# Turning Surfaces into Touch Panels: A Granite-Touch Pad

**Hatem Elfekey and Shogo Okamoto**

**Abstract** Touch sensing interfaces are used in many human to machine applications with the natural feeling to the touch missing. We propose the use of humantenna touch technique to turn surfaces of natural or artificial conductive or semi-conductive materials into passive touch pads. Because of the conductivity of the human body, AC power lines induce a voltage on the human body which is used as the touch trigger. By the use of electrodes mounted at the edges of the surface, the ratio of voltage detected is used to compute the touch location. Granite touch pad was implemented as an example, and the voltage detected at the electrodes due to various touch locations is presented.

**Keywords** Humantenna · Granite · Touch pad · Human body

## 1 Introduction

Touch sensing applications are in ever high demand as touch sensing interfaces are used in most human-machine interfaces. On the other hand, touch pads require special surface that is manufactured for touch sensing. Consequently, the feeling of touch is limited. For example, touching the screen of a smart phone may not feel as rich as touching an actual wall or table top. To enhance the feeling of touch, many haptic feedback technologies have been implemented with the goal of creating artificial sense of surfaces. In this paper, we propose a different approach. We propose turning surfaces into touch pad instead of recreating particular textures via texture displays. As a result, the rich natural texture of surfaces is preserved, while serving as a touch sensing interface.

H. Elfekey (✉) · S. Okamoto
Graduate School of Engineering, Nagoya University,
Furo-cho, Chikusa-ku, Nagoya, Aichi Prefecture, Japan
e-mail: elfekey.hatem.mahmoud@h.mbox.nagoya-u.ac.jp

S. Okamoto
e-mail: okamoto-shogo@mech.nagoya-u.ac.jp



S. Hasegawa et al. (eds.), *Haptic Interaction*, Lecture Notes
in Electrical Engineering 432, DOI 10.1007/978-981-10-4157-0_51

For the aforementioned purpose, many touch technologies are available. Candidates comprise infra-red, camera, acoustic and capacitive technologies. Infra-red based touch sensing technology demands the use of many transmitters and receivers to extract the location of the touch, which may not be prefered for some applications [1]. Although the acoustic pulse recognition (APR) technique use only four microphones and an easy algorithm to precisely locate the touch position, the "touch and hold" feature is unavailable [1, 2]. On the other hand, surface acoustic wave (SAW) touch technology can detect "touch and hold", yet, the accuracy of the touch detection is dependent on the geometry of the surface [3]. Capacitive touch techniques make use of the capacitance change of the surface due to touch to calculate the position of that touch. Consequently, transmitters and receivers of electrical signals are required to measure the change of capacitance. For example, the user is asked to wear, hold or use a device that acts as the transmitter of an electrical signal [4]. In an earlier study [5], a mat was used as a transmitter of high frequency signals to travel though the human body. When the human touches a surface with four electrodes mounted on the corners, four high frequency currents are detected by the corner electrodes. Depending on the ratios of these currents, the touch location is identified. Such a mat demands additional space and specific installation requirements which are not available for general objects and materials [5].

We propose the use of the induced voltage on the human body from the AC power lines as the touch input, instead of the aforementioned transmitter device. Thus, the proposed touch-sensing technique is passive. Furthermore, the proposed technique turns conductive/semi-conductive surfaces into a touch panel. As a result, materials with desirable mechanical or thermal qualities could be touch sensitive. Also, the geometrical properties of the touch surface does not interfere with touch signals, unless the electrical path between the touch location and the electrode is altered. As proof of concept, a passive granite touch panel is proposed in this paper.

## 2 Operation Principle

Due to the fact that the human body contains minerals and salts, it exhibits conductive qualities, and hence, is affected by nearby line's 100/220 V, inducing a potential on the human body [6]. The induced voltage on the human body will be used as the touch trigger for the proposed touch panel.

Granite tiles have relative permittivity range of 5 to 8 F/m [7], hence, it was used to implement a touch floor [8]. However, multiple tiles were used to implement that touch floor. In the present study, using only one tile and four electrodes and a signal conditioning circuit, we implemented a touch pad. The voltage detected at the each corner of the tile has an inverse relation to the distance between the touch location and the respective electrode. Thus, by calculating the ratios of the voltage detected, the touch location is computed.

