GemiN' I: Seamless Skin Interfaces Aiding Communication through Unconscious Behaviors

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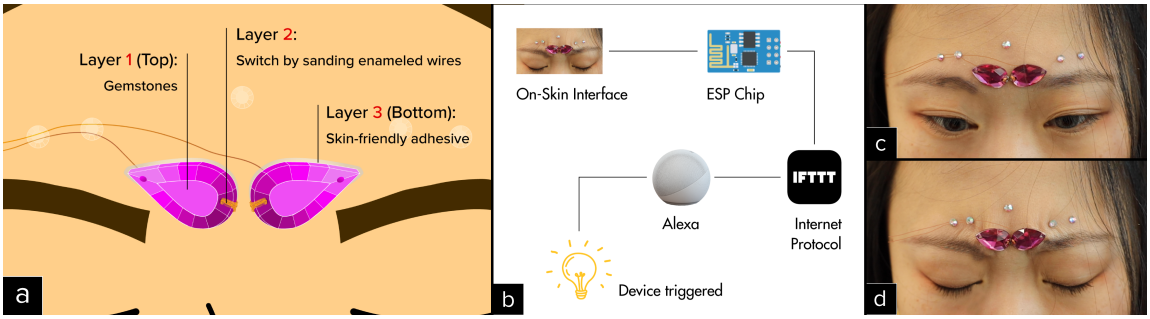

Fig. 1. GemiN' I prototype. a) on-skin interface through 3 layers: aesthetic top layer with gemstones, circuit design by switches and connections, and adhesive for insulation in the bottom layer. b) System design c,d) Interaction through a frown to activate the device

Voice command is the primary way of interacting with smart home devices and virtual assistants. However, being vocal is not always feasible or appropriate. This project aims to explore the potential of on-skin interfaces in social settings by discreetly communicating to a smart home device when enacting nearly unconscious behaviors. GemiN'I is a Beauty Technology that aesthetically and inconspicuously embeds sensors in face jewels to detect facial muscle movements, which then signals smart home devices without vocal commands, allowing the user and observers to interact without vocal interrupts. Our design rationale consists on: a) the form factor of a commercially available product for face decoration such as facial gems, b) novel discrete interfaces by making the technology invisible(circuits hidden within the gems), and the interaction by triggering devices when enacting unconscious behaviors (frowning), and c) seamlessly triggering a device in presence of an observer.

CCS Concepts: • **Human-centered computing** → **Ubiquitous and mobile computing**; **HCI design and evaluation methods**; *Collaborative and social computing*.

Additional Key Words and Phrases: wearable, smart home, Beauty Technology, gesture recognition

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1 INTRODUCTION AND RELATED WORKS

Beauty Technology [18, 19] uses the body's surface as an interactive platform by integrating technology into beauty products applied directly to one's skin [16], fingernails [17], and hair [15]. Some of these are located on the face, and take advantage of unconscious gestures to detect emotions [5] or to voluntarily trigger certain actions [8, 12, 14]. Nearly unconscious gestures often serve as subtle nonverbal cues in communication, but with an embedded technology, they could augment these gestures and trigger desired outcomes on devices. For example, in a previous study, a hair extension triggered a phone to send a message or record a conversation subtly [15].

Household items are being incorporated into the interconnected Internet of Things. As seen in popular commercial products such as Amazon's Alexa and Google Home, voice recognition dominates the methods of control[4]. However, it is not always appropriate to vocalize commands. Certain situations may make it impolite or even dangerous. Wearable projects used a microphone for identity confirmation [7], VAuth to detect internal body sounds to trigger actions with smart home [11], a hat technology that commands Alexa through gestural and touch interfaces [6], a thermal camera for sensing both dynamic and static gestures [22], temporal tattoos for controlling a computer and smartphone [10, 20], and facial electrodes to detect emotions [9].

This project uses facial gestures to communicate discreetly with smart home devices in social settings. One of our main contributions of this research would be the Beauty Technology prototype. For our goals, first, we would like to see how users and observers respond to device-activated actions compared to traditional methods. Also, we are exploring whether users and observers perceive the usage of such on-skin interfaces differently in settings varying in visibility and platforms. We hypothesize 1) Usage of a non voice controlled on-skin interface to control smart home device is useful for discretion of the user. 2) Usage of an on-skin interface with a smart home device can be helpful for avoiding distracting observers. 3) People use and react to interface-controlled smart home devices differently in in-person and online settings.

