# Health and Environment Monitoring Service for Solitary Seniors

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**Abstract.** In this paper, we propose a health and environment monitoring service for solitary seniors using semantic web technologies (ontology modeling, semantic annotation, and ontology-based context awareness). This service defines and logically deducts the environmental conditions which threaten the health of the solitary seniors. This service includes solitary senior, guardian, social workers, health sensors, environment sensors, and energy sensors. By sensing the health status and the indoor environment and extracting events from them, this system provides more efficient welfare services for the solitary seniors.

Keywords: semantic context · healthcare · solitary senior · sensor

## 1 Introduction

We live in an aging society. According to reports [1, 2, 3], Korea became an "aging society" in 2000 when the number of seniors aged 65 or older reached 7.2% of its total population. In 2018, Korea will become an "aged society" when the seniors comprise 14.4% of its population, and a "super-aged society" by 2027 when the seniors comprise 21.8%. The rapid changes in demography have brought two challenges, care and support, to seniors. Traditionally, Korean seniors have depended on their adult children for care and financial support. In 2011, the number of solitary seniors who live alone in a home comprise 19.6% of Korean seniors, senior couples in which only the couple of old people live 48.5%, seniors living with their children 27.3%, and others 4.6%. Specifically, the number of solitary seniors is increasing rapidly. A lot of them suffer from poverty, disease, and loneliness because their family network is broken. Recently, a solitary senior was found two weeks later after died. Korean government has made various policies for the care of solitary seniors. An automatic monitoring system also is installed in the houses of solitary seniors. For example, a senior welfare center remotely monitors the movements of solitary seniors using a passive infrared ray (PIR) sensor installed in their house. An energy utility has developed a system to check remotely the safety of solitary seniors using the amount of power consumption. These methods can efficiently check the safety of solitary seniors in certain ways. However, these methods do not consider the health of solitary seniors as well as the indoor environment affecting the health of them. Therefore, we have developed a system to provide more efficient welfare services for the solitary seniors.

## 2 Service Description

The left figure of Fig. 1 shows the architecture of the caring system. The system consists of a caring plug, COMUS platform, a caring server, and an application. A caring plug is installed in a house of a solitary senior and measures the indoor environment. The plug includes temperature, humidity, light, PIR, and noise sensor. The PIR sensor reports the number of times the senior has moved during a day. The noise sensor reports the noise level. The plug automatically registers itself in COMUS platform when it wakes up. COMUS platform which we implemented as Internet of Things (IoT) platform manages all sensor nodes and includes semantic functionalities such as ontology, semantic analyzer, semantic repository, SPARQL engine, linked open data, and semantic translator. A caring server includes the personal information on solitary seniors and social workers, and the business process rule to provide a welfare service. An application installed in a smartphone of a social worker is used to send the health status of a senior to the server and receive an emergency message from.

The right figure of Fig. 1 shows the ontology representing the relations among objects. The ontology consists of a solitary senior, a social worker, a guardian, health sensors, environment sensors, and energy sensor. A solitary senior, a social worker, and a guardian are inherited from foaf:Person object. A social worker in the system is a person who is appointed officially by a particular institution (e.g., a senior welfare center) to take

care of a solitary senior and a guardian is selected from relatives of a solitary senior. A solitary senior has environment sensors and energy sensors. A social worker has health sensors. Health sensors measure the health status of a solitary senior, which includes blood pressure, pulse, thermometer, and blood sugar. Environment sensors measure the indoor environment of the house where a solitary senior lives in. They are temperature, humidity, light, PIR, and noise. The energy sensor measures the amount of power which an appliance consumes. Those sensors are inherited from resource ontology included in COMUS platform and installed in a caring plug.

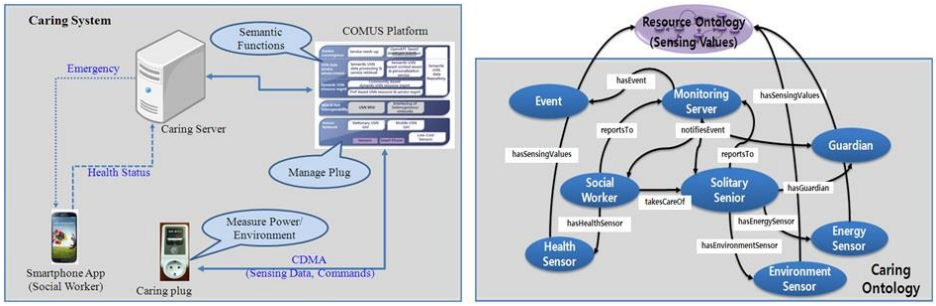


**Fig. 1.** Architecture of Caring Service (left) and Caring Ontology (right)

A semantic annotation [4] is performed by the semantic translator using a translation rule and the caring ontology model. To do this, the type of semantic annotation is analyzed using ontology vocabularies. The type of a semantic annotation is used to define the translation rule for understanding the structure of creating RDF triple pattern. The translation rule defines the method of mapping each elements of the RDF triple pattern into the target ontology model or the value and type of the literal. A semantic processor extracts events and context from sensing values. An event is extracted from individual sensing value and a context is extracted from one or more events. Emergency contexts with high priority are sent to a social worker and a guardian of a solitary senior as fast as possible. For example, an event is that the indoor temperature is too low; a context extracted from events is that a senior is at risk to be frostbite. Fig.2 shows several user interfaces of the proposed service.


Log-In Window (id, password) | Senior List (name, age, address) | Alarm/Event History (date/time, senior name, event description) | Health Data (date/time, blood pressure, blood sugar)

**Fig. 2.** User Interfaces of Caring Service

The proposed service combines the health status and the indoor environment to monitor the daily-life of solitary seniors who do not receive care from their family. By extracting an emergency context and notifying it to a social worker in real time, the caring service can increase the safety of solitary seniors.


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