

# Efficient image segmentation of walking hazards using IR illumination in wearable low vision aids

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## Abstract

Pulsed IR illumination is used to segment near obstacles and hazards from the background from incoming video to a wearable low vision aid that displays icons.

## 1. Introduction

A wearable low vision aid (WLVA) is an assistive technology that is being developed as a navigational aid to persons who are visually impaired. The goal is to take systems approach to the design of low-cost vision aids. Persons who are visually impaired report great difficulty seeing obstacles in their path as they walk, a problem further exacerbated by low light levels. We are developing a WLVA that uses video image segmentation to efficiently identify possible hazards and warn the user of an imminent collision. The system is composed of a small CCD camera with flash IR LED illuminators, a mobile computing device and a novel fiber scanning display currently under development [1]. The CCD camera and illuminator work together to output well controlled images to the wearable computer, the computer then decipherers pertinent information in the scene and relays this information to the user via scanned fiber display.

## 2. Previous Work

The idea of a custom computer interface as an aid for the visually impaired is not a new idea. Efforts to create wearable assistive devices have been attempted over the past 10 years using redisplay of enhanced camera images [2,3], and using GPS [4]. Recent WLVA's have focused on using computer image/video processing as a navigational aid. These recent WLVA's rely on computationally expensive algorithms that process data across the entire frame, such as the convolution of an edge detector across the entire scene, which extracts a significant amount of noise during segmentation. Everingham et al., [4], edge information and comparison of color consistence were used to determine regions of interest. This neural-network approach is

relatively time consuming and not currently possible on wearable computers today. Andersen & Seibel [5] use the Hough transform to determine straight-line segments, thus allowing recognition such obstacles as stairways, doorways, and curbs. Again, this approach is computationally expensive and relatively inflexible, being unable to detect curved lines or the start and end points of lines.

## 3. Systems design approach

In collaboration with low vision volunteers, we have identified three major walking hazards as nonstandard intersections, finding the first stair on a set of descending stairs and collision with unforeseen obstacles in their path. Object in a walking persons direct path are most relevant and require highest priority for avoidance. This requires segmentation of objects in the foreground from all stationary objects in the background. A controlled portable light source will enhance object luminance in the foreground over the background. Synchronized control of the IR light source with the video camera using background subtraction allows for efficient object segmentation and hazard detection.

### 3.1. Hardware

The system uses a CCD camera fitted with a IR filter that blocks visible light and passes near visible infrared. Attached to the camera is a set of pulsed IR LEDs; these LEDs illuminate every other frame that the camera captures. We treat two consecutive frames by subtracting the background (the image without illumination) with the illuminated image.

Figure 1



### 3.2. Hazard Recognition—Preliminary Results

Our hypothesis is that object that are to in your direct path will be significantly brighter than other objects. Secondly object that user is a

going to collide will become increasingly larger and brighter. Simply setting all scene information below a given threshold is a crude method segmenting the darker background from the object that are most likely to come in contact with. To test this we analyzed running video of first person collision paths with several objects, defining a luminance index. This index is defined as the sum of the luminance value of each pixel with luminance above a carefully chosen threshold. The following chart represents these indexes per analyzed frame. The capture rate was 5 frames per second of video taken at average walking speed. The method assumes if an object is growing and getting brighter it is likely to collide with the user.

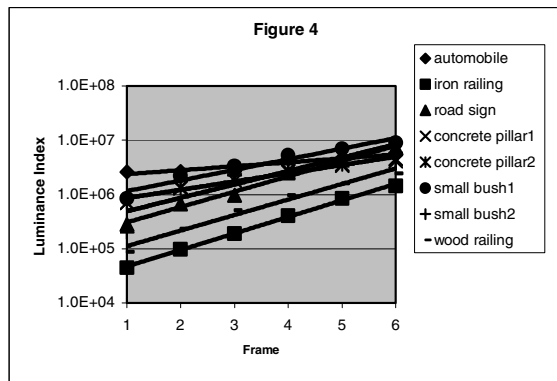
**Figure 2**

*Image without background subtraction*



**Figure 3**

*Image with background subtraction*



This system leaves improvement for software design, which at this time is relatively primitive. Future improvements will include the design of multiple-object tracking software, and neural network recognition system. Immediate improved can be made by developing a small head mounted camera and illumination system. A quick improvement would be to obtain a camera with a manual gain control instead of one with a automatic gain control.

#### 4. References

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