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Empowering Users to Game Development Platform for Visually Impaired Students

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***Abstract*— Computer-exercise game is well served for visually impaired students to engage their physical and mental health exercises. However, these type of games are increasingly unchallenged for long-term usage due to apathy patterns and restricted contents. In this paper, we describe how such drawbacks can be avoided by offering the game development platform. The platform provides a service-based architecture, which empowers teachers to build or to customize numerous game designs for entertainment and learning purpose without jeopardy. Based on our evaluation study, we found evidence that teachers of visually impaired students are satisfied with the game development approach in terms of system reliability and software usability. In addition, the teachers also have very good perception in the aspects of trust, responsiveness, applicability, usefulness and enthusiasm toward the game development approach.**

***Index Terms*— Empowering users, active game, game development platform, service-based architecture, visually impaired students.**

I. Introduction

Motivating human-computer interaction through computer-exercise games [1] also known as active games, which is considered as an effective way to improve both physical and mental health of visually impaired students. However, due to apathy patterns and restricted contents, the deploying of this type of games in practice, such as on a regular basis in schools, can drive their teachers in agony. Since students get familiar with certain games, accordingly teachers have to create a new one to replace them. In fact, this is a tedious work, which can lead to the deteriorate use of the games in schools. We argue that for non-complicated audio games where auditory and textual designs are the prime focus, their pattern and content can be changed or adapted by non-expert users or programmers. To do this, a specialized game development platform which is giving power to the users or programmers is crucially needed.

In this paper, we present the service-based architecture for non-sighted game development. The main goal is to provide a game authoring platform that can facilitate full-sighted teachers to compose software and hardware units needed for building audio-based games at ease. Then, this development platform will play a key role of supplying adequate game resources for pursuing a regular schedule of physical exercises to visually impaired students in the school environment.

In essence, two key contributions are focused in this paper:

a) An insight of user-driven game authoring platform and its architectural design.
b) A discussion of relevant evaluation study.

The rest of this paper is organized as follows. Section 2 presents related work. Section 3 discusses the architecture for game design platform that is capable of composing local software and hardware units. Section 4 illustrates possible audio-based games designed for visually impaired students. Section 5 evaluates the results obtained from participated teachers in our pilot study. Finally, section 6 concludes the paper.

II. Related Work

This work is related to the field of active game, which has been extensively used in many contexts [1], for examples, in the education context for improving cognitive learning process and logical thinking skill of children, in the medical rehabilitation context for motivating consecutive recovery of motor function to patients and in the entertainment context for promoting exercises to visually impaired students. Nonetheless, regular replacements of games will be needed in order to avoid the incurred boredom of users in repetitive game contents. However, users will struggle to find suitable ones from a limited set of specific games in this niche market of game industry, where little or no incentives are provided to game developers. Hence, to ensure a flawlessly long-termed maintenance, users must be capable of building their own games, or managing them at some certain level, instead of relying merely on any game programmers. In this regard, the end-user programming approach [2] looks promising, but it must be equipped with some powerful development platform for non-programmers.

We are convinced that graph-based workflow authoring platforms proposed for Mashups software composition on the Web [3] are fitted well to our purpose. In fact, these Mashup tools, like Yahoo Pipes [4] and jOpera [5] are inadequate for supporting delay-sensitive games, due to the inherent limitation of pull-based web service composition [6]. In addition, the evitable demand of web server obviously introduces a burden of tasks and extra-cost in game deployments. Nevertheless, the visual development approach on user-editable objects for service composition is attractive, particularly in the form-based service composition method as described in [7]. To the best of our knowledge, this method has never been applied so far in the active game context,

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especially for serving people with visual disabilities.

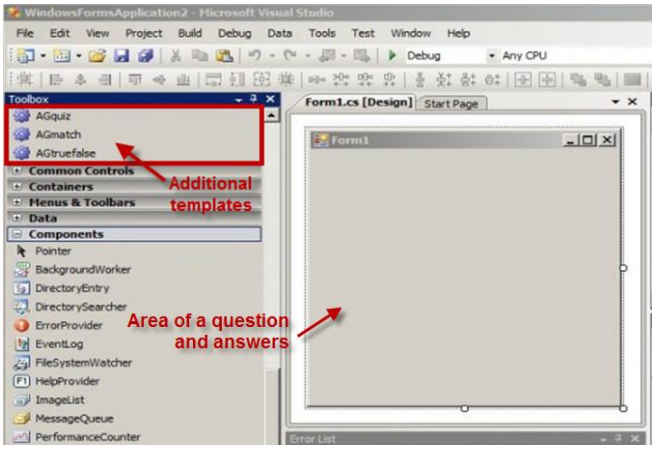


Fig. 1. The layout of game development platform.