2 IMPLEMENTATION

2.1 Beauty Technology Design

Face gems are commonly used in festivals, social spaces and in some cultures practices. GemiN'I uses these gems to hide electronics and interact whe the user frowns. 44 AWG enameled copper wires are coiled around the hole of these "sew-on" gems. The wires in the corner of the gems are sanded in order to expose a conductive area of the wire and use them as a switch when the user frowns and approximates the gems. These switches are adhered with eyelash glue in an aesthetic fashion and, in order to sense a frown, are applied on the procerus muscles between the eyebrows [21], which has higher echo intensity than other facial muscles [3].

The system uses an ESP 8266, ESP 01 chip and a 3.3V LiFePo4 battery. The microcontroller is connected to the face gems through enameled wires, and worn hidden on a hairclip. To interact with a smart home agent, we currently use the Amazon Alexa Echo Dot [1]. Future works could expand to similar smart home devices and other facial movements could be included. Figure 1 shows a) the layers of GemiN'I applied to a user's forehead, b) the communication prototcols and c,d) the user's interaction through a frown.

2.2 Software Design

Our setup is separated into three parts: the wearable device, IFTTT [2], and Alexa. Our wearable device senses a frown and determines which URLs, that are linked to actions, to visit and thus trigger. IFTTT is a popular web server for creating conditional statements that trigger events in other servers. We used it as an intermediary. The wearable device calls a link that is an action from Webhooks from IFTTT, then IFTTT toggles a virtual device active on Alexa. Alexa is then programmed to perform a certain skill, such as blinking a light or sending out a message, when the virtual device is activated.

3 POTENTIAL APPLICATIONS AND IMPLICATIONS

GemiN'I aims to generate a second layer of communication triggered by a frown and interacting beyond traditional vocal methods. It can be used in a variety of social situations, in public or virtual settings. For instance, in situations where users feel unsafe and/or cannot afford to speak/utilize phones, they can use the GemiN'I to contact safety officials, friends or family. The device enables accessibility for people with physical disabilities by controlling applications in their computers with minimal movement or during virtual meetings. Within virtual meetings, users could communicate to others through activating other's smart home utilities directly. GemiN'I can also assist in fact-checking by activating Alexa to find an answer in an interview or in a conversation.

Using GemiN'I to communicate with IoT devices could also raise needs to reconsider privacy issues in communication because they enable services to gather personal data, such as behaviors and locations with little human awareness[13]. Moreover, when the trigger of the device is invisible, further considerations on social acceptance from the observer must be regulated.

4 CONCLUSION

GemiN' I aimed to explore the potential of using Beauty Technologies to seamlessly communicate with a smart home device in various social settings. It took advantage of an unconscious behaviors such as a frown to create a second layer of communication that is discreet. The device considered an aesthetic design to hide the electronics within face gems, a precise application on the facial muscles, and the interaction with IoT devices while social settings are taking place. This project aims contribute as a novel form factor of Beauty Technologies that seamlessly connect computer mediated communication and human interaction. Future works involve tests on the users' and observers' perceptions in a social setting, wearability factors of applying these devices on these and other facial muscles, and accuracy of the gesture control.

REFERENCES

[1] [n.d.]. Amazon Alexa. http://alexa.amazon.com. Accessed: 2020-12-10.

[2] [n.d.]. IFTTT. https://ifttt.com/. Accessed: 2020-12-10.

[3] Nens Van Alfen, H. Jacobus Gilhuis, Jurre P. Keijzers, Sigrid Pillen, and Johannes P. Van Dijk. 2013. Quantitative facial muscle ultrasound: Feasibility and reproducibility. *Muscle & Nerve* 48, 3 (2013), 375–380. https://doi.org/10.1002/mus.23769 arXiv:https://onlinelibrary.wiley.com/doi/pdf/10.1002/mus.23769

[4] S. Bajpai and D. Radha. 2019. Smart Phone as a Controlling Device for Smart Home using Speech Recognition. In *2019 International Conference on Communication and Signal Processing (ICCSP)*. 0701–0705. https://doi.org/10.1109/ICCSP.2019.8697923

[5] Yumiao Chen, Zhongliang Yang, and Jiangping Wang. 2015. Eyebrow emotional expression recognition using surface EMG signals. *Neurocomputing* 168 (2015), 871–879.

