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Website for Facilitating Collaborative Assistive Technology Provision with 3D Printing Technology

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Abstract: To provide better assistive technology services using 3D printing technology in local communities, a database, Support System for Assistive Technology (SS-AT) was created. SS-AT contains data on various types of 3D printable assistive devices along with tips from experts and users with disabilities. By implementing posting functions, SS-AT allows users to share helpful information with others.

Keywords: Assistive Technology; Digital Fabrication; Community Welfare

Knowledge Focus: Best Practices

Topic Area: Health & Wellbeing; Inclusion

Introduction

Assistive technology (AT) services are essential for adapting assistive devices to the individual needs of users with disabilities. Assistive devices are included as environmental factors in the International Classification of Functioning, Disability and Health (ICF). As the main method for applying an AT service, the devices are selected or adjusted. Good examples of such a method include adapting an input device, such as a keyboard or pointing device, and setting the accessibility features of the software for use with a personal computer. If neither selecting nor adjusting an assistive device is suitable for individual needs, methods of production or remodeling can be applied. Such methods include creating a seating system using casting techniques, and remodeling or producing switches or devices that operate communication equipment, a nurse call, or an environmental control system. However, AT services often depend on the empirical knowledge and experience-based skills of individuals or a regional community.

Introduction (cont.)

Owing to such reliance on individuals, problems related to production and remodeling can arise. In addition, there are potential problems with such production or remodeling methods, including the following:

- The continuity of the service is low because information related to production or remodeling is often not shared among the staff or not transmitted to incoming people.
- If the creation of devices takes too much time and the device cannot be provided to the user in a timely manner, it is possible that the user's quality of life or the ability to perform activities will worsen, particularly for people with progressive diseases or in children with disabilities.
- Methods of production or remodeling typically tend to be costly in terms of money, time, and human resources because they require individual handling or repeated trials.
- The reproducibility is extremely low in many cases, because actual adjustment or measurements need to be performed individually.

To overcome the problems mentioned above, we attempted to apply three-dimensional (3D) printing technology to some actual cases and proposed effective applications (Watanabe, Hatakeyama & Tomiita, 2015). 3D printing technology is a well-known type of digital fabrication that is expected to result in a new value creation. Various case studies have reported the use of 3D printing for prosthetics, self-help devices, and special needs education. In the area of special needs education, case studies have reported the use of 3D printing for supporting STEM applications or developing prototypes of self-help devices for children with physical disabilities (Buehler, Comrie, Hofmann, McDonald, & Hurst, 2016). Moreover, there are also case examples in which 3D printing has been applied to create self-help devices in rehabilitation facilities (Matsuda, Ichiki, Okigawa, Tsujimura, & Murata, 2017) and for the customization of ankle foot orthoses (Walbran, Turner, Mcdaid, & Meng, 2016), as a specific example. Accordingly, the development of human resources in the area of digital fabrication, including 3D printing technology, is necessary, and the activities in this regard have begun to be applied in various parts of the world (McLennan & Pasumarth, 2018).

To provide better AT services with implementing such technology in local communities where users with disabilities live, a training program for learning the effective use of digital fabrication for AT services was planned, as shown in Table 1 (Watanabe, Tahara, & Kanamori, 2019a). The program can be classified into four categories: technique of digital fabrication (T), knowledge of disabilities (K), manner of adaptation for an individual user (M), and experience of a team approach for AT services with a user (E). Category T contains four subjects; the use of 3D-CAD, methods for digitizing any shape (e.g., using a 3D scanner), the use of digital machine tools (e.g., a 3D printer), methods of data conversion depending on the digital machine tools applied, and methods for handling and maintaining digital machine tools. Category K includes comprehension regarding the impairment, disabilities, and handicaps of different types of users,

the sharing of independent living conditions of users with their community, and knowledge regarding the social welfare system. Category M includes the importance of providing suitable devices for users with disabilities, comprehension regarding their functions, the use of assistive devices (e.g., self-help devices) and ways to adapt to them, and comprehension of the skills of AT experts. Category E includes case studies, fieldwork, and outreach activities of AT services. The programs were created based on these contents, and experimental hands-on workshops have been conducted in various locations (Watanabe et al., 2019a). The results are promising for the development of human resources that can perform AT services by remodeling and producing for users with disabilities in local communities. The hands-on workshop, using digital fabrication, provided an opportunity for users and their supporters to create community activities in AT services.

