Empathic Computing Lab
Systems That Create Understanding

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NEW ZEALAND

EMiRAs-Empathic Mixed Reality Agents

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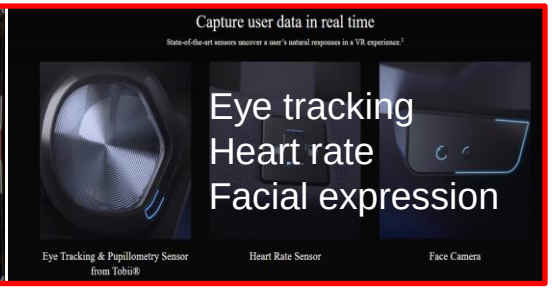
- I am **Zhuang Chang**, a PhD student from the Empathic Computing Lab, University of Auckland.
- My current PhD research topic is **Empathic Mixed Reality Agents**.
- I received a master’s degree in engineering from the Northwestern Polytechnical University, China in 2018.

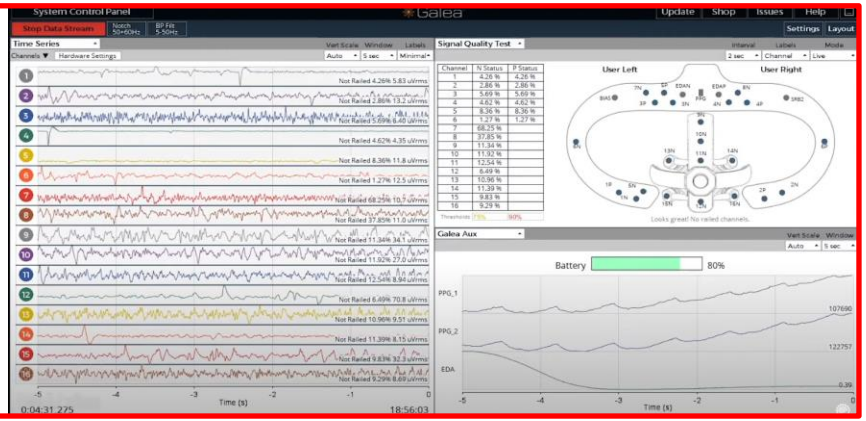
Empathic Mixed Reality

[1] **Mixed Reality systems that create deeper understanding and empathy between human users**

- Understanding
- Experiencing
- Sharing

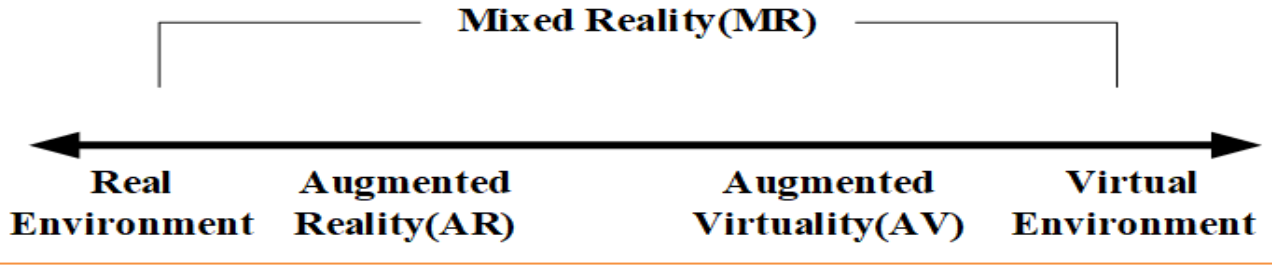


[2]



[1] https://medium.com/super-ventures-blog/the-coming-age-of-empathic-computing-617caefc7016
[2] https://galea.co/#home

Mixed Reality Agent



[1]

[2]

[1] Milgram P, Kishino F. A taxonomy of mixed reality visual displays[J]. IEICE TRANSACTIONS on Information and Systems, 1994, 77(12): 1321-1329.
[2] Holz T, Dragone M, O'Hare G M P. Where robots and virtual agents meet[J]. International Journal of Social Robotics, 2009, 1(1): 83-93.

