Indoor Air Monitoring System in Restaurant Using Portable Electronic Nose

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Abstract—**The propose of this work is to examine the efficacy of the odor removal air purification systems which are installed in Barbecue restaurant and Hotpot restaurant. Portable electronic nose device is used to smell the odor in the restaurants and digitize it with the correlation between the number of occupied tables and the efficacy of the indoor air purification systems. During the lunch time, customers have avoided to be enjoying in the strong odor food restaurant that at times resulted in declining customer traffic because the odor can attach to the customers' hair and cloth and these will disturb them after the lunch. The odor in the restaurants were evaluated about eleven hours each day consistently for three weeks with different conditions of air purification systems. The odor data is analyzed by principle component analysis and total volatiles calculation. The end result from the total volatiles evaluated as well depicted greater correlations between intensity of odors accumulated to the entire number of table being occupied in a restaurant and the efficacy of air ventilation system. (***Abstract***)**

Keywords—**Electronic Nose, Indoor Air Monitoring, Restaurant, Digitization of smell, air purification systems, Odor, Smell. (*key words*)**

I. INTRODUCTION

During the high competition amongst the restaurants that delivered discerned foods and customer services orientation. The customers always avoid the strong odor food restaurants during the lunch time because the odor from the food can attach with their hair or cloth [1]. After the lunch, most of the customers have to go back to work and the attached odor can cause the annoyance their colleges. Therefore, the number of customers during the lunch time is relatively low compare to the dining time which reduce the income of the restaurant. The odor removal air purification system is introduced to solve this food odor problem in indoor restaurants but the cost of installation of this system is quite high and there will be more operation cost to maintain its the highest efficacy [2]. The efficacy of the air purification system must be tested to verify the value of investment, but human testers cannot make a comparison between the odor level and the number of customers and the conditions of air purification system which are really complicate [3].

In this work, the portable electronic nose was used to determine the odor level in two types of restaurants which are (1) Barbecue restaurant, and (2) Hotpot restaurant. Because both have a strong odor in the ambient so there is low traffic of customers during the lunch time on weekdays. Moreover, both are the pilot branch for determining the efficacy of the air purifier system in term of economic as well as odor level reduction. The examined restaurants were used air ventilation and ozone to reduce the ambient odors produced while customers are self-cooking the food. We deployed electronic nose in three different cases by recording number of tables occupied by consumers at different hours of the day. The test was performed to measure odor in closed dining without

ventilation, with ventilation, and with ozone and ventilation operating. We did basically focus to evaluate the odors in a restaurant on weekends because it is fully occupied.

Fig. 1 Portable electronic nose for odor level monitoring in the restaurant.

II. METHODOLOGY

The food odor in the ambient air was measurement by portable electronic nose started from 10.00 am which is the opening time to till 9.00 pm which is the closing. Screening of odors smell proceeded each hour to compare the odors concentration produced by recording the number of tables occupied within two and three consecutive weeks in the barbecue and hotpot restaurant respectively. The odors were also evaluated before opening the restaurant using both air zero grade and normal ambient air as a reference gas to relate the odors patterns between the reference.

The barbecue restaurant experiment was separate to two days. The first day, the air purifier system did not operate during the experiment only normal air ventilation operated while the second day both air purifier system, ozone generator, and air purifier system operated.

The hotpot restaurant experiment was separate to three days. In the first day both ozone generator and air ventilator were fully turned on to the highest performance. The air ventilator was turned off and only ozone was used in the second week. Finally in the third week of the experiment both ozone generator and air ventilator were put off.

To compare the differences between odor of the restaurants, the percentage of sensing response was obtained using the equation (1) and the sum of the percent change of all sensors was combined to show the sum of the total volatiles indicated in the equation (2).

$$X = \frac{R_0 - R_S}{R_0} x \, 100 \qquad (1)$$

$$S = \sum_{i=1}^{8} X_i \qquad (2)$$

X = percentage of sensing response

R_0 = Sensor response to air zero grade (reference gas)

R_s = Sensor response to the odor (sample gas)

S = Total volatiles

TABLE I. Gas Sensors and their target tag

No.	Sensor ID	Target gas
1	TGS 821	Hydrogen gas
2	TGS 2444	Ammonia
3	TGS 823	Organic Solvent Vapors
4	TGS 2600	Air Contaminants
5	TGS 2603	Odorous Gases
6	TGS 2610	LP Gas
7	TGS 825	Hydrogen Sulfide
8	TGS 2620	Solvent Vapors

The the portable electronic nose [4] was controlled by Labview software application with DAQ card connect through the labtop via USB port. Air zero grade was used as the reference gas for the recovery process of each sensor after they sniff the sample odor. The fundamental principle relied for sensing data is due to the signal variations of each gas sensor (See Table I.) when the odors is introduced to the sensing materials on the sensor surface. Analog signal of sensors was altered due to change in the resistance of each sensor. The odor data was analyzed by the percentage sensing response, average total volatiles, cluster analysis and principal component analysis methods.

