RAE2026

Integrating Emotional Intelligence in Design

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Contents

Title:

Designing for Emotional Resilience: Multimodal AI Integration in Daily Life

Descriptor

Professor Stephen Jia Wang's research explores the potential of developing and integrating multimodal emotion recognition technologies into people's daily lives to enhance their emotional intelligence and well-being. The research leverages advanced design and AI techniques to address the growing global concerns of distress, sadness and anxiety, as documented by Daly & Macchia (2010). It examines how interactive and intelligent systems design might effectively reduce stress by recognising and responding to subtle emotional expressions, such as micro-gestures (MGs). It seeks to understand users' emotional support needs to establish the foundational parameters for a framework that guides the design of emotionally intelligent systems, with a specific focus on prioritising and stimulating emotional interactions.

Conducted between 2014 and 2023, this comprehensive literature review identifies a significant shift from traditional subjective emotion assessment methods to multimodal emotion recognition technologies. It highlights that reliance on single modalities limits robustness, especially in complex, real-life scenarios and emphasises three key advantages of multimodal methods:

1) **Enhanced Accuracy**: Simultaneous access to multiple emotional modalities (e.g. smiling and applauding when happy) enhances contextual understanding and accuracy (Baltrušaitis et al., 2018).
2) **Complementary Strengths:** Different multimodal inputs complement each other by addressing their respective limitations during testing (Xue et al., 2024).
3) **Missing Data Compensation:** Missing inputs from one modality can be compensated for by data from another (D'mello & Kory, 2015), such as recognising emotion from visual cues when audio cues are absent.

The Major Collaborative Output (MCO) encompasses five interrelated research projects funded by the Transport Department of Hong Kong's Smart Traffic Fund and industry partners Huawei, GAC and Research Centre for Future (Caring) Mobility (RcFCM), with a total funding of HK$5.7M. These projects collectively address critical research questions (RQs) and provide foundational knowledge for a family of patents. Notable outcomes include the award-winning '*EmoSense*' technology and the '*EmoFriends*' toolkit, which transform common plush toys into intelligent companion robots that provide real-time emotional support and healthier emotional environments.

Personal Profile: Prof. Stephen Jia Wang

Prof. Wang's research is centred on using human-centred, design-driven methods to support health and well-being. His work investigates the potential of technologies such as AI models and sensory systems, and advances related curriculum development in the field of innovation-purposed Intelligent Systems Design.

Prof. Wang is a Full Professor of UX Design & Design Intelligence at PolyU, where he has served since January 2020 as Scheme Leader of the Master of Design programmes and Specialism Foundation Leader of Intelligent Systems Design. His diverse educational background includes degrees in industrial and interaction design (BA, Tsinghua University, China; MA, Tama Art University, Japan), computing (M.Eng., RMIT, Australia) and architecture (PhD, Tokyo University of the Arts, Japan).

He is also a Distinguished Visiting Professor at Tsinghua University (The Future Lab). Since joining the School of Design at PolyU, he has established and now leads the University-level RcFCM, which comprises 18 researchers from 12 different schools/departments at PolyU and Tsinghua University, leading manufacturers in the GBA region, 4 post-doctoral scholars and 15 doctoral candidates. The research centre has attracted >HK$67M of competitive and industrial research funding.

Research Questions

1. **What are the critical challenges in emotion monitoring, and how can advanced emotional monitoring systems address these gaps?**
   This RQ is addressed through a systematic literature review (see pages 8–9) where key literature, including foundational studies and recent advancements, were analysed to identify current limitations and knowledge gaps. Building on these findings, a theoretical framework, Activity Theory-User-Centred Design (AT-UCD) (detailed on page 10), was proposed to guide the following studies.
2. **How do users perceive emotional experiences, and what expectations do they have regarding emotion monitoring across various AI-driven applications?**
   This RQ was explored through an empirical user study of this MCO (see pages 11–14). Precisely, a mixed-methods study (quantitative survey [N = 22] and qualitative interviews [N = 458]) was designed and conducted, selected through a purposive sampling approach to represent diverse user demographics and application contexts.
3. **How can AI-based interactive solutions be designed to deliver more effective emotion monitoring and support?**
   To address this RQ, a series of iterative user-centred experiments was conducted (see pages 15–19). Further experimental results are provided and analysed on pages 20–22. These studies aimed to move beyond the limitations of unimodal emotional data processing by developing and testing multimodal interactive systems that respond to emotional states in real time.

Research Outputs

Based on the **research outputs (ROs),** the work demonstrated its impact across both academic fundamental research and industry application domains, highlighted through:

- **ROs of Fundamental Study:**
    - 9 research papers (5 conference papers and 4 journal articles)
- **ROs of Industry Applications:**
    - 3 exhibitions
    - 1 workshop
    - 3 patents
    - 2 public news reports
    - 4 awards

Research Field & Key References

Emotional well-being has become a critical area of research in design, particularly in response to the increasing pace and interconnectedness of modern life. Global researchers are exploring how technology and design can address rising emotional challenges.

We conducted a literature review study over the past decade (2014–2023) to explore the potential challenges and opportunities in emotion monitoring technologies through various interactive methods. Moving beyond the limitations of traditional, single-modality emotion assessment, multimodal data integration to enhanced robustness and effectiveness in complex, real-world scenarios.

The prevailing consensus, as established by key researchers (D'mello & Kory, 2015; Baltrušaitis et al., 2018; Xue et al., 2024), is that multimodal approaches enhance robustness through three primary mechanisms: providing contextual redundancy (Baltrušaitis et al., 2018), enabling cross-modal complementarity (Xue et al., 2024), and compensating for missing data streams (D'mello & Kory , 2015).

While multimodal integration demonstrates significant technical potential, two critical gaps hinder its effective application in real-world mental health contexts. First, existing work predominantly focuses on technical performance metrics (e.g., accuracy) in controlled settings, leaving the experiential and ethical dimensions in complex, real-world scenarios largely unexamined. Second, the relationship between specific multimodal inputs (e.g., sensory touch, EEG) and their contribution to emotional outcomes remains poorly understood, particularly from a user-centred perspective.

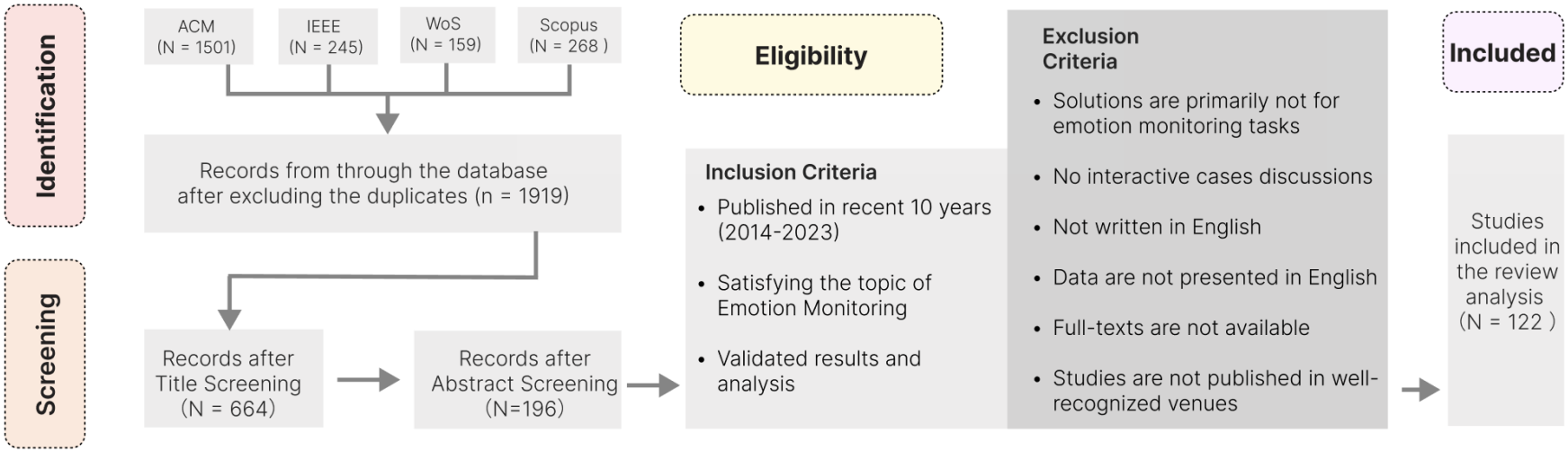
Our research programme establishes its point of departure at this junction. We move beyond the question of "can we recognize emotion more accurately?" to address "how should we design these systems to be trustworthy, context-aware, and genuinely effective for users in their daily lives?" To this end, our studies empirically examine how multimodal inputs influence emotional changes and leverage AI to enable real-time recognition. This shift from a purely technical optimization to a human-centred design challenge constitutes the original contribution of our research, aiming to create UCD solutions that are both technologically robust and experientially valid.

Literature Review

Challenges and Opportunities in Emotion Monitoring

To answer RQ1 (page 5), we conducted a systematic literature review to identify critical challenges:

RQ1: What are the critical challenges in emotion monitoring, and how can advanced emotional monitoring systems address these gaps?