Empathic Mixed Reality Agent (EMiRA)

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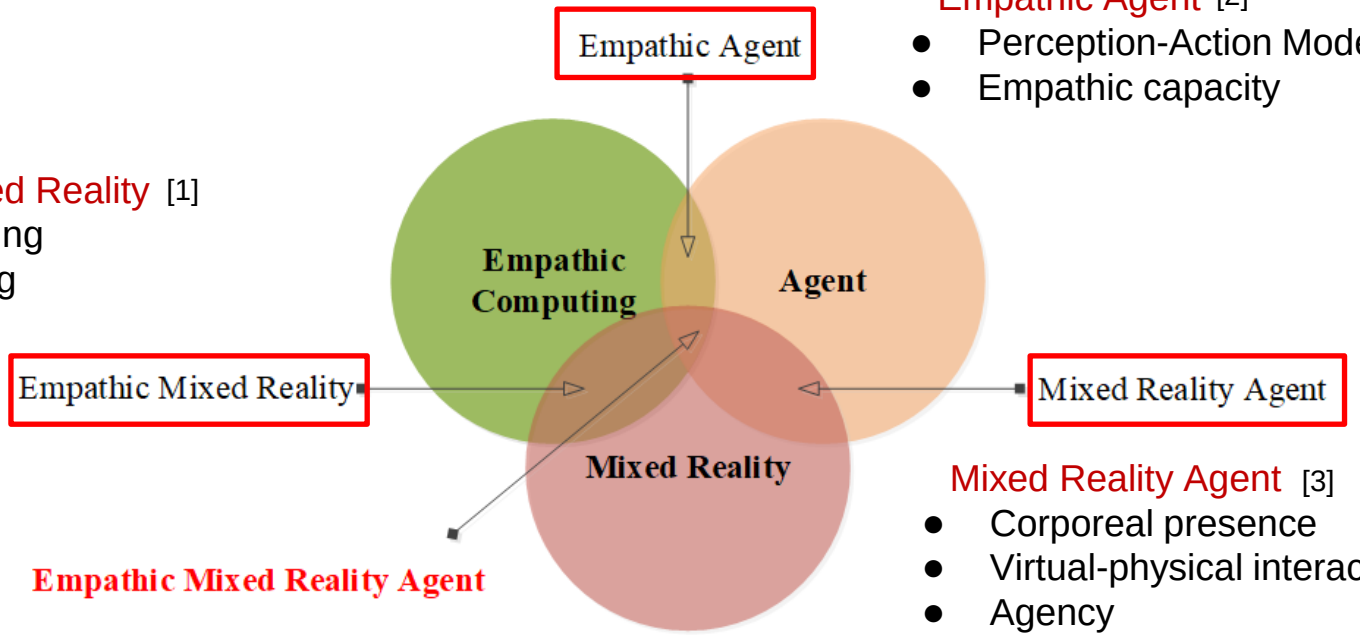
Empathic Mixed Reality [1]

- Understanding
- Experiencing
- Sharing



Empathic Agent [2]

- Perception-Action Model
- Empathic capacity

Mixed Reality Agent [3]

- Corporeal presence
- Virtual-physical interaction
- Agency

[1] Piumsomboon, T., Lee, Y., Lee, G. A., Dey, A., & Billinghurst, M. (2017, June). Empathic mixed reality: Sharing what you feel and interacting with what you see. In 2017 International Symposium on Ubiquitous Virtual Reality (ISUVR) (pp. 38-41). IEEE.
[2] Paiva, A., Leite, I., Boukricha, H., & Wachsmuth, I. (2017). Empathy in virtual agents and robots: A survey. ACM Transactions on Interactive Intelligent Systems (TiiS), 7(3), 1-40.
[3] Holz, T., Campbell, A. G., O'Hare, G. M., Stafford, J. W., Martin, A., & Dragone, M. (2011). Mira—mixed reality agents. International journal of human-computer studies, 69(4), 251-268.

