Feasibility study for lifestyle monitoring of older adults living independently at home using smart water meter data

B. M. Mathunjwa & Y. L. Hsu

Purpose There are three types of technologies commonly used in home monitoring services: (1) Wearable devices, which can be uncomfortable and intrusive to users; (2) Ambient sensors, which require extra installation; and (3) household meters, such as smart electricity and water meters. While smart electricity meter data have been used for long-term lifestyle monitoring of independent older adults (Ruano et al., 2019), few studies use smart water meter data for the same purpose. A study by Wilhelm et al. (2023) exploited water consumption data from smart meters for human activity event recognition. This paper presents a feasibility study for lifestyle monitoring of older adults living independently at home using smart water meter data. **Method** A water meter was installed in a 61-year-old male tester's home who lives alone, retrieving water consumption data at 10-second intervals. Water consumption data (Figure 1 top) was collected for 7 days, and the tester was asked to record the ADLs when using water during that period. Water consumption data with a flow rate of less than 0.2 liters per 10 seconds was considered noise and filtered out. Water usage ADL events (Figure 1 bottom) were collected by identifying 60 seconds of consecutive non-water consumption before and after each event. Events shorter than 20 seconds were considered not ADL and were removed. The water consumption data was converted to water usage ADL activity in 15-minute periods (0/1 in Figure 2 top), returning "1" when there were water usage ADL events in the 15 minutes and "0" for periods with no water usage ADL events. A self-comparison was conducted between the daily water usage ADL activity data and the 4-week norm to identify deviations in lifestyle patterns. Activity levels were assessed by comparing the active score (AS) with the norms AS for the previous 28 days. Low and high norms were determined from the user's preceding 28-day data by averaging the ASs of the 14 days with lower and higher ASs, respectively. Regularity was assessed by calculating the correlation coefficient (CC) between the day's water usage ADL activity data and the 4-week norm. **Results and Discussion** A total of 54 events from 8 types of water usage ADL events (flushing toilet 13, handwashing 6, bathing 5, morning hygiene 6, evening hygiene 9, meal preparation 6, post-meal cleaning 8, and laundry 1) were recorded. The algorithm described above identified 58 water usage ADL events, and 53 were true events, which yielded a sensitivity of 98.1% and a positive predictive value of 91.4%. "Laundry," a long-duration event, was identified as 4 independent water usage ADL events. Two other false events were noise that was not filtered out. After confirming the accuracy of the algorithm, Figure 2 shows the water usage ADL activity data for one day and the 4-week norm. The norm AS is 7.33, with high and low norms of 12.65 and 2.01, respectively. The one-day water usage ADL activity resulted in an AS of 9.38, between the high norm and norm, indicating a normal activity level. An AS higher than the norm indicates a high activity level, an AS between the norm and low norm signals a low activity level, and an AS lower than the low norm indicates an abnormally low activity level. The CC of the one-day water usage ADL activity data is 0.32, indicating a low regularity level. The CC higher than 0.7 indicates a high regularity level, the CC between 0.7 and 0.5 shows a normal regularity, and the CC lower than 0.3 indicates an irregular level. Based on this feasibility study, a lifestyle monitoring system using smart water meter data will be constructed.

References

Ruano, A., Hernandez, A., Ureña, J., Ruano, M., & Garcia, J. (2019). NILM techniques for intelligent home energy management and ambient assisted living: A review. Energies, 12(11), 2203

Wilhelm, S., Kasbauer, J., Jakob, D., Elser, B. and Ahrens, D., 2023. Exploiting Smart Meter Water Consumption Measurements for Human Activity Event Recognition. Journal of Sensor and Actuator Networks, 12(3), p.46.

Keywords: lifestyle monitoring, smart water meter, elderly care, activity level

Address: Gerontechnology Research Center, Yuan Ze University, Taoyuan 320, Taiwan

Email: yehlianghsu@gmail.com

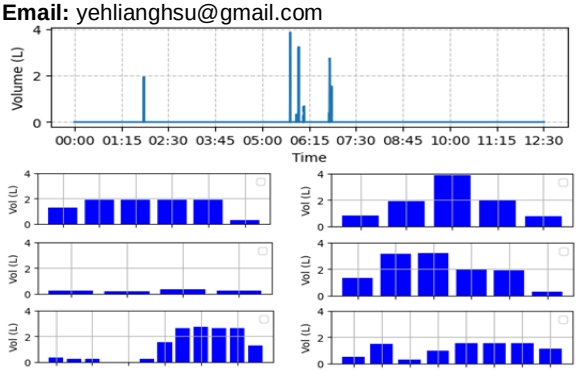

Figure 1 Water consumption data and some water usage events

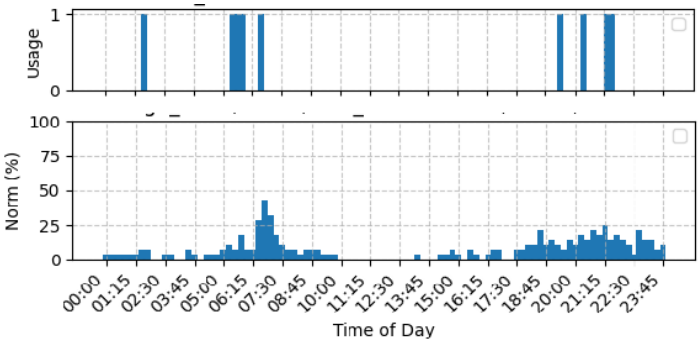

Figure 2 Water usage ADL activity for one day and water usage norm for the 28-day