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Experience Report of a Blind Gamer to Develop and Improve the Accessible Action RPG ShadowRine for Visually Impaired Gamers

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Abstract

Computer games are becoming increasingly diversified. The lead author of this paper first encountered them early in elementary school. One of the authors recalls quite often having had fun playing games with his neighborhood friends, who were healthy individuals. He, however, was completely blind essentially from birth, which made it impossible to visually recognize screen displays or to play any game at a satisfactory level. Visually impaired persons, including him, have had to deal with barriers in computer games, which are extremely difficult to overcome, in order to play computer games. Therefore, our group decided to embark on the task of developing a game on their own that could be enjoyed to the satisfaction of everyone, regardless of visual impairment. This report describes the sequence of events that led to the development of an action role playing game (RPG) that can be played by sighted and visually impaired persons alike, as well as the development process and the details of the finalized game.

Keywords

Visually impaired persons; inclusive game; integrated game development environment for the blind

Introduction

Computer games are becoming increasingly diversified; they are popular in a variety of formats, such as commercial arcade games, home console games, and personal computer games. The lead author of this article first encountered computer games early in elementary school. One of the authors recalls quite often having had fun playing games with his neighborhood friends, who were healthy individuals. He, however, was completely blind essentially from birth, which made it impossible to visually recognize screen displays or to play any game at a satisfactory level. Sighted persons are able to visually recognize information displayed onscreen that indicates the status of the game, such as maps or text. Totally blind persons must instead rely primarily on auditory information to discern what is occurring onscreen. These circumstances made it necessary for us to devise means for understanding the status of a game by associating the sound effects and background music with game status or by memorizing the sequential arrangements and hierarchical structures of menus. Furthermore, one of the authors with visual impairment required the collaboration of sighted friends to play games that contained scenes where progress was not possible without obtaining visual information.

Despite all such playing tactics and published accessibility guidelines (Miesenberger et al. 247-260; Porter, and Kientz 3:1-3:8; Yuan, Folmer, and Harris Jr. 81-100) and studies to create accessible game for visually impaired people (Dobosz, and Ptak 523-529; Archambault, and Olivier 450-453), there were few games that gamers with blindness could play relying solely on sound. The determination of whether any given game could be played using solely auditory information could only be made by verifying each game in a painstakingly elaborate manner. The search for games required gamers with blindness to play the demonstration versions of the games, refer to official game websites, and rely on information provided by friends.

Furthermore, recent games have progressively higher visual resolution and enhanced definition, while there is an increasing trend in games of obliging players to acquire visual information. Visually impaired persons, including one of the authors, have had to deal with these barriers, which are extremely difficult to overcome, in order to play computer games.

However, there has also been progress in developing games intended for visually impaired persons. A report covering games that can be played by visually impaired persons, on their own or with assistance of others, was featured by the website AudioGames.net (AudioGames.net). Information on games for visually impaired persons that can be operated in a screen reader environment, primarily by using auditory information such as sound effect cues, and audio games was gathered from around the world. The author with blindness became aware of audio games and began playing them around the time he advanced to junior high school. At this point, he no longer simply played the games but started to develop them on his own, relying on information provided by more senior students at school, as well as by the Internet. In high school, the author established a computer club with friends and developed games with several people. These games were enjoyed via the Internet by users with visual impairments, but it was difficult for sighted individuals to actually enjoy playing games that could be played solely by relying on sound. The author therefore continued to play ordinary computer games with friends with normal or weak vision, in addition to playing and developing audio games.

Much ingenuity and effort are required of visually impaired persons to play ordinary computer games conversely (Miesenberger et al. 247-260; Porter, and Kientz 3:1-3:8; Yuan, Folmer, and Harris Jr. 81-100; Dobosz, and Ptak 523-529; Archambault, and Olivier 450-453), it is difficult for sighted persons to enjoy playing games that are developed for visually impaired persons. Therefore, it has been difficult for visually impaired persons like the author to play the

same games as sighted persons and to share common topics of conversation. Therefore, we decided to embark on the task of developing a game on his own, that could be enjoyed to the satisfaction of everyone, regardless of visual impairment (Matsuo et al. 303-312; Matsuo et al. 537-544). This report describes the sequence of events that led to the development of an action role playing game (RPG) that can be played by sighted and visually impaired persons alike, as well as the development process and the details of the finalized game. The definition of role playing game in this paper is the game that players act the role of main characters in a fictional virtual world.

