Framework for promoting social interaction and physical activity in elderly people using gamification and fuzzy logic strategy

Juana Isabel Méndez, Pedro Ponce, Omar Mata, and Arturo Molina

School of Engineering and Sciences
Tecnológico de Monterrey, México City

Alan Meier

Lawrence Berkeley National Laboratory UC Berkeley, California, USA

Therese Peffer

Institute for Energy and Environment UC Berkeley, California, USA

Agenda

- Introduction
- Objective
- Current solution
- Proposed solution
- Methodology
  - Proposed Framework
- Results
- Conclusion
- Future work
- References

Introduction

- Population over **65 years** in the **United States** is projected to increase from **18% to 26%** and in the **world** from **9% to 16% by 2050** [1].

- **Elderly people** spend **more time** at their **home** than any other family members [5].
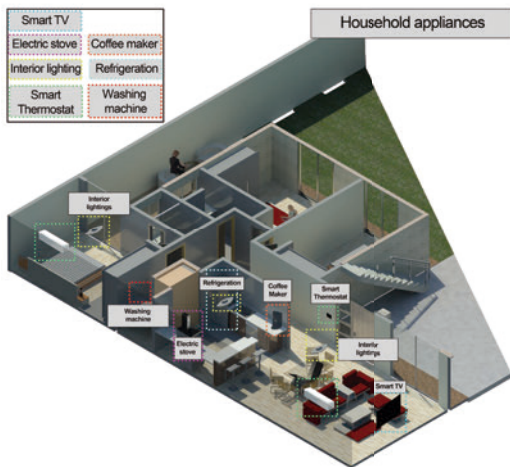
- **Thermostats** are used in **85%** of **residential buildings** in the **United States** [6].

- **New household products** and applications are appearing due to advances in tehcnology

- **e-Health applications: Improve quality of life by** promoting **routine exercises**.

- **Elderly people failed** in adopting **new technologies** due to **lack of technological skills** causing **social isolation** [4].

Introduction

Source: MajorImpact is licensed under CC BY 4.0
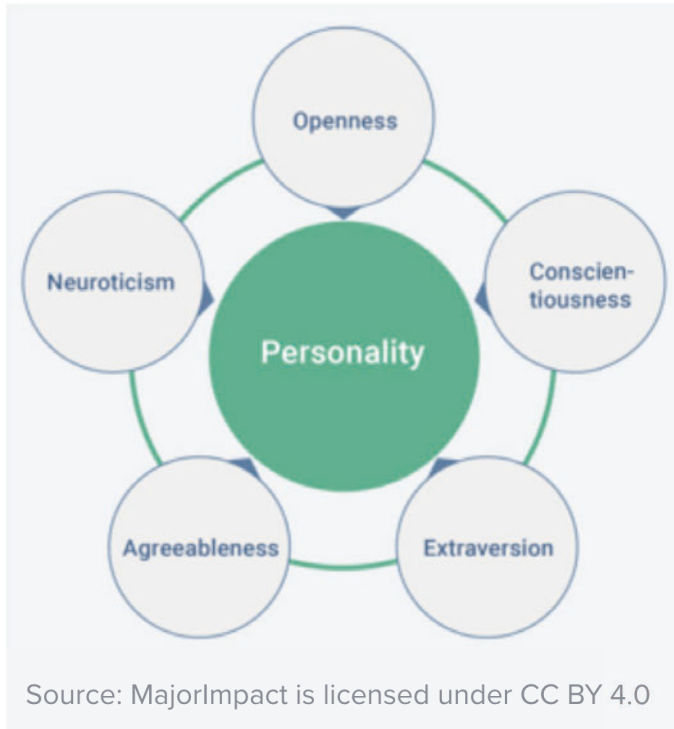
- The **acceptation** of a product relies on **personality traits** [7,8].

- **Gamification** within **a device** may increase **enjoyment** in elderly users [9].

- **Gamification** with **fuzzy logic** has been proved to be **useful** in the **decision-making process**, such as **profiling the type of user** for the personnel selection process [18].

- **Nevertheless**, to the best of our knowledge, applying a **gamification** strategy based **on fuzzy logic** and **the type of personality** to **develop** a **tailored product** has **not been studied previously.**

Personality traits in e-Health applications for elderly users [7,8]

|	
Neuroticism (N)	They are not attracted to learn and try new things.
Agreeableness (A)	They are not attracted to technology; however, some of them are barely attracted to learn new things.
Openness (O)	Can or cannot be attracted to use Internet
Conscientiousness (C)	Attracted to learn and engage in activities, but they require to be convinced on the usefulness of the technology.
Extraversion (E)	They are extremely attracted to learn and try new things. They are a pro-technology user.

Objective

Propose a **strategy** that promotes **regular physical activities** and **social interaction** by considering the **elderly's personality traits**, the use of **gamification** techniques in mobile interfaces and the **connected thermostat**, to **teach, engage,** and **motivate** them to have a **healthier lifestyle**

Current Solution

ENABLE project

Safety and assistive technologies for monitoring and controlling bath, temperature and gas stove.

Silver Promenade

Video game that simulated real-life activities.
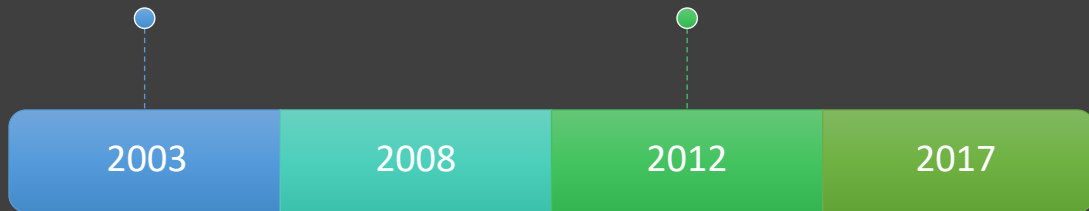
| 2003 | 2008 | 2012 | 2017 |

UbiFit Garden

On-body sensing, activity inference and mobile to promote physical activity.

