Indian Journal of Science and Technology, *Vol 9(45), DOI: 10.17485/ijst/2016/v9i45/106771, December 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Lifelog-Based Activity Ontology Representation Approach for Disadvantaged Groups

Yoosoo Oh

School of Computer and Communication Engineering, Daegu University, Gyeongsan 38453, Republic of Korea; yoosoo.oh@daegu.ac.kr

Abstract

In this paper, we propose an approach of a lifelog-based activity ontology representation that expresses activity logging, activity tracking, and activity reasoning. In addition, we analyze related research works, and then we classify them based on our defined ontology. Especially, we design the activity ontology model, then we evaluate the proposed approach by utilizing developed systems for disadvantaged groups. Furthermore, we expect that the proposed approach can be utilized to develop rehabilitation application for the disabled and non-disabled people.

Keywords: Activity Ontology, Activity Tracking, Disadvantaged Groups, Lifelog, Smart Welfare

1. Introduction

Recently, various assistance systems for smart welfare are developing[1-10]. Such smart welfare systems can support lifelog service for the socially disadvantaged groups. Precisely, the systems are being developed based on activity of the disadvantaged groups. The socially disadvantaged group scan be a neglected class of people, lower-income group, disabled person, the elderly, or children. In order to provide appropriate service by recognizing the disadvantaged groups' activity, a lifelog-based system should admit their psychological state and the surrounding environmental elements.

For example, we can consider a situation that the psychological condition of an elderly, who has a mental and physical breakdown, is unstable. In such a case, the lifelog-based system should recognize the elderly's activity, because the situation can affect the simple physical movements or emotional state. As another example, it is difficult to understand the physical activity in the case of the sudden movement of the visually impaired. Because environmental factors such as obstacles hinder the movement path of the visually impaired.

Since these difficulties are impediments to recognize the activity, we should resolve by obtaining information of the daily life of the disadvantaged groups. The lifelog of the disadvantaged groups is data, which is saved to quantify the physical and mental state[1]. Such data is logged, tracked, and monitored in their daily lives and then it goes through the reasoning process to be aware of the activity.

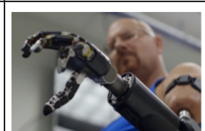
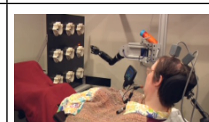
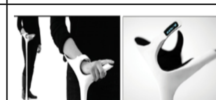
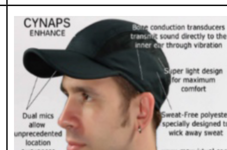
In this paper, we propose an approach of a lifelog-based activity ontology representation for disadvantaged groups. The proposed approach has three representations, such as activity logging, activity tracking, and activity reasoning. Activity logging ontology presents daily sensing and logging information for lifelog activities. Activity tracking ontology describes tracked data with data cloud. Activity reasoning ontology presents inference results by accumulating reasoning steps. In order to evaluate the proposed approach, we analyze related research works, and then we classify them based on our defined ontology. Moreover, we discuss how to represent an activity ontology with the proposed approach by adapting previously developed systems.

2. Related Research Activities

Smart welfare is well revealed on the welfare for disadvantaged groups. It is also closely related to the rehabilitation

**Author for correspondence*

Table 1. Related Rehabilitation Systems for the Disabled People

System	Description	Description
TOYOTA Partner Robot[2]	Walking Assist Robot	
Honda's Robotic Assistant[3]	Walking Assist Device Visualizes unique walking patterns	
TOYOTA Human Support Robot[4]	Performs to pick and move objects	
The Modular Prosthetic Limb[5]	Uses 100 sensors Performs as a human arm and hand	
Brain Computer Interfacing[6]	Activate the machine through a human's thought Measures an electroencephalogram	
THE AID[7]	Design of a cane for disabilities people Designed to measure a health status	
Bone Conduction Measuring Cap for the Deaf[8]	Built in dual-microphone to pick up sound Provides location awareness	
In Touch Health's RP-VITA[9]	Video based medical service by the remote robot Performs as a human arm and hand	
MariCare's eLea Smart Detection[10]	Smart nursing system for the elderly who lives alone	

of the disabled people. We analyzed the rehabilitation systems by comparing the existing works in a viewpoint of the disabled. The analyzed rehabilitation systems contain IoT healthcare, telemedicine services, mobile healthcare applications, healthcare machines for the disabled, and wearable healthcare devices. Table 1 explains related rehabilitation systems for the disabled people.