Discussion

Preparation of Development Environment

Sequence of events that led to development

One genre of games that visually impaired gamers had been unable to play without using visual information was action RPGs. Such games require instantaneous decisions based on information displayed on the screen; operations must be performed based on understanding on the field of the game and positional relationships with opponent characters. The leading author was unable to play action RPGs at will for this reason. This study, therefore, was intended to develop a real-time action RPG, which had in the past been difficult for visually impaired persons to play. We intended to create a game that incorporates elements belonging to the computer games that he had previously been unable to play, despite a strong desire to, and to create a novel system for arranging audio games such that visually impaired and sighted persons can play. Figure 1 shows the overview of the developed game. This figure includes a game screen, and a tactile display (KGS Corporation DV-2).

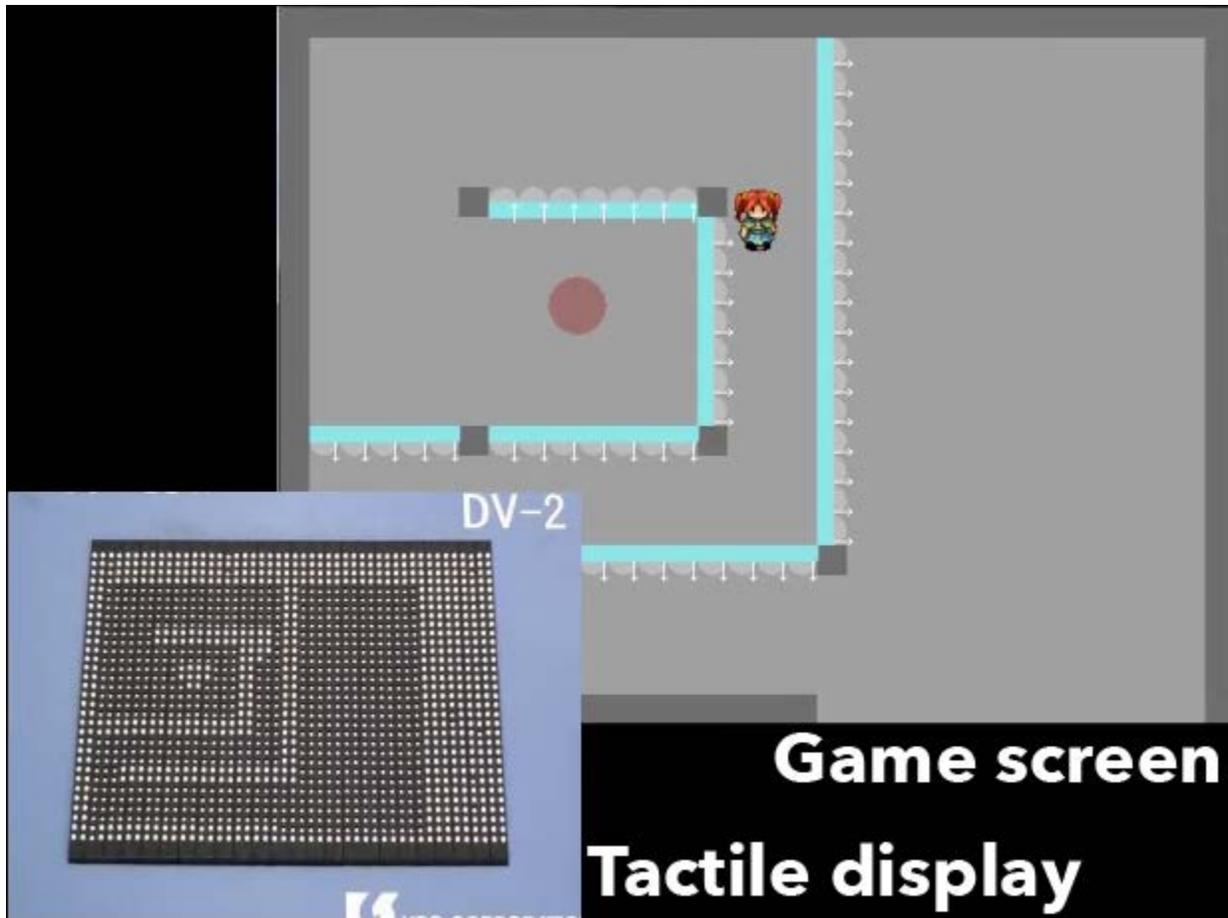


Fig. 1. Game View and Its Presentation on a Dot Matrix Display.

An environment designed to accommodate the development of an action RPG by a visually impaired person, however, did not exist. A decision was made to set up an environment intended for the development of an action RPG that could accommodate development by visually impaired persons. Of particular necessity was a map editor, necessary to prepare fields of the game, for visually impaired developers, which did not previously exist. Thus, a map editor that enables a developer to prepare two-dimensional maps by listening to sound was developed.

Summary of Development Environment

The implementation of the game development environment was conducted entirely by one of the author, who is a totally blind individual. The other authors played a role to mainly advise the design implication including user interfaces, and evaluation scheme of the game. The programming language selected for game development using a screen reader was the Hot Soup Processor (HSP) (HSPTV!). This programming language was used to develop the game's basic algorithm. Additionally, the text displayed by the game was prepared using Otonove (Otonove), which one of the authors had developed previously. This tool was developed using the HSP and can be used even by individuals who have visual impairments. Otonove makes it possible to prepare sound novel games (sound-based adventure games played primarily based on text information) by combining text information with available options, as well as sound effects. The development of text content for this RPG was simplified by incorporating such content into the algorithm for displaying portions of the story in the game.

