Pin Array Tactile Display Being Able to Express Ultra-Structure Depending on Its Position.

位置に応じた微細形状表現可能なピンアレイ型触覚ディスプレイ

14m5212 Anzu Kawazoe Supervisor Hiroki Imamura

SYNOPSIS

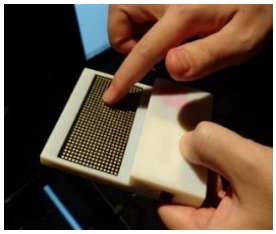
近年,VR 技術の発展に伴い,3D-CG に触れた際の触れた感覚を呈示するハプティックインターフェースの開発がされている．特に,物体表面の触れた感覚を再現する触覚ディスプレイが注目されている．本研究では,指のなぞり位置に対して動的に物体表面の微細形状を呈示するための新しいピンマトリクス型触覚ディスプレイの開発を行った．その結果,ピン間隔 0mm,1mm 四方内に 25 ピンのピン配列を実装したピンアレイ型触覚ディスプレイを開発した.本触覚ディスプレイは物体表面のテクスチャの微小形状を指のなぞりの位置に対して動的に表現を行い,操作者に触知させる．

Keywords: Tactile display, Haptic, Virtual Reality, Argumented Reality, Human Computer Interface.

1 INTRODUCTION

In recent years, the study about human computer interface using Virtual Reality and Argumented Realty have been studied more and more[1]. Especially, Haptic interface to manipulate virtual object easily has been developed. Falcon and PHANToM mainly used as Haptic Interface. When a user touches virtual object with pen type interface on PHANToM and the user can feel the haptic feedback from virtual object. Haptic interface is attractive because it has been applied for simulation in surgeons[2] and robot remote control[3].

Tactile display is a kind of haptic interface. Especially tactile display is a device to provide the sense of touch. For example, we can perceive the sensation of the texture when we trace the object. Tactile display provides the sensation of texture in various materials. In conventional study, some types of conventional tactile displays have been developed. For example, there are electronic display and vibrotactile display showed by Fig.1. Pin tactile display is also tactile display and provides the sense of touch by shaped pins. The electronic display stimulates electronic stimulation to the receptors in a finger. When we are touching texture on the object, we have a friction vibration. TECHTILE toolkit provides vibratory stimulation that is pretend to a friction vibration. These tactile displays are compact size and easy to embed in tactile contents. However, compared to these, recent study concluded that pin tactile display is the easiest to provide sensation of edgy texture[4]. Therefore, to recognize ultra-structure on the surface, the pin tactile display is proper to use. In decade years, many type of pin tactile display has been developed. A basic consideration for design of tactile display have been conducted. In the study for tactile shape recognition, Nakatani et al created pin tactile device model and conducted experiment. They concluded that pin pitch in 0 mm is adaptive for tactile shape recognition[5]. Actually, we percept ultra-structure on the surface with moving finger. Therefore, we can percept better ultra-structure on the surface using by the pin tactile display with providing sense of touch actively based on finger position. We would like to recognize the sense of touching ultra-structure using by the pin tactile display with active feedback based on finger position and pin pitch 0mm. However there is no such a pin tactile display because of difficulty to design and motor limitation.



Hamsa Touch

Electronic tactile display

TECHTILE toolkit

vibrotactile display

Fig1: Tactile display

In this study, we develop the pin tactile display to provide the sense of touching ultra-structure actively based on tracking a motion of finger position. We implement pin array display with 0 mm distance between pins.

2 Our Approach

(a) Default (b) Controlling

Fig2: Proposed tactile display

Fig.2 shows proposed tactile display. The tactile display has 25 pins with a diameter of 1[mm]. As shown Fig.2-(a), pins are arranged 5×5 matrix array without space between pins. When the height of each pins is actuated, the pin tactile display shows texture pattern showed by Fig.2-(b). User touches this texture pattern with a finger pad and user recognize tactile feedback. The proposed tactile display tracks the index finger position and shows different texture pattern according to index finger position. In this way, users can feel tactile feedback from the tactile display controlled in real-time.

3 Hardware

Fig.3 shows our developed pin tactile display. Our developed pin tactile display has handle to move and optical mouse to detect the position. Fig.4 shows hardware configuration of the tactile display. In the hardware configuration, there are tactile display and control circuit. The control circuit consists of Arduino UNO, ATmega328 microcomputers, motor driver (7NVC771D, TOSHBA) and Optical mouse. Optical mouse (M-

K6P2RWH/RS, ELECOM) obtains the tactile display position. Linear actuate motors (PFCL25-484D, NPM) actuate 25 pins. Arduino UNO receives texture pattern information from PC and send information to each ATmega328. ATmega328 and motor diver control linear motors. In inside of tactile display, each linear motor is connected to each joint and each joint is connected to each pin. When each motor is actuated, connected each pin is actuated.

