

# Modeling, Monitoring and Measuring of Social Isolation for Community-based Care in Nursing House

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## Abstract

We proposed a model to monitor and measure social isolation and developed a monitoring system for nursing home. We defined social activities in daily living (SADL) which are essential for living in the community, such as conversation with others, playing game, eating together, etc. We also defined measuring scheme by extending FIM, since FIM measures the normal ADL, our measuring scheme measures SADL. Finally, we evaluated the system by conducting clinical experiment in actual environment.

## Introduction

According to CIGNA's 2018 survey, 40% of the participants said that they have sometimes or always a feeling of isolation and loneliness. Social isolation is caused by a combination of various kinds of incidents such as: high blood pressure, heart disease, obesity, decreased immunity, affect depression, cognitive decline, Alzheimer's disease, and various parts until death. In order to understand the state of social isolation, it is important to build a model to represent a relationship between social isolation and other factors such as cognitive functions, social activity, etc.

Thus, we first designed the social isolation model by W3 standard ontology language OWL. To measure ADL performance, functional independence measurement (FIM) is known an established method to evaluate the state of physical and cognitive function as individual independence. In order to measure the social activity performance, we define Social activities in daily living (SADL) which includes activities such as eating with friends, chatting with friends, meeting to family member, etc. Some activities are overlapped with normal ADL, but the difference is that the ADL is interested in the subject's activities, whereas SADL is interested in the interaction between the subject and other people in community. Based on the SADL, measuring framework is designed by extending FIM, to measure the social activity. To evaluate feasibility of our proposal, we developed a multi-modal sensor based monitoring system named "Mimamori-Fukuro (watching owl)". Collaboration with St. Marianna University School of Medicine, we conducted a clinical experiment to monitor the activity of residents with

dementia in nursing home, how daily activities and sleep affect to long-time changes of state.

## Modeling of Social Isolation

To understand social isolation, the relationship among other entities such as community, care, symptoms, mental issue (feeling) and human function should be identified. It is because that social isolation is caused by community events such as bereavement with partners, mental events such as loneliness, and human functions events such as physical and cognitive decline. Human Functions is further divided into cognitive function and physical activity. Social isolation develops as a symptom of depression or acceleration of cognitive decline. There is a care such as rehabilitation to deal with them. A model of these is shown in Figure 1.

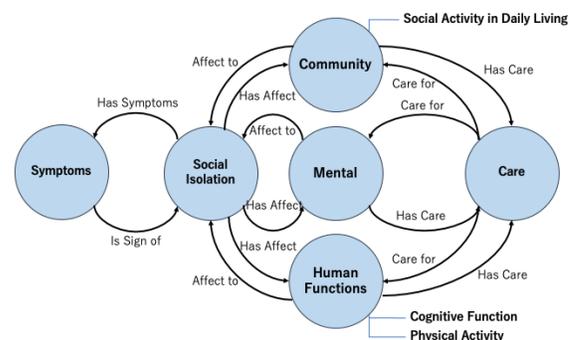


Figure 1: Social Isolation Model

## Monitoring of Social Isolation

In the above model, Community and Human Functions classes are used for monitoring social isolation. We place SADL properties in Community class and normal ADL properties in Human Function class. SADL identifies the activity in the community such as conversation, eating together, playing game, etc.

## Physical Activity

Physical activity refers to an individual's daily activities such as eating, excretion, and moving etc. All of the FIM

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exercise items are used as indicators. The maximum score is 91 points.

### Cognitive Function

Cognitive function refers to memory, comprehension, expressive ability, and communication ability. All of FIM's cognitive items are used as indicators. The maximum is 35 points.

### Social Activity in Daily Living

Social activities refer to activities with social exchanges such as communication with friends, conversations with others in nursing home, participation in recreation, conversations with nursing staff, family visits, etc. Specifically, we will give a score based on the items related to Social Loneliness in LUBBEN SOCIAL NETWORK SCALE-6(Lubben et al. 2006) and De Jong Gierveld Loneliness Scale(De Jong 2010). It can be measured with two types of information: action-based scoring and information obtained from conversations such as whether a person who can speak is familiar. The maximum is 45 points.

### Implementation of System

We integrate different kind of sensors that are installed differently: centralized and distributed. First one is vital sign and cognitive status monitoring by a robot "Watching Owl" (Figure 2) which is placed in a resident's private room. The robot has a camera, microwave sensor, and temperature sensor, which can identify person, measure vital sign, and recognize facial expressions. It can also make a conversation such as greeting and simple chatting, by which it can measure cognitive function and SADL. The measurement of cognitive function is based on the HDS-R.

Second one is location and movement monitoring using RFID. RFID tags are attached to the clothings of residents, such as pajama and shoes to identify their location and movement. They are also attached to the tools such as wheel chair and sticks to identify the usage of tools. RFID reader and antenna installed in the facility to read the RFID tag.



Figure 2: Mimamori-Fukuro (Watching OWL)



Figure 3: Movement Monitoring Result

### Experiment and Evaluation

We conducted a clinical experiment in actual nursing home and a simulated experiment at a laboratory room. For the experiment at nursing home, we installed RFID: 5 antennas at ceiling, and RFID tags at desks, chairs, slippers, and clothing. 1 robot at public area.

Figure 3 shows the gantt chart (left) and radar chart (right) of the person with different care level (upper and lower). Gantt chart shows the movement of resident in a specific day. Each line shows the period the person stays in a specific location, which is recognized as ADL because many ADL is location based. Other ADL and SADL should be recognized by combination of location and vital sign and conversion that are monitored by the robot.

Radar chart shows the social isolation score in three axis: physical activity score, cognitive function score, and SADL score. In the upper diagram, the person spent long time in conversation with other person, which reflects a good score of social activity in the radar chart, the person also gets a good score of HDS-R. On the other hand, the person in the lower diagram spent most of time alone, which results in the poor score at the radar chart.

### References

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