Table 1. *Contents of Training Program for Learning Digital Fabrication for AT Service*

Category		Contents
T:	Technique of digital fabrication	1. Design methods for assistive devices using 3D-CAD application software. 2. Methods of digitization for AT service and conversion methods of digital data. 3. Modeling methods of assistive devices using digital machine tools. 4. Methods of handling and maintenance of digital machine tools.
K:	Knowledge of disabilities	1. Comprehension of users with different types of disabilities. 2. Comprehension of independent living of users in their community.
M:	Manner of adaptation for an individual user	1. Comprehension of functions and utilization of assistive devices. 2. Skills to adapt assistive devices to individual user needs. 3. Comprehension of skills of AT experts and specialists.
E:	Experience of a team approach for AT service with a user	1. Brainstorming regarding AT and user needs. 2. Practice experience of assistive technology services.

To implement AT services using digital fabrication in each local community, Support System for Assistive Technology (SS-AT), an online database of 3D printed assistive devices, was created using a cloud database (Watanabe, Iwabuchi, Tejima, & Ueda, 2019b). SS-AT was created using the API of Airtable[1], which is a cloud-based database application. As a cross-

platform website, SS-AT can be accessed on any OS or hardware. SS-AT is directly accessible from https://ss4at.nanalabo.co and at its present stage contains various types of 3D-printable files, including joysticks for operating electric wheelchairs and pointing devices, straw clips, keyguards, and self-help devices, etc. (SSAT, n.d.). Each item in SS-AT contains not only 3D printable files on assistive devices, but also tips based on experience from experts (e.g., AT specialists, therapists, designers, and developers), as well as user feedback, including from users with disabilities, related to advice on adaptation, design and printing. Such empirical information helps provide suitable AT services.

Furthermore, the system continuously requires practical follow-up activities that allow the workshop participants to utilize the knowledge they have gained, as well as the opportunities to learn more about the services. In other words, the next step is to provide practical follow-up activities that will allow the participants to use the knowledge they have gained in the workshops. In this study, SS-AT was implemented using functions that enable the posting of comments for the workshop participants.

Methods

SS-AT was implemented with the three posting functions shown in Figure 1: “Posting tips,” “Platform for discussion,” and “Sharing ideas.”