III. Proposed Game Development Platform

In essence, we consider the form-based style of service composition in visual programming environment as a key enabler for easily combining both software and hardware services in games of which prime modality is audio. Our first prototype is realized through a visual development platform using Microsoft Visual C# and .NET framework as shown in Fig. 1. Newly custom-built icons representing 3 different game templates (*AGquiz*, *AGmatch* and *AGtruefalse*) are added to the top of Toolbox palette so that the usability feature targeted to full-sighted users and non-programmers can be achieved. So, only three simple steps are required for building executable audio-based games; a) Dragging the icon, b) Dropping it on the application template, and c) Starting to fill in the form. While these form-based game templates are excellent for accelerating the end-user programming, they are also efficient for encapsulating the complexity occurred in the service interfaces to underlying software and hardware functionalities as shown in Fig. 2.

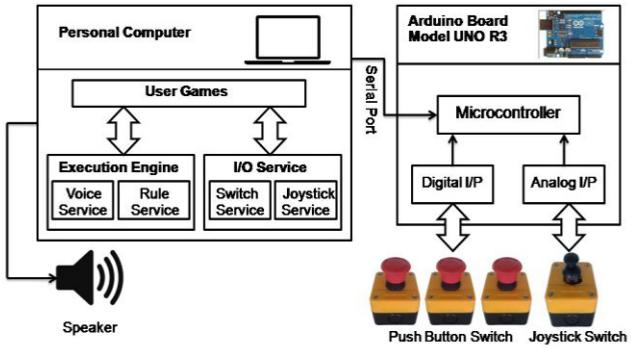


Fig. 2. The architecture of game execution platform.

The system services driving the user game at the backend are separated into two groups:

a) Game execution engine has two subtle functions, i.e. Rule checking service and Voice service. The former service determines how the game engine will be reacted according to the user input and the pre-specified game rules. The latter service performs the playback of audio (mp3) files obtained as results from the Google Text-to- Speech (TTS) based on Google Translate API[1] when the question and related choices are passed as parameters.

b) I/O service has a function of handling Input and Output signals from peripheral hardware. However, instead of having direct connections, these signals are pre-managed and relayed for serial transmission over a USB link by a microcontroller in Arduino board[2]. By exploiting this popular and low-cost controller board, the "*separation of concern*" principle for software implementation can be realized in our system. In this regard, all interface tasks related to game player's inputs are separately handled by Arduino controller, therefore reducing the complexity of operations on game execution engine significantly. As a consequence, the near real-time response of user inputs can be achieved, besides the flexible management of variously input switches.

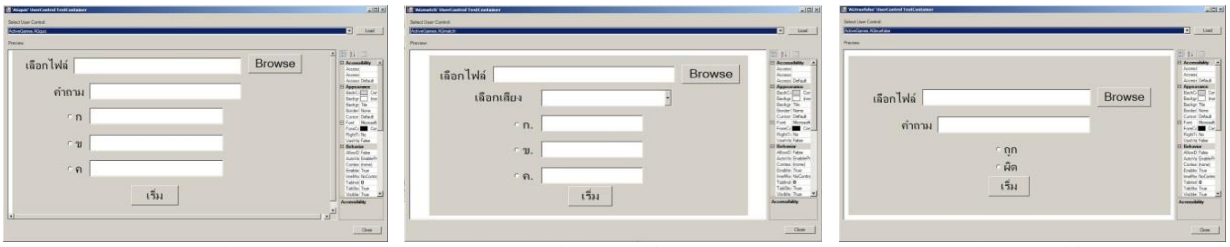
IV. Supported Active Games

Even though our game classification is done on the basis of question types, it has a potential of serving for various game genres, which have been classified diversely in many studies (such as [8]). The available choices are quiz-type, matching-type and true-false type of active games, which are respectively called *AGquiz*, *AGmatch*, and *AGtruefalse* in our custom-developed icons. Examples of game templates according to these choices can be seen in Fig. 3. No matter what template is; users will have to prepare for the game contents in a form-based question by a) filling in the first field with the name of audio file serving as an overture of the question by clicking at the browse button, and b) typing texts representing a question and answer choices in subsequent fields. During the game execution, audio playback of the audio file will be directly performed, while all other texts will be fed to the voice service for automatic generation of synthesized voices. In Table 1, we summarize the support of active games for visually impaired people in each type of given custom tool.

TABLE I: The Support of Active Games for The Visual Impaired

Custom Icons	Game Genres			
	Action	Adventure	Puzzle	Education
AGquiz	-	✓	✓	✓
AGmatch	✓	-	✓	✓
AGtruefalse	-	✓	-	✓

[1] http://translate.google.com
[2] http://arduino.cc



(a) AGquiz (b) AGmatch (c) AGtruefalse

Fig. 3. Different styles of active games supported by each custom tool.