[6] Christine Dierk, Scott Carter, Patrick Chiu, Tony Dunnigan, and Don Kimber. 2019. Use Your Head! Exploring Interaction Modalities for Hat Technologies. In *Proceedings of the 2019 on Designing Interactive Systems Conference* (San Diego, CA, USA) *(DIS '19)*. Association for Computing Machinery, New York, NY, USA, 1033–1045. https://doi.org/10.1145/3322276.3322356

[7] Huan Feng, Kassem Fawaz, and Kang G. Shin. 2017. Continuous Authentication for Voice Assistants. In *Proceedings of the 23rd Annual International Conference on Mobile Computing and Networking* (Snowbird, Utah, USA) *(MobiCom '17)*. Association for Computing Machinery, New York, NY, USA, 343–355. https://doi.org/10.1145/3117811.3117823

[8] Patricia J Flanagan, Katia Vega, and Hugo Fuks. 2012. Blinklifier: The power of feedback loops for amplifying expressions through bodily worn objects. In *Proceedings of APCHI*. 641–642.

[9] Lilah Inzelberg, Moshe David Pur, Stefan Schlisske, Tobias Rödlmeier, Omer Granoviter, David Rand, Stanislav Steinberg, Gerardo Hernandez-Sosa, and Yael Hanein. 2018. Printed facial skin electrodes as sensors of emotional affect. *Flexible and Printed Electronics* 3, 4 (2018), 045001.

[10] Hsin-Liu (Cindy) Kao, Christian Holz, Asta Roseway, Andres Calvo, and Chris Schmandt. 2016. DuoSkin: Rapidly Prototyping on-Skin User Interfaces Using Skin-Friendly Materials. In *Proceedings of the 2016 ACM International Symposium on Wearable Computers* (Heidelberg, Germany) *(ISWC '16)*. Association for Computing Machinery, New York, NY, USA, 16–23. https://doi.org/10.1145/2971763.2971777

[11] Rui Liu, Cory Cornelius, Reza Rawassizadeh, Ronald Peterson, and David Kotz. 2018. Vocal Resonance: Using Internal Body Voice for Wearable Authentication. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 2, 1, Article 19 (March 2018), 23 pages. https://doi.org/10.1145/3191751

[12] Elle Luo, Ruixuan Fu, Alicia Chu, Katia Vega, and Hsin-Liu Kao. 2020. Eslucent: an eyelid interface for detecting eye blinking. In *Proceedings of the 2020 International Symposium on Wearable Computers*. 58–62.

[13] Ismini Psychoula, Liming Chen, and Oliver Amft. 2020. Privacy Risk Awareness in Wearables and the Internet of Things. *IEEE Pervasive Computing* 19 (07 2020), 60–66. https://doi.org/10.1109/MPRV.2020.2997616

[14] Katia Vega, Abel Arrieta, Felipe Esteves, and Hugo Fuks. 2014. FX e-makeup for muscle based interaction. In *International Conference of Design, User Experience, and Usability*. Springer, 643–652.

[15] Katia Vega, Marcio Cunha, and Hugo Fuks. 2015. Hairware: The Conscious Use of Unconscious Auto-Contact Behaviors. In *Proceedings of the 20th International Conference on Intelligent User Interfaces* (Atlanta, Georgia, USA) *(IUI '15)*. Association for Computing Machinery, New York, NY, USA, 78–86. https://doi.org/10.1145/2678025.2701404

[16] Katia Vega and Hugo Fuks. 2013. Beauty technology as an interactive computing platform. In *Proceedings of the 2013 ACM international conference on Interactive tabletops and surfaces*. 357–360.

[17] Katia Vega and Hugo Fuks. 2014. Beauty tech nails: interactive technology at your fingertips. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction*. 61–64.

[18] Katia Vega and Hugo Fuks. 2014. Beauty technology: body surface computing. *Computer* 47, 4 (2014), 71–75.

[19] Katia Vega and Hugo Fuks. 2016. *Beauty Technology*. Springer.

[20] Martin Weigel, Tong Lu, Gilles Bailly, Antti Oulasvirta, Carmel Majidi, and Jürgen Steimle. 2015. Iskin: flexible, stretchable and visually customizable on-body touch sensors for mobile computing. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 2991–3000.

[21] Joshua M Wieder and Ronald L Moy. 1998. Understanding botulinum toxin: surgical anatomy of the frown, forehead, and periocular region. *Dermatologic surgery* 24, 11 (1998), 1172–1174.

[22] Tengxiang Zhang, Xin Zeng, Yinshuai Zhang, Ke Sun, Yuntao Wang, and Yiqiang Chen. 2020. ThermalRing: Gesture and Tag Inputs Enabled by a Thermal Imaging Smart Ring. Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3313831.3376323