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Development of a Micro-Force Plate for Artificial Tactile Sensing

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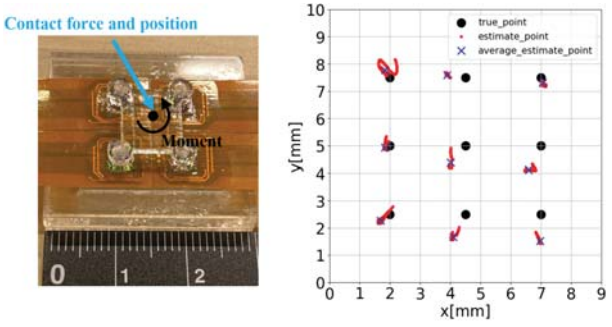

Fig. 1: Micro force plate and center of pressure estimation

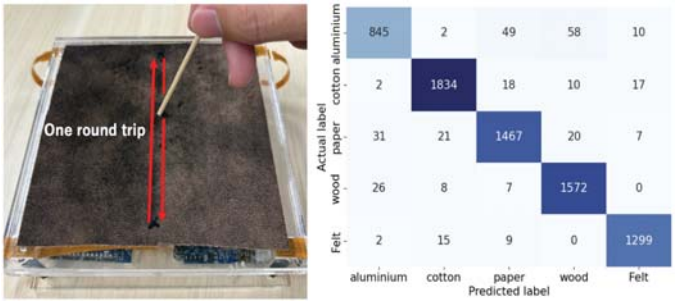

Fig. 2: matrix of identification results

***Abstract*— In this study, we develop a miniature 1cm-square force plate that measures applied three-axis forces and moments on a fingertip-sized area, aiming to realize human-like artificial tactile sensing. To evaluate object recognition with the force plate, we conducted a material identification task. The system achieved high identification accuracy.**

Keywords—Artificial tactile sensing, Force plate

I. Introduction

We aim to realize a fingertip with artificial tactile sensing capable of recognizing where and how contact occurs on the fingertip, like a human finger. Artificial tactile sensing requires some functions such as measuring three-axis forces at the fingertip and recognizing object characteristics [1]. To meet these requirements, we developed two prototype, 1cm-square and 15cm-square. The 1cm-square one allows to detect applied force, and 15cm-square one does material identification placed on the plate.

II. Force Plate

We have developed micro size three axis tactile sensor [2]. Using four of them, we designed micro force plate as shown in Fig. 1. The graph in Fig. 1 shows the estimated result of contact point of applied force. Here, we pressed nine points on the force plate, and red marks represent estimated centers of pressure, and blue marks represent the average at each point. The average estimation errors were less than 1cm.

III. Material Identification

Next, we conduct a material identification task using the large one. We placed target material on the plate, and asked participants to trace each material three times back and forth with a bamboo skewer while observing it. Ideally, the force plate should act as a sensing probe and touch the material. However, this simplified setup allows to measure similar results. Here, we employed five materials: cotton fabric, leather-like felt, aluminum foil, wood board, and newspaper. Four male participants in their twenties completed 10 trials per material. The sampling rate was set to 200 Hz. Finally, we got 200 trials.

We train the constructed CNN on the dataset and evaluates the model using 10-fold cross-validation. Fig. 2 shows the confusion matrix of the identification results. The model achieved a high average accuracy of 95.5%.

IV. Conclusion And Demo

We aim to develop human-like artificial tactile sensing by designing a force plate. The force plate satisfies two requirements for artificial tactile sensing. We demonstrate contact point estimation on the surface and material identification by human stroking.

Acknowledgement

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References

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