Spirit50

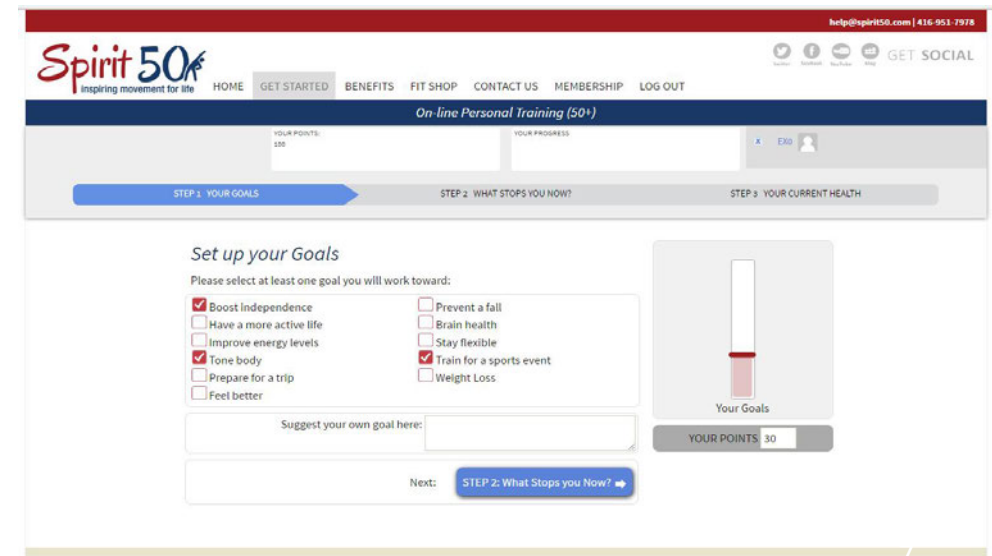Online application for elderly people to promote physical activity.

https://www.consolvo.org/ubifit

http://gamification-research.org/wp-content/uploads/2011/04/12-Gerling.pdf

2017

http://hcigames.com/research/gamification-of-physical-activity-www-spirit50-com/

Proposed Solution

Develop a **framework** that considers **the type of personality** using a **gamification strategy** based on **fuzzy logic** to propose **a tailored Human Machine Interface.**

Methodology

Collection of data from books, journals and proceedings publications:

- The collected data was gathered from surveys, interviews and meta-analysis

- Gamification elements in e-Health applications for the elderly.

- Types of Gamification frameworks.

- Personalities for elderly people regarding their attitude, engagement, and knowledge about using the Internet for health purposes.