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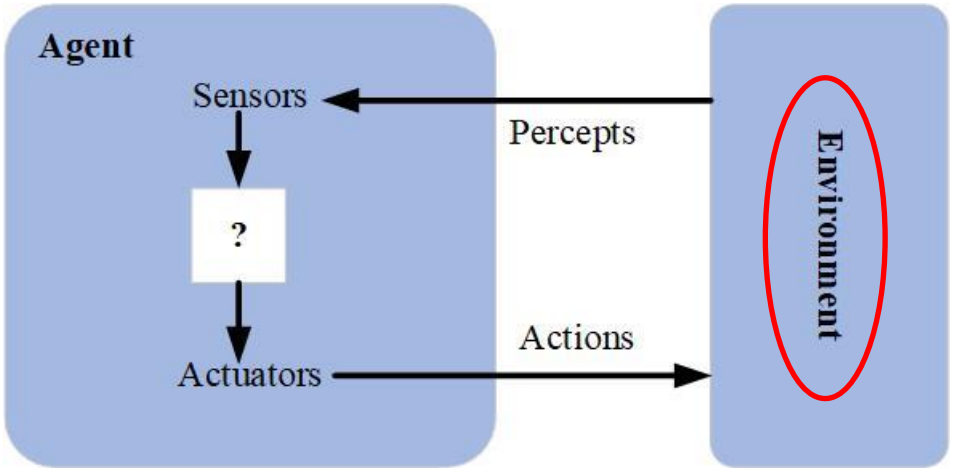
What is the state-of-the-art on EMiRAs?

Empathic Mixed Reality Agent

- **Perception-Action Model**

[1]



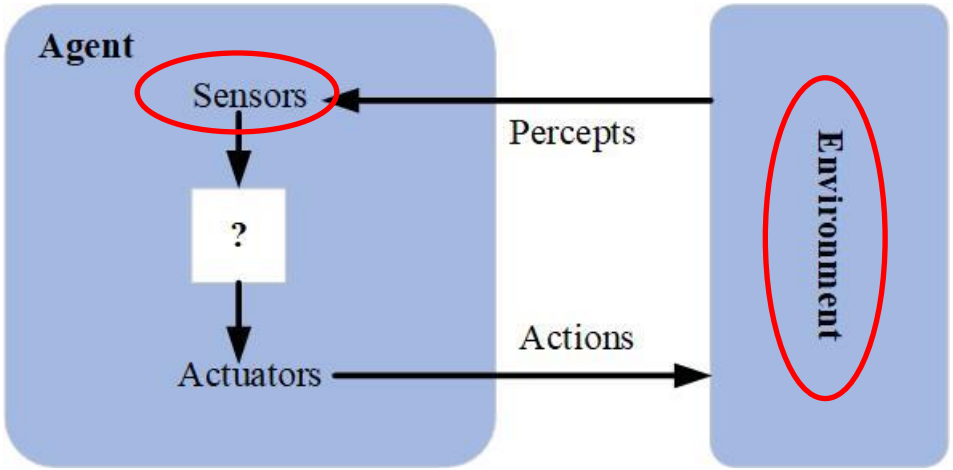
-Virtual environment
-Physical environment
- Non-human objects
- Human/User

[1] Russell, S. J. (2010). *Artificial intelligence a modern approach*. Pearson Education, Inc..

Sensing Physical Environment

- **Physical-virtual Interaction**

[1]



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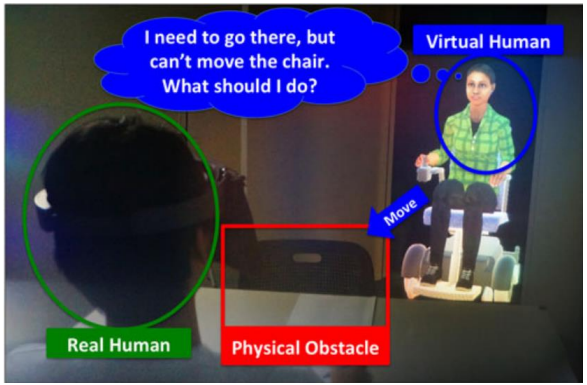
[1] Russell, S. J. (2010). *Artificial intelligence a modern approach*. Pearson Education, Inc..

