

**ELECTRIC TACTILE DISPLAY**

## RELATED APPLICATION

**[0001]** The present invention is based on provisional application No. 60/748,811 filed in the US on Dec. 8, 2005, and claims the benefits thereof. The contents of the aforementioned application are herein incorporated in this specification in their entirety by reference.

## TECHNICAL FIELD

**[0002]** The present invention relates to an electro-tactile display.

## BACKGROUND ART

**[0003]** A configuration for a forehead-mounted electro-tactile display is shown in FIG. 1. The system includes a sensor (camera) **1** that acquires environmental information mounted on a head, an arithmetic section **2** that processes this information and generates a tactile presentation signal, and an electrical stimulation presentation section **3** fitted to the forehead and provided with an electrode matrix that generates sensory stimuli. A compact camera fitted to, for example, sunglasses, captures the frontal view of the wearer. Images of the view captured by the compact camera are converted into tactile information resulting from electrical stimulation by the arithmetic section. The wearer of this system can acquire environmental information as a result of tactile stimulation received via the forehead. The system then functions as a proxy system that brings about sight through the tactile sensation in case that the sensor is an image sensor and the wearer is, for example, a person with impaired vision. Namely, the forehead-mounted electro-tactile display provides an FRS (Forehead Sensory Recognition System). By passing through an appropriate training program, the FRS can function as an artificial retina for the visually impaired without any surgery being required.

**[0004]** The basic theory of electrical stimulation is disclosed in Japanese Unexamined Patent Publication No. 2002-65866 "COMPOSITE ELECTRODE USED IN ELECTRICAL STIMULATION", Japanese Unexamined Patent Publication No. 2002-328596 "TACTILE PRESENTATION METHOD AND DEVICE", and International Patent Publication No. WO01/038958 "TACTILE PRESENTATION METHOD AND DEVICE EMPLOYING ELECTRICAL STIMULATION". Electrical stimulation to the forehead is disclosed in Japanese Unexamined Patent Publication No. 2001-285679 "IMAGE RECOGNITION DEVICE FOR THE BLIND". Similar technology "TONGUE PLACED TACTILE OUTPUT DEVICE" is given in U.S. Pat. No. 6,430,450B1. The contents of the aforementioned documents are herein incorporated in this specification by reference.

**[0005]** However, the related technologies described in the above applications merely relate to an electrical stimulation, or the basic idea of a sensory proxy that presents tactile sensations on a person's forehead, and do not resolve the actual problems in practical terms.

**[0006]** The present invention has resolved several problems that appeared during implementation tests by actually constructing a forehead-mounted electrical stimulation system. Many of the problems to be resolved by the present invention are caused by the device being "forehead-mounted". One problem is of the wearer experiencing pain and discomfort when electrical stimulation is applied. An electro-tactile pre-

sensation display typically electrically stimulates the skin of fingertips. However, the skin on a person's forehead is thin compared to the skin on the fingertips. This means that if the same electrical stimulation as for the fingertips is carried out, the wearer will experience pain and information cannot be presented. This also applies to the electrical stimulation of body parts (breast, back, abdomen, etc.) other than the forehead where the skin is relatively thin compared to the skin of the fingertips.

**[0007]** Further, with a forehead-mounted electro-tactile display, a large number of electrodes are densely arranged compared to electro-tactile displays for use with fingertips. When the number of stimulation points is increased, the scanning time becomes excessive and the overall stimulation frequency falls. It is known that when the stimulation frequency falls below a certain value (for example, 30 Hz), a "coarse feeling" characteristic of stimulation occurs, and the wearer experiences a strong feeling of unpleasantness. This problem also applies to the case of the electrical stimulation of body parts (breast, back, abdomen, etc.) other than the forehead of a wider area than the surface area of the fingertips where a large number of electrodes arranged at high-density are used. The object is therefore to generate electrical stimuli that feel pleasant.

**[0008]** It is a further object of the present invention to provide a forehead-mounted electrical stimulation presentation board appropriate for the curvature of a person's forehead. This object is also applicable to electrical stimulation presentation boards fitted to other parts similar to a person's forehead where the Gaussian curvature is not zero. Other objects to be resolved by the present invention will become apparent from the description of the specification described in the following.

## DISCLOSURE OF THE INVENTION

**[0009]** The present invention provides an electro-tactile display including an electrode substrate provided with a plurality of stimulation electrodes, a conductive gel layer positioned between the stimulation electrodes and the skin of a wearer, a switching circuit section electrically connected to the stimulation electrodes, a stimulation pattern generating section electrically connected to the switching circuit, and means for alleviating a sensation experienced by the wearer as a result of the stimulation electrodes.

**[0010]** The plurality of stimulation electrodes are typically electrodes in the shape of a matrix or arrayed electrodes that comprise a plurality of electrodes arranged in series in transverse and vertical directions (x and y directions). In one mode, the conductive gel layer is provided directly on the surface so as to cover the surface (surface where the stimulation electrodes are formed) of an electrode substrate. In one aspect, another conductive layer can be interposed between the surface of the electrode substrate and the conductive gel layer. Alternatively, another conductive layer can be provided between the conductive gel layer and the skin. In a preferred mode, the electro-tactile display is a forehead-mounted electro-tactile display. However, it is also made apparent in the description that the present invention is also applicable for electro-tactile displays other than forehead-mounted electro-tactile displays.

**[0011]** In a preferred mode, the means for alleviating a sensation is configured from the conductive gel layer. The conductive gel layer has a resistance value equivalent to that of the horny layer of the skin. The thickness of the conductive