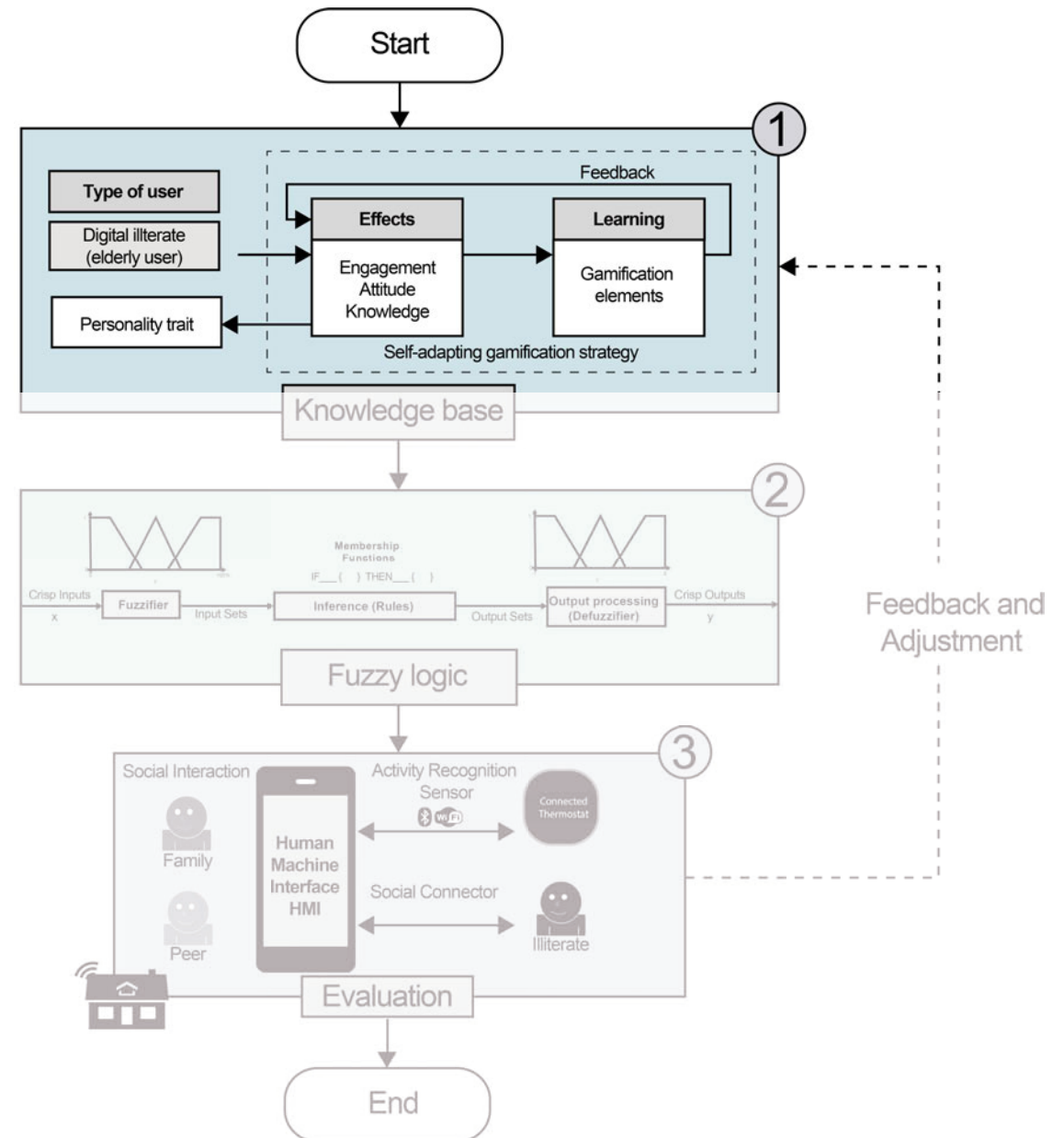- The evaluation and metrics used in those publications to validate the HMI.
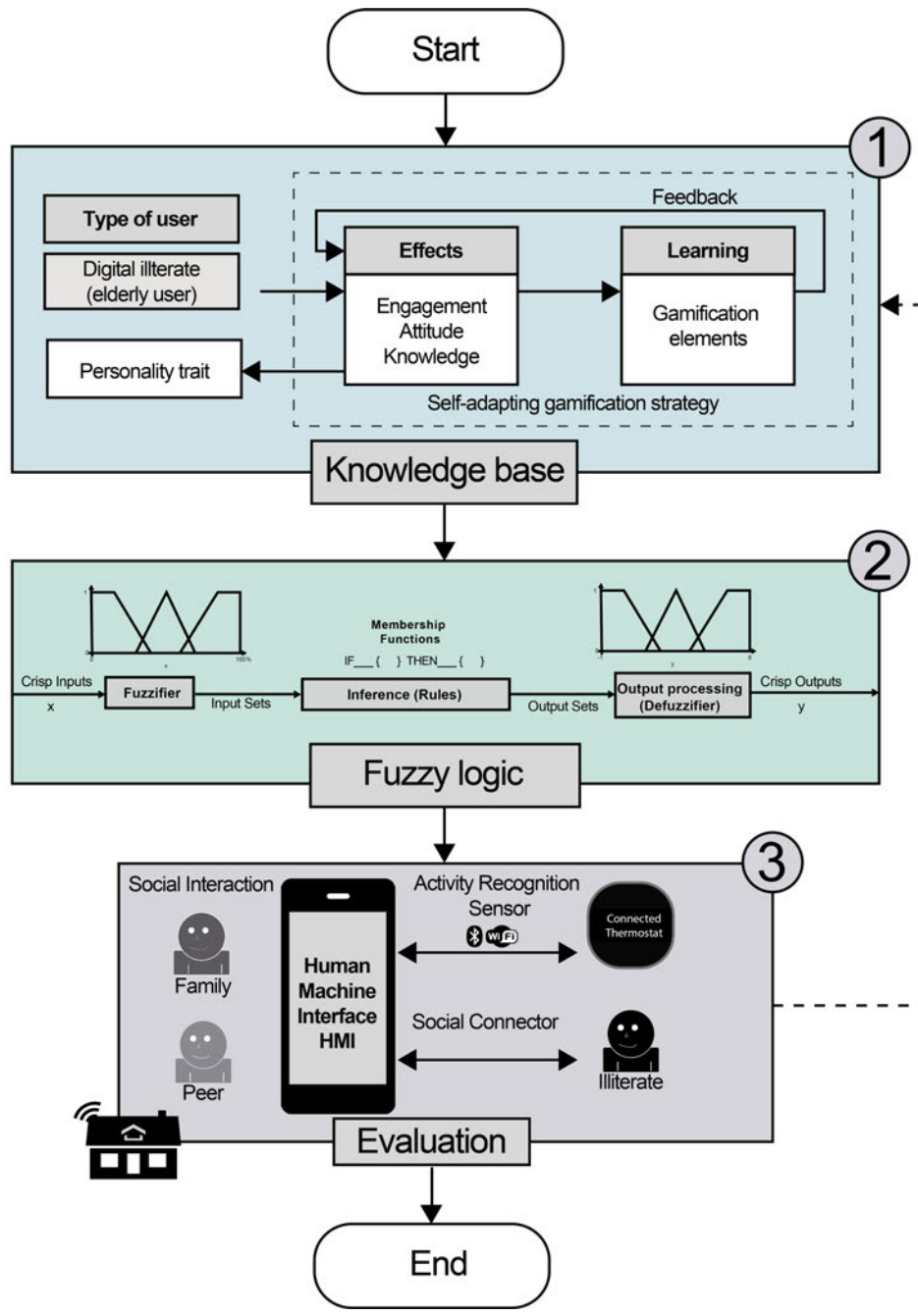
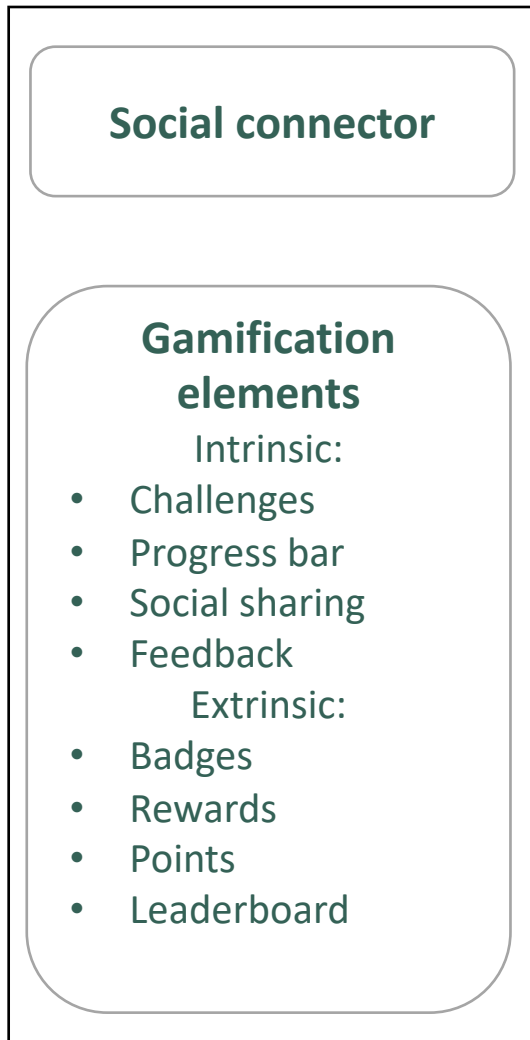Framework

1. Knowledge base phase

This step gathers all the information from the literature review.

Analyzes the types of personalities, as well as the effects of the application, and the gamification elements used in e-Health applications for elderly.

