

MERIT Internship (Domestic) Report

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Internship period

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Host company

TAIYO YUDEN CO., LTD., Department of Functional Device Development,
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Theme

Data collection using odor sensor and verification of judgment accuracy by statistical processing for the purpose of practical evaluation

Internship contents

The use of physical information such as sound and light is widespread, but the use of chemical information like aroma and taste is not common at present. If this chemical information can be used, it is expected to be applied in a wide range of fields such as healthcare, environmental measurement, food stock, and detection of dangerous substances. As part of its solution development, TAIYO YUDEN CO., LTD. develops sensors that visualize odors and proposes ways to use them. In this internship, I first drew up a lean canvas. Based on this, I measured the aroma of coffee beans using an odor sensor and performed judgment and evaluation by machine learning. In addition, I also performed microstructural analysis of the odor sensor.

First, in order to learn the process of solution development, I created a lean canvas that is used to visualize startup businesses. As a theme related to the odor sensor, I selected the evaluation of the aroma of coffee beans, and investigated the characteristics of coffee beans, roasting methods, problems, and so on. As a result of the survey, it was found that the degree of roasting of coffee beans has a greater impact on the aroma and taste than the place of origin and extraction method of coffee beans. In addition, it became clear that the selection of an appropriate roasting method according to humidity and temperature largely depends on skill and intuition based on experience and is difficult for ordinary people.

Therefore, as the first step in realizing feedback on the degree of roasting from the smell during roasting and proposing roasting methods according to individual preferences, I measured the aroma of coffee beans with the odor sensor and verified the identifiability of the degree of roasting using machine learning. Quartz crystal microbalance-type odor sensor was used to measure the odor emanating from finely ground coffee beans of three different degrees of roasting (light roast, medium roast, and dark roast). Since there was a difference in humidity between the inside of the odor sensor and the coffee gas, I changed the position of the zero point and corrected the effect of humidity on the obtained measurement data. Then, I investigated how these affect machine learning. As a result of principal component analysis, humidity correction improved the separation of light roast, indicating that humidity greatly affects the aroma measurement of coffee beans. Machine learning was performed by analyzing the data measured by the odor sensor using a unique algorithm. The trained model was tested with other measurement data that was not used for training, and the judgment accuracy was evaluated. As a result, it was found that the data measured on the same days as the data used for learning tended to have higher determination accuracy, while the data measured on different days showed lower determination accuracy. By correcting the humidity, the accuracy of the determination was improved even with the data on different days, but it was inferior to the measurement data on the same days, so it became clear that disturbances other than humidity also had an effect.

Finally, I also dealt with semiconductor-type odor sensor. Since the sensor characteristics change depending on the structure, observation of the fine structure is important. Therefore, I learned about microstructural analysis using scanning electron microscope, and performed elemental analysis by energy dispersive X-ray spectroscopy.

Impressions

I had never touched machine learning before, so I was worried before starting the internship. However, through the odor evaluation during this internship, I was able to deepen my understanding of machine learning while using it under attentive guidance and discussing the evaluation method. The research theme of this time, odor sensing, is related to my own research, and I feel that I was able to focus on understanding machine learning.

There were many things that could not be verified only during the internship period. So, there were times when I was in a hurry, but I think one month was just right for me to concentrate and work on it.

In addition to odor sensors, I was given opportunities to interact with people from other departments, and I learned a lot from the detailed explanations about multilayer capacitors and piezoelectric materials.

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