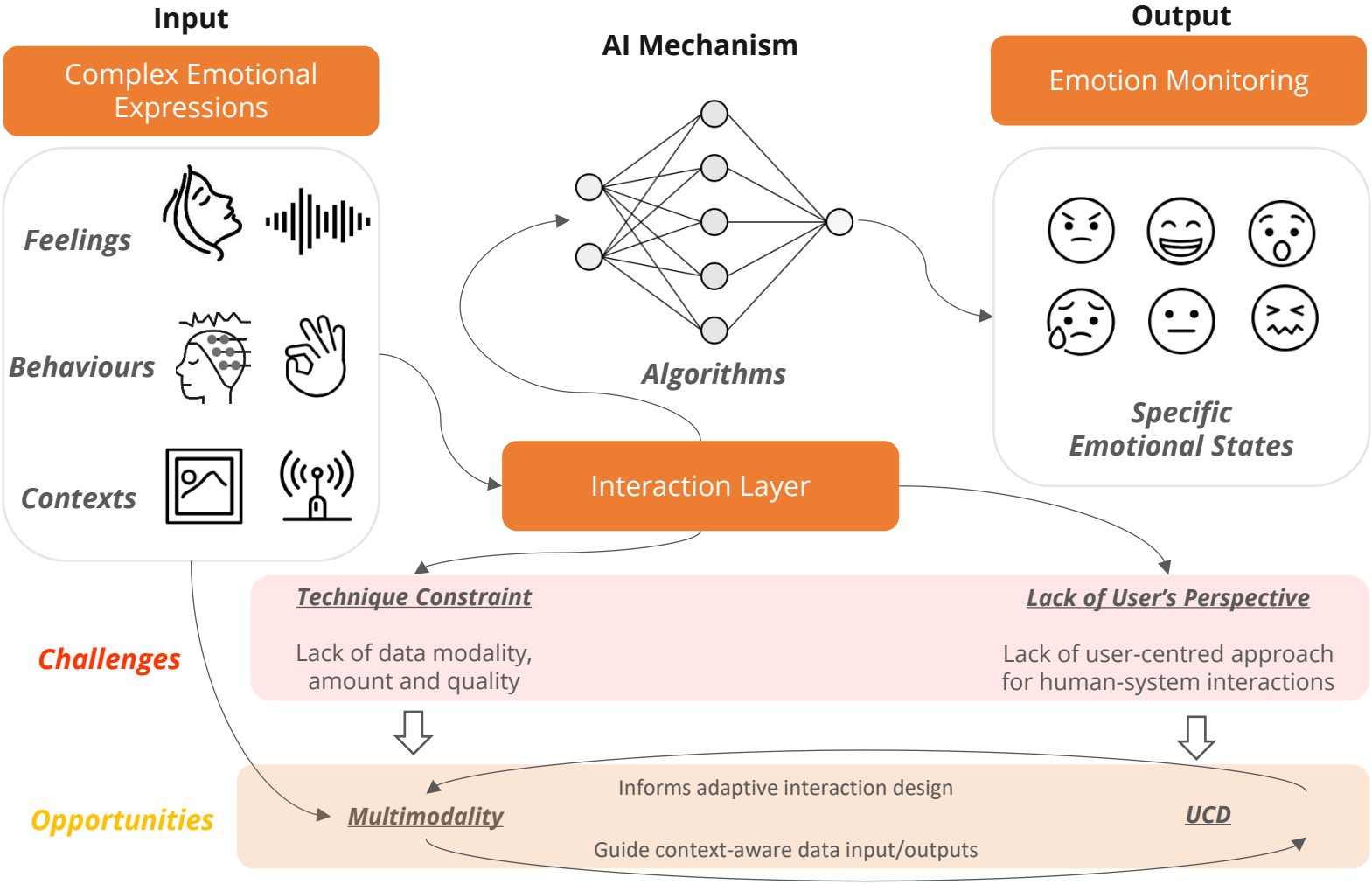
* **ACM**: Association for Computing Machinery; **IEEE**: Institute of Electrical and Electronics Engineers; **WoS**: Web of Science; **Scopus**: a scientific database by the academic publisher Elsevier.

As the principal investigator, Prof. Wang led the following key intellectual interventions:

- Discussed inclusion/exclusion criteria with other co-authors to establish a clear, focused scope for the project's literature review, including identifying and retaining papers that specifically focused on emotion monitoring within interactive systems.
- Guided the manual coding of the retained papers to identify methodological patterns, common data modalities, system goals and the extent of user involvement.

Literature Review

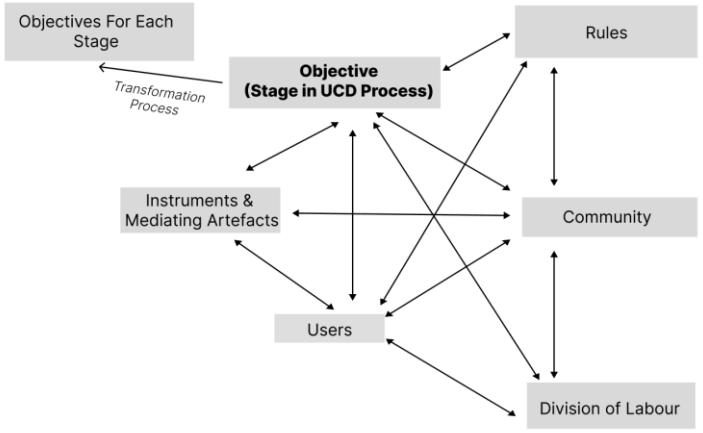
Challenges and Opportunities in Emotion Monitoring

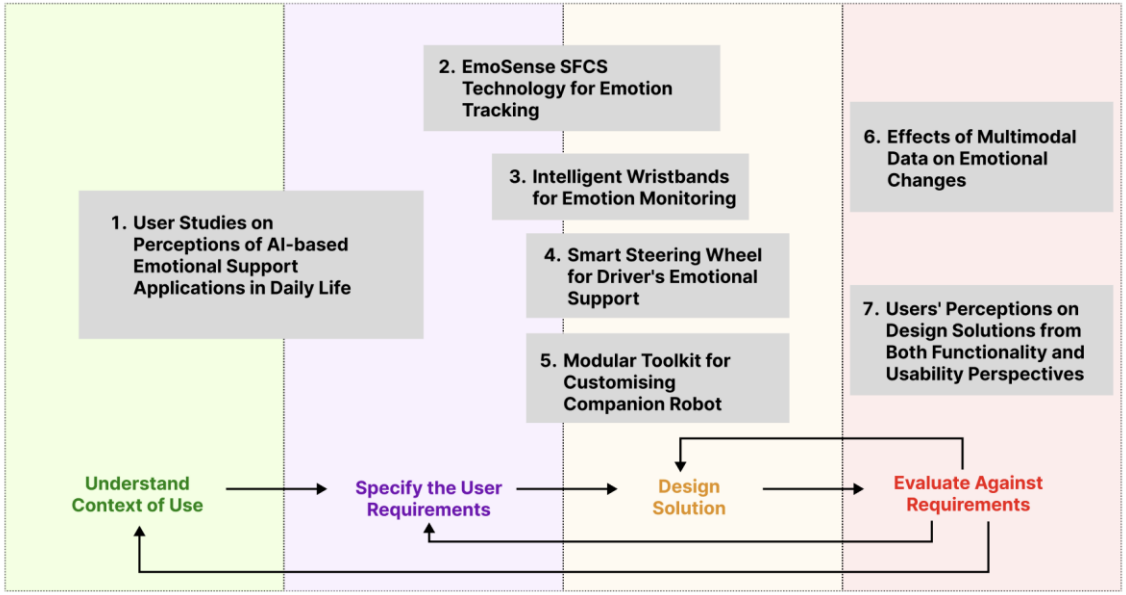


Building on the literature review's findings of technique constraints and limited user engagement, the following studies explore **how multimodality and UCD** can better support emotional monitoring (pages 11–16).

Research Methods, Prototypes & Materials

AT-UCD: Integrating AT into the UCD Process





* **SFCS**: Swept frequency capacitive sensing.

Given the complex influence of social and cultural environments on human emotional states, relying solely on understanding users' needs is insufficient for applying the UCD process to develop effective AI-based solutions for emotional support (Good & Omisade, 2019). To address this gap, AT (Engeström, 2015) provides a valuable theoretical framework by incorporating contextual information to gain a deeper understanding of the users' situation in relation to their surrounding environments and components.

We propose the AT-UCD framework, which integrates AT into the UCD process, to guide subsequent user studies (see pages 11–18). In this framework, the four UCD design stages serve as the 'objectives' of the AT framework.

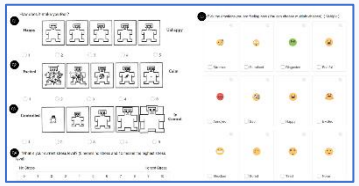
Research Methods, Prototypes & Materials

Building on the findings from the literature review (pages 8–9) and the AT-UCD framework (page 10), we adopted a structured research approach to inform the design of more effective emotion monitoring systems.

Literature Review

Formative Study

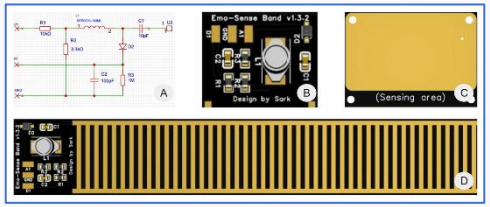
- Focus Group



- Questionnaire

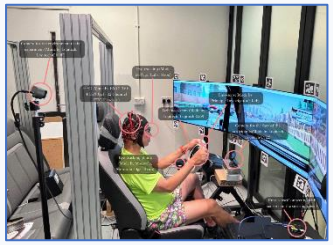
Development

- EmoSense for Emotion Monitoring



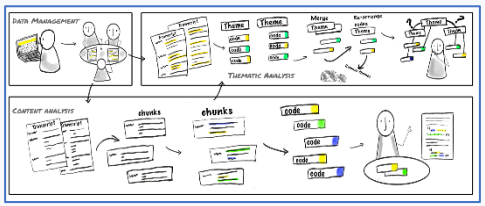
- Multimodal Toolkit for Emotion Support

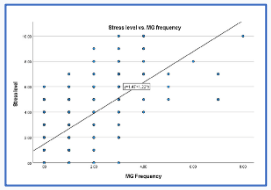
User Study



- User Study to Collect Multimodal Data

Data Analysis





Formative Study

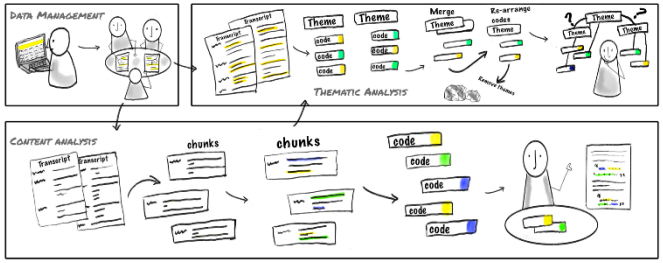
Understand Users' Perceptions of Emotion Monitoring and Requirements in Daily Life

To answer RQ2 (page 5), we adopted a mixed methods approach to gain users' perceptions.