Gamification is the use of game elements in non-game contexts to improve user experience and engagement [3,4,9-16]

Knowledge base phase

Social connector

Gamification elements
Intrinsic:
- Challenges
- Progress bar
- Social sharing
- Feedback

Extrinsic:
- Badges
- Rewards
- Points
- Leaderboard

Motivational affordances [3]

Intrinsic:

Challenges, progression, feedback, choice, quest and social sharing

Extrinsic:

Badges, rewards, points, incentives, and leaderboards

Barriers [3]

Physical and activity barriers: related to osteoporosis, back pain, knee issues or injuries.

Mental barriers: related to confidence, time constraints, fear of complicating health conditions or being ridiculed by others

**Usability problems in interfaces** [17]

They prefer big, thick and clear font, control and contrast setting, video conference, and a lower game speed due to their dexterity and maneuverability.

2. Fuzzy logic phase

L. Zadeh (1965) proposed a fuzzy set theory that models uncertainty based on linguistic variables related to human reasoning. It does not require a mathematical model of the real system to develop the set, but the experts' knowledge to propose the system [19,20].
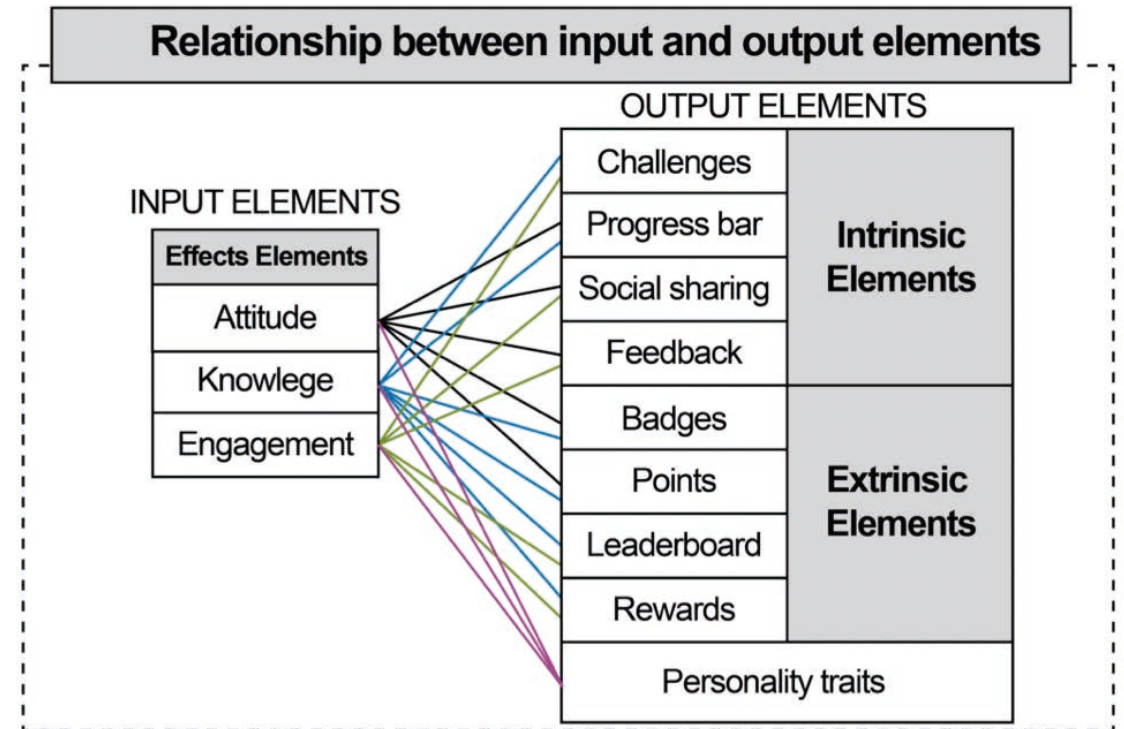
This step analyzes the effects of the game to propose the gamification elements that best fit the user type.

The fuzzy system helps the designer propose a tailored interface.

13
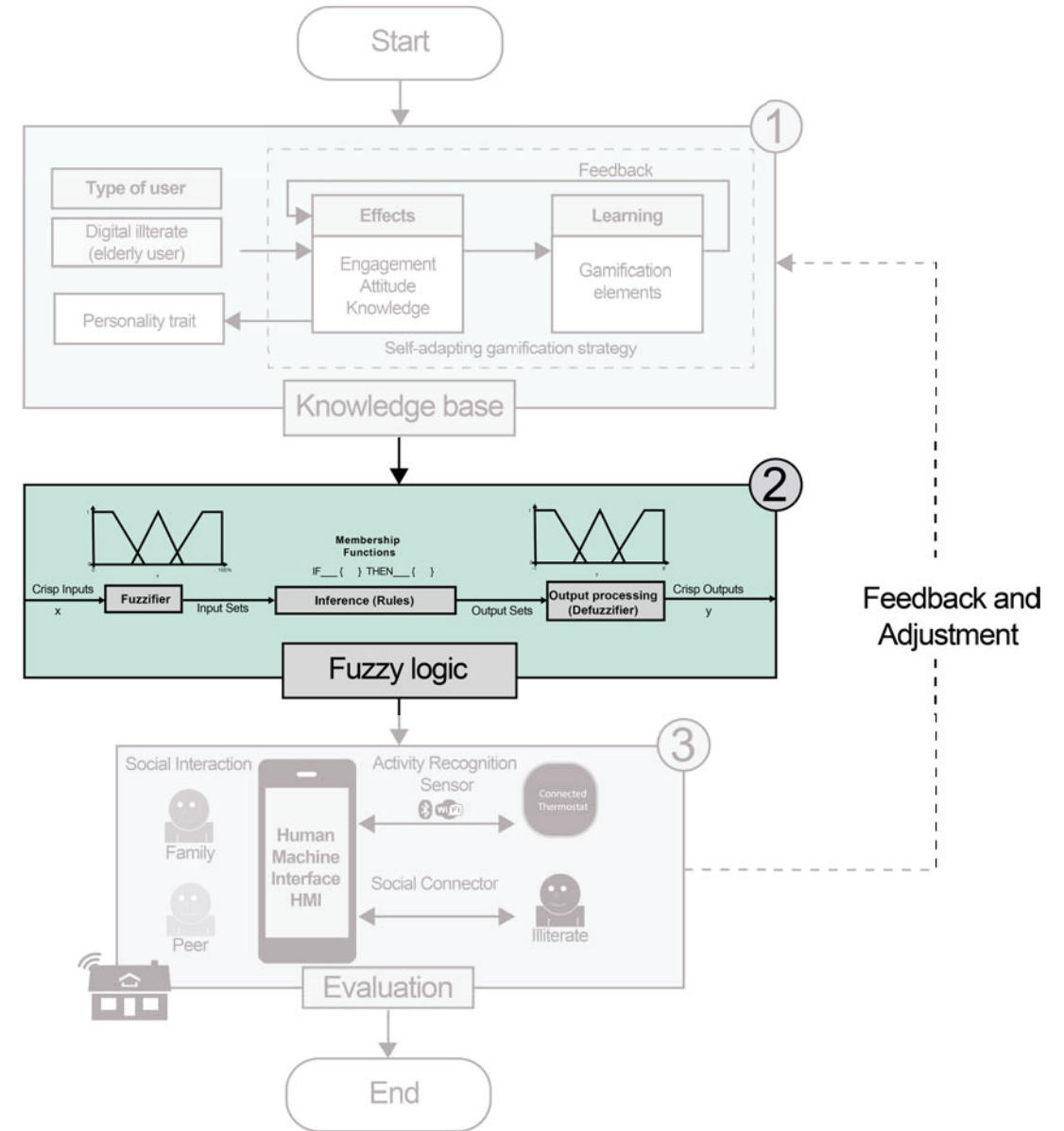
Relationship between input and output elements