By comparing the related works, we can find the reason why we need lifelog activity reasoning approach. To develop lifelog activity recognition for smart welfare, we need to deduce high-level semantic information from sensing devices. A method to develop lifelog activity recognition is to adaptively processing in accordance with the data inputted from various sensors on the user environment. Thus, we can consider an approach on user activity reasoning through the ontology design for the lifelog-based personal big-data.

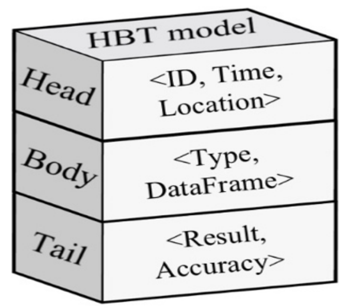
3. Design and Implementation

An ontology is a description of the concepts and relationships with expressing the fact. The ontology describes a formal specification of a lifelog-based program. Ontological analysis clarifies the structure of knowledge, which represents lifelog-based activity. Activity ontology enables sharing of logging data.

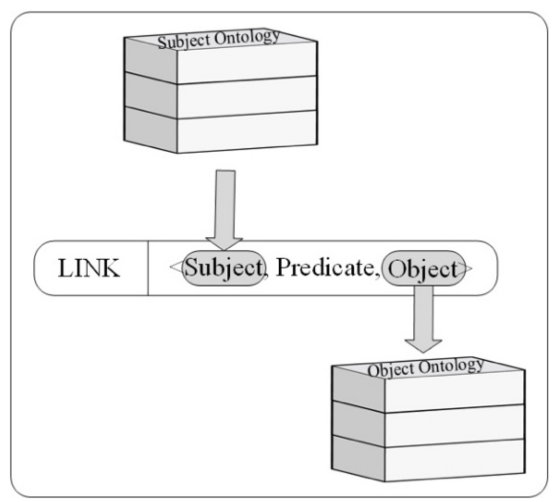
If we represent activity ontology, we can receive input, make inferences, and generate output from wearable devices by using the activity ontology.

We define three representations, such as activity logging, activity tracking, and activity reasoning. Activity logging ontology presents daily sensing and logging information for lifelog activities. Ontology metadata for describing activity logging depicts sensing data log that contains classified information, such as id, saved time, sensing location, sensor type, and measured values. Activity tracking ontology describes tracked data with data cloud. Ontology metadata for describing activity tracking depicts tracked activity history which contains id and data sequence (past-present-future values). Activity reasoning ontology presents inference results by accumulating reasoning steps. Ontology metadata for describing activity reasoning depicts inferred activity log that contains information, such as time, location, type, accumulated reasoning result, and confidence of inference.

For metamodeling in domain ontologies, we can utilize RDF (Resource Description Framework) which is a markup language based on XML syntax. The RDF is developed to representation for various resources dispersed in the distributed web environment. The RDF has a basis for data representation, which is a triple representation as like <subject, predicate, object>. From the RDF's representation, we get a design idea for representing activity ontology.



(a)



(b)

Figure 1. Head-Body-Tail (HBT) model: (a) HBT ontology, (b) Subject-Object ontology linkage with LINK ontology.

As shown in Figure 1(a), we design the Head-Body-Tail (HBT) model that represents each activity ontology. The Head ontology describes identification, timestamp, and location. The Body ontology describes type information, and DataFrame, which presents measured values as the Python syntax. The Tail ontology explains reasoning or calculation results, and sensing accuracy or reasoning confidence. Table 2 explains each element of the HBT model with detailed description. In order to represent the relationship between two ontologies (HBTs), we design the LINK model, which describe <HBT subject, predicate, HBT object>. Figure 1(b) depicts the relationship between two HBT ontologies with the LINK model.

Table 2. HBT ontology details.

HBT	Element	Description
Head	ID	device ID or service ID
	Time	measured timestamp: symbolic or absolute
	Location	measured current location: symbolic or absolute
Body	Type	sort or classification
	DataFrame	sequence values, unit (range), interval
Tail	Result	reasoning or calculation or null
	Accuracy	probability (0.0~1.0): reasoning confidence, sensing accuracy

In order to evaluate the designed HBT ontology model, we previously implemented two rehabilitation systems: Emergency monitoring system for safe working of the elderly and Tactile and auditory-based navigation system for the blind.

The emergency monitoring system is a form of shoes that assists safe walking for the socially disadvantaged people, such as the elderly, children, and pregnant women. This emergency monitoring system tracks their biological status, and then notifies an urgent situation to their guardian through a smartphone. This system consists of a temperature sensor, a heart rate sensor, an acceleration, a gyro sensor, and a tilt sensor. By applying the proposed HBT ontology model, we built an activity ontology diagram for this emergency monitoring system, as shown in Figure 2.