RQ 2: How do users perceive emotional experiences, and what expectations do they have regarding emotion monitoring across various AI-driven applications?

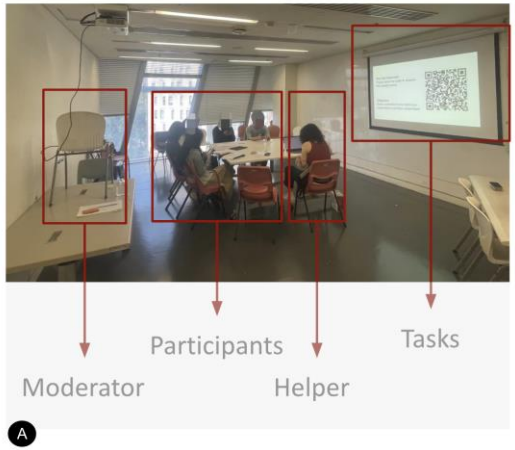
Focus Groups: The focus groups were conducted in 4 sessions (split into 6/6/6/4); **22 participants, with no speaking/hearing disorders,** were recruited through online advertisements and allocated to a focus group.

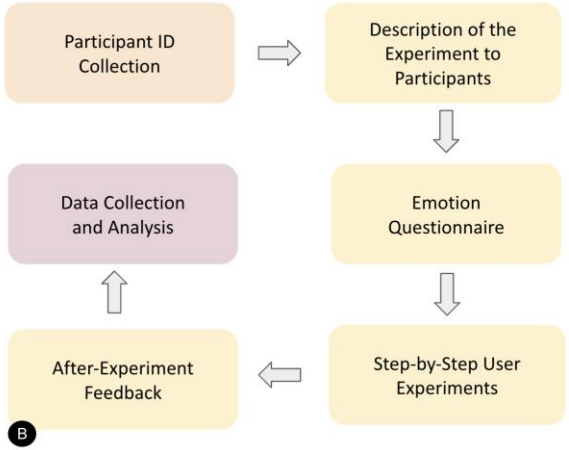
Qualitative Analysis: The qualitative data, derived from audio recordings and their corresponding transcripts, were analysed using both **thematic and content analysis** (Vaismoradi et al., 2013).



Integration of Thematic and Content Analysis

The Setup and Procedures of the Focus Group





Questionnaire Protocol (* indicates multiple-choice question).

Part 1. Demographic Information

Nickname	Gender	Age	Degree	Subject	Relationship

Part 2. Emotional Questionnaire

Standard DASS-21 questionnaire (Lovibond and Lovibond, 1995) from 3 dimensions: Depression, Anxiety, Stress

Part 3. Perceptions of Emotional Experiences

Question	Options				
How often do you encounter emotional issues?	Daily	Weekly	Monthly	Annually	None
What cause your emotional issues? *	Communication	Study	Family	Work	Friendship
	Relationship	Health	Others		
I intend to talk with friends.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I got emotional relief talking with friends.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Friends can help with solutions.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I intend to talk with family members.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I felt relief talking with family members.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Family members can help with solutions.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I intend to talk with counselors.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I got emotional relief talking with counselors.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Counselors can help with solutions.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I intend to face emotional issues directly.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I got emotional relief through self-comfort.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I can solve emotional issues by myself.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
What concerns do you have when talking with others about your emotional issues? *	Empathy	Trust	Express Emotions		Suitable person
	Problem-solving		Bring negative energy		Others
What other regulation strategies do you choose? *	Multimedia resources		Game	Sports	Rest
	Make a plan		Food	Shopping	Others

Part 4. Perceptions of AI-Driven EMR applications

Question	Options			
Do you know EMR services or products?	Yes	No		
Have you used any EMR services or products?	Yes	No		
What functionality factors would you care about for EMR technologies? *	Warning function		Objective analysis	Real-time
	Multimodal interaction		Regulation solutions	Accuracy
	Professionalism		Emotional report	Others
What usability factors would you care about for EMR technologies? *	Customization		Specific user groups	Data security
	Personalization		Reliance on AI	Trust
	Empathy	Cost	Privacy leakage	Others
What do you think about EMR tech compared to traditional counseling services? *	Feasible cost	Real-time	Objective analysis	Feedback
	Lack of empathy		Lack of body language	Others
How do you think about the collaboration between EMR and counseling services? *	Early diagnostic process		Simplify the diagnostic process	
	Complementary strengths with professionals			Others
What do you think about the future trend of generalization for EMR? *	Increased trust		Combination with counseling experts	
	Herd mentality		Higher accuracy	Others

Part 5. Use Scenarios of AI-Driven EMR applications

Question	Options			
What scenarios are suitable to use EMR applications? *	Home	Before sleep	Working status	Stay alone
	Encounter emotional issues		Daily use	Others
What scenarios are unsuitable to use EMR applications? *	Social mobile applications		Emergent situations	
	Normal emotional fluctuations		Social activity	Others
Agreement on data-sharing and data security *	Emotion-related research		Reputation	Transparency	Authorities
	Medical collaboration		Privacy protocols		Others

Questionnaire Protocol

Questionnaire: To validate these insights through focus groups, a questionnaire was crafted, drawing from selected themes and consideration factors. Finally, the survey collected **458** valid results.

Quantitative Analysis: First, reliability and validity tests were performed. Then, the **Spearman correlation coefficient** was used to assess the monotonic relationship between the two factors.

Formative Study

Qualitative Results:

Users' Perceptions Towards Emotional Issues

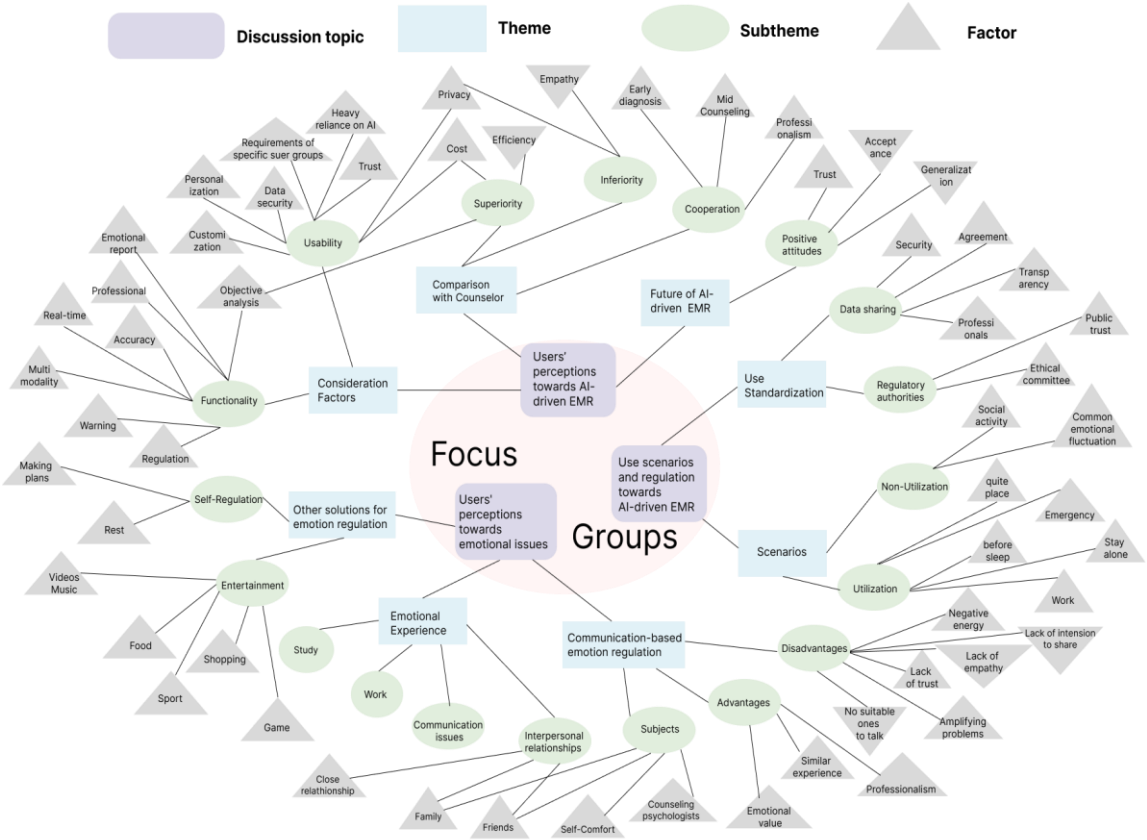
- Emotional issues happen everywhere.
- Positive communication is the most selected strategy to regulate emotions.
- Multiple emotion coping strategies are common across various use scenarios.

Users' Attitudes Towards AI-based Services

- Users compare AI-based applications with human-provided mental health services.
- Both usability and functionality are important factors for AI-based applications.
- Users have a positive outlook regarding the future of AI-based emotional support.

Expectations for Use Scenarios

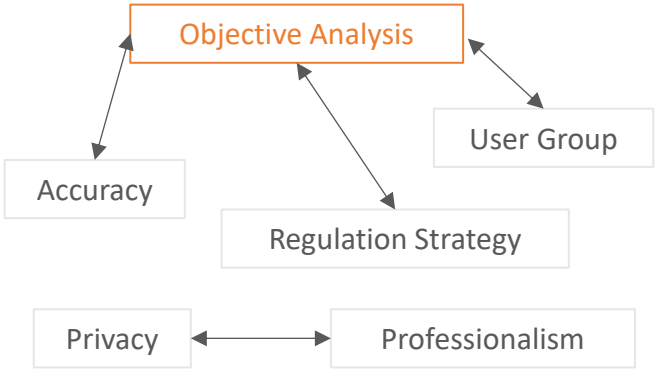
- Both suitable and unsuitable use scenarios were discussed by users.
- Strong data security and ethical regulatory support should be involved.



