Proposal of a flexible touch panel using a resistive film

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Abstract

The beginners are hard to use traditional remote controllers to operate sophisticated moving machines like robot, helicopter, airplane, and so on. Thus, only well-skilled operator has controlled them conventionally. This fact disturbs the spread of such sophisticated moving machines. Therefore, it is important to make their operation simple. In this paper, we propose a flexible touch panel with a single resistive film and some point electrodes. Any form of touch panel can be realized by using the flexible touch panel. That is, our flexible touch panel will realize an intuitive controller to operate sophisticated machine, by providing a simple operation interface. Through the experiments on a prototype system with a circular touch panel, the axis of the finger touching can be detected by using three point electrodes.

Keywords: flexible touch panel, human-machine interface, any shaped touch panel, resistance film touch panel

1. Introduction

The beginners are hard to use traditional remote controllers to operate sophisticated moving machines like robot, helicopter, airplane, and so on [1]. Thus, only well-skilled operator has controlled them conventionally. This fact disturbs the spread of such sophisticated moving machines. Therefore, it is important to make their operation simple.

In this paper, we propose a flexible touch panel with a single resistive sheet and some electrodes. Since the resistive sheet can be cut to any form, any form of the touch panel can be made. The some electrodes which are used to estimate the axis of the touched point can provide the multidimensional shaped touch such as ball-type touch panel. That is, our flexible touch panel will realize an intuitive controller to

operate sophisticated machine, by providing a simple operation interface.

The rest of the paper is organized as follows. Section 2 explains the principle of our touch panel. Section 3 describes a prototype system. Section 4 shows the experimental results and Section 5 discusses about them. Finally, Section 6 concludes our paper.

2. Principle and Configuration

Figure 1 shows a device configuration of the proposed flexible touch panel. The gray hatched part means a flexible touch panel made of a resistive sheet. The circular touch panel has three point electrodes to be used for calculating the touched point.

The electrodes are connected to a demultiplexer. The demultiplexer is connected to a resistor and an AC power supply serially.

The touch portion is estimated by measuring the voltage on the resistor, R , switching the demultiplexer. The detail is mentioned later.

Figure 2 depicts the principle of our flexible touch panel. The resistive sheet has a resistance value, R_2 , according to the touched point. When there is no contact by human, no current flows since no closed circuit exists. Once the human finger touches to the resistive sheet, the series circuit of a capacitor and a resistor is formed in the human body to the ground. Then, an AC current flows through this path. As the resistance value of the resistor sheet is changing according to the position touched, also the amount of current flow and the voltage on the resistor, R_1 , are changing. We can detect the position by using such characteristics.

The voltage, V_1 , on the register, R_1 , in Figure 2.2 is calculated simply by the equation (1). By switching the demultiplexer, each V_1 of three point electrodes can be

acquired. Using their V_1 , the position touched can be estimated by some method such as lookup table, interpolation, and so on.

Fig. 1 Device Configuration

Fig. 2 Principle

$$V_1 = \frac{R_1}{R_1 + R_2} v \quad (1)$$

3. Prototype System

We have developed a prototype system to perform the preliminary experiments for our proposal. This prototype is equal to the organization shown in Fig. 1. The touch panel is a circular resistive film with 3 electrodes. In addition, a character LCD is attached for debug and measurement.

3.1 Detector Circuit

Figure 3 shows a detector circuit used in this prototype. This circuit acquires the voltage on the R_1 shown in Fig. 2 via an instrumentation amplifier. Since the voltage acquired is AC wave, the smoothing circuit converts it to the DC waveform which represents the level of the voltage on the R_1 in order to let a microcontroller process. Details of the instrumentation amplifier and the smoothing circuit will be described later. We configured some parameters as follows; $R_1 = 25 \text{ [k}\Omega\text{]}$, $R_2 = 60 \text{ [k}\Omega\text{]}$, $R_3 = 10 \text{ [k}\Omega\text{]}$, $R_4 = 1 \text{ [M}\Omega\text{]}$, $C_1 = 10 \text{ [nF]}$.

(a) Instrumentation Amplifier

Figure 4 shows the circuit diagram of the instrumentation

amplifier. Instrumentation amplifier is a high-precision gaining block with closed loop. It has a pair of differential input terminal and a single-ended output with respect to the reference terminal potential. Typically, the input impedance is higher than $10 \text{ [M}\Omega\text{]}$. Unlike the operational amplifier, the instrumentation amp uses the gain setting resistors and one-chip feedback resistor network. In addition, the gain-setting resistors and resistor networks are disconnected from the input terminals unlike the operational amp.

