AromaBlendz: An Olfactory System for Crafting Personalized Scents

Shihan Fu*
Computational Media and Arts Thrust
The Hong Kong University of Science and Technology (Guangzhou)
Guangzhou, China
sfu663@connect.hkust-gz.edu.cn

Jianhao Chen*
Smart Manufacturing Thrust
The Hong Kong University of Science and Technology (Guangzhou)
Guangzhou, China
jchen628@connect.hkust-gz.edu.cn

Yi Cai
Smart Manufacturing Thrust
The Hong Kong University of Science and Technology (Guangzhou)
Guangzhou, China
yicai@hkust-gz.edu.cn

Mingming Fan†
Computational Media and Arts Thrust
Internet of Things Thrust
The Hong Kong University of Science and Technology (Guangzhou)
Guangzhou, China
Division of Integrative Systems and Design
Department of Computer Science and Engineering
The Hong Kong University of Science and Technology
Hong Kong SAR, China
mingmingfan@ust.hk

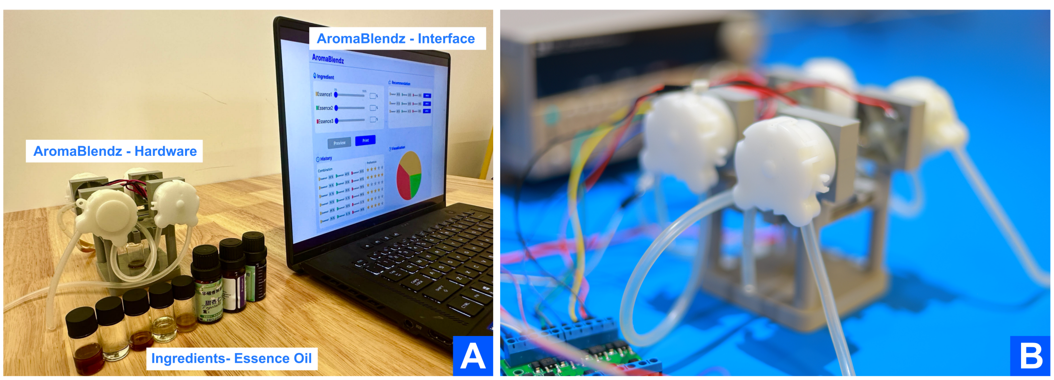

Figure 1: AromaBlendz: customizable olfactory system (a) components designed for ease of use, including a diverse selection of essence oils, hardware for mixing mechanism, a control unit user interface, (b) standalone hardware module

ABSTRACT

Although the HCI community has recently begun to explore the usage of scent to enrich interactive system experiences (e.g., making VR more immersive), scent is often preset. In contrast, personalized scents might help trigger emotional responses and memory recall in many application scenarios, ranging from fostering relaxation to managing emotional states. We present AromaBlendz, a novel digital platform that enables users to create and customize their unique scent profiles. AromaBlendz comprises both hardware and software components that collectively deliver a seamless scent customization experience. The hardware includes a blending mechanism for essence oils and a user-friendly control unit, while the software component provides an intuitive interface for users to create, preview, and store their preferred scents. The platform not only allows for the generation of personalized scent profiles using a library of essential oils but also facilitates the process of scent creation through an accessible and interactive user interface.

*Both authors contributed equally to this research.
†Corresponding Author

CHI EA '24, May 11–16, 2024, Honolulu, HI, USA

ACM ISBN 979-8-4007-0331-7/24/05
https://doi.org/10.1145/3613905.3648670

CCS CONCEPTS

• **Human-centered computing**; • **Hardware**;

KEYWORDS

Olfactory Device, Hardware, Digital smell technology, Odour interfaces, Olfactory experiences

ACM Reference Format:

Shihan Fu, Jianhao Chen, Yi Cai, and Mingming Fan. 2024. AromaBlendz: An Olfactory System for Crafting Personalized Scents. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '24), May 11–16, 2024, Honolulu, HI, USA.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3613905.3648670

