An Ambient Awareness System for Enhancing Family Connectedness

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Abstract. As family members become increasingly physically separated due to work and educational commitments, maintaining a sense of connection can be challenging. We developed an ambient awareness system to facilitate real-time data collection and visualization. The system integrates a mobile Android application for real-time step count collection, a cloud database for synchronized data storage, and a web interface for visualizing step counts as ambient art display. By combining quantified-self data with dynamic ambient displays, the system aims to provide a non-intrusive way for users to be aware of family members' status, thereby enhancing family connectedness.

Keywords: Ambient awareness· Social connectedness.

1 Introduction

The transition to adulthood often involves young adults leaving their parents' homes to pursue higher education or career opportunities, creating physical distance between family members [1]. This separation can lead to a decline in spontaneous interactions and shared experiences, making it challenging to maintain a sense of connection [6]. As a result, there is a growing need for technologies that support meaningful ways of staying aware of close family members without disrupting daily routines.

Ambient displays have emerged as a promising solution by offering a non-intrusive, aesthetically engaging means, enabling peripheral awareness without demanding the user's direct attention [7, 4]. These displays are well suited for keeping users aware of people or general states of large systems [7]. Research has demonstrated the efficacy of ambient displays in keeping family members informed of the health and activities of their relatives, thus enhancing social connections and support networks [2, 5, 3].

In this study, we focus on enhancing family connectedness through the integration of quantified-self data and dynamic ambient displays. By collecting real-time step count data from young adults via a mobile application and transforming this information into dynamic digital art displayed in their parents' homes, we aim to provide continuous, unobtrusive insight into the daily activities of family members, thereby strengthening the connectedness between parents and their adult children living apart.

2 System design

Our system integrates several key components to support interaction between remote family members by combining mobile sensing, cloud data management, web visualization, and sensor-based engagement tracking.

2.1 Mobile Android Application

On the young adults' side, the interface is provided through a dedicated Android application built in Kotlin. The application continuously monitors step count data using the device's native pedometer sensor. During initialization, the application performs a sensor check to ensure data acquisition is possible and immediately transitions into a foreground service. This design choice guarantees that step data is captured seamlessly throughout the day without requiring repeated user intervention.

2.2 Cloud Data Management

Step count data collected by the mobile app is transmitted to a cloud database hosted on Google Cloud. Within this cloud environment, data is structured into a dedicated collection, with each record associated with a unique user identifier. This approach not only authenticates user entries but also maintains real-time synchronization across devices, ensuring that the latest information is always available for downstream processing.

2.3 Web-Based Visualization

For the parents' interface, we have developed a responsive web application using HTML5 and JavaScript frameworks. This application takes the synchronized step data and transforms it into three types of dynamic digital art. The visual output is presented in a manner that emulates a framed painting, creating an aesthetically engaging display in the home environment. Users can enter a specific user ID to access personalized visualizations, which are refreshed at regular intervals to reflect the most recent data.

2.4 Sensor-Driven Engagement Module

To further enrich the user experience, a supplementary hardware module is incorporated. This module, managed by an Arduino microcontroller, integrates two types of sensors. First, an NFC module enables users to change the visual presentation by scanning uniquely tagged NFC cards, each corresponding to a distinct art style. Second, a PIR motion sensor continuously monitors the physical presence of a user in front of the display. Both types of interaction, whether triggered by an NFC scan or detected motion, are logged with timestamps. These logs are then synchronized with a central system to allow detailed analysis of user interaction with the display.

3 Experiment

We plan to conduct a field study involving pairs of parents and children (young adults), where the parents reside in one city, while their young adult children live in different cities. The children will use the mobile application to continuously record real-time step count data. Parents will interact with the responsive web interface that transforms these data into dynamic digital art, offering them a subtle yet continuous visual insight into their children's daily activities. This study has been approved by the university ethics board.

The study will assess both objective system interaction and subjective user experience. Objective measures will include interaction logs, such as the frequency and duration of viewing different visualization types. Subjective assessment will be conducted through surveys and interviews, capturing participants' perceptions of the system's usability, engagement, and impact on their sense of connectedness.

4 Conclusion

This study takes important strides in promoting social connectedness between parents and their young adult children living apart by introducing an ambient display that visualizes quantified-self data through art. The quantified-self information of step count was selected because. Using real-time step count data collected from children's smartphones, we have developed a system that provides parents with dynamic, continuously updated visual feedback. As this research unfolds, we anticipate that the insights gained will inform the development of future ambient displays, ultimately enriching social interaction and deepening familial bonds.

About Tianqin Lu Tianqin Lu is pursuing her Engineering Doctorate in the Human System Interaction program at the Department of Industrial Design, Eindhoven University of Technology (TU/e). She is a member of the STRAP (Self Tracking for Prevention and Diagnosis of Heart Disease) consortium. She holds a Bachelor of Science degree in Mechatronics Engineering with a concentration in Mechatronics, Robotics, and Automation Engineering. Additionally, she obtained a Master of Science in Industrial Design with a specialization in Constructive Design Research. Her recent research interests focus on the experience sampling method in the context of preventive healthcare.

References

1. Arnett, J.J.: Emerging adulthood: A theory of development from the late teens through the twenties. American psychologist **55**(5), 469 (2000)
2. Cornejo, R., Favela, J., Tentori, M.: Ambient displays for integrating older adults into social networking sites (09 2010). https://doi.org/10.1007/978-3-642-15714-1_24
3. Davis-Owusu, K., Owusu, E., Hu, J., Marcenaro, L., Regazzoni, C., Feijs, L.: Promoting social connectedness through human activity-based ambient displays. pp. 64–76 (10 2016). https://doi.org/10.1145/2996267.2996274
4. Mankoff, J., Dey, A.K., Hsieh, G., Kientz, J., Lederer, S., Ames, M.: Heuristic evaluation of ambient displays. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. p. 169–176. CHI '03, Association for Computing Machinery, New York, NY, USA (2003). https://doi.org/10.1145/642611.642642, https://doi.org/10.1145/642611.642642
5. Markopoulos, P., Ruyter, B., MacKay, W.: Awareness systems: Advances in theory, methodology and design. Awareness Systems (01 2009). https://doi.org/10.1007/978-1-84882-477-5
6. Thapa, D.K., Visentin, D.C., Kornhaber, R., Cleary, M.: Migration of adult children and mental health of older parents 'left behind': An integrative review. PLoS ONE **13** (2018), https://doi.org/10.1371/journal.pone.0205665
7. Wisneski, C., Ishii, H., Dahley, A., Gorbet, M., Brave, S., Ullmer, B., Yarin, P.: Ambient displays: Turning architectural space into an interface between people and digital information. pp. 22–32 (02 1998). https://doi.org/10.1007/3-540-69706-3_4