K-004

Ontology-based Life Motivation Analysis for Proactive Health Care to Elderly

Thwin Zar Hein†, Fumiko Harada‡, Hiromitsu Shimakawa‡

1. Introduction

With the expensiveness of formal care-giving and the shortage of caregivers, pervasive computing becomes a challenging research area for providing necessary care to 'aged-single-person-households'. Monitoring of Activity of Daily Living (ADL) and Instrumental Activity of Daily Living (IADL) [1] enables ambient control, warning alert, assisted actions, info services. The existing systems detect whether the elderly do the important activities such as taking meal, medicine on time and some other activities. Moreover, as accidental falls are common causes of serious injury to the elderly, the researchers proposed many methods (e.g., using accelerometer [2], video [3], etc.,) to detect falling down. Mostly the researchers paid attention to detect dangerous situations. However, proactive health care and prevention are still ongoing research items.

For providing proactive health care to them, we study their life motivation. The efforts for activities becomes to diminish when their life motivation declining. In this paper, we utilize time and place ontology to analyze how the elderly do the activity. We provide sample analysis model of vacuuming activity to present analysis results with understandable model by the caregivers and family members. The experiment results indicate the potential of our work.

2. Proactive Health Cares based on Life Motivation

Most of the elderly prefer to live independently in their home environment. As their situations can be guessed from their daily activities, researchers present several approaches for monitoring their activities. We study on life motivation of the elderly through their daily activities. The studied results and discussions have noticed us the followings. When their life motivation is declining, 1) they tend to have their meals in the bed room 2) they avoid tiresome works that are not essential in their daily life 3) even though they do tiresome works, they do not perform the work thoroughly. From their activities, if the caregivers can find the symptoms at early state, they can provide proactive health care to the elderly before the situation arrives to severe ones.

3. Ontology-based Life Motivation Analysis

3.1 Time and Place Ontology

To know the trend of their life motivation, we monitor how they do the activities. We apply natural factors such as time and place ontology [4] to analyze their action. Ontology is an explicit specification of a conceptualization. In this paper, we apply ontology in knowledge reuse notion. Fig. 1 represents the ontology-based analysis model, where a is activity, t is time of day, p is place (area) at home, and f is analysis functions.

The analysis functions (f) are used to analyze how the activity (a) is done. When the elderly do the activity a_1 at time t_1 and place p_1, the analysis functions f_1, f_2, f_3, f_4, f_5 are done.

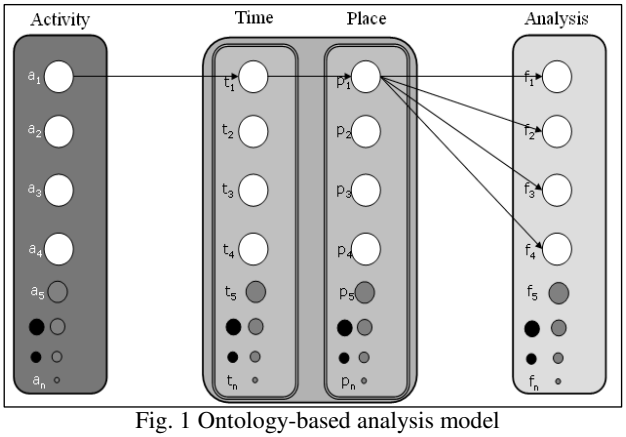

Fig. 1 Ontology-based analysis model

IF (activity.a==a_1) THEN
  IF (time.t==t_1) && (place.p==p_1) THEN
    DO functions (f_1, f_2, f_3, f_4, f_5)

The analysis functions differ according to the nature of activity. For example, in vacuuming activity, the movement or walking speed are checked. In sleeping activity, the movement on bed is checked. Using time and place ontology, it is possible to analyze detail performance of the elderly such as which parts of home are easy to vacuum (they clean thoroughly) or which parts are not (they just clean on a small space or not thoroughly). From day by day comparison of the data, it can measure their life motivation that is useful for proactive health care.

3.2 Analysis Example: Vacuuming Activity

There are several activities that are performed at daily life of human. Daily activities are detected by analyzing touched objects [1] [6], the time and place ontology [4] takes the role of dividing the activity based on the place domain of specific time. Basing on time and place ontology, the system performs analysis activities of the elderly. In this paper, we express the scenario of ontology-based analysis for vacuuming activity as shown in fig. 2. On a specific time and place, the analyses done on vacuuming activity are -

1) Touched objects analysis – Touched objects in a specific activity can be divided into three kinds. A vacuum-cleaner, brooms, dust-pans, dust-rags, and dust-bins are the main touched objects. Tables, chairs, and stools are supporting objects because the elderly move these objects to clean under the objects, if the elderly are active. Televisions, radios, and remote controllers are unsupported objects. Touched objects analysis is done on how many times and what kinds of objects they touch in a specific place.
2) Spending time analysis – We measure how long they stay on a specific place. It enables to analyze how long they spend to vacuum a particular place.

