Community Participation Support Using an ICF-Based Community Map

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4: Japan No Lifting Association

Abstract. Social participation is essential for health promotion, but it requires that participation is designed considering each individual's health status, capabilities, and desires, which vary greatly. In particular, a person with a disability may require a detailed individualized plan. In this study, we present a system for supporting the rehabilitation of patients through promoting their community participation. The system has a function for using a smartphone to create a community map based on the codes designed by the World Health Organization - International Classification of Functioning, Disability, and Health (WHO-ICF) [1]. It also has a function that recommends walking routes that take into consideration the patients' physical function and how they wish to participate in their communities. This study describes our practice at Nagata, Kobe, Japan and assesses the effectiveness of this system.

Keywords: Social participation, International Classification of Functioning, Disability, and Health (ICF), person with disability.

1 Introduction

The aging of the population is increasing worldwide. With an aging population, the number of people with a disability increases. Social participation, which means involvement in daily activities and social roles in communities (World Health Organization, 2001), is considered to be one of the best ways to promote health, especially in seniors. However, mental and physical functions tend to be reduced as a person ages, and this can lead to a decrease in social participation. Moreover, lack of social participation results in further reduction of both mental and physical functions. This negative cycle can cause disuse syndrome [2]. To solve this problem and improve the individual's quality of life, there is a need for new technology that supports rehabilitation and daily life, and aides the desired types of social participation.

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2 Concept of an ICF-Based Community Map Based on Canonicalization

Personalization of social participation requires technology that not only matches a person's needs to the locally available social services but also accumulates reusable data on the social participation of many people. Both personalization and reusability are important, since otherwise one person's knowledge of what is good or bad practice cannot be utilized by others. To realize canonicalization, this study uses the code set of the World Health Organization - International Classification of Functioning, Disability, and Health (WHO-ICF) [1], which contains over 1,400 codes. Recently, research using WHO-ICF has been carried out on obesity [3], patients with chronic conditions [4], rheumatoid arthritis from the patient perspective using focus groups [5], and psychosocial features of depression [6]. In contrast to the above research, this paper deals with social participation support for the person with life functions decline by applying by WHO-ICF to a geographic information system [7]. Figure 1 shows the concept of the ICF-based community map. The figure shows the mechanism by which the map created for Place A or Person A can be utilized in Place B or Person B, through canonicalization using the ICF code. For example, Person A is a man who likes playing gateball, which is one of the most popular sports among old people in Japan, and he cannot walk on a steep slope because the range of movement of the joints in his foot is limited. His occupational therapist can recommend the most suitable route for walking to the field where he plays gateball, and the therapist can use the community map to record that route, along with information such as his life

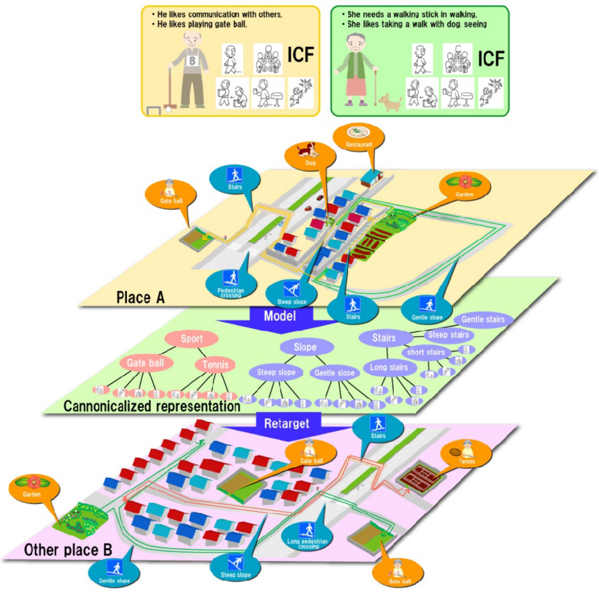

Fig. 1. ICF-based community map (canonicalized for reusability)

functions (physical, daily, and social function), the steepness of the road, and the location of the social event (e.g., a field for gateball). This information is canonicalized using the ICF code and its extension and registered in a geographic information system (the community map system).

Registered data can then be used in a different place by fitting the data into the circumstances of the other place. We call this function "retarget," which is the word used in the field of computer graphics to indicate that 3D motion data of a person has been fitted to a character with a different bone structure. In this research, we retarget life related data via the ICF code in place of a bone structure.

3 ICF-Based Community Map Creation System Using a Smartphone

3.1 Development of an Environmental Information Measuring Application for a Smartphone

In this study, as the first step in building the above community map, we developed a smartphone application for quantitatively measuring and registering environmental information, such as the steepness and distance of a road in the map system.

