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Feature Quantification of Material Texture Perception Using a Force-Displacement Relationship*

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***Abstract*— The force-induced displacement distribution function (FDDF) is a physical quantity with a high degree of familiarity with product production parameters and sensibility values. In this study, we proposed FDDF (Stroke) as the texture perception by stroking FDDF implementation. Moreover, we showed that FDDF (Stroke) has a highly expressive tactile perception capability for hard materials.**

I. INTRODUCTION

The force-induced displacement distribution function (FDDF) was defined as a conceptual function that has high explain-ability for both physical features and sensibility values (ex. comfortable feeling, luxury feeling) [1, 2]. This function realizes the production based on sensibility values; however, it is not clear how the function is implemented. In this study, we proposed the FDDF (Stroke) as the FDDF implementation regarding the texture perception by stroking. Moreover, we evaluated the validity of the implemented FDDF (Stroke) by using fabrics of JIS L3402 standard.

II. FDDF IMPLEMENTATION

We found the height map feature that constitutes the tactile perception by the study of plastic textures [3], and defined the feature as FDDF (Stroke). The feature is a 23-dimensional vector and is calculated with the following:

$$\mathrm{FDDF(Stroke)} = \frac{1}{\mathrm{N_l}} \sum_{\mathrm{l=1}}^{\mathrm{N_l}} \mathrm{F}(\hat{\mathrm{h}}(\mathrm{x(l)})),$$

where N_l is the analysis line number, x is the line represented by the index l, and F is the function that calculates the one-dimensional sequence power spectrum. Moreover, the converted height map $\hat{h}$ is calculated with the following:

$$\hat{h} = g(h, d),$$

where g is a function that selectively extracts information from the surface texture up to a depth d, which is not perceived by the skin when stroking a surface texture. $\hat{h}$ has information contributing to tactile perception selectively.

III. VALIDATION OF FDDF (STROKE)

To show the quantification validity using FDDF (Stroke), we evaluated whether the tactile characteristics of fabrics can be expressed by FDDF (Stroke). We measured the height maps for 10 sailcloth types (Takeyari Co., Ltd.) using 3D measurement system (Keyence Co. Ltd., VR-5000), and calculated the features for each height map. An example of the measured height map and the calculated FDDF (Stroke) is shown in Fig. 1. The relationship between the tactile perception predicted by FDDF (Stroke) using the tactile prediction model [3] and the type of sailcloth is shown in Fig. 2. The type of sailcloth is standardized by JIS L3402 and expressed as a numeric symbol. In general, roughness and hardness decrease as the number of numeric symbol increases. We confirmed that FDDF (Stroke) is effective for representing the tactile texture of hard fabrics, because the tactile tendency of sailcloth is well represented.

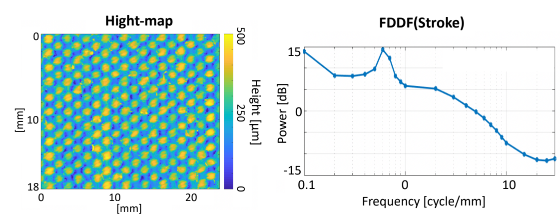

Fig. 1. Example of FDDF (Stroke).

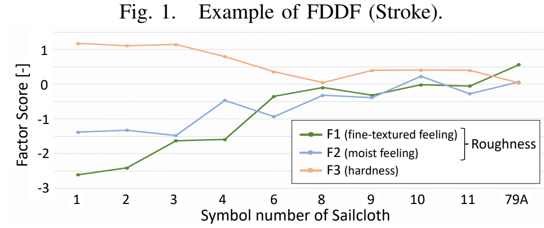

Fig. 2. Relationship between fabric structure and tactile perception.

IV. CONCLUSIONS

We proposed FDDF (Stroke) as a novel feature that has a high affinity with both the physical properties and sensibility values of products. Furthermore, we demonstrated the validity of FDDF (Stroke) for expressing the tactile perception of fabric. In the future, the quantification of various materials with FDDF (Stroke) will make it possible to realize production based on sensibility values.

REFERENCES

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