Sound effects, background music, and graphical elements were selected from materials available on the Internet, either free or for a fee. We selected the processing methods and the allocation of background music and sound effects using free software that operates on the Windows operating system. Since there was a limit to the extent that game displays can be developed by a totally blind individual relying on a tactile display, collaboration was obtained from friends with weak or normal vision. Instances where the combination of background and character colors made it difficult to visually distinguish the two or where the character and wall positioning were misaligned were pointed out. Improvements were implemented together with visually impaired gamers. These people also provided their collaboration in selecting and assigning illustrations for characters and background images.

Furthermore, the Fullvoice Edition of the game, which is its latest version, incorporated human voice actors for conversations of characters in the game. Amateur voice actors were selected from among those who are active on the Internet.

Map Creation Tool AudibleMapper

AudibleMapper is a tool for creating fields that supports accessibility for totally blind persons. The programming language selected for development using a screen reader by totally blind persons was the Hot Soup Processor (HSP) (HPSTV!). This tool conveys the position of the cursor on the screen and two-dimensional fields are drafted through keyboard operations. The conditions under which a totally blind person drafts a map using this map editor is described in Figure 2. First, the map is surrounded on four sides by a wall (Figure 2, Left); then the walls are arranged according to the image of the map to be drawn (Figure 2, Center); and finally objects, such as treasures, are positioned (Figure 2, Right). The red circles in the figure are the cursor for editing. In Figure 2, Left, the field was surrounded by walls. In Figure 2, Center, a road was prepared by at the end of a branching road. In Figure 2, Right, additional road and a treasure were placed.



Fig. 2. An Example of Drawing Using the AudibleMapper.

Specific descriptions of the development operations are provided. Cursor positions were moved according to the directions of arrow keys on the keyboard using this editor, while the walls and waterfronts, as well as tiles such as a lava flow or objects such as treasure chests and

doors, were freely arranged using alphanumeric keys. Types of tiles and objects can also be arbitrarily added, as needed. The range of cursor movements was also selectable and objects located within a selected area can be processed together. A range selection can be made within an area of a square shape, by moving the cursor while the Shift key is pressed down, starting from the starting point for the range selection and then releasing the key. Batch processes can be performed within a region; wherein identical objects can be added or deleted.