Thematic Map Based on the Qualitative Analysis

Formative Study

Quantitative Results: ***Moderate correlations*** among consideration factors:



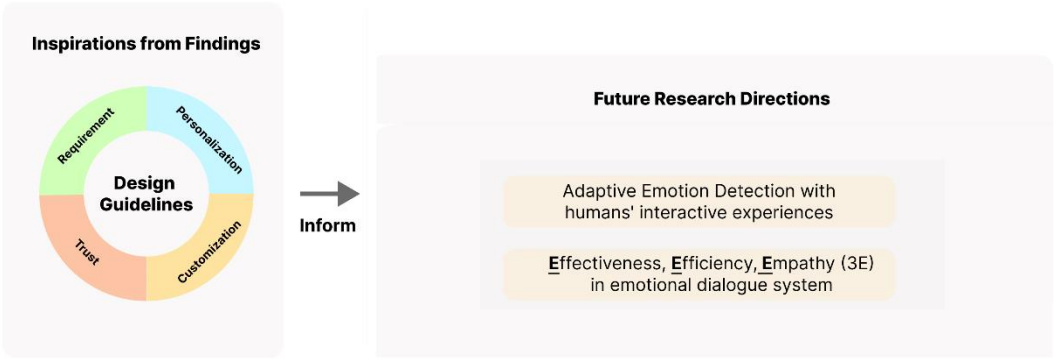
	Accuracy	Customization	Privacy	Real-time	Objective	Professionalism	Trust	Regulation	Multimodality	Cost	User Groups	Data Security
Accuracy	1.00	0.13	0.21	0.29	0.44	0.12	0.36	0.19	0.25	0.22	0.32	0.34
Customization	0.13	1.00	-0.07	0.06	0.05	-0.15	0.19	0.09	-0.10	0.41	0.06	0.07
Privacy	0.21	-0.07	1.00	-0.12	0.06	0.40	-0.12	0.12	0.08	-0.14	0.11	0.01
Real-time	0.29	0.06	-0.12	1.00	0.15	-0.19	0.35	-0.24	0.32	0.30	0.08	0.12
Objective	0.44	0.05	0.06	0.15	1.00	0.18	0.32	0.44	0.11	0.18	0.46	0.36
Professionalism	0.12	-0.15	0.40	-0.19	0.18	1.00	-0.26	0.34	-0.02	-0.16	0.18	0.09
Trust	0.36	0.19	-0.12	0.35	0.32	-0.26	1.00	0.01	0.19	0.29	0.21	0.28
Regulation	0.19	0.09	0.12	-0.24	0.44	0.34	0.01	1.00	-0.24	0.02	0.29	0.27
Multimodality	0.25	-0.10	0.08	0.32	0.11	-0.02	0.19	-0.24	1.00	0.09	0.06	0.15
Cost	0.22	0.41	-0.14	0.30	0.18	-0.16	0.29	0.02	0.09	1.00	0.11	0.11
User Groups	0.32	0.06	0.11	0.08	0.46	0.18	0.21	0.29	0.06	0.11	1.00	0.27
Data Security	0.34	0.07	0.01	0.12	0.36	0.09	0.28	0.27	0.15	0.11	0.27	1.00

Correlation Matrix Among Factors for Choosing AI-based Emotion Monitoring Services

Design Guidelines: User requirements, Personalisation, Customisation, and Trust

Future Directions:

- Developing an adaptive emotion monitoring system
- Creating an **empathetic dialogue system** based on a **3E** consideration factors framework



Design Insights Generated from the Findings

User Study

Emo-MG: A Multimodal Emotion Detection Framework Based on EEGs and MGs

To answer RQ3 (page 5), further experiments were conducted to investigate how multimodalities affect emotional states.

RQ 3: How can AI-based interactive solutions be designed to deliver more effective emotion monitoring and support?

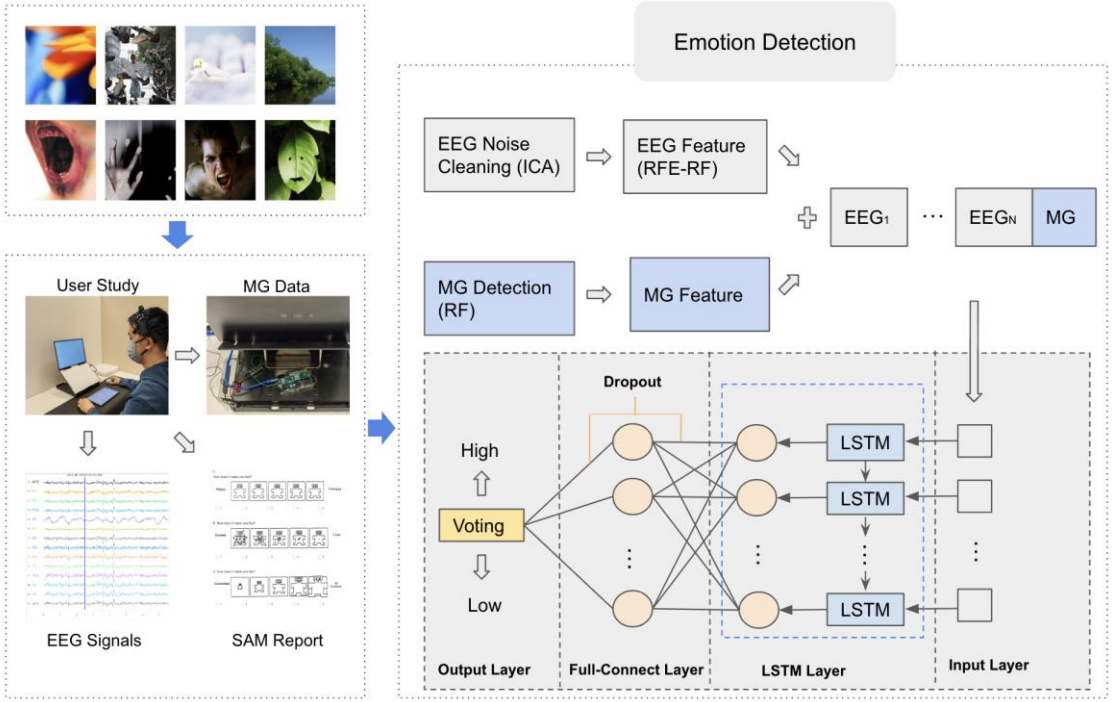
Procedures:

1. User data were recorded using short-interval International Affective Picture System stimuli (Machajdik & Hanbury, 2010), including EEG signals, MG data and Self-Assessment Manikin self-reports (Bradley & Lang, 1994), for rating valence-arousal-dominance (VAD) dimensional scores.

2. Artefacts were removed from the EEG signals, and relevant EEG features were selected for the emotion detection task.

3. A trained Random Forest (RF) model was employed to detect MGs.

4. The extracted EEG and MG features were then input into a Long-Short Term Memory classifier for emotion monitoring.



Left Top: Emotional Stimuli

Left Bottom: Experimental Process

Right: Deep Learning Model for Emotion Detection

Prototype

EmoSense: A Three-Layer Mechanism for Emotion Tracking

To meet users' requirements and enable real-time emotion monitoring (see pages 13–14), we proposed a three-layer **EmoSense** framework designed to enhance user trust while supporting personalisation and customisation across diverse scenarios.

Layer 1:

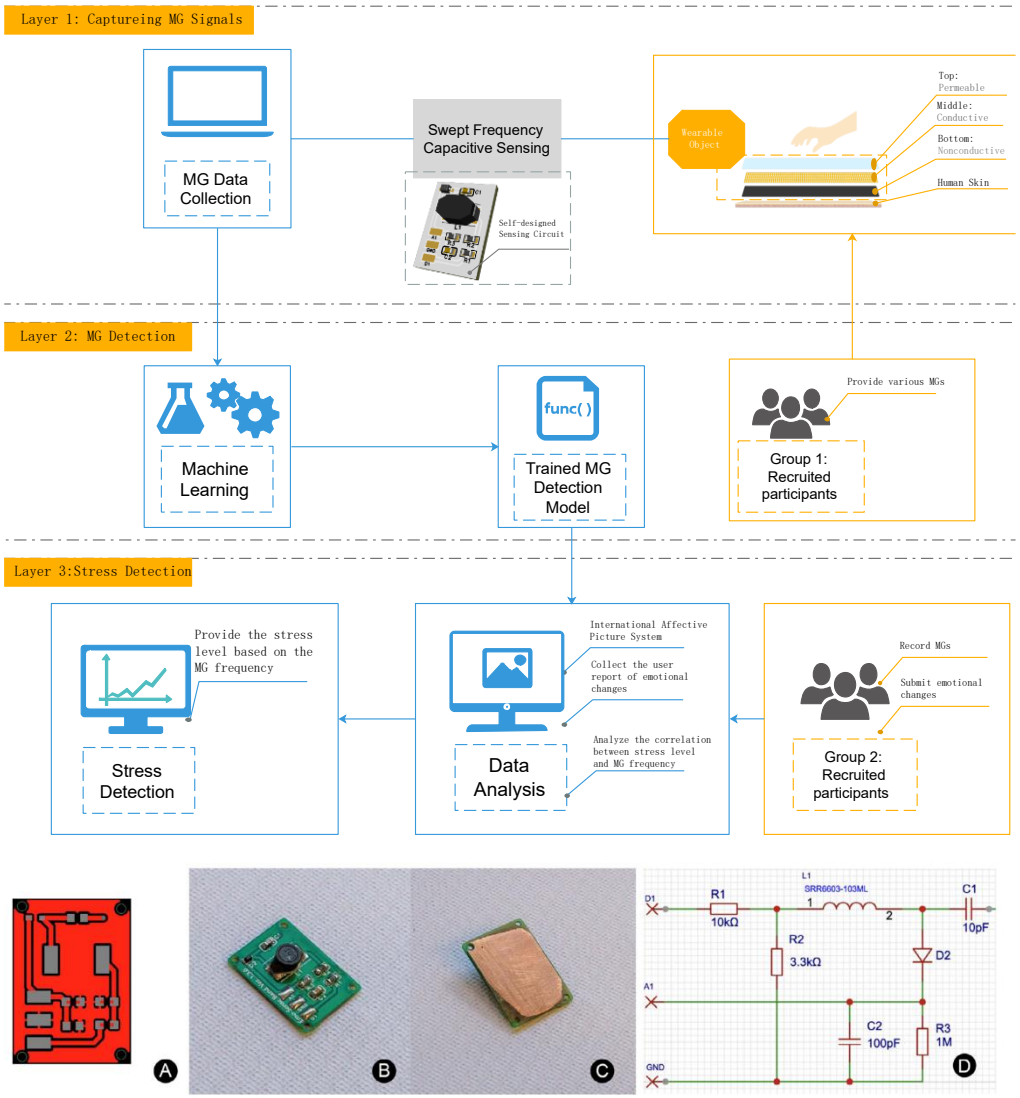
The Swept Frequency Capacitive Sensing sensor (Sato et al., 2012) was integrated into the wearable device for MG data collection.

