Designing a Kinect2Scratch Game to Help Teachers Train Children with Intellectual Disabilities for Pedestrian Safety

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Abstract

Children with intellectual disabilities (ID) may need to undergo long-term cognitive training to enhance the possibility of social inclusion. Pedestrian safety is a critical issue when it comes to participating in community activities for children with ID. Currently, no commercial pedestrian safety training products are available for public special education schools. Consequently, teachers normally gave lectures with the support of slides and pictures to enhance children's ability of getting around in the community. This study employs the Microsoft Kinect technology and image recognition technology to create a pedestrian safety training system which may be applicable for people with ID. To motivate people with ID to engage in the training, we gamified the training of pedestrian safety for children with ID in special education school settings. By leveraging the Scratch language and Kinect2Scratch tool, the teacher who will use the system may be able to do the customization without technical support. Preliminary results of 15 children with ID, aged 9-10, testing the game are presented.

Keywords

serious games; gamification; Kinect; Scratch; Kinect2Scratch; pedestrian safety.

Introduction

With sufficient and appropriate support, many people with cognitive impairments are capable of participating in the world of work, which provides both financial support and the opportunity for social integration (community-based living, recreation and leisure pursuits, use of community services, and use of public transportation). However, with increased independence and integration comes greater risk. To decrease risk for individuals with disabilities as they increase community participation and seek social inclusion, recent strategies focus on increased autonomous functioning [1]. Because individuals with intellectual disabilities (ID) are frequently dependent on others for support across environments, these strategies and skills must directly help access such support. Staff supervision can increase commuter safety; however, it is time-consuming and expensive. Furthermore, protracted or indefinite staff supervision emphasizes the dependence of persons with ID, minimizing the value of responses. The pedestrian safety problems that children with ID typically have include insufficient sense of danger, not knowing the meaning of traffic lights, not being able to pay attention to cars or traffic lights, and lack of practice.

In [2, 3] a Kinect-based system was used to assist young adults with motor impairments in rehabilitation. In this study, we designed a Kinect-based training game to be used by teachers for pedestrian safety lessons. Pedestrian safety lessons are difficult to implement because teachers normally do not train students in the street for the reasons of safety. On the other hand, lectures in the classroom do not help much. Therefore, it is much desired to design a game that can simulate street and traffic scenarios in the special education school setting. Unfortunately, there was no such facility to the best of our knowledge. The teacher that we worked with decided to take the initiative to design such games for the students.

Game Design

This study primarily employed the Microsoft Kinect sensory device to measure the distance of the user by leveraging its depth imaging. The design was inspired by a special education teacher who collaborated with the research team during implementation. This system enables teachers to develop a series of street and traffic scenarios based on the level of ID for each child. Moreover, this Kinect-based system calculates the performance for the mentioned scenarios to determine whether the outcome of each student corresponded to teacher's expectations.

In specific, Kinect and its SDK automatically detect the student's depth in front of the Kinect device, and use the depth data to determine whether the students' distance. The system also includes an interactive interface with audio and video feedback to enhance students' motivation, interest, and perseverance to engage in training sessions.

Based on student ability and Individualized Education Program (IEP), a teacher in a special-education school developed various training scenarios. To motivate the students

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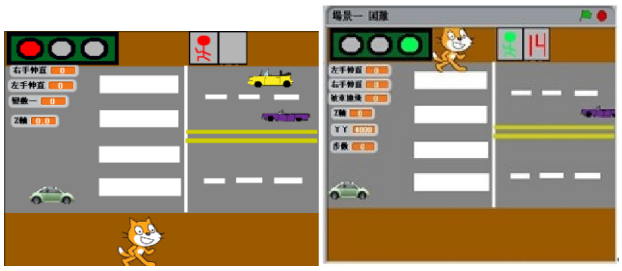
to engage in such exercises, a game approach was adopted. The game was called Cat Walk which is implemented using the Kinect2Scratch tool, Kinect API for the Scratch programming language. Using Scratch means that the teacher can easily customizes the games we developed with less technical support after delivery. The screenshots of Cat Walk are shown in Figure 1.



(a)At the start (b) At the finishline

Figure 1: Game screenshots

To play the game, a child with ID stood at the start and was told to walk to the Kinect sensor when the traffic light on computer screen turned green. The child had to walk 3 meters that simulated using a crosswalk on the screen. Three levels were designed so far: entry, medium, and advanced. For the entry level, no traffic conditions were designed and what the child needed to watch was the traffic light. The child learned to walk on green and stopped on red. For the medium level, there was traffic in both directions on the street in addition to traffic lights. However, the cars always followed rules of the road. At this level, no cars ran through a red light and none violated speed limits. At the advanced level, more cars were added and occasionally some cars violated the road rules.

Experiments and Results

In our experiment, 15 primary school students with an IQ of less than 70 were invited to test the games. Seven students were 9 years old and eight were 10 years old. The teacher instructed the students to play the games three times per week for 18 times in total. Each game play took 2 min. The players were requested to rest for 5 min before proceeding with the next gameplay.

Two scenarios were created: one is with traffic lights (TL) and the other is without traffic lights (WTL). For both scenarios, no cars showed up at the entry level, an average of three cars per min showed up in the line of sight at the medium level, and an average of ten cars came into the scene at the advanced level. At the advanced level of the TL scenario, some cars ran though the red light on purpose.

For the TL mode, a trial was considered a success if the player stopped on red, walked on green, and was not hit by any car while crossing the street. For the WTL mode, a trial was considered a success if the player was not hit by any car while crossing the street. For the TL mode as shown in Figure 2, 75% of trials were successful at the entry level. This indicated that most students could tell red lights from green ones. For the WTL mode (Figure 3), 100% of trials were successful at the entry level because no traffic lights existed. Furthermore the TL performance differed from the WTL performance at both the medium and advanced levels. The results showed it was more difficult for students to walk across the road without traffic lights.

Every child was interviewed after the experiment was finished. Most children enjoyed the Cat Walk game. Only two of them did not like it because they thought the screen was too small. The teacher that used the game in the IEPs considered the game useful and interesting. She was willing to recommend the game to her colleagues. She also suggested the game be adopted in the kindergarten for typically developing children in addition to special education schools.

The preliminary results show the Kinect2Scratch games have the potential to motivate pedestrian safety training for children with ID. The teacher was happy with the feasibility study and prepared to introduce the game to the prospective students by including the game-based training in the IEP. Special education teachers in the same school district also showed interest in Cat Walk and considered the use of the game in their curriculum.

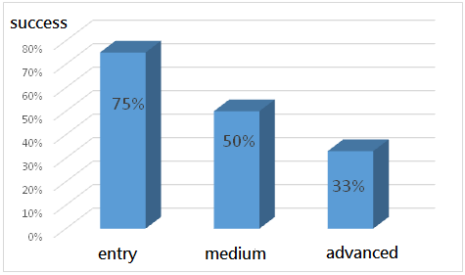


Figure 2: Scenarios with Traffic lights

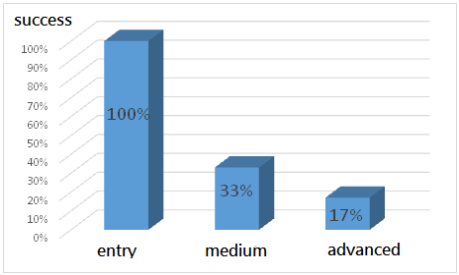


Figure 3: Scenarios No traffic lights

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