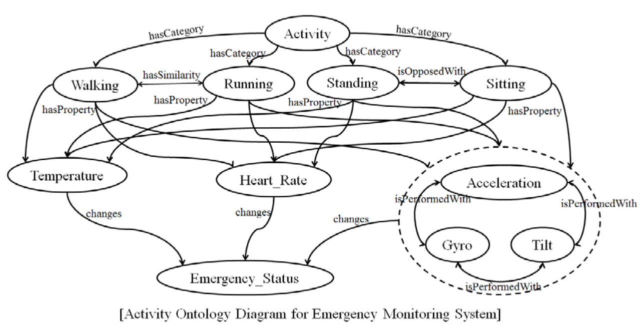


Figure 2. Activity Ontology Diagram for the Emergency Monitoring System.

The tactile & auditory-based navigation system (ActivCane) is a form of the white cane that assists safe walking for the blind people. This tactile & auditory-based navigation system recognizes obstacles, and then guides safe paths to avoid an urgent situation. This system consists of seven ultrasonic sensors, a camera, GPS from a smartphone, and a database (DB) server. The DB server manages the entire map data with updated obstacles by communicating this navigation system. By using this system, we also applied the proposed HBT ontology model. As shown in Figure 3, we built an activity ontology diagram for this the Tactile & Auditory based Navigation System.

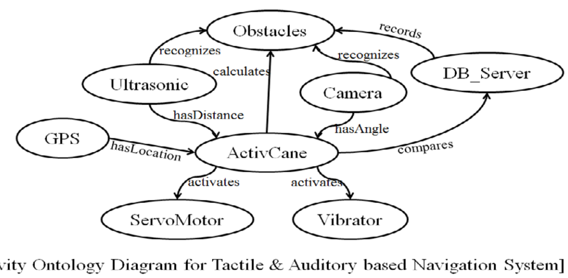


Figure 3. Activity Ontology Diagram for the Tactile & Auditory based Navigation System (ActivCane).

4. Conclusion

In this paper, we proposed an approach of a lifelog-based activity ontology representation that expresses activity logging, activity tracking, and activity reasoning. Moreover, we discussed how to represent an activity ontology with the proposed approach by adapting previously implemented two rehabilitation systems. In particular, we designed the Head-Body-Tail model that represents an activity ontology. To evaluate the proposed model, we built activity ontology diagrams for the implemented rehabilitation systems. In near future, we expect that the proposed approach can be utilized to develop rehabilitation application for the disabled and non-disabled people.

5. Acknowledgments

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2014R1A1A2056194).

6. References

1. Wolf G. The Social Memex – Mark Carranza's Memory Experiment. Quantified Self 2009. Date accessed: 2013. 3. 20: Available online: http://quantifiedself.com/2009/09/the-social-memex.
2. Walk Assist Robot. Date accessed: 2016. 9. 01: Available online: http://www.toyota-global.com/innovation/partner_robot/family_2.html#h203.
3. Walking Assist. Date accessed: 2016. 9. 01: Available online: http://world.honda.com/Walking-Assist/.
4. Human Support Robot (HSR). Date accessed: 2016. 9. 01: Available online: http://www.toyota-global.com/innovation/partner_robot/family_2.html#h210.
5. Johannes MS, Bigelow JD, Burck JM, Harshbarger SD, Kozlowski MV and Van Doren T. An overview of the developmental process for the modular prosthetic limb. Johns Hopkins APL Technical Digest, 2011; 30(3):207-16.
6. Hochberg LR, Bacher D, Jarosiewicz B, Masse NY, Simeral JD, Vogel J and Donoghue JP. Reach and grasp by people with tetraplegia using a neurally controlled robotic arm. Nature. 2012; 485(7398):372-75.
7. The Aid, Grand Prize of Fujitsu Design Award 2011. Date accessed: 2011. 5. 20: Available online: http://www.fujitsu.com/global/about/resources/news/press-releases/2011/0520-01.html.
8. Cynaps. Date accessed: 2016. 9. 01: Available online: http://www.maxvirtual.com.
9. Ackerman E. iRobot and In Touch Health Announce RP-VITA Telemedicine Robot. IEEE Spectrum. 2012.
10. eLea Smart Detection. Date accessed: 2016. 9. 01: Available online: http://www.maricare.com/elea/index.php/en/solutions/nursing-home.