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Electrovibration Technology

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Abstract- Electrovibration is a characteristic rubbery feeling when dragging a dry finger over a conductive surface covered with a thin insulating layer and excited with a 110 V signal. The attraction force created between the finger and the surface is too weak to perceive, but it generates a rubbery sensation when the finger is moving on the surface..

I. INTRODUCTION

Electrovibration (also known as Electrostatic Vibration) was accidently discovered by E. Mallinckrodt, A. L. Hughes and W. Sleator Jr. They reported that if a dry finger is moved gently over a smooth metal surface covered with a thin insulating layer, and the metal is given 110 V electric supply, the surface has a characteristic feeling that disappears when the alternating voltage is disconnected. [2]

II. ELECTROSTATIC FORCE THEORY

An electrostatic force is created by applying a time-varying voltage between an electrode and an insulated conductor plane. When a finger drags over the insulated conductor with a time- varying voltage, the finger works as the induced ground plane. The induced static electricity creates an electric force field between the finger and the surface.

The perceived friction experienced on the dry skin is directly proportional to the applied voltage.

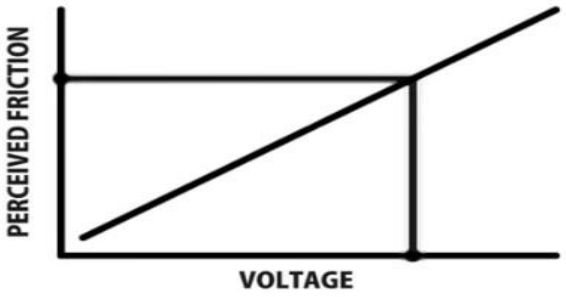

Figure 1

A parallel-plate capacitor model can be used to approximate the skin–surface interface. The electrode acts as one plate, while the conductive subcutaneous layer in the skin acts as the other, thus representing a hybrid natural/artificial electrostatic actuator. [1]

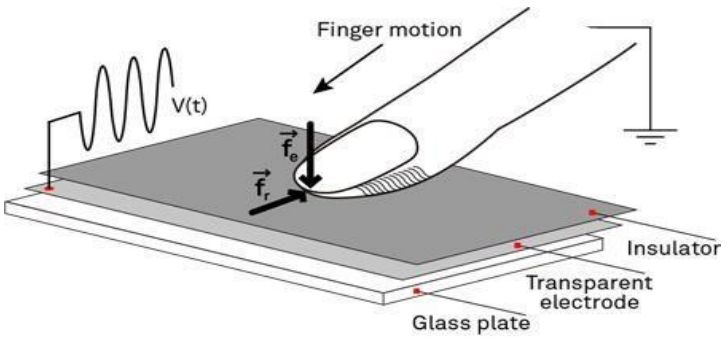

Figure 2

The following equation approximates the electrostatic force experienced between the finger and the electrode:

$$F_e = \frac{\varepsilon_0 \varepsilon_r A V^2}{2d^2},$$

Where,

ε_0 permittivity of free space

ε_r dielectric constant

A - area of electrodes

V - voltage applied between the two plates

D - distance between two plates

The resulting force is too small to perceive by human skin, but when the finger is moving on the surface, a frictional force appears on the moving finger, which can be expressed as

$f=\mu Fe$

Where μ is the coefficient of friction

III WORKING

The "characteristic feeling"—a sensation of friction—results from the electrostatic force produced by the alternating voltage across the electrode and insulated ground plane. As a person runs their finger over the ground plane, the movement induces an electric force field between the finger and the plane surface. Because the current alternates, the force field also alternates to attract and repel the finger. This field is ordinarily too small to be perceived by human skin directly, but movement over the surface provides a perceptible frictional force by modifying the rate at which individual cutaneous mechanoreceptors (pressure sensors in the skin) deform and send signals to the brain.

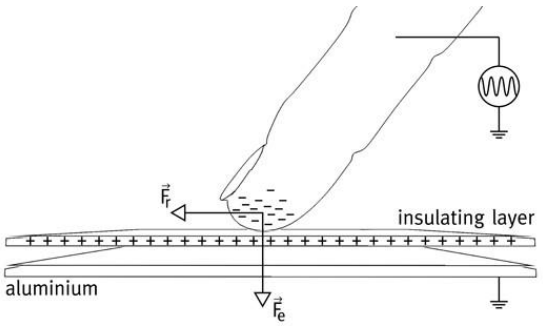

Figure 3

IV. APPLICATION

- TeslaTouch [4]

TeslaTouch is a new technology for enhancing touch interfaces with tactile sensations. It is based on the electrovibration principle, which can programmatically vary the friction between sliding fingers and a touch panel. The TeslaTouch technology requires no moving parts and therefore is inexpensive, lightweight and requires little power. This technology provides a wide range of tactile sensations to fingers sliding across touch-screens of any shape or size, from small mobile displays to curved or wall-sized screens.

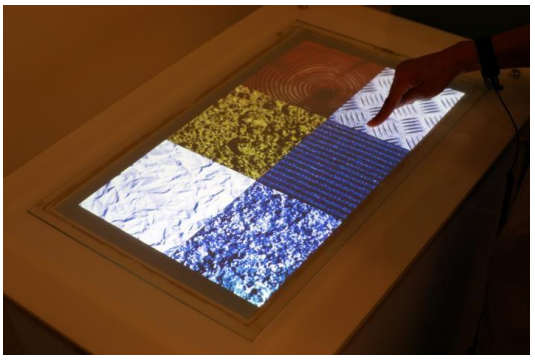

Figure 4

V. FUTURE SCOPE

- Virtual Touch

A virtual touch screen (VTS) is a user interface system that augments virtual objects into reality either through a projector or optical display using sensors to track a person's interaction with the object. For instance, using a display and a rear projector system a person could create images that look three-dimensional and appear to float in midair.[1] Some systems utilize an optical head-mounted display to augment the virtual objects onto the transparent display utilizing sensors to determine visual and physical interactions with the virtual objects projected.

Figure 5

- Braille Touchscreens

By applying a periodic voltage to the electrodes via connections used for sensing a finger's position on the screen, the researchers were able to effectively induce a charge in a finger dragged along the surface. By changing the amplitude and frequency of the applied voltage, the surface can be made to feel as though it is bumpy, rough, sticky, or vibrating. The major difference is the specially designed control circuit that produces the sensations.

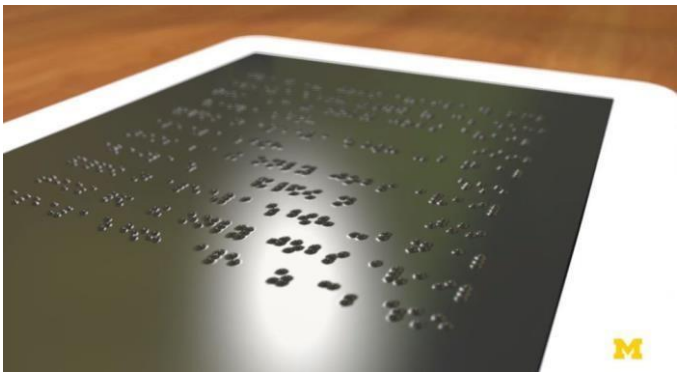

Figure 6

- Online Shopping

Electrovibration Technology will enable users to touch and feel the textures of fabrics while shopping online thereby revolutionizing the online shopping experience and product delivery. By changing the amplitude and frequency of the applied voltage, the surface can be made to feel as per the fabric of the garment while shopping online. This will prevent the seller from delivering low quality garments.

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