FIG. 2 is a block diagram of an exemplary embodiment of the imaging means according to the invention;

FIG. 3 is a block diagram of an exemplary embodiment of the processing means according to the invention;

FIG. 4 is a block diagram of an exemplary embodiment of the tactile display means according to the invention;

FIG. 5 is a block diagram of an exemplary embodiment of the auxiliary display means according to the invention; and

FIG. 6 is a block diagram of an exemplary embodiment of an apparatus for converting sounds into tactile representations for use by a person who is hearing impaired, including auditory means, according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will now be described in more detail by example with reference to the embodiments shown in the Figures. It should be kept in mind that the following described embodiments is only presented by way of example and should not be construed as limiting the inventive concept to any particular physical configuration.

FIG. 1 is a block diagram of the major components of an exemplary embodiment of the invention. Imaging means, which could take the form of one or more video cameras, CCD devices, or other light sensing devices, converts light into electrical signals and provides them to the processing means. The electrical signal may be analog or digital signals. To readily obtain depth information, at least two spatially separated video cameras would be used, as is well known in the art.

In applications where auditory information will be processed instead of, or in addition to, the visual, the imaging means would take the form of, or include, a microphone, or the like, and auditory amplifying, etc., circuitry.

The processing means processes the electrical signals from the imaging means. Such processing may include converting analog signals into digital signals and performing various well understood operations on the signals, such as performing a Fourier transform to extract object edge information, for example. The processing means in essence identifies objects, their relative size, their spatial location relative to the device, their movement, if any, etc.

If the imaging means is used to scan printed text, the processing means would include well known character recognition operations.

In the case of auditory information, filtering to extract spoken words or word segment (phonemes), for example, according to well know speech analysis techniques would be included.

The processing means together with the imaging means could take the form of a conventional robotic vision system, modified as necessary to obtain relevant information, and output signals for controlling the tactile display means, as would be understood by one skilled in the art.

The tactile display means converts the processed electrical signals from the processing means into so-called "tactile images." The tactile images may be felt by a visually impaired person enabling them to ascertain information by touch about the world around them that a sighted person would ascertain through vision. The tactile display means would be placed on a surface of the individual's body and would provide tactile stimulation to the surface of the individual's skin to form a representation of the view of the imaging means. For example, if the imaging means were viewing an apple, the tactile display means could form a 3-dimensional "tactile image" of the surface of the apple. This will be explained in more detail below.

FIG. 2 is a block diagram of an exemplary embodiment of the imaging means according to the invention. In this embodiment, one or more high-resolution video cameras is connected to an analog to digital convertor to produce digital image signals. Other configurations would also work with the present invention, as would be readily apparent to one skilled in the art. To facilitate and simplify obtaining of depth information, a sonar device could be used instead of, or in conjunction with an optical imaging device.

FIG. 3 is a block diagram of an exemplary embodiment of the processing means according to the invention. Memory means would store electrical signals as they are received from the imaging means, and optionally, could perform some rudimentary or sophisticated matrix processing, for example, thereon. The memory means could take the form of a raster memory, for example.

Filtering means is provided to adjust features of the electrical signals stored in the memory means. The term "filtering" is used loosely to cover a variety of image data processing operations, such as fourier transform, convolution, and the like, to identify image features such as edges, shapes, size and relative spatial location, for example. The filtering means may comprise complicated special purpose digital processing integrated circuits, or be performed on a microprocessor under program control running digital signal processing routines.

A data base of common object patterns could be stored and accessed during this processing to identify ubiquitous objects, such as traffic lights, mail boxes, police cars, tanks, etc. There is a set of international symbols for various things, and through pattern recognition, these could be found and identified.

Where auditory information is being processed to extract and identify words or word segments from spoken words, for example, a set of speech analysis operations would, of course, be performed. These processing functions are similar but not identical to those used to process visual images, as is well known in the art. For example, instead of recognizing object edges, the processing word recognize periods of silence indicating the end of a word.

The output means outputs the "filtered" signals as processed electrical signals to operate the tactile display means so that image features are represented thereon as multi-dimensional "tactile images." The filtering means together with the output means function, for example, to identify an object, its shape and size, and then cause the tactile display means to form a tactile representation in multi-dimensions of the object. Since the tactile display means would, in general, be smaller than an object being imaged, the tactile representation would be scaled to relative size.

If the system should also provide color information, the output means and filtering means could cause the tactile display means to also indicate the color of the object, through a particular mechanical vibration for a particular color, for example. Auditory information could be indicated this way as well, such as the sound of machinery or traffic at an intersection.

FIG. 4 is a block diagram of an exemplary embodiment of the tactile display means according to the invention. In an exemplary embodiment, the display means could be formed as a two dimensional grid (X-Y dimensions) on which the individual would place their hand, for example. The surface of the grid would be formed by the ends of rods which would be moved up or down (Z dimension) under control of the processing means.