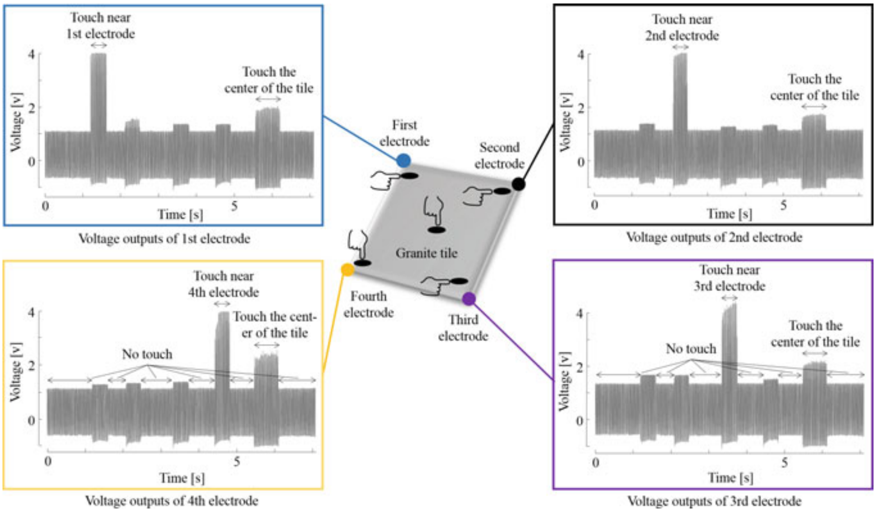


**Fig. 1** The voltage detected at the corners of a granite surface while the tile is touched from near the four electrodes and in the middle of the granite tile

## 3 Experimentation and Results

A regular flat granite tile of 30 × 30 cm with electrodes mounted on the four corners of the tile was used. A user was asked to touch the granite tile using a bare finger in a typical experimental room. The voltage from the four corners was connected to an oscilloscope for signal evaluation. Figure 1 shows the user touching the tile at specific locations in specified time periods. At time 6 s the user touched the granite tile at the center while at times 1.5, 2.5, 3.5 and 4.5 s the user touched near the first, second, third and fourth electrode receptively. Upon each touch event, a 60 Hz voltage signal was observed at each electrode. The electrode nearest to the touch location received the largest signals. Furthermore, the finger was placed at the center of the tile; the four electrodes received nearly equal level of signals. The voltage of "no touch" received at the four electrodes was significantly smaller than the voltage of touch, as seen in Fig. 1. The above mentioned observation indicates that the location of touch is calculated based on the output of the four electrodes.

## 4 Conclusion

In this paper, a methodology of turning a regular surface into a passive touch sensing panel was proposed. The system is simple, cost-effective, and of low power, as it is passive.

**Acknowledgements** This study was in part supported by JSPS Kakenhi (15H05923).

## References

1. Walker, G.: Fundamentals of touch technologies and applications. Society for information display (2011)
2. Reis, S., et al.: Touchscreen based on acoustic pulse recognition with piezoelectric polymer sensors. In: IEEE International Symposium on Industrial Electronics, pp. 516–520. IEEE Press, New York (2010)
3. Ono, M., Shizuki, B., Tanaka, J.: Touch & activate: Adding interactivity to existing objects using active acoustic sensing. In: Proceedings of the 26th Annual ACM Symposium on User Interface Software and Technology, pp. 31–40 (2013)
4. Sato, U., Poupyrev, I., Harrison, C.: Touché enhancing touch interaction on humans, screens, liquids, and everyday objects. In: Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems, pp. 483–492 (2012)
5. Paradiso, J.A., Hsiao, K., Strickon, J., Lifton, J., Adler, A.: Sensor systems for interactive surfaces. IBM Sys. J. **39**, 892–914 (2000)
6. Ma, C.T., et al.: Frequency-bandwidth-tunable powerline notch filter for biopotential acquisition systems. IEEE Electr. Lett. **45**, 197–199 (2009)
7. Nigel, J.: Cassidy: Electrical and Magnetic Properties of Rocks, Soils and Fluids. In: Jol, H.M. (ed.) Ground penetrating radar theory and applications. Elsevier, Amsterdam (2009)
8. Elfekey, H.M., Bastawrous, H.A.: Granite-based touch-sensing floor for machinery safety and exergaming. In: Proceedings of IEEE 4th Global Conference on Consumer Electronics, pp. 593–594. IEEE Press, New York (2015)