

**APPARATUS FOR CONVERTING VISUAL  
IMAGES INTO TACTILE  
REPRESENTATIONS FOR USE BY A  
PERSON WHO IS VISUALLY IMPAIRED**

**BACKGROUND OF THE INVENTION**

**1. Field of the Invention**

The invention relates to the field of imaging and robotic or machine implemented vision.

**2. Background Information**

Robotic vision is a growing field of research and development. Various image processing systems have been developed for guiding autonomous vehicles and the like through simple and complex obstacle courses. While robotic vehicles may be useful for transporting visually impaired individuals, they do not provide the individual with sensory information about the obstacles the robotic vehicle is navigating, nor control over the course the vehicle takes.

Visually impaired individuals are often able to self-navigate on foot through the use of various sensory clues, through the auditory, e.g., the sounds of traffic, or the tactile, e.g., the feel of objects tapped by a cane held in the hand. The sense of touch in a visually impaired individual may be heightened, and visually impaired individuals can "read" through the use of braille. If the person is also hearing impaired, the sense of touch may be additionally heightened.

**SUMMARY OF THE INVENTION**

It is an object of the invention to provide a visually impaired person with a tactile representation of the field of view of a sighted person, e.g., the objects in front of the individual and their respective spatial locations. The tactile representations will be referred to as "tactile images" herein.

The present invention provides the following novel features. According to one embodiment of the invention, imaging means converts light received from the field of view into electrical signals, processing means processes the electrical signals, and tactile display means converts the processed electrical signals into tactile images which can be perceived through the sense of touch by the visually impaired person. Therefore, the tactile images are felt by the visually impaired person and enable them to ascertain information by touch about the world around them that a sighted person would ascertain through vision.

According to another aspect of the invention, the imaging means comprises a portion of a robotic vision system, such as may include one or more high-resolution video cameras and an analog to digital converter for converting an output signal of the cameras into a digital signal. The processing means could comprise memory means for storing the electrical signals as they are received from the imaging means, filtering means for adjusting features of the electrical signals, and output means for outputting the adjusted and stored electrical signals as processed electrical signals to control the tactile display means.

The tactile display means may comprise a plurality of individually controlled miniature actuators, e.g., motors or solenoids, oriented in a grid each of which respond to a portion of the processed electrical signals, a plurality of miniature gear assemblies, e.g., rack and pinion gear assemblies, each of which is operatively connected to one of the miniature actuators so that rotational motion of a pinion connected to a shaft of a miniature actuator is converted into linear motion of a rack, a plurality of rods, each of which is connected to one of the racks, so that when the racks move

linearly, the rods move linearly as well, and means for adapting the tactile display means to a portion of the body of a visually impaired person including means for causing the rods to move perpendicular to the surface of the portion of the body. A tactile image is thus formed by the movement of the rods against the body of the person.

In another embodiment, a plurality of auxiliary miniature motors, rack and pinion assemblies and rods are provided which operate to indicate at least the color of light incident on the imaging means. Color could be indicated by a particular vibration of the rods so that a red traffic light would vibrate a group of rods at a certain frequency, while a green light would vibrate a group of rods at a different frequency.

In another embodiment, sounds may also be converted into tactile representations for use by a person who is also hearing impaired. This embodiment further comprises auditory imaging means for converting sounds into electrical signals, processing means for processing these electrical signals, and tactile display means for converting processed electrical signals into further tactile images. The further tactile images are felt by the hearing impaired person enabling them to ascertain information by touch about the world around them that a hearing person would ascertain through hearing. The further tactile images may be produced by tactile vibrations of at least a portion of the tactile display means.

In another embodiment, the apparatus further comprises speech analysis means, for detecting and recognizing spoken words, and outputting electrical signals to the processing means corresponding thereto. The processing means also processes the electrical signals from the speech analysis means, and the tactile display means also converts the processed electrical signals derived from the speech analysis means into further tactile images, the further tactile images being representations of the spoken words. In this way, the tactile images and further tactile images are felt by the visual and hearing impaired person enabling them to ascertain information by touch about the world around them that a sighted and hearing person would ascertain through vision and hearing. According to another aspect of the invention the further tactile images may be produced on a dedicated portion of the tactile display means.

In another embodiment, the processing means includes text means for processing scanned printed text, and the tactile display means includes text representation means for providing a tactile representation of scanned text processed by the processing means.

In an embodiment for converting sounds into tactile representations for use by a person who is hearing impaired, the apparatus includes auditory imaging means for converting sounds into electrical signals, processing means for processing the electrical signals, and tactile display means for converting processed electrical signals into tactile images. The tactile images are felt by the hearing impaired person enabling them to ascertain information by touch about the world around them that a hearing person would ascertain through hearing. In a further embodiment, the tactile images are representations of spoken words.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other features of the invention will become apparent from the following detailed description taken with the drawings in which:

FIG. 1 is a block diagram of the major components of an exemplary embodiment of the invention;