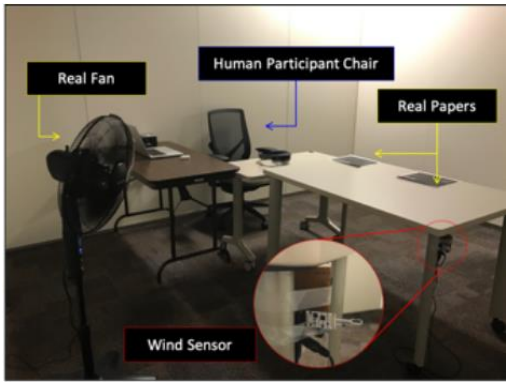
Sensing Physical Environment

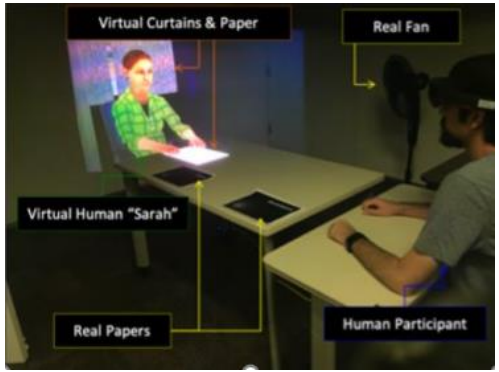
- **IoT sensor-based perception on the physical environment**

[1]



[2]



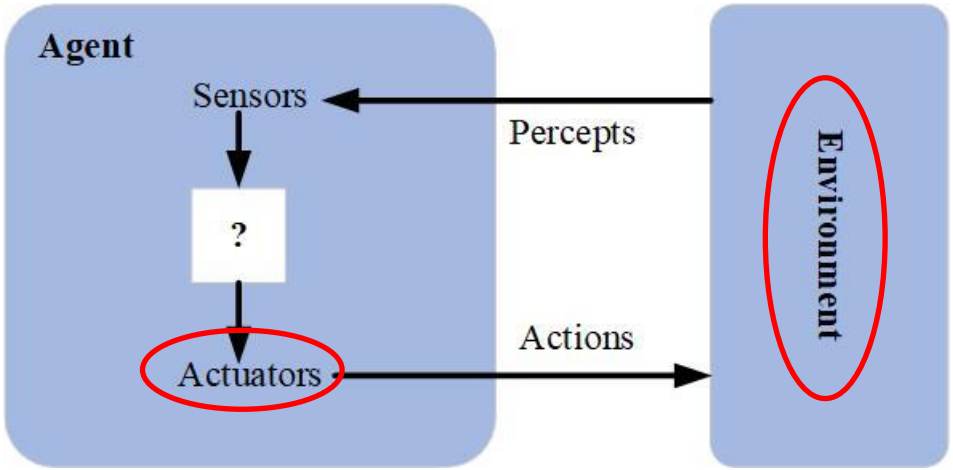


[1] Kim, K., Maloney, D., Bruder, G., Bailenson, J. N., & Welch, G. F. (2017). The effects of virtual human's spatial and behavioral coherence with physical objects on social presence in AR. Computer Animation and Virtual Worlds, 28(3-4), e1771.
[2] Kim, K., Schubert, R., Hochreiter, J., Bruder, G., & Welch, G. (2019). Blowing in the wind: Increasing social presence with a virtual human via environmental airflow interaction in mixed reality. Computers & Graphics, 83, 23-32.