Fig. 2. Smartphone application for assessing the slope of a local road and registering facilities for social participation

The software we developed works in any Android standard smartphone that has a Global Positioning System (GPS) receiver, a three-axis accelerometer, and a digital compass. This system measures and registers not only information such as the steepness and distance traveled on a road, but also facilities for social participation such as hospitals, restaurants, hair salons, supermarkets, convenience stores, cultural centers, and bus stops. Figure 2 shows our smartphone application and a picture of the actual use of the smartphone with the software.

3.2 Evaluation of the Developed Application

To determine the effectiveness of the map system and the feasibility of a community map, we measured an actual community in Nagata Ward, Kobe, Hyogo, Japan in

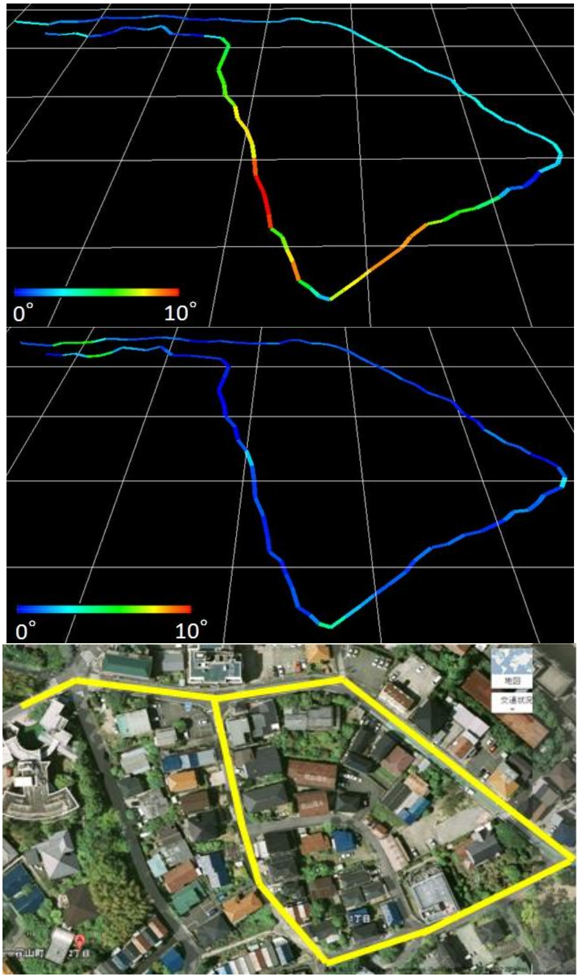

Fig. 3. Example of visualization of the steepness of the slope of a local road. (The top panel shows the steepness of the direction of travel, i.e., pitch, and the middle panel shows the steepness of the crossways direction, i.e., roll.)

cooperation with the Tekiju Rehabilitation Hospital. Figure 3 shows examples of measured and registered road data. The top panel in Fig. 3 shows the steepness of the direction of travel (pitch), and the middle panel of Fig. 3 shows the steepness of the crossways direction (roll). We have thus far measured six walking routes that are used as training routes in the hospital and in the roads that neighbor patients' homes.

4 Development of Walking-Route Recommendation System

4.1 Walking-Route Recommendation System

As a part of the service that we conducted, we developed a route recommendation system that recommends the most suitable walking route based on the patient's desires and circumstances after discharge from the hospital. Figure 4 shows the developed system. This system can recommend a walking route once it has been provided with 1) a walking route used as training in the hospital, 2) start and goal locations, and 3) the range of total vertical distance (patient's burden).

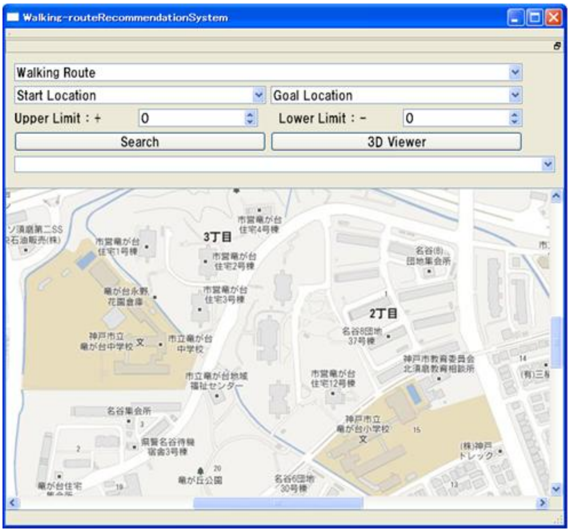

Fig. 4. Walking-Route Route recommendation system

4.2 Algorithm for Walking Route Recommendation

We developed a search algorithm for a walking-route recommendation system. In the algorithm that we developed, we adopted a back-track method that uses a branch-and-bound method. The algorithm considers all route candidates that satisfy the condition for total vertical distance, which is the sum of the absolute values of the altitude differences. The distance works as an important indicator to evaluate the patient's burden in a walking route. Figure 5 shows an example of our algorithm. In this

