Learning Foreign Languages by Using a New Type of Orientation Assistant for the Blind

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Summary

Children and adults often find it difficult to learn basic foreign language vocabulary through conventional teaching methods. This is especially true for blind learners, who lack the benefit of environmental cues. While sighted individuals gain valuable information by noting the position of objects and their association with other objects (e.g., clock on the wall, chairs with the table, etc.), such cues are unavailable to blind learners. We have developed an orientation assistant for the blind that allows both blind and sighted individuals to learn basic vocabulary in their own or different languages while simply exploring their environment. Our device consists of a sensor module and a portable computer, and requires the generation of a 3D model of a specific indoor environment. A database is created which names all objects of interest in several different languages. The user can point the sensor module in any direction, press a key, and the closest object within the modelled environment is announced via text-to-speech engine. Thus, blind children, as they explore their surroundings, gain the environmental cues that facilitate vocabulary development. Blind and sighted individuals of all ages can utilize our device to learn foreign vocabulary, with sighted learners benefiting from the pairing of auditory and visual cues. Additionally, our orientation assistant allows blind individuals to navigate independently and safely within the modelled environment.

1.0 Introduction

As noted above, blind individuals lack the environmental placement cues so helpful when learning object names. In addition, sight provides information about size, shape, and color, which helps the learner categorize and recall newly-learned vocabulary. Retention of new words is further enhanced by the ability of the sighted to glance again and again at the target item.
In 2004 we presented our first prototype of an orientation and navigation assistant system for the blind [1]. In this paper, we would like to show that this system could also be used as a learning tool to acquire basic object names and language concepts in different languages. Furthermore, it can be used as an orientation and mobility teaching aid.

1.1 Local Sensor Information and 3D Models

Our system is based on the combination of local sensor information with 3D environment models. Accordingly, we generated a digital 3D model of our computer science building, including 3D models of the furniture and environmental details like door handles, light switches, door nameplates, etc.

1.2 Hardware Description and Operation

The hardware of our assistant system consists of a sensor module (which contains a 3D compass, 3D gyroscope, 3D acceleration sensor, and a stereo camera), and a portable computer, connected by cable and carried in a backpack. The housing of our first prototype [1] has been modified according to blind users' demands. The sensor module is held like a combination flashlight/cellular phone, and pointed in any direction within the current environment. The keyboard of the integrated cellular phone allows the user to send inquiries to the portable computer, or to a wireless connected service platform [4]. The sensor module can also be attached to the cane.
We determine the location of the user within the building by using a conventional WiFi system. The signal strength of WiFi access points in the user's environment is measured, and compared with the signals in a database containing all possible locations in the building. This comparison allows the system to determine the user's current position.

1.3 Conventional and Augmented Navigation Support

By scanning the environment with the sensor module, the user is informed of nearby objects and their features. It is therefore possible to use our device as a navigation system. Comparable to car navigation systems, a destination is chosen by using the keyboard. The shortest way is calculated by the system, and navigation advice provided over the loudspeaker or on a portable Braille display.
However, when sensor module scanning is done in an unsystematic manner, it may happen that important objects or locations may be missed. Therefore, we introduced the concept of navigation areas [2]. When a blind person enters into these areas, augmented information about these locations can be accessed, e.g., room numbers and their occupants, warnings about stairways, the existence of handrails, etc.

2.0 Interactive Learning of Object Names in Different Languages

2.1 Object Recognition for the Blind and Deafblind

Once the user's location is known, we then look at the direction indicated by the sensor module's 3D compass and 3D gyroscope. This information determines a 3D vector that can be used within the model for object selection. A corresponding picking ray is used, which reflects the vector's direction and identifies the closest object. The name of this object is announced to the user by a text-to-speech engine and loudspeaker respectively. For deafblind persons this name is presented interactively on a portable Braille display [3].

2.2 Learning and Teaching Tool

The user can explore the environment just by pointing at objects. The name of objects can be provided in different languages. Users have the opportunity to learn basic words of the target language just by playing with our device and exploring the current environment, provided that there is a 3d model of these rooms and buildings. Besides learning basic words in several languages, our system can also be used to teach orientation and mobility vocabulary and concepts, such as the four directions, angles, distances, number, velocity, and acceleration.

3.0 Results

For the visually impaired it is possible to explore unknown surroundings using our system, provided that there is a 3D model of the new environment. By pointing the sensor module of our prototype at objects, users learn the name, descriptive feature information, and navigation possibilities. These facts can be provided in different languages. The results can be presented interactively, either over a loudspeaker or on a portable Braille display.
The first usability tests with blind persons showed that our navigation system facilitated learning of basic object names in both native and foreign languages, simply by exploring the current environment.

4.0 Discussion and Future Work

Future work encompasses several areas. One is the application of our device to teaching basic language skills to the learning-disabled. Our orientation assistant is a novel learning aid that focuses and maintains learner attention by pairing both visual and auditory stimuli. Repetition, so necessary to memory and mastery, is under the control of the user, who can activate object naming as many times as necessary, provided that the environment has been modelled.
Our first user study with blind children and adults suggested the need to adjust hardware size, weight, and ergonomics, and to improve localization accuracy. We therefore fuse local sensors with the WiFi system. We also want to better synchronize reality with model information. Another developmental goal is to integrate our system into the “Nexus platform.” This is the term given to a global network of several servers, that is still under development, providing services also for sighted persons [4]. Further, we plan to try to detect semi-static, movable objects like chairs or tables, and later detect fast-moving objects. Our 3D models will be updated using cameras, and software ergonomics adjusted to individual demands taking into account the security of the system. Lastly, we will expand our system to outdoor settings, by the integration of the global positioning system, and expand our orientation and mobility support to stores and individual workplaces.

5.0 Acknowledgements

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6.0 References

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