business

There was no new business.

9. Future Meetings

The next two meetings of the WG are scheduled to occur at 10 AM ET on June 13 2022 and July 11, 2022.

10. Adjourn

The WG Chair asked for a motion to adjourn. The motion to adjourn was made by Cynthia Burham and seconded by Susan Schiffman. Without objection to unanimous consent, the Chair adjourned the meeting at 10:54 AM ET.

Attachment A: Meeting Participants (21)

Last Name	First Name	Affiliation
Bernardini	Sandrine	Aix-Marseille University
Burham	Cynthia	University of Texas at Austin
Carneiro	Magnovaldo	Self
Chen	Allen C	Self
Covington	James	Professor, School of Engineering, University of Warwick
Danesh	Ehsan	Adsentec Ltd
Izquierdo	Cyntia	Olores.org website
Kuna	Kishore	Honeywell Technology Solutions
Li	Hua-Yao	Huazhong University of Science and Technology
Lozano	Jesus	Universidad de Extremadura
Majewski	Leszek	The University of Manchester
Mulla	Mohammad Yusuf	Research Institutes of Sweden (RISE)
Nagle	Troy	ECE, NC State University
Palma	Susana	NOVA university of Lisbon
Petrache	Ana	Beia Consult
Reimringer	Wolfhard	3S - Sensors, Signal Processing, Systems GmbH
Romain	Anne-Claude	University of Liege
Sabry	Yasser	Faculty of Engineering, Ain Shams University
Saffell	John	Alphasense Ltd.
Schiffman	Susan	North Carolina State University
Suciu Jr.	George	Beia RO/AT/BE