Development of a Vision Assistive Device for Veterans with TBI-Associated Visual Dysfunctions

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PUBLIC ABSTRACT

Traumatic brain injuries (TBI) affect thousands of soldiers on battlefields and millions of civilians in their daily lives (car accidents and strokes are major causes). In addition to mental and motor disabilities, visual and cognitive vision loss is also among the common consequences of TBI, which may occur in about one-third of TBI victims. Typical forms of vision loss include tunnel vision (complete loss of peripheral vision) and hemianopia (loss of vision on the same half side in both eyes), which all reduce the patients’ ability to spot objects in blind field. These dysfunctions greatly impair safe and efficient mobility, and often cause secondary injuries. Restricted mobility impairs patients’ quality of life.

As there is no curative treatment available for TBI-associated vision loss, there is a large need for rehabilitation options. However, the available options have limited utility. Reversed telescope was used in the clinic to provide expanded visual field by means of minification, but did not succeed, because minification causes reduction in visual acuity and also alters visual directions of objects. Currently, prisms are the most commonly used devices in clinics, which shift images from the blind side to visible side by up to 25 degrees. While the prisms can help some patients detect obstacles in blind field, many other patients reject them because object direction seen through the prism is greatly changed, which may easily cause confusion and prevent correct actions.

We propose to develop an intelligent collision-alerting system using advanced image processing technology. The system can determine collision risk in terms of time to collision and collision point and give patients auditory alerting messages. The core image processing algorithms in the system are based on our understanding of the collision judgment mechanism in the human visual system and a mathematic model that utilizes the same mechanism. The advantage of this method is that it does not need to perform complicated pattern recognition and collision detection can be successful even based on tracking of a portion of obstacles. Our preliminary processing results have demonstrated that this approach is highly promising.

In this project, we will first develop processing algorithms that can function in a variety of situations in the real world, and then implement the algorithms in an FPGA/DSP (Field Programmable Gate Array/Digital Signal Processing) image processing board to develop a portable prototype. We will then conduct a study in collaboration with the Boston Department of Veterans Affairs hospital to test the prototype in a high density obstacle course with TBI patients with tunnel vision or hemianopia.

We believe our innovative collision detection technique has great potential to lead to a breakthrough in mobility rehabilitation. The technology can also be implemented as a smart camera phone application, to turn the widely used smart phones into rehabilitation devices to help millions of visually impaired and blind people.