- The attitude element measures if the user is having a change in attitude toward exercising [4].

- The knowledge element measures through challenges, the learning obtained by the elderly, and how much they fulfill their objectives [3,4].

- The engagement is measured based on the player's behavior while they are using the application [3,4].

Relationship between input and output elements

INPUT ELEMENTS

Effects Elements

Attitude
Knowlege
Engagement

OUTPUT ELEMENTS

Challenges
Progress bar
Social sharing
Feedback

Intrinsic Elements

Badges
Points
Leaderboard
Rewards

Extrinsic Elements

Personality traits

Personality traits

Input elements

	Attitude	Knowledge	Engagement	Characteristics

Output elements

| Neuroticism (N)	Low	Low	Low	They are not attracted to learn and try new things.
Agreeableness (A)	Low	Med	Low	They are not attracted to technology; however, some of them are barely attracted to learn new things.
Openness (O)	Med	Med	Med	Can or cannot be attracted to use Internet
Conscientiousness (C)	Med	High	High	Attracted to learn and engage in activities, but they require to be convinced on the usefulness of the technology.
Extraversion (E)	High	High	High	They are extremely attracted to learn and try new things. They are a pro-technology user.

3. Evaluate phase

The HMI is proposed so the end user interacts with the application.

This phase provides continuous feedback to the user and the knowledge base to determine whether the user is engaged or if adjustments are required.
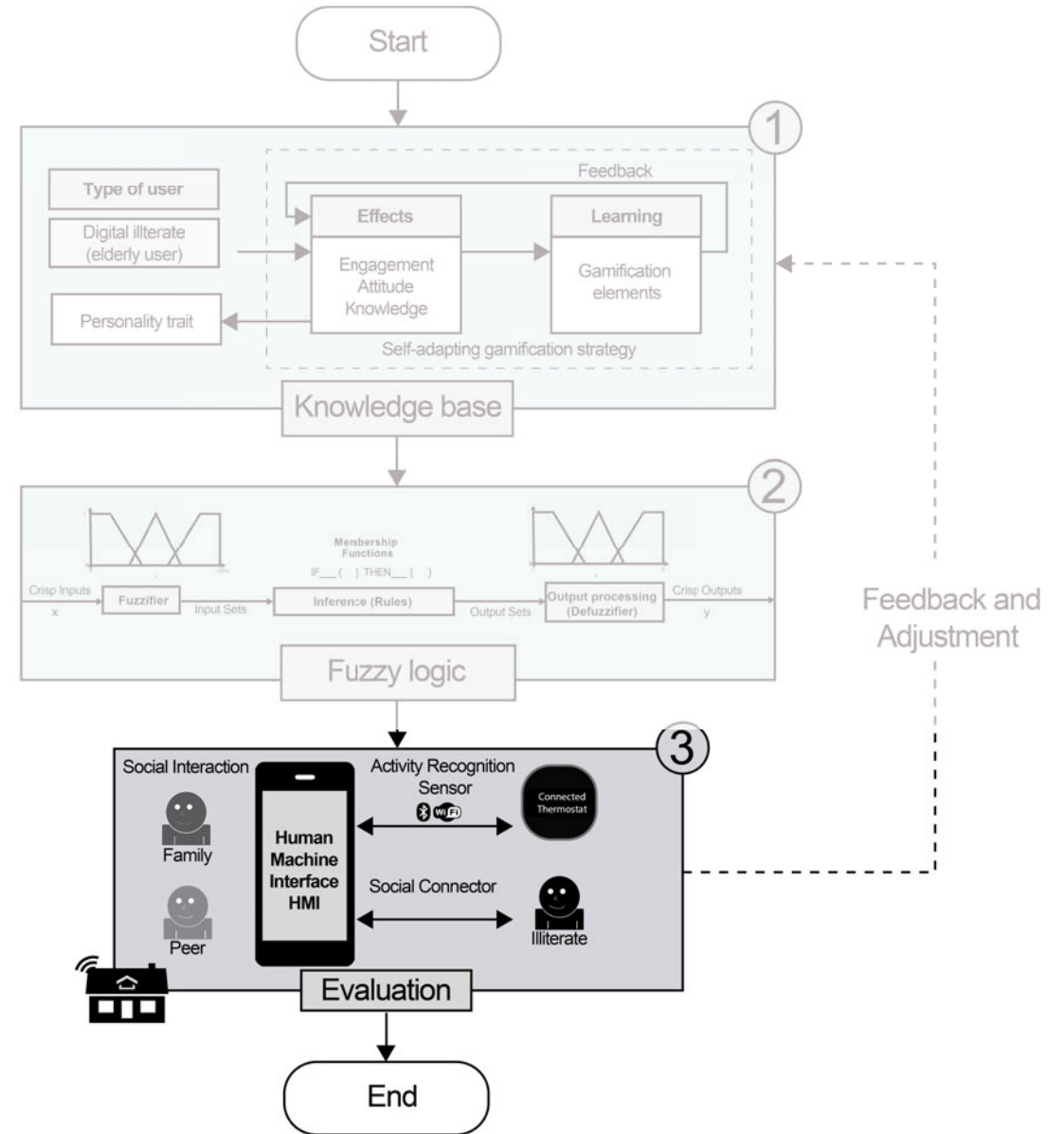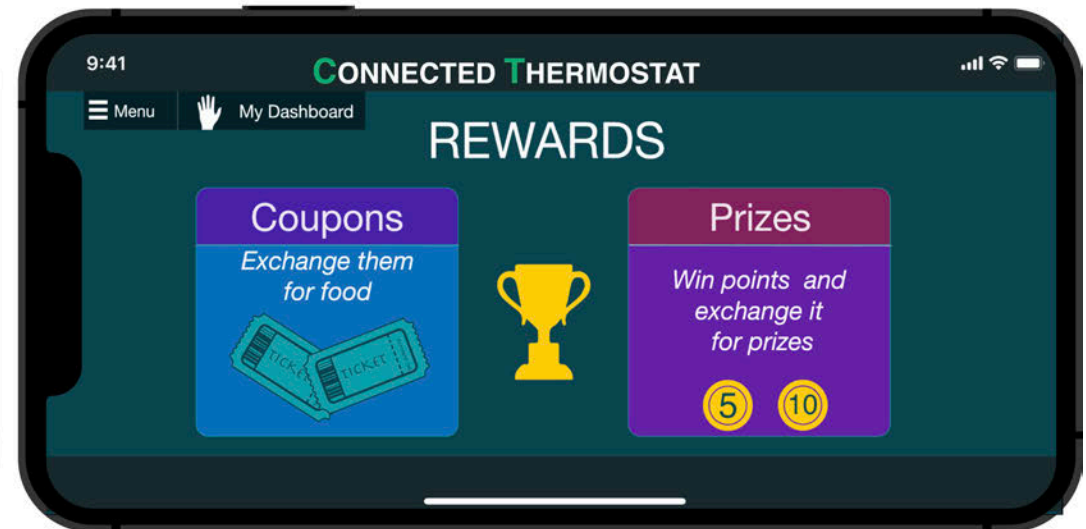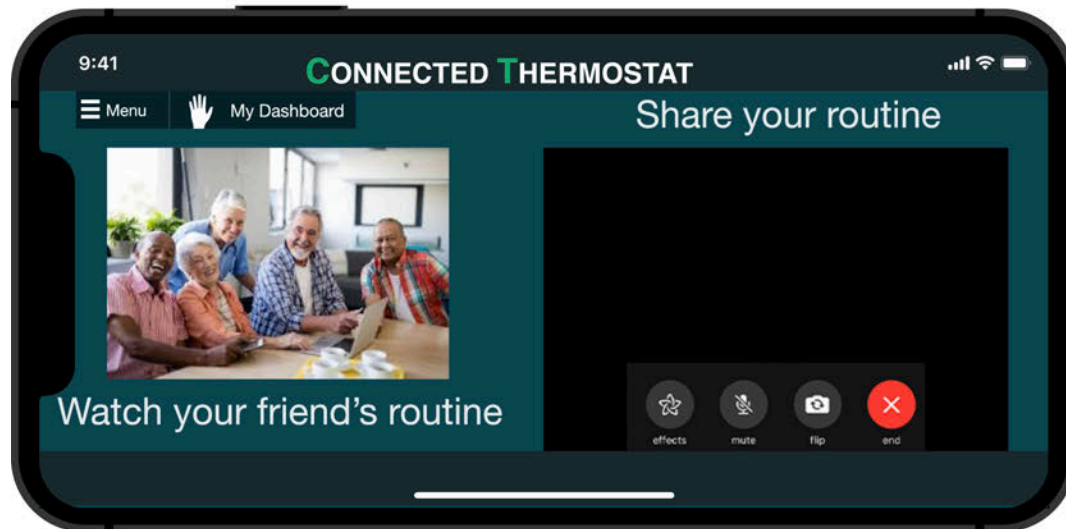
Results
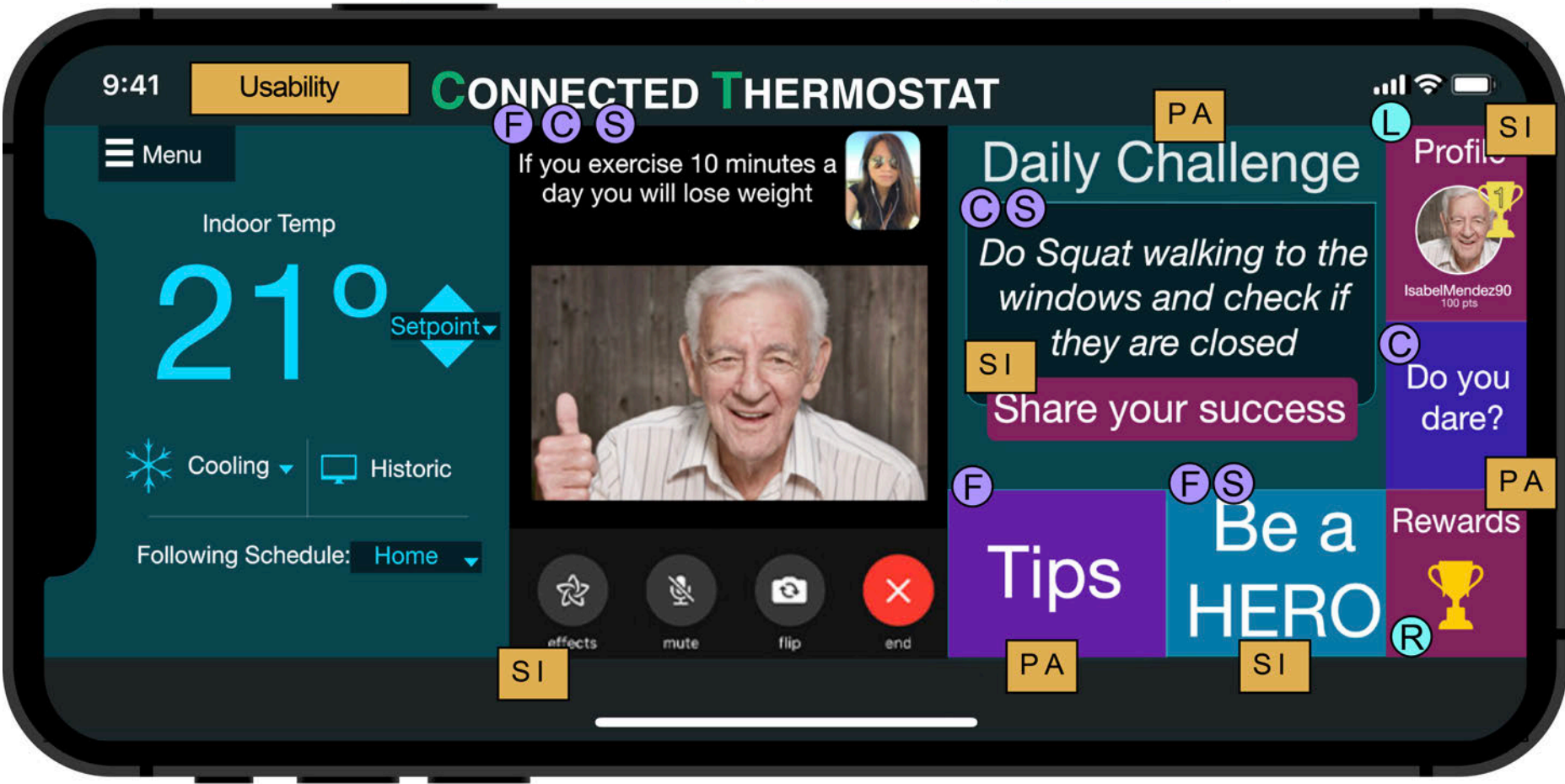
Results
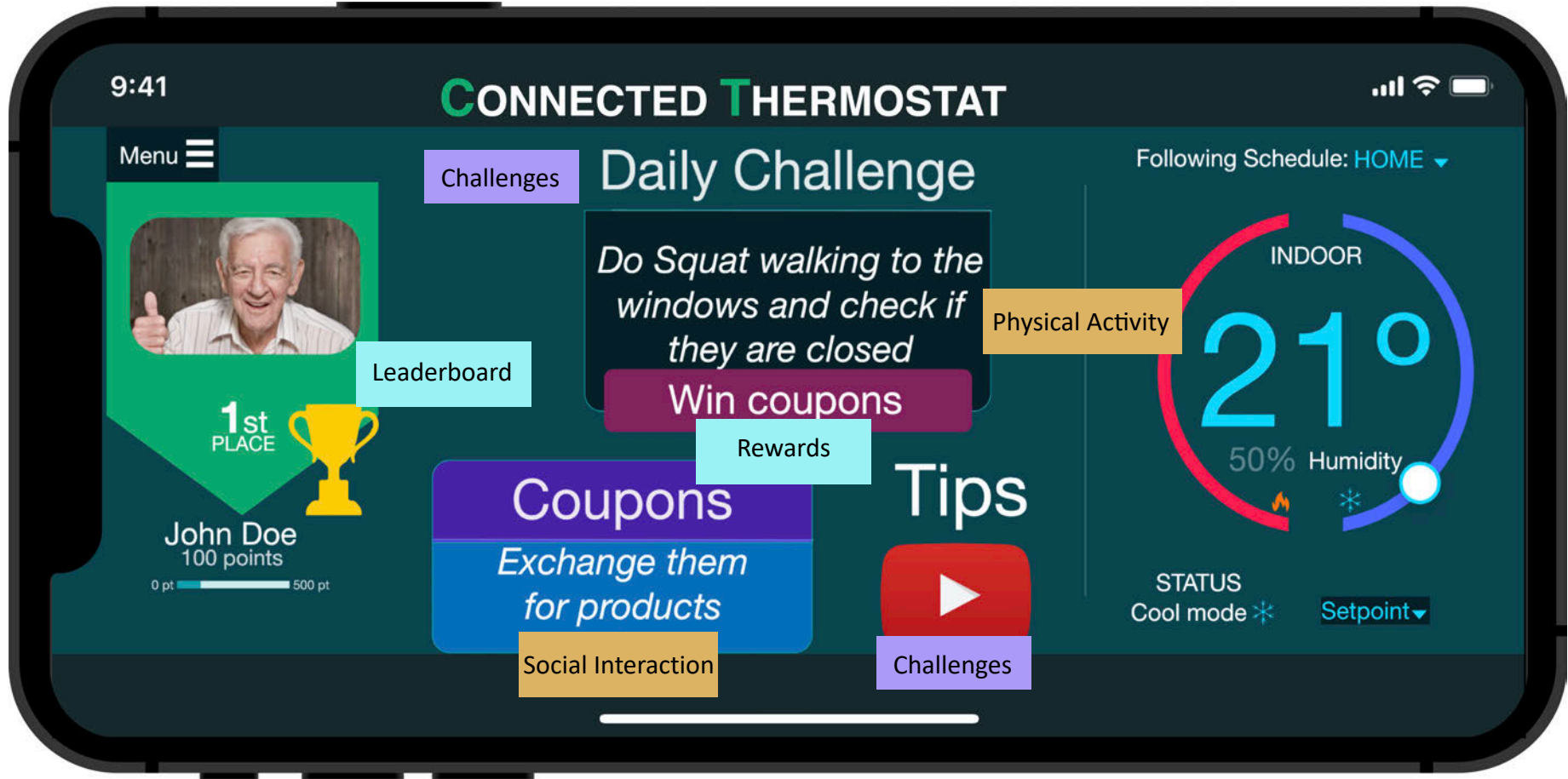
Results