(b) Smoothing Circuit

Figure 5 shows the circuit diagram of the smoothing circuit. It consists of a rectifier circuit and a resistor-capacitor filter. The half wave generated by the rectifier circuit charges the capacitor. The capacitor is discharged when the half wave finishes charging. However, the charged voltage remains enough level until the next half wave comes by setting the RC time delay appropriately.

Thus, we can get the most constant voltage according to the AC wave on the R_1 .

Fig. 3 Detector Circuit

Fig. 4 Instrumentation Amplifier

Fig. 5 Smoothing Circuit

3.2 Process Flow

Figure 6 shows the flowchart of the operation of the microcontroller. First, the output voltages from 3 electrodes are acquired through the AD converter. To debug, these values are displayed on the character LCD.

To get X-Y axis of the finger touching the touch panel, we calculate the ratios by equation 2. V_A , V_B and V_C mean the output voltages of 3 electrodes respectively. Why we use the ratio instead of the values of the output voltage? This is because the value is dependent on the used resistive film, the used electrode, the form of the resistive film, and so on. Thus, we decide to use the ratio to hide such dependency.

The calculated ratios are converted to the fixed point number. The fixed point number is normalized to the index to the table. This table holds the X-Y axis. That is, the calculated ratio can be converted to the X-Y axis by the look-up table.

Fig. 6 Flowchart

$$V_i' = \frac{V_i}{V_a + V_b + V_c} \quad (2)$$

4. Experiment

4.1 Experimental Environment

Figure 7 shows the photo of a touch panel used in this experiment. The circular diameter of the used resistance film is 100 [mm]. Three electrodes are attached to the resistive film. In this experiment, we have realized a demultiplexer using a switch IC of MC14016BCP manufactured by Motorola. In addition, the amps of the detection circuit amp were INA128P manufactured by BURR-BROWN.

Fig. 7 Touch Panel of the Prototype

4.2 Measurement Coordinate Acquisition

Experiments in this section measure the output voltage of each electrode.

(a) Experimental Methodology

We drew a circular line on each radius 10 [mm] from the center of the membrane resistance, as shown in Figure 8. $3n$ ($n = 1, 2, 3 \dots$) points on each circular line were taken. The author pushes each point by the finger. When the author touches the resistive file, the output voltage of the three electrodes was measured. Each measurement was taken by three times.

(b) Experimental Result

Figure 9 to Figure 11 show the average value of the measurement results. The regions are colored according to the touched point. The area where the output voltage is large is colored by red. The area where the output voltage is small is colored by blue.

The output voltage is relatively high when the finger touches the close point to the electrode. Output voltage becomes small as the finger moves away from the electrode. The same trend can be seen in all Figures.

That is, by using such trend, the finger position can be estimated by a deterministic way.

Fig. 8 Experimental Condition

Fig. 9 The Output Voltage at the Electrodes A

Fig. 10 The Output Voltage at the Electrodes B

Fig. 11 The Output Voltage at the Electrodes C

4.3 Position Detection Accuracy

This section attempts to estimate the position by using the result mentioned above. In addition, we evaluate the accuracy of this estimation.

As shown in Fig. 12, we assume 9 point to be touched. By comparing the measured coordinate estimated with the

actual point, we confirm an accuracy of our estimation.

We estimate the coordinate of each point 10 times. That is, total number of measurements is 90 times.

Average accuracy is 95.5%. This fact indicates that our proposal using the circular resistive film and few point electrodes can provide the point touched by the finger precisely.

Fig. 12 Nine Points Anywhere on the Resistive Film

5. Conclusion

We have proposed a flexible touch panel with a single resistive film and some point electrodes. Any form of touch panel can be realized by using this flexible touch panel. That is, our flexible touch panel will realize an intuitive controller to operate sophisticated machine, by providing a simple operation interface. Through the experiments on a prototype system with a circular touch panel, the axis of the finger touching can be detected by using three point electrodes actually.

As future work, we will evaluate more resistive touch panels with several forms. Also, we will plan to develop a real touch panel system using our proposal.

References

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