The sound for indicating the current position of the cursor was varied in order to enable the user to gain understanding of the current cursor position. The horizontal positional information indicator for the cursor utilizes the asymmetry in sound volume level between left and right, making it possible for a user to gain an understanding of the horizontal coordinates on the screen based on auditory localization. The vertical positional information indicator for the cursor utilizes the difference in the sound volume, making it possible for a user to gain understanding on the vertical coordinates on the screen. Understanding the entire map is possible with the help of sound effects alone, by tracing over the entire map by moving the cursor position. The change in sound pressure that occurs as the cursor position is changed was set to 2 dB or higher in the horizontal direction based on reports provided by Hafter et al. and Yost et al. (Hafter et al. 829-834; Yost, and Dye 1846-1851), while it was set to 1 dB or higher for movements in the vertical direction based on reports by Miller (Miller 609-619). The map tool was also set to replay various sound effects, depending on the positioning of the tiles. We employed not three-dimensional spatial acoustical presentation method but two-dimensional presentation method because the employed method was suitable for the purpose. Concretely, the 3D presentation method present surrounding acoustical field that a listener is virtually located at the center while 2D method can present absolute positions of a cursor and various objects on a map. Moreover,

because 3D presentation method can be utilized by the head-related transfer function (HRTF), the position of localized sound image varies between individuals (Wenzel et al. 111-123).

An example of the game map, prepared according to the flow described in Figure 2, is shown in Figure 3. A map prepared with the assumption that players make intuitive movements (positioning and routes are easily understood) is depicted in Figure 3 (a) and a map prepared with the assumption that players perform searches (positioning and routes are difficult to understand) is depicted in Figure 3 (b), while Figure 3 (c) depicts a field prepared with the assumption that players must consider methods for acquiring the treasure chest. These are used in the game as a section of a town, a dungeon, or a field in which an item is hidden, respectively.

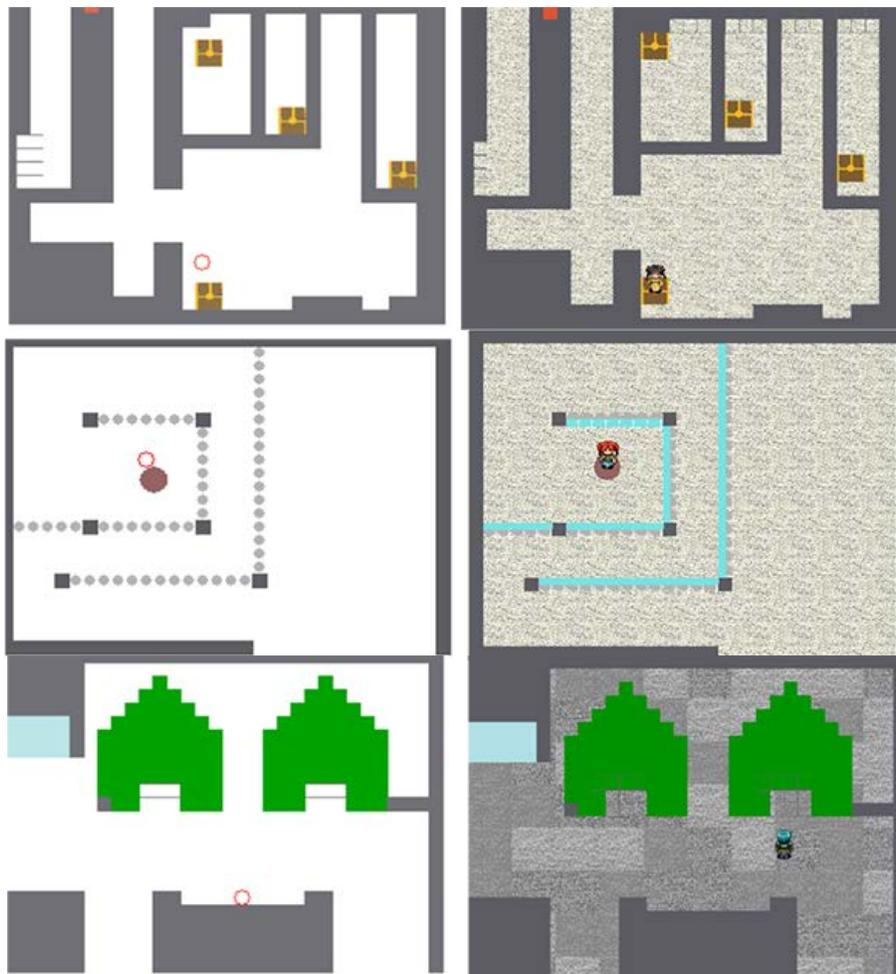


Fig. 3. AudibleMapper (Left) and Corresponding Game Maps (Right)