1 INTRODUCTION

Olfactory information has usually been ignored, as people generally do not pay much attention to odors in their environment [8]. Ambient scents are difficult to escape, making them subtle yet powerful influencers [8]. Meanwhile, olfaction provides a rich source of information to humans [1]. Given its relevant properties, the sense of smell has the potential to enhance relaxation and emotion regulation. It has a unique relationship with emotions and homeostasis that is closer than that of other senses, as it depends on chemical reactions linked to energy balance, reward, disgust, and aversive signals [14, 19]. However, olfaction is more difficult to control than vision or hearing, as it relies on chemical reactions [4]. Enabling odor stimuli in media has proven to cause widespread benefits across a variety of applications, such as entertainment, arts, education, advertising, and medicine [6, 10, 16, 18, 23].

The most immediate and basic response we have to a scent is whether we like it or not, referred to as odor hedonics [7]. Individuals differ in their scent preferences [24], both the characteristics of the scent as well as the subject's personal preferences and subjective judgment can affect how a scent is received [5]. One of the most prominent characteristics of olfactory perception is its ability to trigger emotional and affective experiences [11, 26]. In other words, aromas have a modulating effect on psychophysiological activity and arousal [15]. The potential mechanisms through which odors yield these effects include influencing attentional processes, memory, judgment, and decision-making [3, 13, 20, 22]. It is important to consider both the type and characteristics of an aroma to ensure individuals can accept certain scents [11, 26]. Factors like scent preferences, subjective judgments, and working conditions all play a role in how odors are perceived and their potential effects. Careful selection and testing of aromas can help match scents to individuals for optimal outcomes.

Therefore, customized scents can be an effective approach for individuals. Personalized scent profiles have been qualitatively collected using techniques like autobiographical "smell stories" to build individualized scent libraries[17]. Exposure to personalized smells may trigger memories while reducing cognitive load compared to deliberate recall alone [21]. However, standard olfactory delivery systems face limitations for customization, which are often expensive, and lack simple interfaces for general users to formulate personalized scents [12, 25]. A potential solution for this is to allow custom odor formulations through more accessible interfaces.

To this end, we present **AromaBlendz**, a digital solution that can overcome existing drawbacks. AromaBlendz provides precise and controllable scent generation through replicable odor formulation. The system contains hardware components to generate blended essence oils automatically. It also features an accessible user interface to allow users to preview, create, and store their preferred scents(See Figure 1). AromaBlendz opens up opportunities for a low-cost, customized scent tool. With controllable scent generation and simple customization, it has the potential to personalize exposures through matched formulations according to individual profiles and memory associations.

2 DESIGN OF AROMABLENDZ

2.1 Software design

We designed a front-end user interface, which is divided into 4 parts (See Figure 2(A)). The first part is ingredients. Users can adjust each essence recipe by dragging the slider. The proportion of a fragrance's raw material and the customized fragrance after mixing can be previewed and printed by clicking two buttons(Figure 2(A-1). Each preview and printed recipe will be recorded in the database(Figure 2(A)-4) and visualized in the third part, History(Figure 2(A)-3). The second part is laid out in the upper right corner of the interface and will provide users with some recommended formula choices(Figure 2(A)-2). The user selects the formula after that, clicks Apply, and the corresponding proportions will be displayed directly in the ingredients. Users can rate their preferences for each prepared formula here to facilitate the generation of more suitable formula recommendations for them. The last part in the lower right corner uses a pie chart to visualize the proportions of each ingredient.

We used Mysql to configure two databases for history and recommendation. The recommendation database contains the recipes that the current user has tried and some of our preset recipes. When the user scores a recipe very high on the history interface, the recommendation interface will recommend recipes that are similar to the rated solution; when the user's rating on the history interface is very low, the recommendation interface will recommend a recipe that is different from the rated solution.