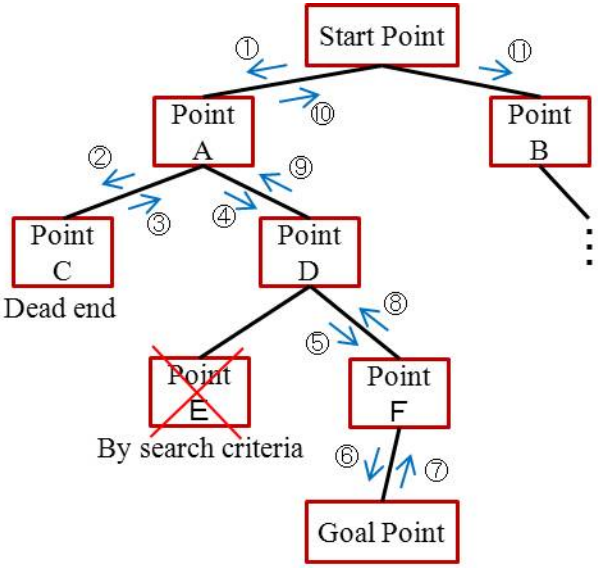

Fig. 5. Example of the search route algorithm

example, the algorithm searches for the ways to begin at “Start Point” and travel to “Goal Point.” During the search, when a dead end is reached, the algorithm returns to the previous point and then continues to search the other candidates. If there are more than two candidates that satisfy the conditions, the present point moves to other candidates.

4.3 Evaluation of Walking-Route Recommendation System

Figure 6 shows an example of a route recommendation. In the case of Fig. 6, the condition are 1) Hanayama1-Chome_1 (total vertical distance: 22.6 [m]), 2) Start