All game maps were drawn quickly and efficiently by a totally blind person using this editor. The conventional procedure involves entering numerical values directly into the program screen to prepare a map, which makes it difficult to achieve detailed placements of objects and complicates source code, requiring dozens of minutes to prepare a single map. Preparation time is shortened to just dozens of seconds or a few minutes by using this editor, however, which improved work efficiency. A totally blind person using this tool to develop an action RPG prepared about 500 sets of maps comprised of 32 horizontal and 24 vertical cells. A field viewer for verifying game screen details, based on the map editor, was also incorporated as a base component of the game. This function is intended for understanding the game status when it is being played solely based on sound. Visually impaired persons using this function, who are proficient with a variety of games, are now able to proceed with their game while gaining an understanding of the map and their current position.

The Developed Game, *ShadowRine*

Game summary

ShadowRine is a tactile action RPG that can be played by both sighted and visually impaired persons (Though the author firstly named it ShadowRun that meant “run in the dark,” there was a game with the same name. He then alternatively chose “line” and called ShadowLine that meant “trace on lines in the dark.” However, he wanted to leave subtle nuance of “run,” decided to use “R,” and finally named ShadowRine.). The game was developed with the aim of creating an action RPG that can be enjoyed by both visually impaired and sighted persons alike, for their satisfaction as well as to enable them to share conversations relating to the game. The game was designed in such a way that all information relating to the details of the screen can be obtained using sounds and tactile information (Figure 1). Sighted persons perform operations

while visually verifying information displayed on the screen, much as in conventional action RPGs. Visually impaired persons, on the other hand, perform operations by relying on auditory information and tactile sensory information. A game that clearly secures accessibility of auditory and tactile sensory indicators while offering finely detailed visual scenes had not previously existed. The game operates on Windows and has been packaged to perform multimedia processes using Direct X. Text information provided by the game can be read out using a screen reader; the game also supports screen readers that are capable of automatically reading out clipboard contents, as well as such representative screen readers as NVDA or SAPI. The use of a tactile sense display makes it possible for a player to determine the status of the screen tactilely, in real time.

Game flow

The basic operation of the game involves the vertical and horizontal movement of a character, who represents the user, in a two-dimensional field, much like conventional action RPGs. Sites where progress is possible and those where it is not possible, as well as enemy characters that attempt to prevent the character's progress using a variety of methods, are positioned on the field. Users proceed with the game by either avoiding such enemies or defeating them with weapons. New characters that have different functions or characteristics become operable as the game progresses. Such characters contribute to the expansion of the field in which adventures can unfold, as they are capable of performing such activities as jumping over valleys or swimming across rivers and lakes. The game contents include conversations between characters and the users can proceed with the game along the flow of the story.

Users may select from three levels of difficulty, ranging from beginner to advanced, so that all players can enjoy the game. As shown in Figure 4, a tutorial mode intended for beginners,

which shows operations while explaining how to play the game, was also made available. The advanced level featured sub-events (elements that have no relevance to the main thread of the game, which can be pursued by a player) that involve discovering treasure chests hidden in various locations to accomplish achievements requested by a non-player character, as well as special elements that are added on depending on the player's performance in clearing game stages. The time required to clear all game stages is about ten hours. The situations of each view and the meanings of the Japanese texts in each view are as follows. a) Single road: Pass this field, and aim at the north. b) Branch road: This area has a branch. You should not get lost! c) A road that a player need to dash: Don't stop using the "dash" action to go to the opposite shore. d) A field with monsters and items: When you destroy objects or defeat enemies, items sometimes appear.