Acting on Physical Environment

- **Physical-virtual Interaction**

[1]



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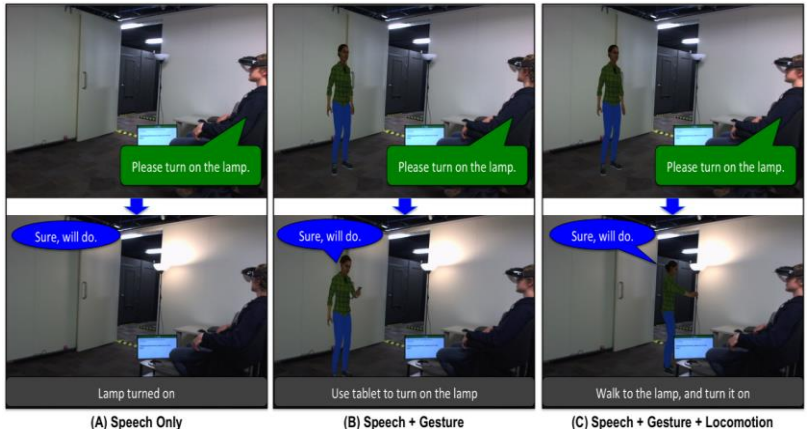
[1] Russell, S. J. (2010). *Artificial intelligence a modern approach*. Pearson Education, Inc..

Acting on Physical Environment

- **IoT sensor-based actuation in the physical environment**

[1]



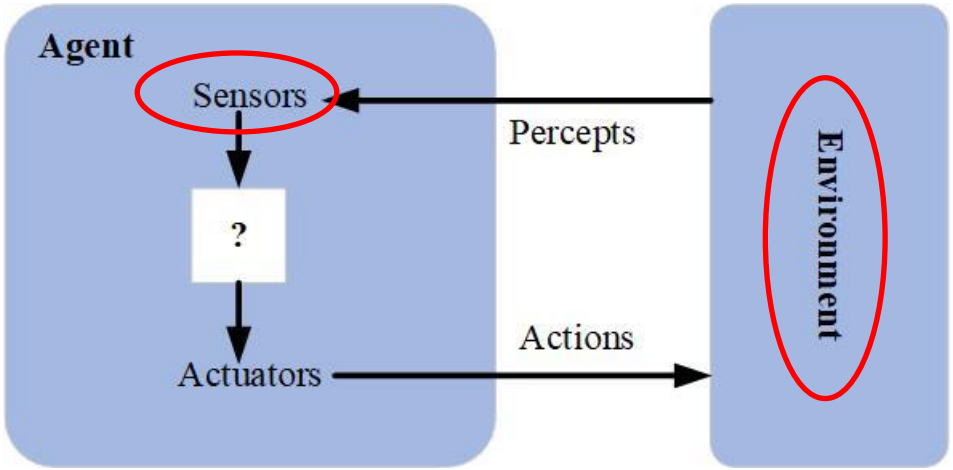
[2]

[1] Kim, K., Boelling, L., Haesler, S., Bailenson, J., Bruder, G., & Welch, G. F. (2018, October). Does a digital assistant need a body? The influence of visual embodiment and social behavior on the perception of intelligent virtual agents in AR. In *2018 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)* (pp. 105-114). IEEE.
[2] Schmidt, S., Ariza, O., & Steinicke, F. (2020). Intelligent blended agents: Reality–virtuality interaction with artificially intelligent embodied virtual humans. Multimodal Technologies and Interaction, 4(4), 85.

Perceiving Human

- **Physical-virtual Interaction**

[1]



-Virtual environment
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[1] Russell, S. J. (2010). *Artificial intelligence a modern approach*. Pearson Education, Inc..

Perceiving Human

- **Physiological sensor-based perception on the human**

[1]