2.2 Hardware design

The hardware design part of the prototype is seen in figure 2(B)(C). The entire prototype is made of 3D-printed PLA material. The four brackets are designed to support the four original peristaltic pumps. There are four wire troughs on the upper plane for guiding the path of the water pipes, and the water pipes derived from the four peristaltic pumps converge into a hollow center, and then drip together to the same position. There are two layers designed in the middle of the platform, one is the preview layer and the other is the baffle. Users can insert fragrance paper into the preview layer to preview the fragrance of the current formula. After being pumped out, the liquid pumped out by the peristaltic pumps will be directly collected by the spice bottle placed on the bottom platform.

Preview and print output signals are connected to the Arduino UNO control board equipped with ESP8266 through UDP communication. The proportion and dosage of each part of the raw materials are controlled by the running time of the peristaltic pump: we stipulate that the total running time of the peristaltic pump in the case of print is 8s, and the total running time in the preview is 2s.

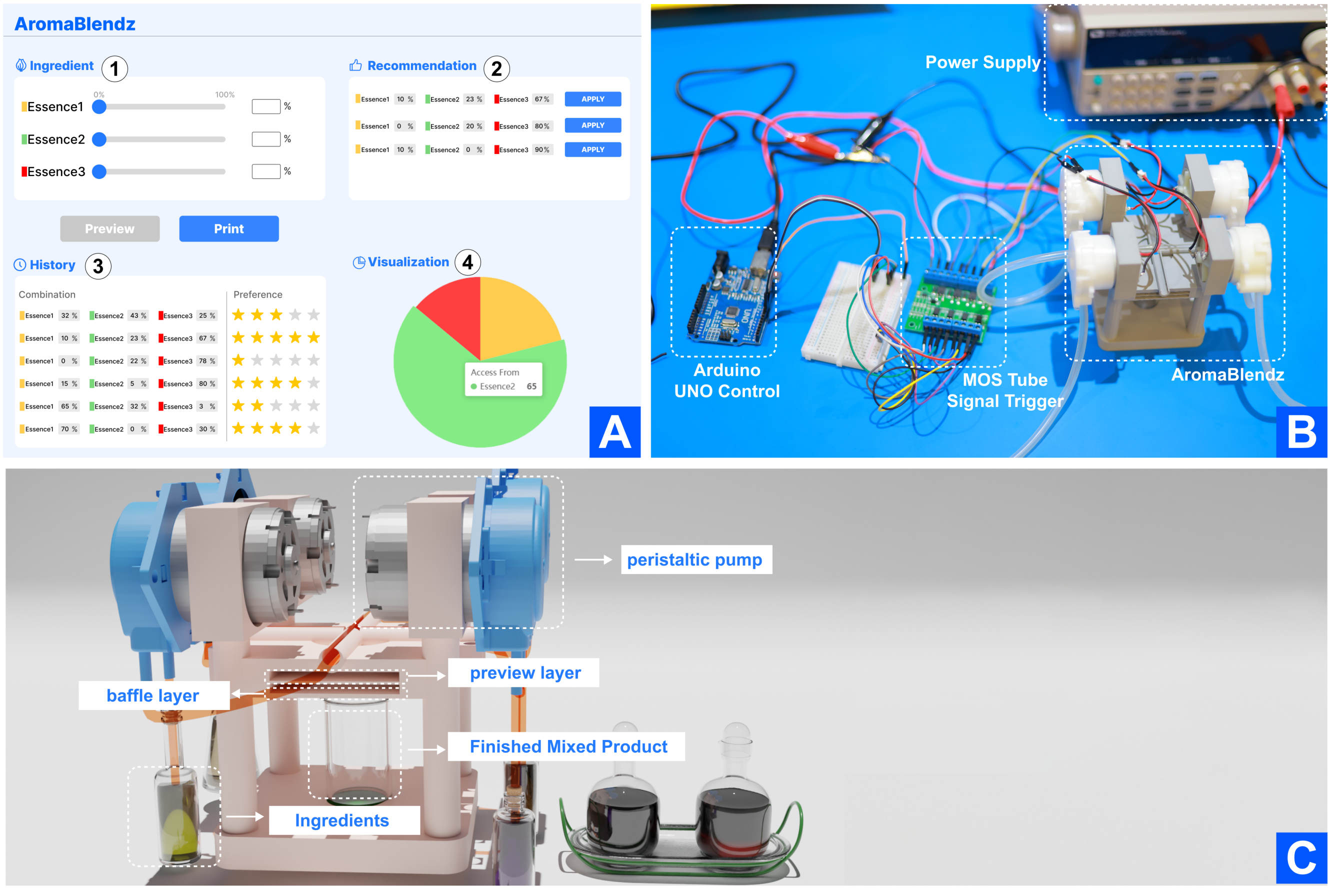

Figure 2: System design: (A) user interface for AromaBlendz. It features sections for adjusting the percentage of three essences, a recommendation area with combination suggestions, and a pie chart visualization of essence usage. A history section tracks user preferences with a star rating system. (B) hardware demonstration of AromaBlendz. (C)3D rendering of hardware model

2.3 Usage Process

The usage process is as shown in Figure 3. First, users can select from a variety of ingredients and install them. Then select the proportions of each ingredient, once the selection is complete, users can click "Preview" to start experiencing their personalized scent formula. The system delivers each component in proportion and allows real-time adjustments of intensity for online optimization. This process simulates the perceived effect of the final essential oil blend. Finally, after previewing, a scent formula is determined. By clicking "Print," users activate the physical module