Layer 2:

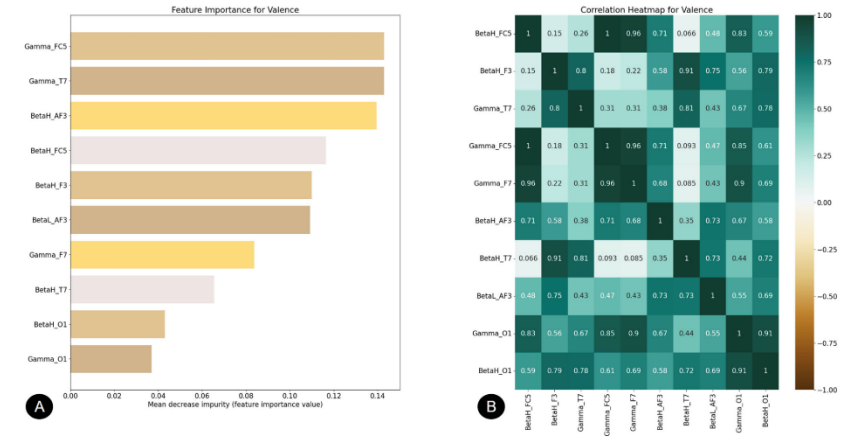
Data from 4 user study participants was collected to train an RF model. The model demonstrated a 96.81% accuracy rate in detecting four MGs (tap, pinch, press and grab) and a 'no touch' state.

Layer 3:

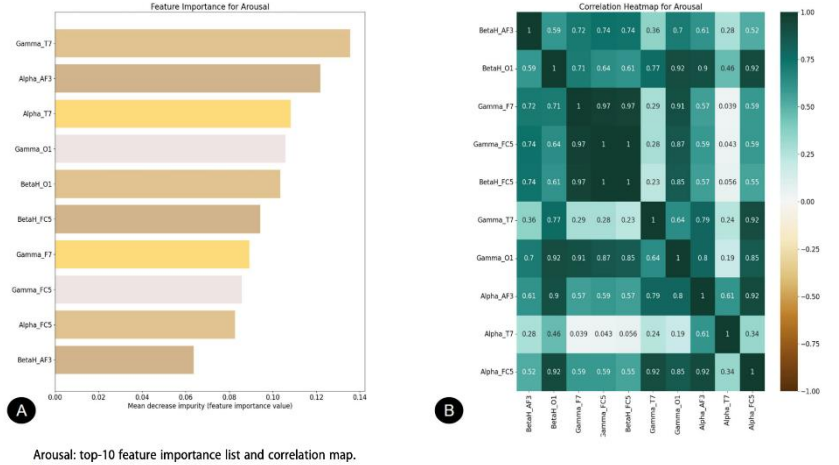
MG data and user emotional reports were collected through user studies (N = 16). Further data analysis served to illustrate the correlation between MG features and emotional levels.



Research Outcomes, Findings & Further Research

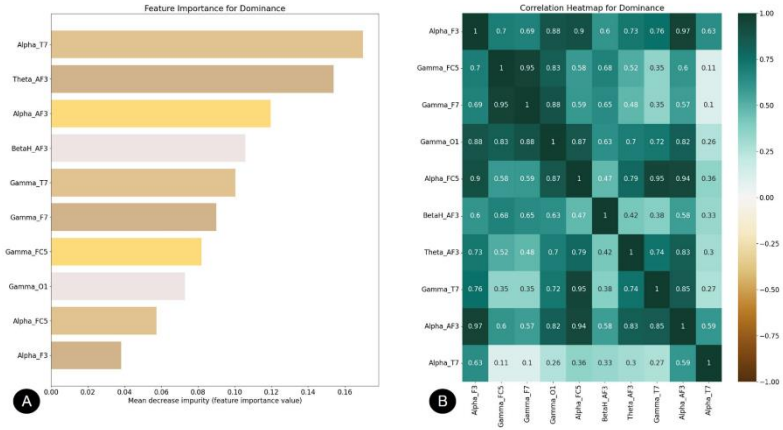


Valence: top-10 feature importance list and correlation map.



Arousal: top-10 feature importance list and correlation map.

By collecting both **EEG and MG** data, we demonstrated the importance of these values for emotion detection in the **VAD emotional Space**.



Dominance: top-10 feature importance list and correlation map.

		Valence		Arousal		Dominance	
Model	Feature	Accuracy (%)	F1-score (%)	Accuracy (%)	F1-score (%)	Accuracy (%)	F1-score (%)
DGCNN	EEG	79.1	**73.4**	67.6	62.3	66.7	64.6
RGNN	EEG	**80.0**	71.1	69.5	68.7	71.4	**70.3**
TSception	EEG	78.1	71.4	70.5	63.2	64.8	61.1
Emo-MG	EEG	77.4	72.7	**71.0**	**68.8**	**73.4**	65.3
Emo-MG	EEG + MG	**83.1**	**80.6**	**81.1**	**70.6**	**79.2**	**71.0**

To verify the significance of multimodality, we compared Emo-MG with deep learning methods for emotion detection and summarised the accuracy and F1-score results. Our model, **Emo-MG,** showed outstanding or comparable performances by comparing with other models through the VAD space.

Research Outcomes, Findings & Further Research

We summarise the **main outcomes** from the following perspectives:

Users' Requirements Toward Emotion Recognition: Building on the literature review, we conducted user studies to gain a deeper understanding of users' perceptions of emotion monitoring techniques and their use scenarios. The studies provided valuable insights to inform more user-centred technological developments.

Advanced Multimodal Emotion Recognition: To address emotion monitoring in real-world scenarios, *EmoSense* technology was developed. This touch-based capacitive sensing system leverages AI to detect emotional states and provide real-time emotional support. **EmoSense** integrates with various prototypes, including emotion-aware wristbands, a smart steering wheel and a modular toolkit for companion robots—each offering distinct interaction possibilities.

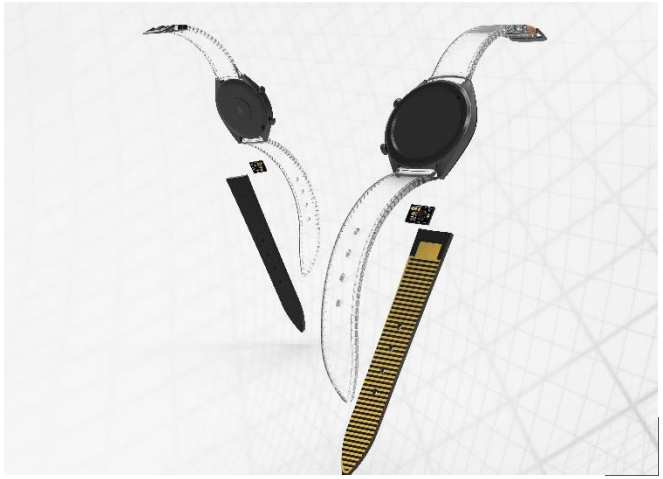
For **further research**, multimodal emotion monitoring can be integrated into various applications, such as emotion-aware driving. Additionally, ethical concerns should be thoroughly examined and addressed.

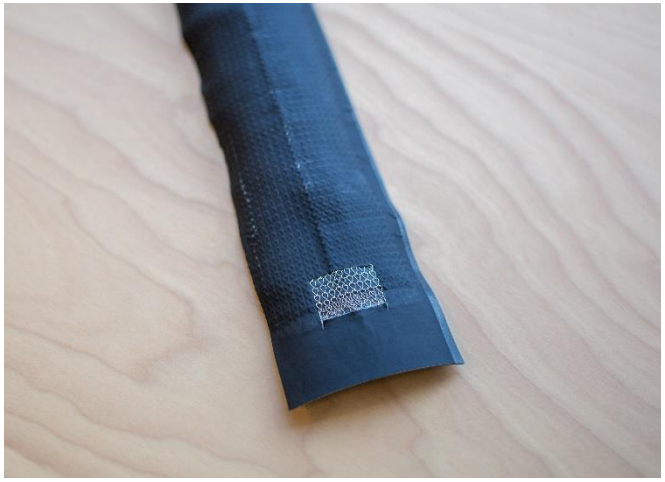
Real-World Scenarios of Emotion Monitoring Systems: Extensive user studies were conducted to evaluate the functionality and usability of the prototypes in real-world applications, such as emotion-aware driving scenarios. These studies also explored additional application contexts and offered insights into the effectiveness of the developed systems in supporting emotional well-being.