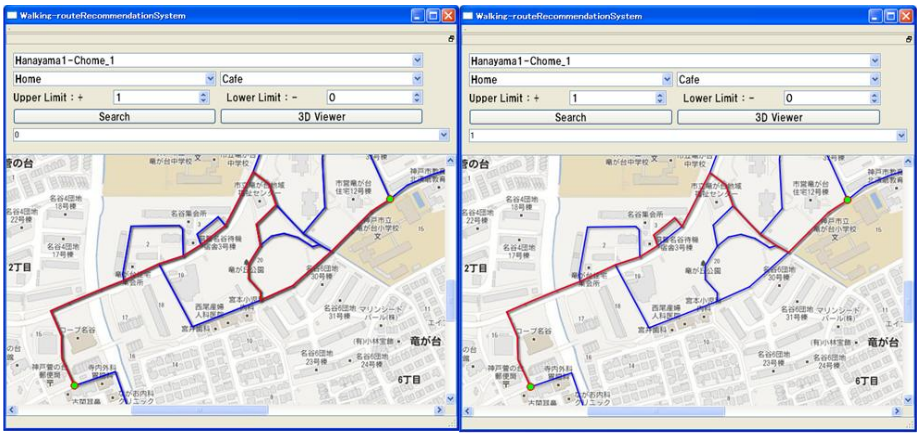

Fig. 6. Example of a route recommendation

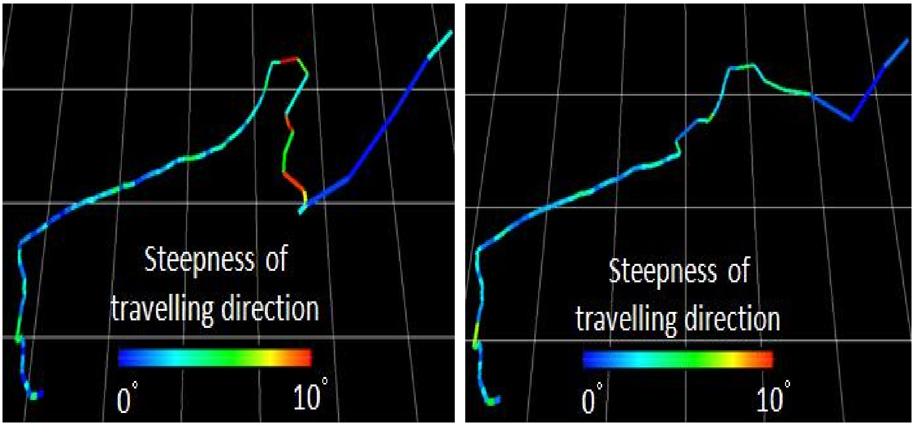

Fig. 7. Steepness in the direction of travel

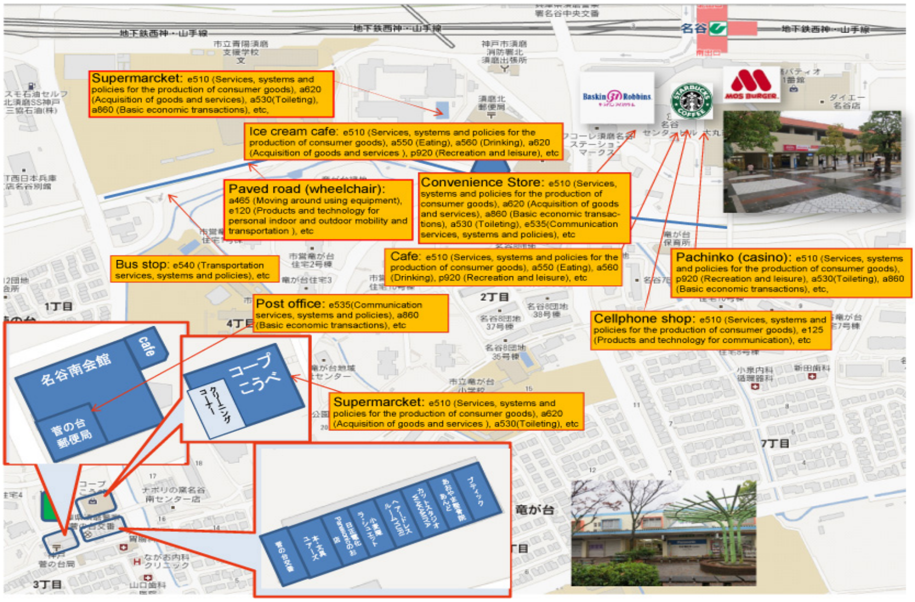

Fig. 8. ICF-based community map that describes various facilities for social participation

Location: Home, Goal Location: Cafe, 3) Range of total vertical distance: 22.6–23.6[m] (Upper Limit: +1 [m], Lower Limit: -0 [m]). The system found two acceptable routes. The first route has a distance of 22.8 [m] and is shown on the left side of Fig. 6. The second route has a distance of 23.0 [m] and is shown on the right side of Fig. 6. Figure 7 shows the steepness in the direction of travel.

Using this system, it is possible for a user to add ICF-code-based information after registering facilities for social participation. For example, for a convenience store, the user can add such information as 510 (services, systems, and policies for the production of consumer goods), a620 (acquisition of goods and services), a860 (basic economic transactions), a530 (toilet), e535 (communication services, systems, and policies) [8]. This kind of information is useful for planning a walking route that improves social participation. Figure 8 shows examples of the registered facilities for social participation around a patient's house.

5 Inquiring Survey on the Usefulness of the Developed System from Physical Therapist of Rehabilitation Hospital

We asked physical therapists at the Tekiju Rehabilitation Hospital about the usefulness of this route recommendation system. The therapists pointed out three advantages. First, the system allows the therapist to conduct a quantitative evaluation of the vertical distance of a walking route. Conventionally, the therapist had to make a walking route based on intuition and experience. Second, this system allows a therapist to conduct a subsequent evaluation of the social participation of a patient after discharge. For example, it can help a therapist understand the reason why a patient may fail to accomplish the intended social participation. In particular, a therapist can determine if a problem is due to a lack of physical ability or if it is due to a lack of commitment. Finally, the system allows a therapist to judge which assistive device is required because the map has information such as road steepness. Here, assistive devices include wheelchairs, ankle foot orthoses (AFOs), and other types of equipment. It is difficult for a wheelchair user to travel on a road that has a large degree of steepness in the crosswise direction (roll). An AFO limits ankle motion, so it is necessary for the therapist to judge the adequacy of the supplementary harness.

6 Conclusion

To prevent disuse syndrome and improve the quality of life of individuals, we developed a walking-route recommendation system that supports rehabilitation and the type of social participation that a patient wishes. We also developed a smartphone application for measuring and registering environmental information, such as the steepness of a road and the distance traveled on a local road. The application has a function that allows a user to create an ICF-based community map using the registered environmental information. To examine the effectiveness of our developed application and system, we measured environmental information in cooperation with a rehabilitation hospital. Experimental results show the feasibility of our walking-route recommendation service, which is based on the ICF-based community map.

In the future studies, we plan to accumulate additional information for the community map and evaluations of recommended routes, in cooperation with a rehabilitation hospital and patients.

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