V. Preliminary Evaluation

The user evaluation involves 3 teachers who have experienced with the visual impaired students about 10 years at Thamasakon School for the blind in the Sonkhla province of Thailand, where the number of students is around 200. The questionnaires were given to these teachers, after listening to a brief overview, practicing on game development system (as shown in Fig. 4), and experiencing with generated active games for a while. In questionnaire, the key focuses were set on system reliability, software usability, and users' perception. In the first part, the system reliability was related to physical device or hardware, and the factor of durability, size and stability were set as criteria to be evaluated by the users. In the second part, the software usability was related to the ease of learning, learning curve, ease of use and reliability of game applications. In the third part, the users' perception was related to the criteria of trust, responsiveness, applicability, usefulness and enthusiasm. All questions were based on 5-level of scores ranging from the highest, high, moderate, low, and lowest.

Fig. 4: A participant teacher during the prototype evaluation.

A. Physical device/System reliability

The statistics related to the physical device/system reliability of the system architecture are given in Fig. 5. The blue wide upward diagonal chart demonstrates the data about durability; the orange blue confetti chart demonstrates the data related to the size whereas the dark blue horizontal chart illustrates the data for stability. Overall, the results are very positive; the users have rated the related criteria of physical device/system reliability at the highest level 44.4%, high level 22.3%, and medium level 33.3%. They have not rated any criteria at low and lowest level.

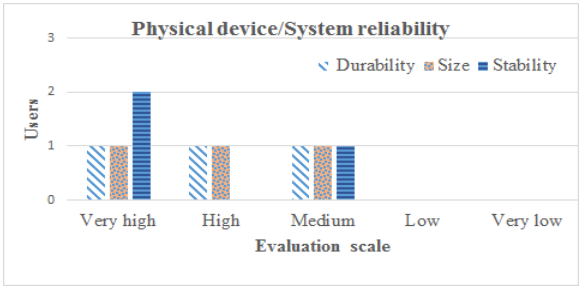


Fig. 5: A participant teacher during the prototype evaluation.

B. Software usability

The statistics related to the software usability of the system are given in Fig. 6. The yellow red confetti chart demonstrates the data about ease of learning, the blue wide upward diagonal chart demonstrates the data related to learning curve, the orange blue confetti chart illustrates the data for ease of use, and the dark blue horizontal chart demonstrates reliability. The usability criteria have been evaluated as positive by users. The affirmative results show that the software usability was not giving rate at low and lowest levels while was given percentage of 25% for highest level, 66.7% for high level, and 8.3% for medium level.

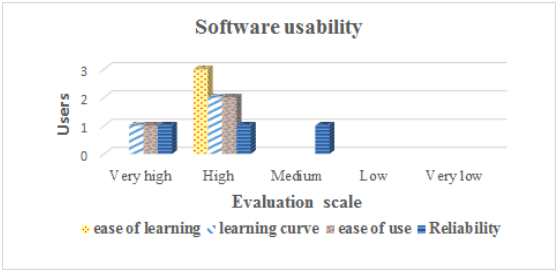


Fig. 6: A participant teacher during the prototype evaluation.

C. User Perception

The statistics related to user perception of the system are given in Fig. 7. The blue wide upward diagonal chart demonstrates the data about trust, the orange blue confetti chart demonstrates the data related to responsiveness, the dark blue horizontal chart illustrates the data for applicability, and the yellow red confetti chart demonstrates data related to usefulness, and the green grid chart illustrates data related to enthusiasm. The results show that the users percept the system positively. The affirmative results show that the highest rate is at 73.3% and the high rate is at 26.7% while medium, low, and lowest rate is at 0%. Generally, we can see that all users are

satisfied with the system.

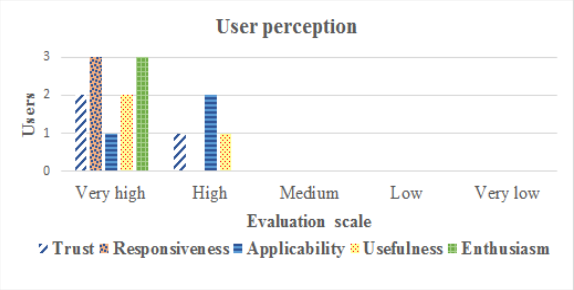


Fig. 7: A participant teacher during the prototype evaluation.

VI. Conclusion

In this paper, we have described our concern on the scarce supply of active computer games that will inhibit teachers to promote physical interaction activities for their visually impaired students in long term. A sustainable solution for this scarcity problem was suggested by empowering teachers to develop their own games. Based on the form-based style of visual template, we confirmed, though our first prototype, that users can succeed on building audio-based active games for visually impaired and blind people without the need of programming skill. Therefore, it was not doubtful why we received the high satisfaction level of evaluation results from participating teachers. However, the study of realistic game scenarios and alternative game modalities will be explored further. These are currently key issues of our ongoing work.

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