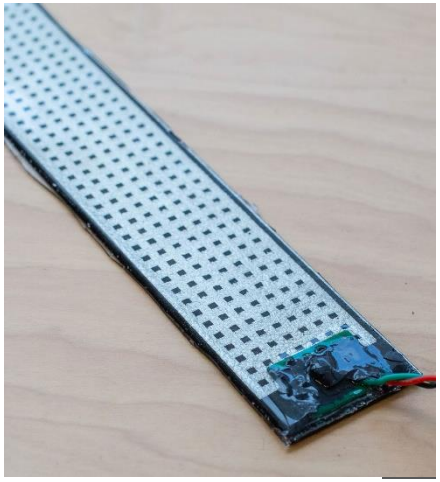
Ethical Concerns: Ethical and privacy concerns will be thoroughly examined and addressed to ensure the responsible development and deployment of this technology in future emotion-related research. This includes prioritising user consent and data transparency to enhance privacy protection and foster trust.

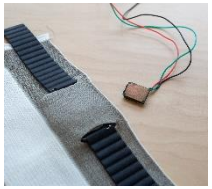
Application Developments:

- Customizing Wristbands for Emotional Support









A. Technical Integration of the **EmoSense** sensor into Smart Watches

B. **Top:** TPU (thickness 0.15 mm), **Middle:** Liquid Metal-Printed Circuit, and **Bottom:** Leather + TPU (thickness 0.15 mm)

C. **Top:** TPU (thickness 0.15 mm), **Middle:** Metal Conductive Mesh, and **Bottom:** TPU (thickness 0.5 mm)

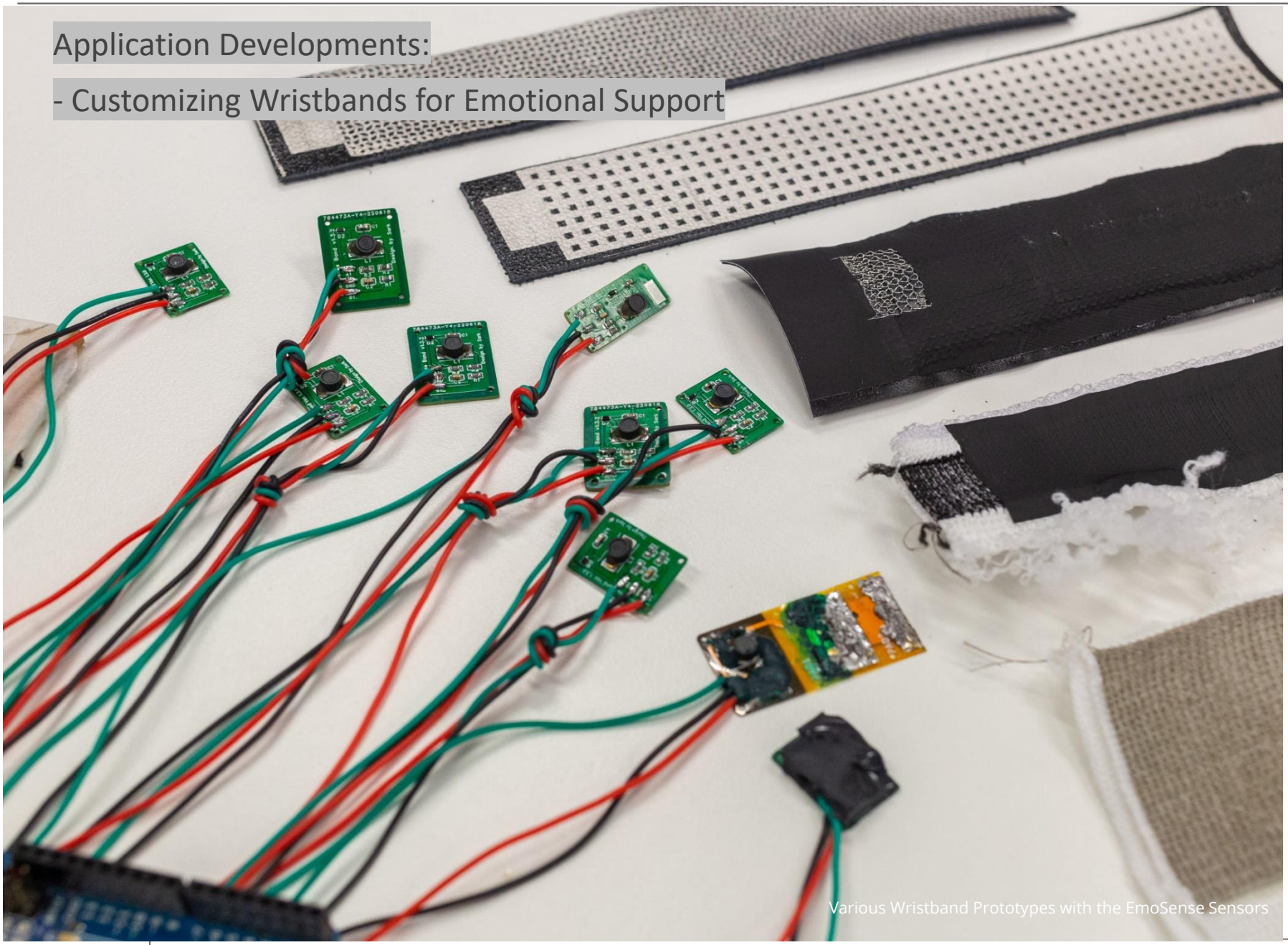
D. **Top:** TPU (thickness 0.15 mm), **Middle:** Flexible Printed Circuit, and **Bottom:** Fluoro Rubber Strap

E. Double-Layer Knitted Wristband (front: conductive, back: nonconductive)

F. Illustration of Wearing the Wristband

Application Developments:

- Customizing Wristbands for Emotional Support



Various Wristband Prototypes with the EmoSense Sensors

Application Developments:

- EmoFriends: Interactive Emotional Support Toy

Modular and Transparent design

- ***Modular Design:*** **EmoFriends** features three modules, including stress tracking, emotion-aware chatting and haptic stimulation.
- ***User Trust through Transparency:*** The system offers clear visibility into AI and sensor interactions, fostering user trust.

Emotional Support AI Technology

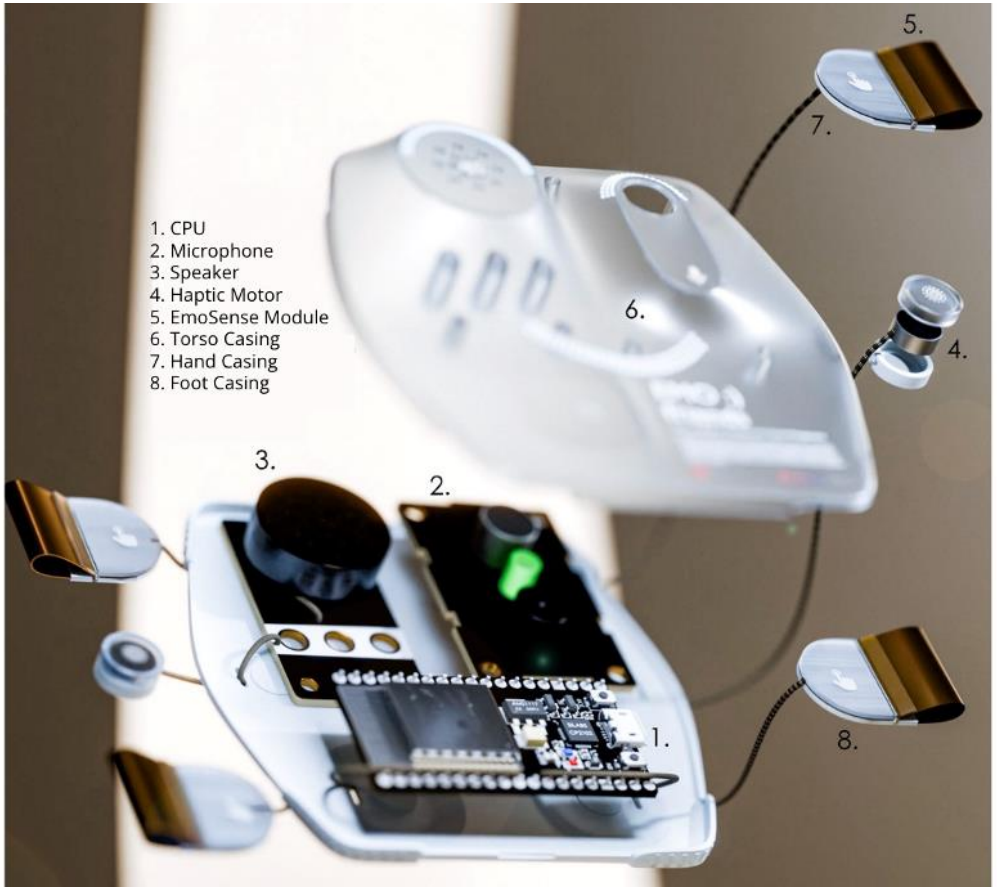
- ***Advanced Stress Tracking:*** Monitors stress through MGs and offers real-time feedback.
- ***Empathetic Emotion-Aware Chatting:*** The AI engages empathetically, recognising emotions to help reduce stress.
- ***Contextual Adaptation:*** Provide tailored support based on stress levels and environment.

Plushie Integration

- ***Comforting Design:*** The plush toy offers a soothing tactile experience and responds to touch and pressure.

Customisation and Accessibility

- ***Personalised Interaction:*** Users can customise limb movements, and the plushie's actions reflect their emotional state for greater engagement.



Video Link:

https://youtu.be/1STwz_gooug

Applied User Studies

- Emotional Experiment and Data Collection by Simulating Driving Scenarios

To design more effective emotion-monitoring systems for real-world applications, we plan to conduct experiments exploring how emotional states influence driving experiences.