Conclusion

- This framework facilitates the adoption of HMI by taking advantage of a connected device that provides elderly people with an interface according to their personality characteristics.

- This interface teaches, engages and motivates the elderly achieve a healthier lifestyle.

- The customizing method for each type of personality trait is by using fuzzy logic that defines the gamification elements required to promote exercise in the elderly and social interaction.

Conclusion

- This framework interacts with a single device; however, further research is needed to propose interaction between devices.
  - It can be optimized by applying an Artificial Neural Network that analyzes and considers the user's needs and expectations.

- Moreover, the interface only considers the elderly as the main interactor; thus, this interface is not customized for younger users.
  - Besides, the HMI can be optimized using the principles for interaction design to propose a more appealing interface.

Future work

- Design the interface considering the Nielsen's heuristics design.

- Use an ANN for the collected data in the knowledge base step.

- Validate the design interface with the elderly users.

- Launch the app in the market.

Thank you

Contact: A01165549@itesm.mx

References

[1] U. N. Departament of Economic and Social Affairs, "World Population Prospects 2019," p. 39, 2019.

[2] U.N. Department of Economic and Social Affairs programme on ageing, "Health Inequalities in Old Age," Tech. Rep., 2015.

[3] D. Kappen, "Adaptive engagement of older adults' fitness through gamification."

[4] D. Muñoz, F. Gutierrez, S. F. Ochoa, and N. Baloian, "Enhancing social interaction between older adults and their families," in *Ambient Assisted Living and Active Aging*, C. Nugent, A. Coronato, and J. Bravo, Eds. Cham: Springer International Publishing, 2013, pp. 47–54.

[5] C. J. Brown and N. Markusson, "The responses of older adults to smart energy monitors"," *Energy Policy*, vol. 130, pp. 218 – 226, 2019. [Online]. Available: http://www.sciencedirect.com/science/article/ pii/S0301421519302368

[6] B. Huchuk, W. O'Brien, and S. Sanner, "A longitudinal study of thermostat behaviors based on climate, seasonal, and energy price con- siderations using connected thermostat data," *Building and Environment*, vol. 139, pp. 199 – 210, 2018.

[7] J. Oliver and S. Srivastava, *The Big Five Trait taxonomy: History, measurement, and theoretical perspectives*, second edi ed. New York: The Guilford Press, 1999.

[8] R. Rockmann and H. Gewald, "Elderly people in ehealth: Who are they?" *Procedia Computer Science*, vol. 63, pp. 505 – 510, 2015, the 6th International Conference on Emerging Ubiquitous Systems and Pervasive Networks (EUSPN 2015)/ The 5th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH-2015)/ Affiliated Workshops. [Online]. Available: http://www.sciencedirect.com/science/ article/pii/S1877050915025119

[9] S. Malwade, S. S. Abdul, M. Uddin, A. A. Nursetyo, L. Fernandez- Luque, X. K. Zhu, L. Cilliers, C.-P. Wong, P. Bamidis, and Y.-C. J. Li, "Mobile and wearable technologies in healthcare for the ageing population," *Computer Methods and Programs in Biomedicine*, vol. 161, pp. 233–237, 2018. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S0169260717314578

[10] S. Merilampi, A. Koivisto, and J. Virkki, "Activation game for older adults — development and initial user experiences," in *2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH)*, May 2018, pp. 1–5.

References

[11] L. Sardi, A. Idri, and J. L. Ferná ndez-Alemá n, "A systematic review of gamification in e-Health," *Journal of Biomedical Informatics*, vol. 71, pp. 31–48, 2017. [Online]. Available: http://www.sciencedirect.com/ science/article/pii/S1532046417301065

[12] I. Ayed, A. Ghazel, A. Jaume-i-Capo, B. Moya-Alcover, J. Varona, and P. Martinez-Bueso, "Fall prevention serious games for elderly people using rgbd devices," in *2016 8th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES)*, Sep. 2016, pp. 1–3.

[13] M. Peham, G. Breitfuss, and R. Michalczuk, "The ecogator app: Gamification for enhanced energy efficiency in europe," in *Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality*. New York, NY, USA: ACM, 2014, pp. 179–183. [Online]. Available: http://0-doi.acm.org.millenium.itesm. mx/10.1145/\2669711.2669897

[14] P. Ponce, T. Peffer, and A. Molina, "Framework for evaluating usability problems: a case study low-cost interfaces for thermostats," *International Journal on Interactive Design and Manufacturing (IJIDeM)*, vol. 12, no. 2, pp. 439–448, may 2018. [Online]. Available: https://doi.org/10.1007/s12008-017- 0392- 1

[15] ——, "Framework for communicating with consumers using an expectation interface in smart thermostats," *Energy and Buildings*, vol. 145, pp. 44–56, 2017. [Online]. Available: http://www.sciencedirect. com/science/article/pii/\S0378778816312658

[16] S. Stieglitz, C. Lattemann, S. Robra-Bissantz, R. Zarnekow, T. Brock- mann, and S. I. P. AG, *Gamification Using Game Elements in Serious Contexts*. Cham, Switzerland: Springer, Cham, 2017.

[17] E. Brox, S. T. Konstantinidis, and G. Evertsen, "User-centered design of serious games for older adults following 3 years of experience with exergames for seniors: A study design", journal="jmir serious games," vol. 5, no. 1, Jan 2017.

[18] J. A. Romero, P. A. G. Garćıa, C. E. M. Maŕın, R. G. Crespo, and E. Herrera-Viedma, "Fuzzy Logic Models for Non-Programmed Decision-Making in Personnel Selection Processes Based on Gamifi- cation," *Informatica, Lith. Acad. Sci.*, vol. 29, pp. 1–20, 2018.

[19] L. A. Zadeh, "Fuzzy sets," *Information and Control*, vol. 8, no. 3, pp. 338–353, 1965. [Online]. Available: http://www.sciencedirect.com/ science/article/pii/S001999586590241X

[20] P. Ponce-Cruz, A. Molina, and B. MacCleery, *Fuzzy Logic Type 1 and Type 2 Based on LabVIEW(TM) FPGA*, 1st ed. Company, Incorporated, 2016.