Fig. 4. Four Example Views of the Tutorial Mode.

Auditory and tactile information indicators

Information on the screen is indicated using a diverse range of sound and other effects, which are fed by connecting stereo speakers and headphones to the computer. Gaining understanding of the positional relationship between enemy characters, treasure chests, and the player's characters was made possible using the interaural difference of the acoustic volume between left and right to indicate range in the horizontal direction, as well as differences of sound pressure level to indicate range in the vertical direction. Furthermore, dedicated sound effects were incorporated to prompt the user about locations of objects, as well as a surround sound viewer function that conveys bending angles using the sound of the wind.

Connecting a tactile display to the computer makes it possible to perform operations while touching the game screen (tactile observation playing), as shown in Fig. 5. All screen information provided in the game —the positional relationships of playable characters and enemy characters, field locations where movement is possible and where it is not— are also provided by binary means that varies depending on whether the location is up or down in relation to the pin. Such information is indicated in real time, enabling the player to easily and immediately discern the status of the field. Using the dot matrix display, a player with blindness can selectively understand the positions of a) all the objects including monsters, items, the player's character, and the current field, b) only the player's character, c) only the monsters, and d) only the items. As shown in views b), c), and d), the dot matrix display always shows positioning indicators at the left edge.

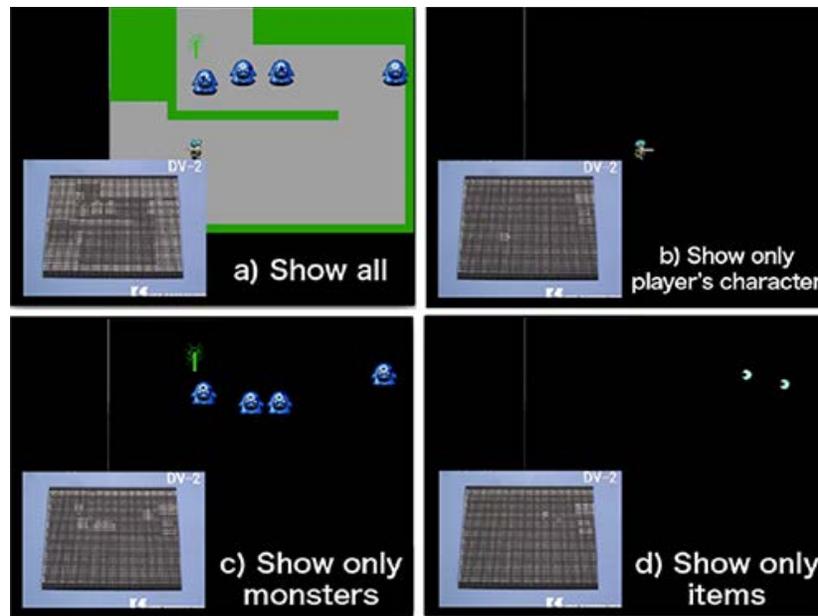


Fig. 5. Game Views and Corresponding Presentations on a Dot Matrix Display.

Number of Downloads and Reactions from Players

ShadowRine was freely distributed on a website beginning on February 9, 2014 (ShadowRine). The game became a focus of attention as an action RPG that visually impaired persons can enjoy playing and has been downloaded 2,508 times as of November, 2015. An anonymous survey addressing users that had played the game was conducted at the game's distribution site from June 11, 2014. The survey question items consisted of two formats: those that requested an overall evaluation on the fun and user-friendliness of playing the game rated on a five-point scale and those that requested free descriptions of the positive and negative aspects of the game. This resulted in responses received from 99 individuals, with 63 of those responding rating the game with a score of 5 (Extremely fun to play), and the average and median of the score were 4.6 and 5.0, respectively.

The free-form comments indicated that experienced game players that are visually impaired generally offered highly positive evaluations, indicating such positive aspects of the game as the broad range of fields, the long stories, the crossroads set up in the story, difficult

dungeons, and the presence of deviating paths that include elements like item collection.