Procedures:

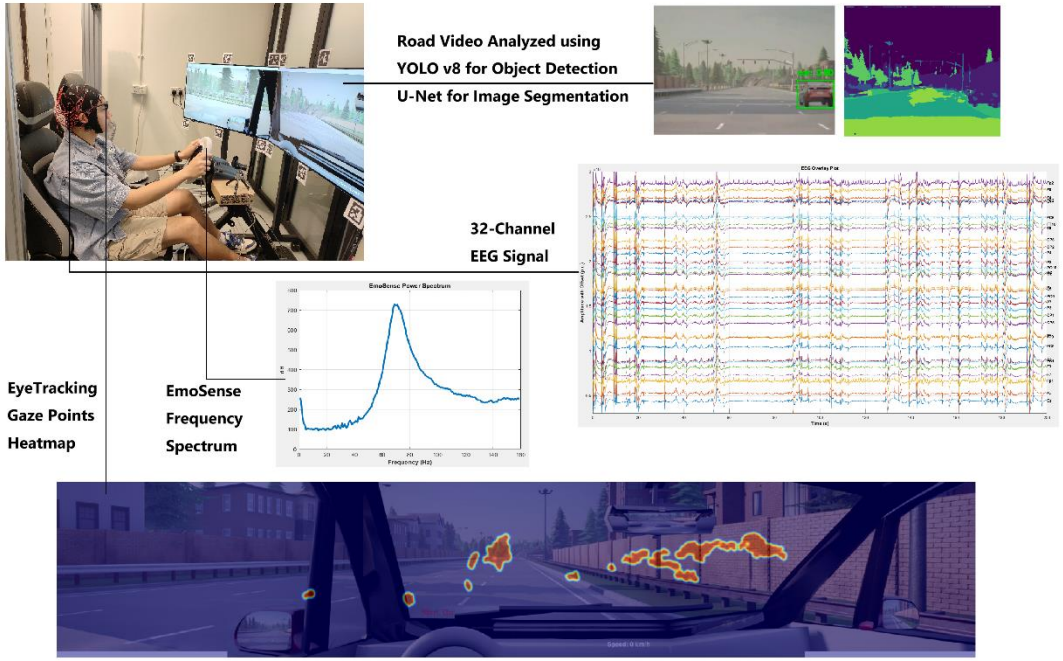
Data will be collected from participants using a driving simulator and sensory devices. The resulting dataset comprises **six types** of data:

1) **Facial expressions** are captured using a Logitech camera near the steering wheel.

2) **Car dynamics**, including speed, steering, throttle and brake inputs, are recorded.

3) **Road video** is collected to emulate a dashcam.

4) Physiological and psychological signals are measured, including 32-channel **EEG signals** (EMOTIV Flex Gel), **eye-tracking data** (Pupil Labs) and **EmoSense sensor data** (touch data) installed on the steering wheel.



Left Top: Experimental Setup

Left Middle: EmoSense Frequency Spectrum

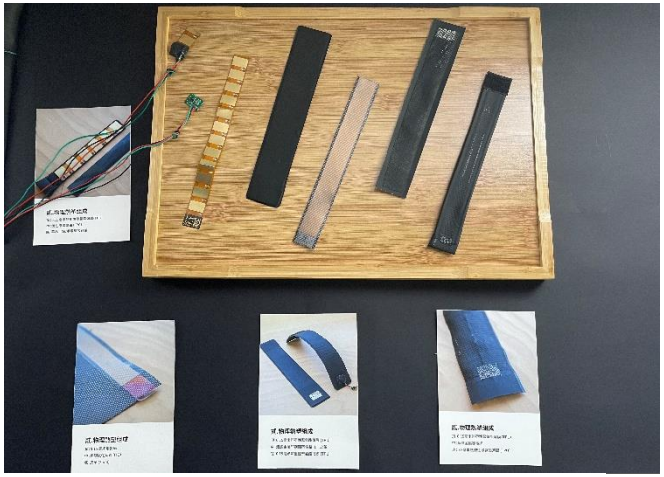
Right Top: Collected Road Videos for Image Segmentation

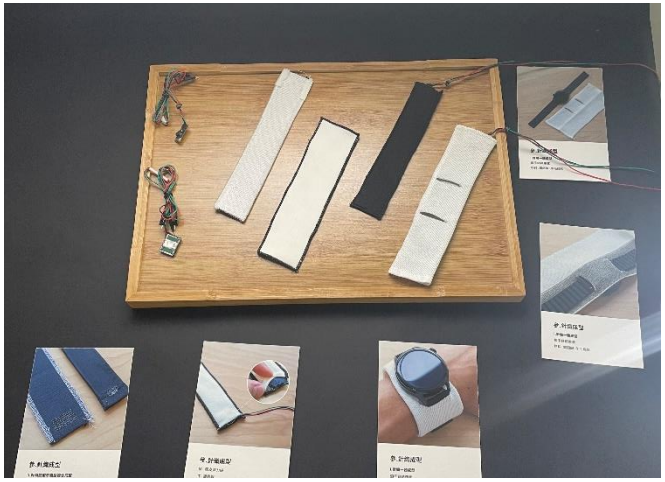
Right Middle: Real-Time 32-Channel EEG Signals

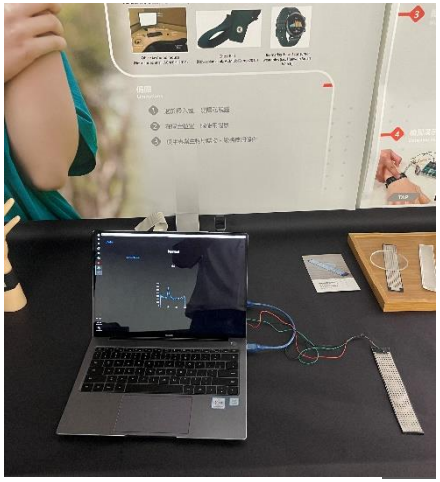
Bottom: Gaze Points Heatmap Based on the Eye Tracking

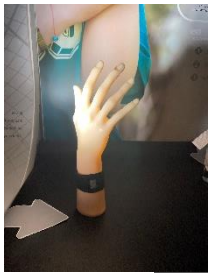
Research Dissemination:

PolyU-Huawei Exhibition, Shenzhen, China









POLYU DES*GN

HUAWEI

The PolyU-Huawei exhibition showcased the most recent touch-based emotion tracking strategy—***EmoSense*** sensor, various wristband prototypes and the user interface.

In addition to dissemination, the exhibition was used as part of a research method for data collection, gathering user evaluation (quantitative) and feedback (qualitative).

Video link:

https://ira.lib.polyu.edu.hk/video.jsp?id=115349a

Research Dissemination:

2024 Global Research in Design Innovation Exhibition, HKSAR, China

FUTURE (CARING) MOBILITY 未来（關愛）移動研究中心

清華大學未来实验室 The Future Laboratory, Tsinghua University

EmoSphere:

The emotion ball contains a piezoelectric ceramic sensor, an LED light strip and an Arduino controller. The sensor detects touch pressure, which the Arduino controller then translates into a corresponding color displayed on the LED light strip.

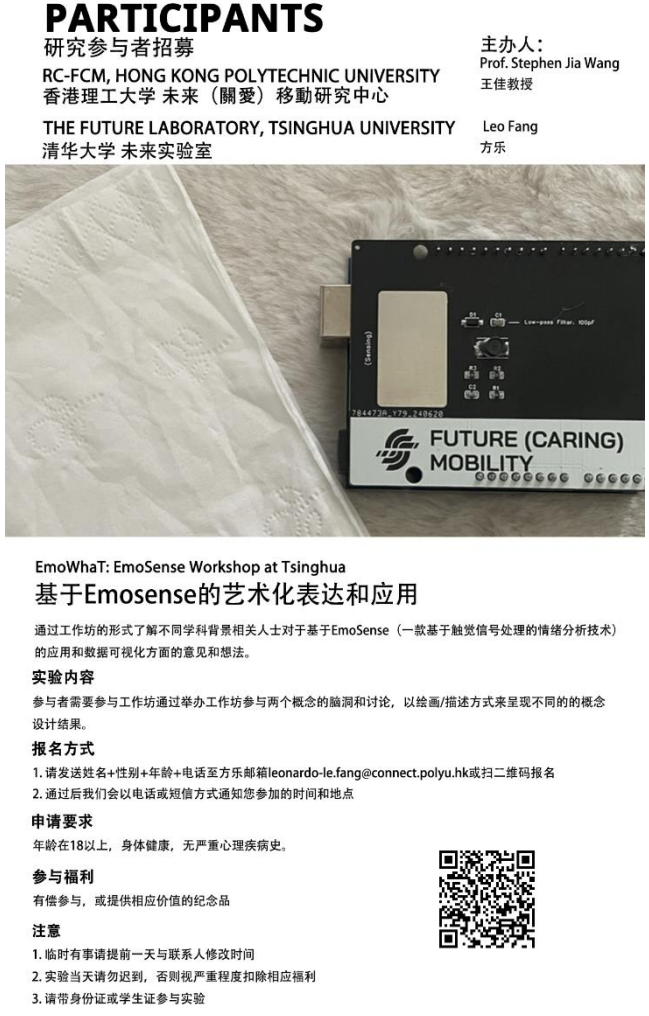
In addition to dissemination, the exhibition was used as part of a research method for data collection, gathering user evaluation (quantitative) and feedback (qualitative).

