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Education

Virtual world interfaces for special needs education based on props on a board

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ABSTRACT

A main goal of special education is the teaching of skills needed for an independent life. Virtual worlds are a valuable tool for this, enabling users to train real-world tasks in a save environment. An intuitive interaction device for mentally handicapped users are props on a board, but until now their interaction space has been limited to the size of the board, whereas the training of realistic tasks requires the use of a large and complex environment, detailing different aspects of everyday life. We devised four navigation strategies for props on a board and tested them with mentally handicapped users. The most suitable strategy was implemented in an educational game teaching common tasks, which may even span multiple locations, such as shopping at the supermarket and then preparing a meal at home. A user study with 24 participants showed that the system enabled all of them to navigate through the virtual environment to complete given tasks and indicated that the system supports learning processes. With our system, mentally handicapped people will be able to train everyday tasks in realistic surroundings, using intuitive prop-based navigation and a navigation strategy tailored to their needs.

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1. Introduction

Three-dimensional (3D) graphics tools are of great interest for the education of mentally challenged people, but there are still few programs catering to their special needs [1]. Schools often use standard children's software instead. Unfortunately most programs use two-dimensional (2D) graphics only. Virtual environments offer few, unconnected scenarios and only mouse and keyboard interaction is supported [1].

Props on a board have been shown to be an expedient input device for the training and education of mentally challenged children in a virtual environment [2]. The original implementation is, however, limited to a supermarket scenario in a single room represented by a board and additional wooden guidance structures, which prevents a wider use of this innovative concept. This paper presents four navigation strategies which have been developed based on the props on a board idea to allow the use of a single board as representation of an arbitrarily expandable virtual environment consisting of multiple rooms, floors and buildings. No further structures are necessary to mark boundaries inside the environment. We evaluated our navigation strategies with children at a special needs school and chose the best navigation strategy for implementation in a virtual city environment. In this city users can execute tasks in different parts of a building or even across buildings solely controlled by a puppet-shaped prop on a board (Fig. 1). These tasks focus on different aspects of everyday life whose mastery prepares for a more autonomous life after school. Our evaluation of two planning tasks with mentally handicapped children confirmed that the system is easy to control and comprehend and that ProbonoWorld represents an efficient learning environment. It was much enjoyed by the users and appreciated by the teachers.

2. Related work

2.1. Virtual reality in special education

Under certain conditions, virtual reality can be a helpful tool in education [1,3–5,11]. With special education, maximum realism in the learning environment is a fundamental principle of effective learning, thus groups of pupils are often brought into a real environment such as a supermarket for education [2]. However, this arrangement provides logistical difficulties (transportation, staffing and funding) as well as other obstacles early in training like unknown dangers, failure or social stigmatisation. Here, a simulation can provide a safe environment with maximum realism [6]. Transferring the experiences in the realistic virtual environment to the real world is considered to be little difficult [7]. Stewart and Menzel [8] state that "Virtual worlds aren't

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pictures, they're places. You don't observe them, you experience them." This makes virtual reality an ideal tool for special education [12] .

2.2. Educational concepts for mental handicaps

To ensure a high learning success through our application, extensive studies of the structure and organisation of education for mentally handicapped pupils were conducted prior to planning the system. The school for children with mental handicaps in Germany is structured into five grades, from primary grade at around age 6 to Werkstufe ("working grade") at around age 16–18 [9]. The schools are organised as all-day schools. As target audience of our educational game we concentrate on the Werkstufe. As our interviews with instructors revealed, in the Werkstufe, children are practically educated. The instructors focus on the capability to cope with subsequent occupational challenges and to live independent from parents. It is most important for the pupils to reach a high grade of autonomy in all aspects of life. The main aims at school are therefore: right use of the senses, space awareness, language comprehension, understanding of quantities and values and simple symbol recognition.

Our system supports these aims in two ways: first, the tasks we devised for our demo system reflect what is taught at school in setting tasks which have to be mastered to cope with everyday life such as preparing a meal, doing the laundry or writing a letter. Second, the virtual environment consists of common buildings with rooms in which these tasks have to be performed, such as the home itself, a supermarket, a post office, etc., which also offers the opportunity of devising tasks which stretch more than one place like buying food at the supermarket and then preparing a meal from it.

Fig. 1. User navigating through the virtual environment by moving a puppet-shaped prop over the board. Actions are initiated by pressing a button in the hat of the prop.

3. World structure

The virtual environment is divided into layers forming a tree structure as seen in Fig. 2. The first layer represents a city with several buildings which can be entered. On the second layer lies a central space in every building like a hallway with doors leading to different rooms or an office with several counters.

The third layer contains a further subdivision of space, e.g. rooms. The user can move freely among the different layers by using entrance and exit doors according to the tree structure of the layers. In detail, this means that a user standing in the city can reach a supermarket or her home, but has to walk into her home's hallway before she can reach the living room. The conscious movement from one layer to the next is also supported by the design of the input device as described in Section 4.1.

Every instance on the third layer can be filled with one or more tasks for the user to complete. This requires that the user is able to identify the corresponding room, e.g. the kitchen for preparing a meal, without much effort. The individual houses and rooms were therefore given easily recognisable designs and unique colour schemes, like the pink home which has a garden, the yellow post office with a big posthorn sign or the grey office building with a glass front. Inside the houses, the doors and doorframes all have the same colour corresponding to the building.

4. Navigation and interaction

A central issue in designing a system for mentally handicapped persons is the choice of a suitable input device and navigation strategy [12]. The user must be able to move around and orientate himself intuitively and without difficulty. As input device we therefore chose an isotonic device with position control in the

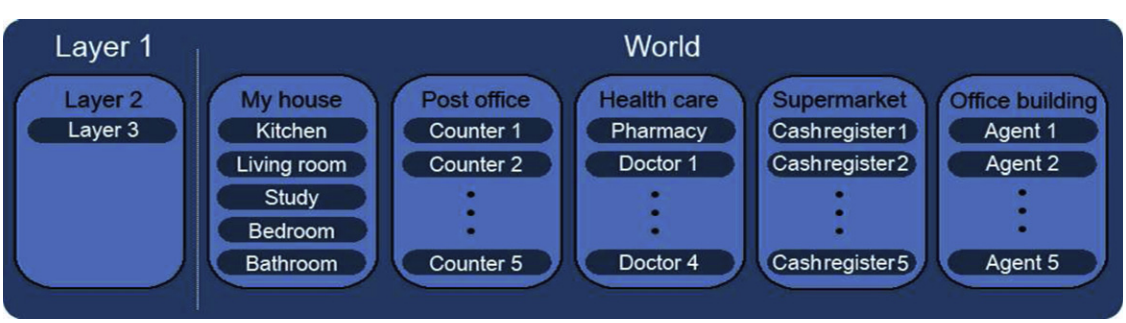

Fig. 2. Layer structure of the virtual environment.

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