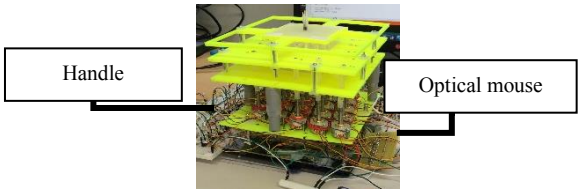


Fig.3: Pin tactile display

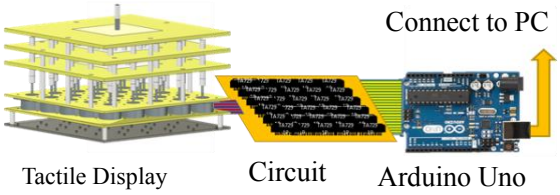


Fig.4: Hardware construction

4 System Configuration

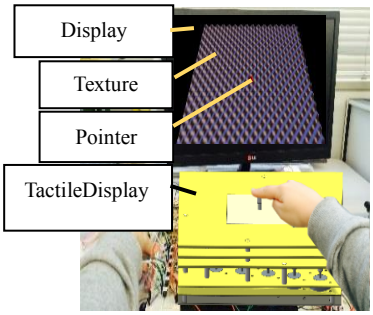


Fig5: System configuration

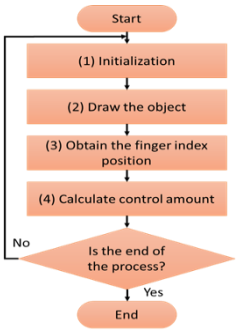


Fig6: Flowchart

Fig.5 shows system configuration. The system has the tactile display and PC. A user trace the texture on object with the tactile display using a finger of a hand. User put on the index finger on the pin array. User grip the tactile display using another hand and move. The right index position is showed by red pointer on VR space.

4.1 System Flow

System flowchart is shown in Figure.6. Following is the detail explanation of each processing.

(1) Initialization

The pin tactile display calibrate each pin height with pressure sensor. We define this pin position as default position.

(2) Draw the object

The display draw and show the texture of the object with open library source, OpenGL.

(3) Obtain the finger index position

The center position of the pin tactile display is the same with the finger index position. By using the optical mouse, we obtain the position of tactile display. Arduino sends the finger position to the PC and PC draws the CG graphic.

(4) Calculate control amount

Arduino calculates each pin height by using position of tactile display obtained in process (3). Arduino controls the height of each pin.

5 Experiment

5.1 Evaluation experiment

We conducted evaluate experiment. In the evaluate experiment, 5 subjects of this experience used pin tactile display and touched the edgy object in VR. They evaluate following items.

・When you put the index finger on the object, you could feel touching edgy surface.

・When you traced the index finger, you could feel the edgy surface.

・User did not feel a sense of discomfort with CG graphic on display and motion of tactile display.

They evaluated with evaluate value in 5 scales.(5: Strongly agree, 4: Agree, 3: Neutral, 2: Disagree, 1: Strongly disagree)

5.2 Results

Table 1: Results

Question Number	The average of evaluation	The standard variation
Q1	4.6	0.49
Q2	4.2	0.75
Q3	3.2	1.17

The table 1 shows results of the evaluation experiment. From Q2, when the user moves the index finger, the pin tactile display provide the sense of touch. Pin tactile display can provide ultra-structure actively base on motion of index finger. We confirmed the discomfort between PC drawing and processing.

6 Conclusion

In this paper, we propose and developed a novel tactile display. We conducted the basic evaluate experiment and confirmed the basic performance of the pin tactile display. We conclude that our pin tactile display tracks motion of index finger and provides the sense of touching ultra-structure actively base on motion of index finger. In the future, we have to develop another type of pin spaced pin array and conduct experiment to compare actually perception tactile characteristic.

REFERENCE

[1] KE Maclean: Haptic Interaction Design for Everyday Interface", Reviews of Human Factors and Ergonomics, Volume 4 Chapter5 pp.149-194 2008.

[2] T.Terada: "Haptic Device in Medical VR", IPSJ Magazine Vol.43 No.5 May 2002

[3] I. Ivanisevic and V.J. Lumelsky: "Configuration Space as a Means for Augmenting Human Performance in Teleoperation Tasks," IEEE Trans. on SMC, Part B, vol.30, no.3, pp. 471–484, 2000.

[4] H.Kajimoto "Tactile Display" Journal of the Society of Instrument and Control Engineers Vol.47 No.7, July 2007

[5] M.Nakatani, N.Kawakami, S.Tachi,"Tactile Shape Recognition on a Tactile Display Using a High Density Pin Matrix,"TVRSJ Vol.14, No.3, 2009.