in the system. It precisely blends different essential oils in the formula, mixing them in the blending tank and then filling them into an air diffuser to create a customized physical scent. Thus, users can conveniently complete the entire customization process from imagination to tangible product in three steps, fully utilizing the interactive and personalized design advantages of this odor customization system.

3 APPLICATIONS

3.1 Olfactory training

Olfactory training, actively smelling different scents twice a day over several months, can help people to better understand their olfactory ability, and serve as an effective method in rehabilitating smell function [2, 9]. Our AromaBlendz platform prototype could potentially support olfactory training. Compared to traditional methods, our system is capable of precisely controlling different concentrations of compound scent components, which creates superior conditions for effective olfactory training. Additionally, the system is capable of recording users' typical responses to optimize personalized training programs. Integrating olfactory training software in the future could be considered to develop customized training programs tailored to the needs of different groups. For example, assisting elderly individuals in enhancing their olfactory functions for everyday life or aiding professional evaluators in improving their ability to distinguish subtle or complex scents.

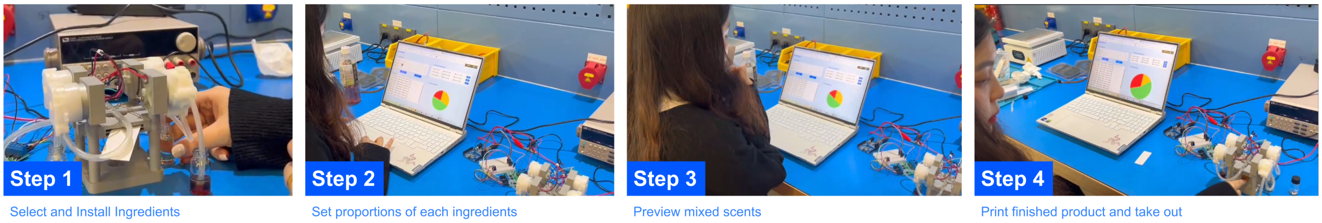

Figure 3: Usage Process of AromaBlendz

3.2 Symbolic Olfactory Display

Olfactory designers need to create more advanced scents. For example, they may want to craft scent menus or customer-tailored fragrance schemes, a more comprehensive user interface tool is essential. For instance, for olfactory design tasks, the AromaBlendz interface design could offer sliders for adjusting the proportions of different scent components. This allows designers to conveniently tweak and save their personally preferred fragrance formulas. The combination blending feature allows designers to flexibly adjust the ratios between multiple components. Version management would enable designers to iterate and collaborate on different design schemes conveniently.