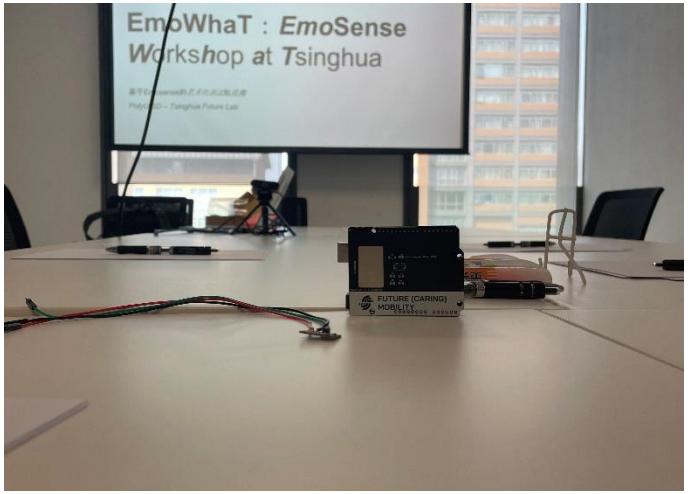
Video link:

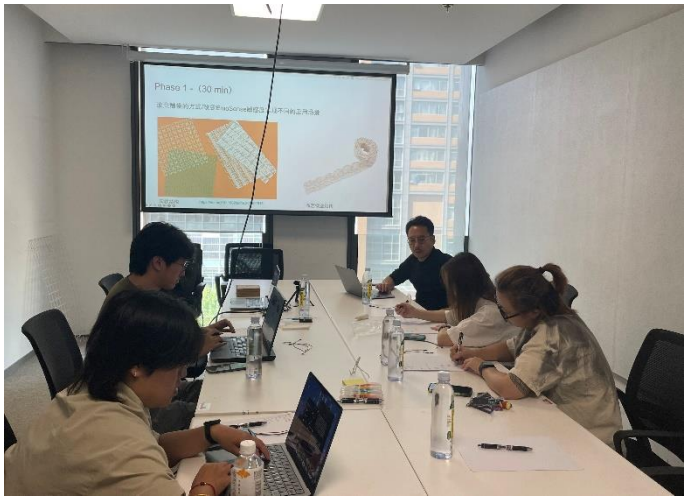
https://ira.lib.polyu.edu.hk/video.jsp?id=115349b

Research Dissemination:

PolyU-Tsinghua *EmoWhat* Workshop, Beijing, China







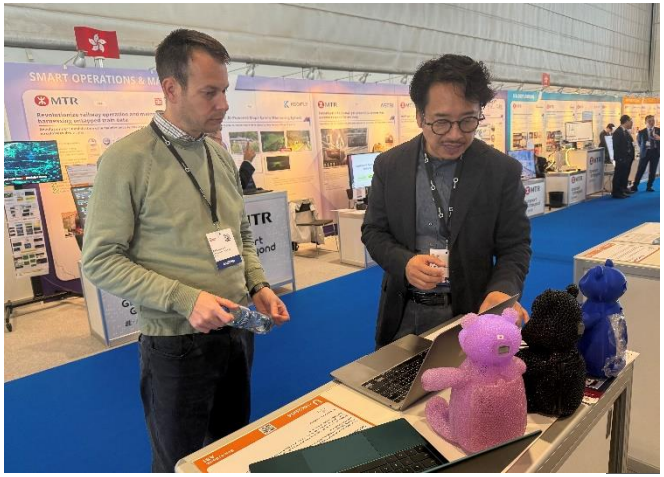
FUTURE (CARING) MOBILITY 未来（關愛）移動研究中心
清華大學未来实验室 The Future Laboratory, Tsinghua University

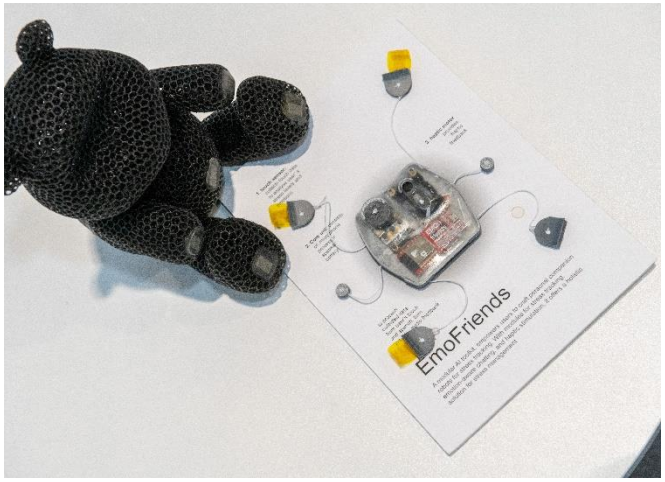
The PolyU-Tsinghua *EmoWhat* Workshop was organised to introduce **EmoSense** technology and gather insights on its potential applications from both practical and artistic perspectives.

In addition to dissemination, the exhibition was used as part of a research method for data collection, gathering user evaluation (quantitative) and feedback (qualitative).

Research Dissemination:

50th International Exhibition of Inventions of Geneva





FUTURE (CARING) MOBILITY 未來（關愛）移動研究中心

INDUSTRIAL CENTRE
工業中心

At the 50th International Exhibition of Inventions of Geneva, Prof. Wang unveiled the **EmoFriends** prototype, powered by **EmoSense** technology, which drew significant attention and attracted numerous participants eager to engage with its interactive experiences. The project won the Silver Award at the exhibition.

In addition to dissemination, the exhibition was used as part of a research method for data collection, gathering user evaluation (quantitative) and feedback (qualitative).

Dissemination and Distribution of Outcomes (Theoretical)

Publications (6 accepted and 3 under review)

Year	Publication
2022	Zhu, Y., Lee, K., Zhang, L., & Wang, S. J. (2022). Meaningful smart health data: A design guide for transparent data to enhance self-reflection. In Proceedings of the 8th International Conference on Human Interaction and Emerging Technologies (pp. 22-24). https://doi.org/10.54941/ahfe1002748
2023	Fang, L., Xing, S. P., Long, Y., Lee, . P., and Wang, S. J. (2023). EmoSense: Revealing true emotions through microgestures. Advanced Intelligent Systems, 5(9), 2300050. https://doi.org/10.1002/aisy.202300050
2024	Fang, L., Xing, S. P., Ma, Z., Zhang, Z., Long, Y., Lee, K. P., & Wang, S. J. (2023). Emo-MG framework: LSTM-based multi-modal emotion detection through electroencephalography signals and micro gestures. International Journal of Human–Computer Interaction, 40(18), 5056-5072. https://doi.org/10.1080/10447318.2023.2228983 Long, Y., Luo, X., Zhu, Y., Lee, K. P., & Wang, S. J. (2024). Data transparency design in internet of things: A systematic review. International Journal of Human–Computer Interaction, 40(18), 5003-5025. https://doi.org/10.1080/10447318.2023.2228997
2025	Chen, X., Wang, X., Fang, C., Fang, L., Gong, W., Liu, C., & Wang, S. J. (2025). Emotion-aware design in automobiles: Adaptation of AI to enhance human-vehicle interaction. In Proceedings of CHI Conference on Human Factors in Computing Systems. https://doi.org/10.1145/3706598.3713571 Fang, L., Chai, B., Xu, Y., and Wang, S. J. (2025). KANFeel: A novel Kolmogorov-Arnold network-based multimodal emotion recognition framework. In CHI EA '25: Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems, pp. 1-8. https://doi.org/10.1145/3706599.3720217 Xing, S. P., Hu, H., Fang, L., Bai, Z., Jiang, K. S., and Wang, S. J. (2025). Crafting knitted wristbands: A collaborative and interdisciplinary design journey. (Under Review) Fang, L., Li, J., Fang, C., Chen, X., Zhu. Y., Xu, Y., and Wang, S. J. (2025). Beyond accuracy: Designing user-centred privacy in speech emotion recognition. (Under Review) Fang, L., Zhu, Y., Li J., Fang C., Xu Y., and Wang, S. J. (2025). User perspectives on AI-supported emotion monitoring and regulation: A focus group study in non-clinical contexts. International Journal of Human-Computer Interaction. (Under Review)

Dissemination and Distribution of Outcomes (Applied)

4 awards, 3 patents, 3 exhibitions, 2 news report and 1 workshop

Year	Exhibition/Workshop, News, Award and Patent
2022	**[Exhibition]** Huawei-PolyU UCD Sleep, Emotion & Body-weight UX Innovation Exhibition, Shenzhen, China (Supporting Video Material: https://ira.lib.polyu.edu.hk/video.jsp?id=115349a)
	[Patent] Stephen Jia Wang, Le Fang, Pangrui Xing. Psychological Stress Level Detection Method, Apparatus and System, HK30085572, April 28, 2023.
2023	**[Patent]** Stephen Jia Wang, Le Fang, Pangrui Xing. 心理压力水平检测方法、装置及系统, CN116343998A, June 27, 2023.
	[News] Scientists test the link between tiny subconscious gestures and stress.
	https://www.advancedsciencenews.com/scientists-test-the-link-between-tiny-subconscious-gestures-and-stress/
2024	**[Workshop]** Tsinghua-PolyU EmoWhaT: EmoSense Workshop at Tsinghua, Beijing, China (Supporting Video Material: https://ira.lib.polyu.edu.hk/video.jsp?id=115349b)
	[Exhibition] 2024 Global Research in Design Innovation Exhibition, School of Design, PolyU, HKSAR, China
	[Patent] Stephen Jia Wang, Le Fang, Pangrui Xing. Psychological Stress Level Detection Method, Apparatus and System, Application Number PCT/CN2024/086005, April 3, 2024.
2025	**[Award]** Gold Award: EmoFriends, Trusted AI & Data Science (Open Group), HK Techathon+ 2025
	[Award] EmoFriends, iF Design Award 2025 (Supporting Video Material: https://youtu.be/1STwz_gooug)
	[Award] EmoFriends, Global Design Award 2025
	[News] PolyU emerges as one of the institutions with the Highest Number of Gold Awards at HK Techathon+ 2025! https://www.linkedin.com/posts/polyukteo_polyu-polyimpact-kteo-activity-7287370282116268034-kseS
	[Exhibition and Award] Silver Award, 50th International Exhibition of Inventions of Geneva, Geneva, Switzerland

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11) Xue, J., Wang, J., Liu, X., Zhang, Q., & Wu, X. (2024). Affective video content analysis: Decade review and new perspectives. Big Data Mining and Analytics, 8(1), 118-144. https://doi.org/10.26599/BDMA.2024.9020048