Beginning game players that are visually impaired, on the other hand, offered opinions suggesting that the field being too broad causes the player to lose track of their present location, the unclear meaning of system sounds, or the difficulty in achieving such action movements as jumping over a valley. Issues derived in this manner were addressed by improving the field viewer through version upgrades, extending the tutorial mode, and adding a sound effect when a character jumps.

Although the survey was made available in Japanese only, there were still 38 responses provided by visually impaired persons from outside Japan. (This is based on tabulation that identified countries of origin for accessing the survey to be outside Japan.) Their comments included requests for future games, as well as a desire for an English translation of the game. Information relating to the game was also featured by AudioGames.net (Shadow line Full voice, AudioGames.net), which made it evident that the game was also enjoyed by visually impaired persons in English-speaking regions. An opinion that expressed the pleasure of having disabled and able-bodied persons play a game together was also posted on the user exchange bulletin provided on the game distribution site.

Version upgrades of game

The game had been played by many people, as it was made available on the website and offered at exhibits. Improvements are still being made based on user feedback. The current version of the software, as of May, 2016 is 3.12; there have been 30 version upgrades so far. A summary of details of the version upgrades, in particular relating to the game system improvements made based on requests from users, is provided in this section.

This paper describes details of the Fullvoice Edition, which is the current version of the game software. The former version, released on September 29, 2012, had also undergone seven version upgrades. Two issues relating to playing the game by relying primarily on tactile observations were cited as for the development of the initial version of the Fullvoice Edition. These two aspects consist of the one regarding the fact that all displayed objects tend to become connected on the screen and become individually indistinguishable in fields where there is a concentration of locations through which movements are not possible, such as walls, as well as enemy and operated characters, which cannot be readily memorized by beginners of the game, causing them to lose track of their current position. These problems arose due to the fact that the game system did not support a blinking pin indicator or due to the low resolution of the dot diagram display. Improvements were made on these issues by incorporating a navigation function that is capable of individually indicating operated characters and enemy characters.

Issues relating to sound play were also mentioned. Opinions posted on the user exchange bulletin board included those that suggested that structures, such as positions of walls within fields, were difficult to understand. A field viewer was incorporated in the game to address this issue. This function is an application of the program used to prepare fields during the development of the game by a totally blind person. It notifies the user the positions of the walls and objects inside fields by indicating cursor position using sound. The opinion that suggested that the jumping operation for leaping across valleys was difficult to perform was addressed by extending the contents of the tutorial, combined with the improvement made by adding a sound effect that is emitted while the character is jumping to warn the player of the danger zone. The opinion that pointed out that it was difficult to keep track of what each sound effect meant

because a lot of sound effects were played back from the initial stages of the game was addressed by adding a function for trial listening of sound effects while running the tutorial.

When this game was available only in Japanese, overseas users have indicated their desire to see this game translated into English. Currently, an English language translation of the game text had completed and English version of the game has just released on October 2016 (ShadowRine Official site; Matsuo et al. 2826-2827). Other than those described above, efforts are being made through the extension of the game by incorporating more sub-events and adding more elements, as well as implementing bug fixes.

Conclusions

One of the authors with total blindness developed an action RPG that can be played independently by either visually impaired or sighted persons, based on his experience as a player of games for visually impaired persons. This RPG can present various game information acoustically and tactually as well as visually. The game was released on the web and is being played by users around the world. This game has undergone several upgrades to implement improvements based on user feedback that modify the game to be more enjoyable and easier to play.

In the future, we intend to utilize the method for discerning game status through auditory and tactile senses that was achieved in the development of this game to develop action games with even faster indicator times that can promote collaborative playing between visually impaired and sighted persons. A field preparation tool for visually impaired persons to develop games on their own was developed and more improvements will be implemented to the map editor in the future, to make it possible for visually impaired persons to draw maps more efficiently. Verifications will be performed to ensure that visually impaired persons can use the

map editor to prepare maps and gain an understanding on maps representing actually existing topographies as well as routes plotted to the intended destinations. Such efforts are expected to make it possible for visually impaired persons to gain understanding on information regarding two-dimensional planes such as maps relying solely on sounds. This should enable visually impaired persons to draw a variety of maps on their own.

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