3.3 Combine with VR

AromaBlendz could be integrated with Virtual Reality (VR) technology. For example, the user could customize their VR experience by pre-selecting and customizing the scents they wish to encounter through our prototype. As users don the VR headset, they are not only met with visual effects but also the scents they have pre-customized, harmoniously integrated with their virtual surroundings. This application can extend beyond leisure and entertainment to education, training, and therapy, among others. By integrating AromaBlendz with VR, a comprehensive, multi-sensory immersive experience is offered, significantly enhancing the realism and user engagement in virtual environments.

4 CONCLUSION AND FUTURE WORK

In this work, we presented the AromaBlendz, a platform that allows users to customize scents. AromaBlendz uses hardware to support specific and repeatable scent essential oil blends. We describe the hardware and software components of the system, as well as the functionality of visualizing scent preferences and compositions. We support fundamental operations and exploration of this technology in various scent use cases, such as olfactory training, symbolic olfactory displays, and novel olfactory media design. Through our interactive design, users can customize and generate tailored scents on demand, thereby exploring the possibilities of novel olfactory experiences. We plan to conduct more user studies to understand the effectiveness and user experience of the prototype and provide design guidelines and opportunities for future research.

ACKNOWLEDGMENTS

This work is partially supported by 1) the 2024 Guangzhou Science and Technology Program City-University Joint Funding Project (PI: Mingming Fan); 2) the 2023 Guangzhou Science and Technology Program City-University Joint Funding Project(Project No. 2023A03J0001); 3) the Guangdong Provincial Key Lab of Integrated Communication, Sensing and Computation for Ubiquitous Internet of Things (No.2023B1212010007).

REFERENCES

[1] Woodrow Barfield and Eric Danas. 1996. Comments on the use of olfactory displays for virtual environments. *Presence: Teleoperators & Virtual Environments* 5, 1 (1996), 109–121.
[2] Wegener Birte-Antina, Croy Ilona, Hähner Antje, and Hummel Thomas. 2018. Olfactory training with older people. *International Journal of Geriatric Psychiatry* 33, 1 (2018), 212–220.
[3] Nicolao Bonini, Michele Graffeo, Constantinos Hadjichristidis, and Valentina Perrotta. 2015. The effects of incidental scents in the evaluation of environmental goods: The role of congruity. *PsyCh journal* 4, 2 (2015), 66–73.
[4] Sylvain Delplanque, Géraldine Coppin, and David Sander. 2017. Odor and emotion. *Springer handbook of odor* (2017), 101–102.
[5] Shun'ichi Doi, Kousuke Kamesawa, Takahiro Wada, Eiji Kobayashi, Masayuki Karaki, and Nozomu Mori. 2010. Basic study on individual preference for scents and the arousal level for brain activity using MNIRS. In *IEEE/ICME International Conference on Complex Medical Engineering*. 119–124. https://doi.org/10.1109/ICCME.2010.5558859
[6] Walter Greenleaf, Tom Piantanida, and JD Bronzino. 2003. *Medical applications of virtual reality technology*. Vol. 2. CRC Boca Raton, FL.
[7] Rachel S Herz. 2006. I know what I like: Understanding odor preferences. *The smell culture reader* (2006), 190–203.
[8] Rachel S Herz. 2011. The emotional, cognitive, and biological basics of olfaction: Implications and considerations for scent marketing. *Sensory marketing* (2011), 87–107.
[9] Titus Sunday Ibekwe, Ayotunde James Fasunla, and Adebola Emmanuel Orimadegun. 2020. Systematic review and meta-analysis of smell and taste disorders in COVID-19. *OTO open* 4, 3 (2020), 2473974X20957975.
[10] Yasuaki Kakehi, Motoshi Chikamori, and Kyoko Kunoh. 2007. hanahana: An interactive image system using odor sensors. In *ACM SIGGRAPH 2007 posters*. 41–es.
[11] Elizabeth A Krusemark, Lucas R Novak, Darren R Gitelman, and Wen Li. 2013. When the sense of smell meets emotion: anxiety-state-dependent olfactory processing and neural circuitry adaptation. *Journal of Neuroscience* 33, 39 (2013), 15324–15332.
[12] Weiling Liu, Jingling Bao, Kehua Zou, Changjian Li, Liyuan Wang, and Yan Xu. 2010. Computer-controlled olfactometer for quantitative study of odor concentration measurement. In *2010 3rd International Conference on Biomedical Engineering and Informatics*, Vol. 4. IEEE, 1440–1443.
[13] Emanuela Maggioni, Robert Cobden, Dmitrijs Dmitrenko, and Marianna Obrist. 2018. Smell-O-Message: integration of olfactory notifications into a messaging application to improve users' performance. In *Proceedings of the 20th ACM international conference on multimodal interaction*. 45–54.
[14] Alan Morris. 2017. Olfactory senses linked to metabolism. *Nature Reviews Endocrinology* 13, 9 (2017), 499–499.
[15] Mark Moss, Jenny Cook, Keith Wesnes, and Paul Duckett. 2003. Aromas of rosemary and lavender essential oils differentially affect cognition and mood in healthy adults. *International Journal of Neuroscience* 113, 1 (2003), 15–38.
[16] Takamichi Nakamoto and Kenjiro Yoshikawa. 2006. Movie with scents generated by olfactory display using solenoid valves. *IEICE transactions on fundamentals of electronics, communications and computer sciences* 89, 11 (2006), 3327–3332.
[17] Marianna Obrist, Alexandre N. Tuch, and Kasper Hornbaek. 2014. Opportunities for Odor: Experiences with Smell and Implications for Technology. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Toronto,