III. CURRNET RESULTS AND DISCUSSION

A. Odor Analysis by PCA Pattern

The data archived from the two restaurants were statistically evaluated by principle component analysis. The result of the barbecue restaurant indicates that the odor patterns for the first date before the opening time is different from the others while the odor patterns for second date is grouping (See Fig. 2). These results can imply that the air purifier system can maintain the odor level during it is operating.
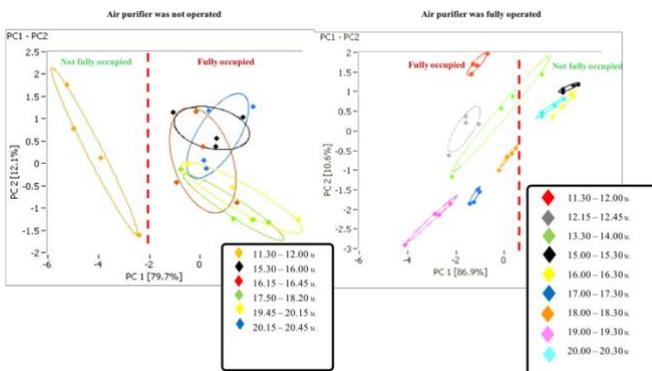

Fig. 2 PCA Odors Patterns of the barbecue restaurant

The result of the hotpot restaurant indicates that the odor patterns for second and third date were similar (See Fig. 3). These results can imply that the odor in the restaurant during the air purifier system is fully operating has the different odor pattern from the days it was not operated or not fully operated.
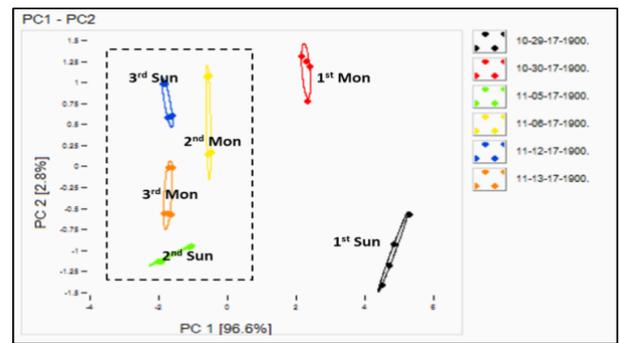

Fig. 3 PCA Odors Patterns of the hotpot restaurant

B. Odor level analysis by Total volatiles calculation

The intensity of odors produced in the hotpot restaurant for three days was compared during the Sunday of different weeks which all the tables were filled. As shown in figure 5, the odor level in the ambient of the hotpot restaurant during the air purifier system was fully operated is lower compare the date which it did not operate. However, without air ventilation system, the odor intensity is not much reduced from the day without air purifier system due to the ozone generator needs the new oxygen from the air ventilation system for the highest performance.
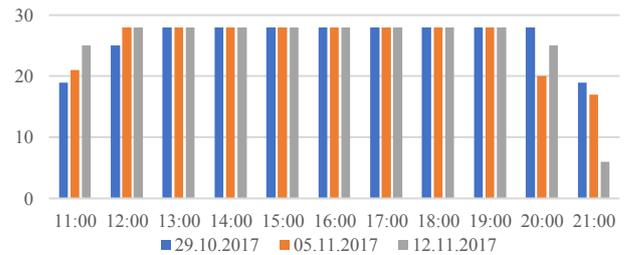

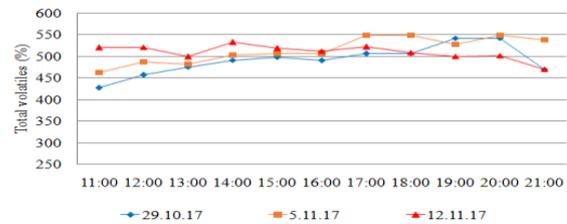Fig. 4 Comparison of odors during Sunday in MK Restaurant

Fig. 5 Comparison of odors during Sunday in the hotpot Restaurant

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