

Introducing the **Audio-Visual Walker** for gait improvement:

It has been observed, and reported extensively in the medical literature, that the walking abilities of patients with movement disorders is improved by visual and auditory cues. Drawing from research advances in vision and adaptive control and incorporating state-of-art wearable computing, display, motion-sensing and software technologies, the Audio-Visual Walker displays on a see-through micro-display a virtual tiled floor that responds dynamically to the patient's own body motions. A small control unit, the size of a cell-phone, is clipped onto the belt or pants or put in a shirt pocket. It measures the patient's motion, learns the patient's individual characteristic dynamics, and filters unwanted signals, such as tremor, from the measurements. Consequently, the patient feels as if he/she is walking on a real steady floor.



The checkerboard tile pattern provides continuous stabilizing visual information which safeguards against stumbling and falling while walking. An auditory feedback cue, adapted to the patient's own steps, is provided through micro earphones. The patient hears a click every time he makes a step. A steady balanced gait produces pleasant visual and auditory cues, synchronized with the patient's own steps, rewarding the patient for making the effort. The patented innovation is the first of its kind to respond to the patient's motions rather than just providing constant visual and auditory cues.

Clinical Trials

Preliminary clinical trials have investigated the separate effects of the visual and the auditory channels of the Audio-Visual Walker. These trials included 20 randomly selected patients with Parkinson's disease (PD) and 16 patients with multiple sclerosis (MS), predominantly affected by cerebellar ataxia, on their regular medications. Both on-line effects and short-term residual effects (measured 15 min after removing the device) were tested. The percentage of patients who improved either walking speed or stride length or both by more than 10% are reported below:

PD patients:

Visual Walker – on line :	68%
Visual Walker – residual:	87%
Auditory Walker – on line:	45%
Auditory Walker – residual:	50%

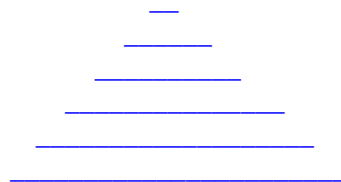
MS patients:

Visual Walker – on line :	56%
Visual Walker – residual:	56%
Auditory Walker – on line:	57%
Auditory Walker – residual:	86%

Pilot studies have indicated an additional on-line improvement of approximately 10% when the auditory feedback signal was added to the visual channel.

Is the Visual Walker right for you?

You can find out for yourself if this device can improve your walk by checking if your walk is improved when you use real markings on the ground. You may already know the answer from your past experience, or you may perform a simple test to find out. You may use a tiled floor with highly visible color contrast between the tiles for this purpose. You may also use a colored adhesive tape, a color marker, sticks, or other such objects, to create lines, half a meter apart, perpendicular to the direction of motion. When you walk, try to reach the next line with your foot. Change the distances between the lines until you feel comfortable in your walk. You may ask a family member or a friend to time your walk, or simply observe you as you walk. If you find that your walk pattern has improved, or that you are more comfortable walking with the lines than without them, the Visual Walker is likely to improve your walk. All it does is place virtual lines, or a checkerboard pattern, on the ground in front of you in places where there are no real lines. These virtual lines respond dynamically to your walk just like real ones. With almost no training, these virtual lines will work for you as real markings on the floor.



Operating Instructions

The Visual/Auditory Walker consists of the following parts:

- A pair of virtual reality glasses housing a binocular display and stereo earphones connected through a wire to
- A 9V operated, cell-phone sized control unit which may be clipped onto the belt or pants or put in a shirt pocket.

Connection and start up:

Connect a fully charged 9V battery into the battery compartment of the control unit.

To turn device on, turn the knob in a clockwise direction. When the device is on, a green light will light up by the knob.

If no light turns on:

- Turn the device off by turning knob counter clockwise
- Make sure the battery is fully charged
- Make sure the battery is properly connected
- Turn the device on again by turning knob clockwise

Attach the belt clip on the back of device to the belt or the pants securely. If you prefer, you may insert the device into your shirt pocket. The glasses are worn normally. You will see a floating display in front of you with a graphic representation of a checkerboard-like tiled floor. The Virtual Walker is designed to be as non-obstructive as possible, so you will see the virtual image in addition to your surroundings. Attached to the glasses are ear pieces which may be placed in your ear lobes for additional auditory feedback. Auditory volume may be adjusted by turning the knob.

Usage:

Seeing the virtual tiles in front of you, imagine you are going to take a step over the tiles and then do so. The tiled floor will move toward you, so you will be ready to take your next step over the next tiles that have now moved in front of you. If you change your gait, you will receive immediate visual feedback from the movement of the tiles. You do not need to worry about where you step. You do not need to put your feet exactly within the tile boundaries, or to persistently step on tiles of one color or the other. You may step on tile edges. Walk normally as you would on a real tiled floor, trying to extend your leg forward so as to reach the next tile.

When you are ready to turn, start by turning your waist in the desired direction. The tiled floor will respond by also turning in that direction. You may now proceed in taking steps over the tiles as before, only now your direction of movement is the new direction of the floor, aiding you in completing your turn.

With the ear plugs in your ears you will receive auditory feedback on your stride. With a steady balanced gait pattern, you will hear a rhythmic pulse sequence, synchronized with your steps. Your gait will improve when you attempt to produce a fine rhythmic sequence of pulses.

"Practice makes perfect": The more you practice, the better you become at it. Here is an email message sent by a research assistant, reporting progress to the head physician:

Dr. Espay,

I spoke to our two freezing study patients today. Both told me they felt the goggles were helping them walk better. R stated that other people noticed that her stride was longer after she wore the goggles. She says the "trick is to wear them (the goggles) a lot". Both are using the goggles as much as they can (more than half an hour everyday). They have been visualizing the tiles and they are using the clicking noises to help them walk better when they are not wearing the goggles. It sounds like we will get positive data from these patients next week.

*Noël Burton, MA
Research Assistant
Movement Disorders*

Maintenance:

- *Clean the glasses regularly with a dry soft piece of cloth
- *Charge the battery

Additional Products:

Auditory Walker

In addition to the Audio-Visual Walker, GaitAid Medical has developed the Auditory Walker as a separate device, which employs the auditory channel for providing the patient with sensory gait feedback. The apparatus produces a ticking sound in response to the patient's steps, one tick per step. The patient hears the auditory cue produced by the steps through earphones, and can modify the auditory cue by modifying gait. A steady balanced gait will produce a pleasant auditory cue, synchronized with the patient's own steps, "rewarding" the patient for making the effort. The Auditory walker has been clinically tested and found to significantly improve gait in PD and MS patients. This product can be particularly helpful as a low cost alternative to the Audio-Visual Walker, and as a solution for patients with vision impairment.



Gait Monitor

GaitAid Medical has also developed a gait monitoring device for physician use. The Gait Monitor is a wireless data communication system, connecting the measurement box, which forms the basis for the Audio-Visual Walker and the Auditory Walker, to a hand-held receiver, which collects the data, calculates gait performance parameters, such as walking speed, stride length and variance-of-cadence, and displays them to the doctor for evaluation of gait performance and disease progression.



References

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Video clips of patient performance can be viewed at

www.cs.technion.ac.il/~baram

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