Figure 1. *“Posting tips,” “Platform for discussion,” and “Sharing ideas.”*

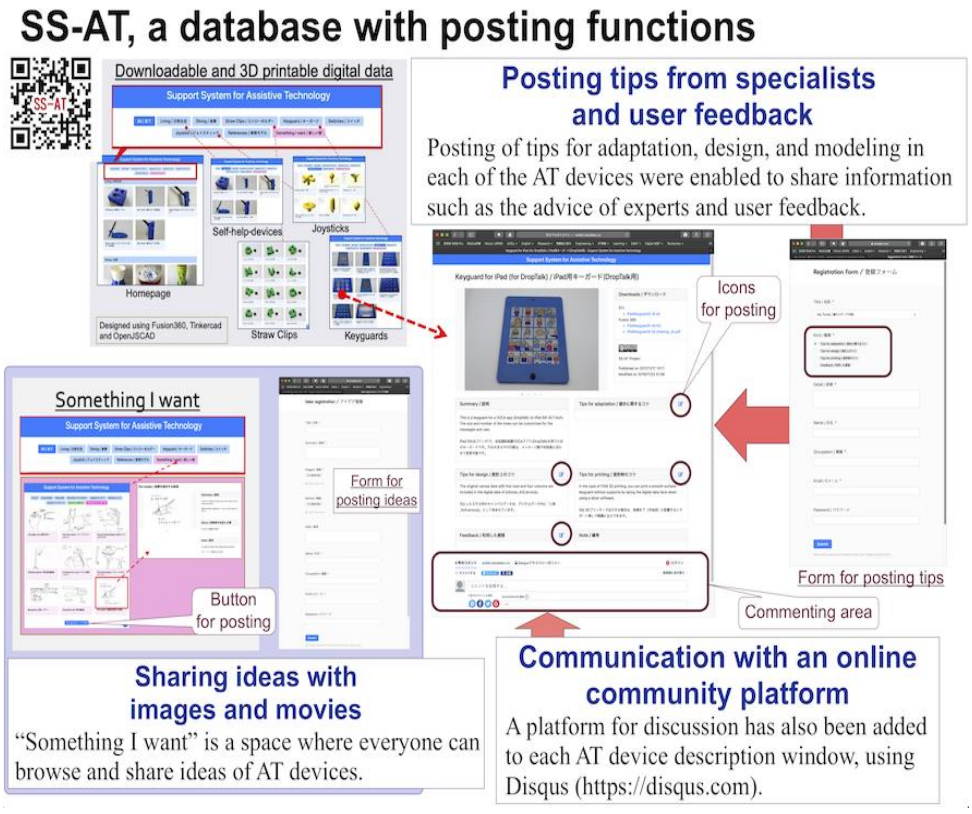

Figure 1. Image Description: Image represents how SS-AT was implemented with three posting functions: posting tips from specialists and providing user feedback, communication with an online community platform, and sharing ideas with images and movies. SS-AT is directly accessible from https://ss4at.nanalabo.co and by using the QR code shown in the figure (SSAT, n.d.). Figure 1 includes four different images representing the descriptions previously mentioned.

Posting Tips

"Posting tips" is a function that enables the workshop participants as well as experts to post tips for the adaptation, design, and modeling of all AT devices. A form for posting tips was created in Airtable using a feature called "Airtable forms." This function allows SS-AT to collect information from any user and save it automatically to the Airtable database of SS-AT. If the posting icon provided on each AT window is clicked, a form pops-up allowing users to write their tips for the adaptation, design, and modeling of each of the AT devices and to share useful information, as shown in Figure 1.

Platform for Discussion

"Platform for discussion" is a function for exchanging information through comments, and was added to each AT device description window using Discus[2], as shown in Figure 1. Discus is a commenting system for websites. The workshop participants and core members of the SS-AT project can post comments. The core members are rehabilitation engineers, occupational therapists, physical therapists, and software engineers with AT service experience. Posts made by the workshop participants are published after an evaluation by the core members. Because the aim of this study is to build collaborative AT services through a relationship of trust, the comments are also accompanied by the name and occupation of the author.

Sharing Ideas

The "Sharing ideas" function was implemented as a content called "Something I want." "Something I want" is a space where anyone can browse and share ideas regarding assistive devices, as shown in Figure 1. As with "Posting tips," If the icon for posting on the "Something I want" page is clicked, a form for allowing the posting of ideas pops up. In addition, the title and a summary of ideas with handwritten sketches, images, and movies related to the idea are enabled in the Airtable database of SS-AT. This function allows all types of collaboration between the workshop participants, resulting in the production of assistive devices based on these ideas.

Results and Discussion

Starting in October 2018, hands-on workshops have been conducted four times throughout the country during the last two years in Aichi, Shiga, and Okinawa prefectures in Japan. A total of 72 people have participated. The participants consist of 16 special needs education teachers, 11 AT users, 11 rehabilitation specialists (OT, PT, and PO), 9 local

volunteers, 6 care professionals (caregivers and welfare officers), 4 parents, 3 technical professionals (engineers and designers), 7 AT suppliers, and 7 others. During and after the workshops, we encouraged the participants to post comments and upload their ideas using the posting functions implemented in SS-AT. As a result, 48 ideas were uploaded to “Something I want” and some comments were posted from the workshop participants. Some example feedback from the participants on these functions is as follows:

- We can share various ideas and unexpected concepts (a local volunteer and a grad student).
- I would like to be able to post comments using a smartphone (a teacher).
- I think it would be better to provide a structure that lets us work collaboratively to develop an idea into an actual assistive device (a prosthetist).
- The comments were extremely helpful in letting us know the practicality among a range of assistive devices (an occupational therapist).

In the implementation of the posting functions to SS-AT, it was expected that the participants could actively apply the experience of others to the AT service in the local community as well as the knowledge they gained during the workshop. Moreover, it convinced us that these functions can facilitate the AT services as well as the creation of user-oriented assistive devices in collaboration with one another.

Conclusion and Future Work

This study involved the creation of SS-AT, a database that enables participants to post their experiences and share knowledge and ideas with others and to provide AT services using digital fabrication. The practical effectiveness of SS-AT will be verified through a continual trial use, which will help improve the site and make it more user-friendly, while ensuring the use of an open-access system. We have a plan to release SS-AT as a searchable website within 2020. In the future, we will aim to build an international, face-to-face AT service using SS-AT, and we hope to contribute to community-based AT services in cooperation and collaboration with distant regional communities.

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Endnotes

1. See https://airtable.com
2. See https://disqus.com