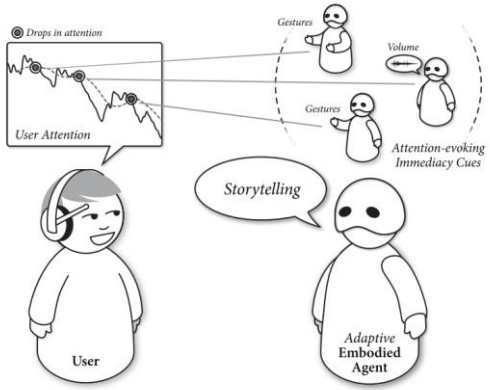


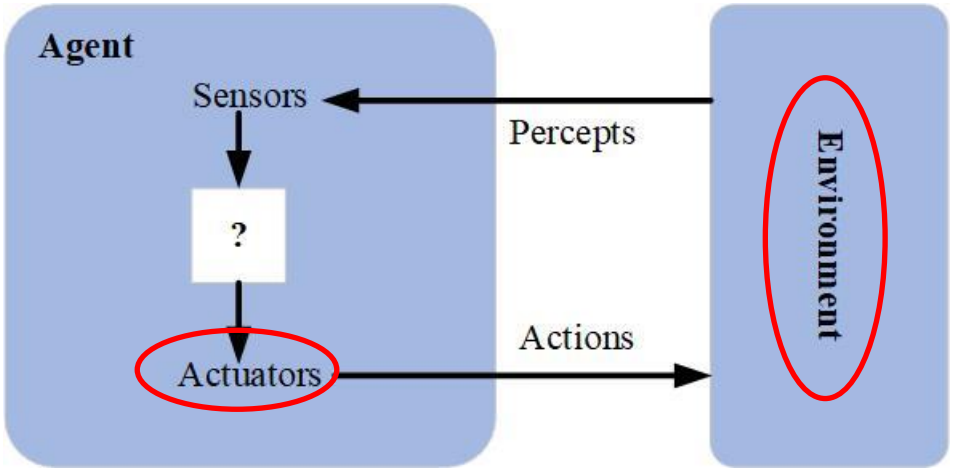
Figure 1. In our study, participants interacted with an embodied agent that monitored their attention using EEG signals in realtime and adapted its behavior to improve the discourse.

[1] Szafir, D., & Mutlu, B. (2012, May). Pay attention! Designing adaptive agents that monitor and improve user engagement. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 11-20).

Acting on Human

- **Physical-virtual Interaction**

[1]



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[1] Russell, S. J. (2010). *Artificial intelligence a modern approach*. Pearson Education, Inc..

Acting on human

- **Tactile sensor-based acting on the human users**

[1]

[2]

[1] Boucaud, F., Tafiani, Q., Pelachaud, C., & Thouvenin, I. (2019, February). Social touch in human-agent interactions in an immersive virtual environment. In 3rd International Conference on Human Computer Interaction Theory and Applications (HUCAPP 2019) (pp. 129-136).
[2] Hoppe, M., Rossmy, B., Neumann, D. P., Streuber, S., Schmidt, A., & Machulla, T. K. (2020, April). A human touch: Social touch increases the perceived human-likeness of agents in virtual reality. In Proceedings of the 2020 CHI conference on human factors in computing systems (pp. 1-11).

A Classification Tool

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Corporeal Presence and Interactive Capacity (CPIC) matrix

	Virtual Environment	**P**hysical Environment		**M**ixed Reality Environment
		Non-human objects	**H**uman	
Virtual Embodiment	-	VPN	VPH	VM
Physical Embodiment	PV	-	-	PM
Mixed Reality Embodiment	MV	MPN	MPH	MM

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Opportunities and Challenges in EMiRAs

Opportunities

- **Enabling EMiRAs to deeper understand humans**
  - Multiple sensors based human understanding
- **Understanding the impact of EMiRAs' multimodal communication cues on human perception**
  - verbal and nonverbal cues
  - Empathic touch
- **Exploring factors that foster empathy in EMiRAs**
  - IoT sensors/actuators based physical-virtual interaction
  - biosensors based perception on users' states
  - Tactile sensors based empathic touch

Challenges

- **Ethical Concerns**
  - Data privacy
  - Safety

- **Evaluating perceived empathy**
  - Lack of effective methods

- **Computing human cognitive and emotional state**
  - Hard to detect human states accurately
  - Poor user experience

Summary

- We defined the concept of Empathic Mixed Reality Agent (EMiRA)
- We provided Corporeal Presence and Interactive Capacity matrix to examine the EMiRA's embodiment and interaction capacities
- We identified research opportunities and challenges on EMiRAs

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Thank you

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