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Title
Bus Simulator in Virtual Reality for Young Adults with Intellectual Disabilities

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Abstract
Virtual Reality (VR) can be used to simulate training scenarios that may be too dangerous or too expensive to be recreated in real-life. Currently, people with intellectual disability (ID) train complex everyday situations in the real world under the strict supervision of one (or more) accompanying person until they become autonomous. However, these real-life simulations present risks, can be complicated to set up, and mobilizing the involved people requires time and money. This paper presents a VR simulator conceived with the help of social educators destined to teenagers and young adults with a light or moderate ID. The simulation allows the users to train different conditions in the scenario of a public transport bus in an urban area.

Context
Self-determination has been defined as "the attitudes and abilities necessary to act as the primary causal agent in one's life and to make choices and decisions regarding one's quality of life free from undue external influence or interference" [1]. Young adults with intellectual disabilities (ID) often have the ability to have personal control over the events in their life. However, this capacity is often underestimated but and they can engage in processes of self-determined behavior when given the opportunity and the means to choose. Therefore, it is very important to continue supporting young people with ID into acquiring the skills to be more independent. Practically, this means to permit them to test certain situations autonomously and safely (e.g., taking the bus, how to behave if they miss the right stop, manage conversations with strangers, etc.).

Targeted issues
Currently, in order to allow young people with ID to train in the situations of interest, several people have to participate to reconstruct the desired conditions and provide constant supervision. This is not always possible due to the cost and the time required. However, new technologies, such as Virtual Reality (VR), could be used to simulate certain conditions safely, in a structured, repeatable and controlled way. This project aims to create a system based on VR that would offer learning situations to adolescents or young adults with a light to moderate intellectual disability, in order to allow them to face these situations without risk before practicing them in real life (see Fig. 1).
With the help of social educator, in this project we designed and developed a bus scenario in which the user can simulate the three following conditions:
- Get on the right bus
- Get off at the right stop

- Interact with a stranger

Proposed solution

The solution we propose in this paper is a VR simulator that allows playing three scenarios, one per condition presented at the end of the previous section. These three scenarios can be played independently or joined together depending on the skills that we want to train (however, usually for our target population it is better to train one skill at the time). The three scenarios take places in a urban environment.
In the “Get on the right bus” scenario, the user waits for his bus at a bus stop. Several buses arrive one after another within a customizable interval of time and the user has to get on board of the right one.
In the “Get off at the right stop” scenario, the user sits in the bus and she/he has to select the right stop.
In the “Interact with a stranger” scenario, a human avatar (male or female) approaches the user while asking to follow him/her for a coffee, a cigarette or something else (see Fig. 2). If the user refuses, the stranger insists with an increasing degree of insistence.

Relevant innovation

VR has been previously used to train children and adults with various types of IDs in different scenarios such as street-crossing [2] or route learning [3, 4]. Many studies were performed even before that realistic VR became widely accessible. In 2005, a review [5] showed the efficacy of VR to promote skills for independent living in scenarios such as shopping, cooking, and road safety. With the notable exception of people with autistic spectrum disorders, they also showed that there was a transfer from what they learned in VR to reality. The technology present today may improve these results by providing improved immersion and interaction possibilities and by providing new ways to monitor the behaviors of the user in VR.
In our project, in order to have a realistic simulation of the stranger’s avatar in the “Interact with a stranger” scenario, we combined motion capture (performed using inertial sensors), automatic facial animation (based on recorded dialogs) and manual animation to fine-tuning the facial expression. In addition, we use eye tracking integrated in the VR headset to track the user’s point of view. This will be used in a following analysis to study the differences between the target population and a control group and hopefully provide guidelines for better training practice.
To handle in the best way possible the needs of the target population, the project has been developed by an interdisciplinary team composed of engineers and social educators.

Project outcomes & results

The main result of this project is a functional prototype that can be used to train people with ID in everyday situations. This prototype allows playing the three defined scenarios.
In the “Get on the right bus” scenario, the user is instructed to get on board of a particular bus (identified by its number and the destination). She/he can select the right bus by simply going near the bus door and clicking on the button to open the door with the controller.
In the “Get off at the right stop” scenario, the user sits in the bus waiting for the right stop. Since people belonging to the target population could have reading disabilities,

similarly to what happens in real buses, the next stop served by the bus is presented to the user in a multimodal way: a voice announcing the name of the stop and a writing on a panel above the driver place. The city environment is disseminated of landmarks such as colorful houses, signs of common supermarket chains or post offices. In this way, the user can train to retain or to pay attention to particular landmarks.
The “Interact with a stranger” scenario is the most challenging of the three scenarios and it is currently an early stage prototype. The animation of the character is fluid and realistic but the overall result need to be thoroughly tested with users in order to reduce the possible bias coming from the uncanny valley (you can see the impact of bad illumination in Fig. 2).

Conclusion

Getting on the right bus, get off at the right stop, and interact with a “dangerous” stranger are three scenarios often recreated in real life by social educators to train young people with ID to become more independent and develop self-determination. In this paper, we present our work in which we recreated these scenarios in VR proposing a low-cost, easily reproducible and safe training environment.

Perspectives & Needs

In the short term, the next goal is to perform the first tests of acceptability with users belonging to the target population. In a more long-term view, we would like to assess the transfer of the learning from VR to reality. Finally, we plan to add physiological sensors to the system to monitor elements such as stress and fear.

3 to 7 References and Bibliography (from 250 to 750 characters)

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