Spring-Pen: reproduction of any softness with the 3D printed spring

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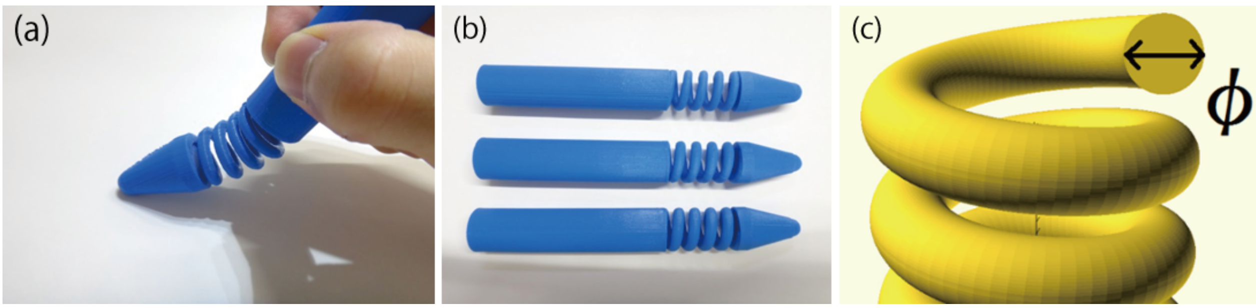

Figure 1: (a) Spring-Pen prototype model (not conductive filament). (b) ϕ=4.5mm,5.0mm,5.5mm. (c) Coil spring diameter ϕ.

ABSTRACT

In this paper, we present a stylus pen with a new tactile feedback in writing pictures and letters on smartphone and tablet terminal. The stylus pen uses a spring structure to reproduce the tactile sensation of the softness like the tip of a brush. In addition, the softness suitable for personal taste can be expressed because the user can adjust the thickness and the number of steps of spring coil with 3DCAD software. Moreover, it makes the feedback from the screen more realistic. It helps expression in our drawing pictures and letters.

CCS CONCEPTS

•Modering →User Interaction;

KEYWORDS

pen-based interaction; haptic feedback; digital fabrication

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1 INTRODUCTION

Recently, smartphones and tablet terminals are widely used. The number of those who use stylus pens to operate tablet screens is increasing. In drawing digital pictures and letters, especially, it is necessary to use a stylus pen. In the previous researches, there is a pen device that can reproduce the feel of pencil, paper and other tactile sensation, by using vibration and electrostatic force. With the existing pen device, however, it was difficult to reproduce soft touch feeling in using a brush like a watercolor paint. For this reason, there is a need to create a pen that can reproduce softness for users depicting digital pictures with brushes. Additionally, in order to be available to many users, producing have to be easy, and parameters of softness according to individual preference have to be freely alterable. Therefore, in this paper, we take advantage of a 3D printer.

2 IMPLEMENTATION AND METHOD

In examining ways to reproduce the softness in the structure, there were [Panetta et al. 2015] and [Schumacher et al. 2015]. However the precision of current 3D printers is not enought to reproduce with the size of the pen and it was difficult to manufacture a fine structure. Therefore, a spring [He et al. 2017] was considered as a structure that can reproduce arbitrary softness within the range of the size that can be used as a pen. Next, we decided to use a 3D printer as a creation method that anyone can easily express various kinds of elasticity. The 3D printer uses MakerBot Replicator+ (FDM), and when creating 3D model, we used software called OpenSCAD. The advantage of this software is that you can produce 3D models with code description. By changing the parameter values of the coils in the code, various types of elastic pen can be manufactured easily. However, in this method using a 3D printer, as the diameter ϕ (Figure1 (c)) of the helical portion of the coil becomes smaller, the durability is weakened and the spring is damaged because it can not withstand the load. In order to impart durability, it is only necessary to increase the value of the diameter ϕ, but the softness decreases. This problem can be solved by maintaining both of durability and softness by increasing the number

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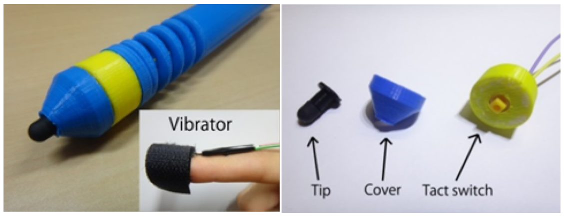

Figure 2: prototype model using a oscillator.

Table 1: Vertical-Required force to shrink 3 mm

ϕ	1	2	3	4	5	average
4.0mm	5.1N	5.0N	4.9N	4.9N	4.8N	4.94N
4.5mm	8.0N	7.9N	8.0N	7.9N	8.0N	7.96N
5.0mm	13.0N	12.8N	12.8N	12.9N	12.8N	12.86N
5.5mm	19.6N	19.7N	19.5N	19.8N	19.7N	19.66N

Table 2: Horizontal-Required force to bend 5 mm

ϕ	1	2	3	4	5	average
4.0mm	0.4N	0.3N	0.4N	0.4N	0.4N	0.38N
4.5mm	0.6N	0.6N	0.5N	0.5N	0.6N	0.56N
5.0mm	1.2N	1.3N	1.2N	1.2N	1.2N	1.22N
5.5mm	1.6N	1.5N	1.5N	1.5N	1.6N	1.54N

of turns of the coil and the pitch number. In addition, we tried to impart vibration to the hand by attaching an vibrator to the finger and aim for further feedback of tactile sensation. The tact switch built in the pen tip is pushed, current flows in the circuit, and the vibrator vibrates. The vibrator was attached so as to be in contact with the fingernail (Figure2). The vibration of the mounted pen has only a single pattern of vibration. We think that by changing the strength of the vibration [Ando et al. 2007] [Lee et al. 2004] [Wang et al. 2016] by the speed of moving the pen or the pressure of the pen tip, it is possible for the user to have a better writing experience.

3 EXPERIMENTAL RESULT

In order to verify the elasticity of the spring, we used a force tester MCT-1150. The elasticity of the spring in the longitudinal and transverse directions was recorded (Figure 3). For this time, we made samples with nonconductive PLA resin and verified how much elasticity difference is created by the diameter ϕ of the spring. The pen elasticity data of each thickness (ϕ) was recorded. The result are shown in Table 1 and Table 2. As a result, it was found that various resilience can be reproduced with the spring. It was shown that elasticity can be controlled by changing the value of ϕ.
※ Unit of force：N (newton)

4 CONTRIBUTION AND DISCUSSION

We propose a method to express softness which could not be expressed by vibration. By combining with an application such as an illustrator, it is possible to obtain a feeling close to the touch of a

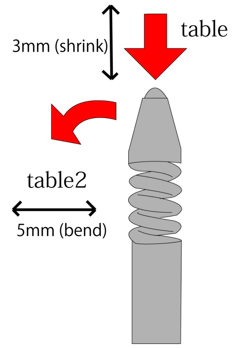

Figure 3: experimental method.

brush. In the present situation, since it will be used on a pressure-sensitive touch panel, we will make it possible to use it as a conductive pen with a capacitive touch panel. In the future, we will work on making stylus pens with various feel by considering structures.

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