Ontario, Canada) *(CHI '14)*. Association for Computing Machinery, New York, NY, USA, 2843–2852. https://doi.org/10.1145/2556288.2557008

[18] Emmanuelle Richard, Angele Tijou, Paul Richard, and J-L Ferrier. 2006. Multi-modal virtual environments for education with haptic and olfactory feedback. *Virtual Reality* 10 (2006), 207–225.

[19] Celine E Riera, Eva Tsaousidou, Jonathan Halloran, Patricia Follett, Oliver Hahn, Mafalda MA Pereira, Linda Engström Ruud, Jens Alber, Kevin Tharp, Courtney M Anderson, et al. 2017. The sense of smell impacts metabolic health and obesity. *Cell metabolism* 26, 1 (2017), 198–211.

[20] Luca Rinaldi, Emanuela Maggioni, Nadia Olivero, Angelo Maravita, and Luisa Girelli. 2018. Smelling the space around us: Odor pleasantness shifts visuospatial attention in humans. *Emotion* 18, 7 (2018), 971.

[21] Alix Seigneuric, Karine Durand, Tao Jiang, Jean-Yves Baudouin, and Benoist Schaal. 2010. The nose tells it to the eyes: crossmodal associations between olfaction and vision. *Perception* 39, 11 (2010), 1541–1554.

[22] Laura K Shanahan, Eva Gjorgieva, Ken A Paller, Thorsten Kahnt, and Jay A Gottfried. 2018. Odor-evoked category reactivation in human ventromedial prefrontal cortex during sleep promotes memory consolidation. *elife* 7 (2018), e39681.

[23] Keisuke Tomono, Hajime Katsuyama, Shuhei Yamamoto, and Akira Tomono. 2012. Image Presentation with Smell for Digital Signage and the Effect on Eye Catching.. In *SIGMAP*. 157–162.

[24] Steve Van Toller and George H Dodd. 2012. *Perfumery: the psychology and biology of fragrance.* Springer Science & Business Media.

[25] Takao Yamanaka, Ryosuke Matsumoto, and Takamichi Nakamoto. 2002. Study of odor blender using solenoid valves controlled by delta–sigma modulation method for odor recorder. *Sensors and Actuators B: Chemical* 87, 3 (2002), 457–463.

[26] Yaara Yeshurun and Noam Sobel. 2010. An odor is not worth a thousand words: from multidimensional odors to unidimensional odor objects. *Annual review of psychology* 61 (2010), 219–241.