†Graduate School of Science and Engineering, Ritsumeikan University
‡College of Information Science and Engineering, Ritsumeikan

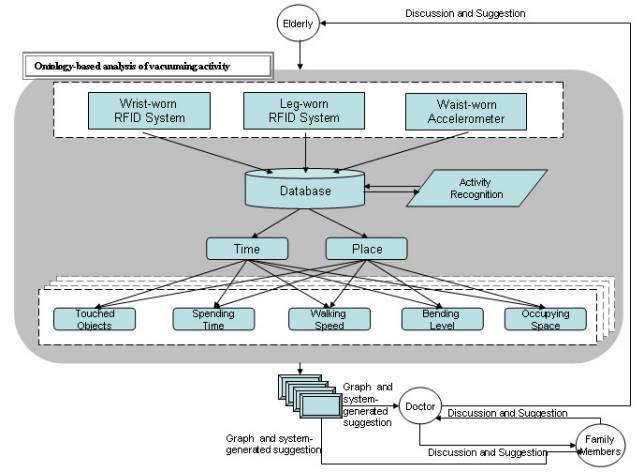

Fig.2 Ontology-based analysis of vacuuming activity

3) Walking speed analysis – The walking speed is an important factor for safe ambulation in the community and provides useful information on health-related outcomes. The pace information (kilometer per hour) are analyzed on each place. From this analysis, the caregiver can know the elderly walking speed on a specific place while doing the activity.
4) Bending level analysis - Bending level is an effective indicator of whether the elderly do the activity actively or not. By applying threshold values for each posture pattern, the system calculates bending level while doing the activity.
5) Occupying space analysis – We should know their occupying space while vacuuming. When they feel depressed, or suffering health problems, they just vacuum on a small space. The calculation results described above are compared to periodically. They are expressed in histograms which comprehensible to doctors and the family members.

4. System Implementation and Experiments

For the analysis of life motivation of the elderly, we steer the data from their touched objects, places, and posture on time series. A wrist-worn RFID (Radio Frequency Identification) reader [1][6], a leg-worn RFID reader [5], and a waist-worn accelerometer [2] are exploited in our system. In our ubiquitous environment, all the objects at homes are tagged by small, durable, battery-free, and cheap RFID tags. The elderly is wearing RFID reader on his wrist. Whenever they touch the objects, the wrist-worn reader takes the tag ID to send to database. The passive RFID tags are embedded on the floors. Indoor walking information is obtained from the leg-worn RFID reader. The trial-axial accelerometer mounted on the waist takes the posture data of sitting, walking, climbing up the stairs, picking up object from the floor, and others. From the three sources of data on a specific time and place, the system analyzes how they take activities. We conducted 6 preliminary experiments to 3 elderly. The system collects the data obtained from their activities. The elderly are doing their daily activities without fix administered by the system administrator.

The analysis data of vacuuming activity for a specific person are shown as histogram in fig.3, where we can find that the south-east part is the easiest area to vacuum and the elderly has

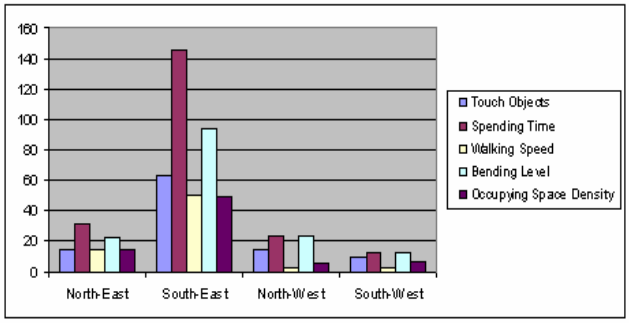

Fig.3 Living room vacuuming activity analysis

high willingness to clean that area. However, the south-west area is difficult to vacuum or luck of willing to clean. From this data, the system can make the conclusions of 1) if their life motivation is high, they actively vacuum difficult areas, 2) if life motivation is declining, touch objects become less, vacuuming time becomes short, movement speed becomes slow, bending level becomes less, and vacuuming space becomes narrow, 3) the caregivers need to consider walking supporting methods for slow walking area. The histogram helps the caregivers to provide necessary care to the elderly in the early state.

5. Conclusion and Future Works

We had proposed ontology-based activity analysis for measuring life motivation of the elderly. Ontology usage has the benefits of detail analysis of situations. Our system can not only provide proactive cares to the elderly who need them, but also reduce the burden of health care workers and family members. Our future works include developing several kinds of analysis based on the natures of the activities and conducting long time experiments with various analyses.

References

[1] Philipose, M. , Fishkin, K. P. , Perkowitz, M., Patterson, D. J., Fox, D. , Kautz, H., and Hahnel, D. : “Inferring activities from interactions with objects,” IEEE Pervasive Computing, vol. 3, no. 4, pp. 50-57 (2004).
[2] Kangas, M., Konttila, A., Winblad, I., and Jamsa, T.: “Determination of simple thresholds for accelerometry-based parameters for fall detection,” Proceedings of EMBS 2007 , pp.1367-1370 (2007)
[3] Emmanuel, S., and Nasution, A. H.: “Intelligent Video Surveillance for Monitoring Elderly in Home Environments,” in IEEE 9th Workshop on Multimedia Signal Processing, pp. 203-206 (2007).
[4] Pinto, H. S., and Peralta, D. N.: “Combining ontology engineering subprocesses to build a time ontology,” Proceedings of the 2nd international Conference on Knowledge Capture, pp.88-95 (2003).
[5] Nakai, T., Yamahara,H., Harada,F., and Shimakawa,H.: “A Prototype System to Acquire Indoor Walking Information with RFID Technologies,” Proceedings of Forum on Information Technology 2008, pp. 525-526 (2008). (In Japanese)
[6] Yamahara, H., Takada, H., and Shimakawa, H.: “An individual behavioral pattern to provide ubiquitous service in intelligent space,” WSEAS Transactions on Systems, vol. 7, pp. 562-569 (2007).