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A Study on the Establishment of Odor Management System in Gangwon-do Traditional Market

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Abstract

Purpose: Establishment of a real-time monitoring system for odor control in traditional markets in Gangwon-do and a system for linking prevention facilities. **Research design, data and methodology:** Build server and system logic based on data through real-time monitoring device (sensor-based). A temporary data generation program for deep learning is developed to develop a model for odor data. **Results:** A REST API was developed for using the model prediction service, and a test was performed to find an algorithm with high prediction probability and parameter values optimized for learning. In the deep learning algorithm for AI modeling development, Pandas was used for data analysis and processing, and TensorFlow V2 (keras) was used as the deep learning library. The activation function was swish, the performance of the model was optimized for Adam, the performance was measured with MSE, the model method was Functional API, and the model storage format was Sequential API (LSTM)/HDF5. **Conclusions**: The developed system has the potential to effectively monitor and manage odors in traditional markets. By utilizing real-time data, the system can provide timely alerts and facilitate preventive measures to control and mitigate odors. The AI modeling component enhances the system's predictive capabilities, allowing for proactive odor management.

Keywords : Odor, Sensor arrays, AI, Deep learning

JEL Classification Code : I30, O31, O32

1. Introduction

Odor is a smell that is unpleasant and repulsive because an irritating substance stimulates the sense of smell (MOE, 2021). Due to the development of the industry, the distance between residential areas and odor generating facilities has increased, and citizens' awareness of odor has increased (NIER, 2019). The traditional market, which is closely

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related to the living area of citizens, is an area where people, space, and economy coexist. It also functions as a complex space where you can experience local customs and community. The main causes of odors in traditional markets are divided into odors during cooking in restaurants, odors from sewers, and odors from food waste (Jung, 2021). In this way, the odor generated in traditional markets has an irregular pattern with a strong concentration instantaneously. Therefore, in order to respond to the odor generated in this way, it is necessary to build a system that can monitor in real time and link prevention facilities. In this study, we researched and developed ways to build an AI server and server framework necessary for system construction.

2. Research Methods and Materials

To build the system, a real-time sensing device that derives data input values was built. The specifications for the real-time monitoring device are presented in Table 1. Based on the data collected from the real-time monitoring device presented above, odor monitoring sensors, control devices, and dashboard protocols are developed. Sensors and devices implement the Berkeley socket server-based protocol and perform unit tests. In addition, the dashboard WAS server-based protocol is implemented and unit tests are conducted. To verify AI learning data and develop a data model, first develop a temporary data generation program for deep learning data. Develop optimal activation functions, performance measures, and models for odor data. Develop a hybrid logic that can be operated in two ways by developing a rule base program so that it can be operated until the accumulation of big data for actual learning and verification. For dashboard design and web publishing development, design the site and web front end, and develop web publishing and business logic.

Table 1: Real-time Monitoring Sensor Specifications

Fluid Used	Air(Odor)
Sampling Method	forced suction
Sensor Array Module	4 types (NH_3, H_2S, TVOCs, NO_2)
Communication Function	Built-in (remote control, notification)
Communication Method	Wireless (Wi-Fi, LTE CAT.M1)
Display Contents	Display of complex odor measurement concentration, dilution factor calculation, meteorological data, etc.
Proper Operating Temperature	-20℃ ~ 70℃
Dimensions (WxHxD)	550(W) x 1,500(H) x 450(D) mm, SUS 304 1.5T
Constant Power	220V AC

3. Results and Discussion

Figure 1 shows the configuration of the protocol and AI virtual server developed through this study. In addition, regarding the specifications of the sensor and control device protocol, the sensor data transmission packet (client->server) is presented in Table 2, and the control device data transmission packet (client->server) is presented in Table 3.

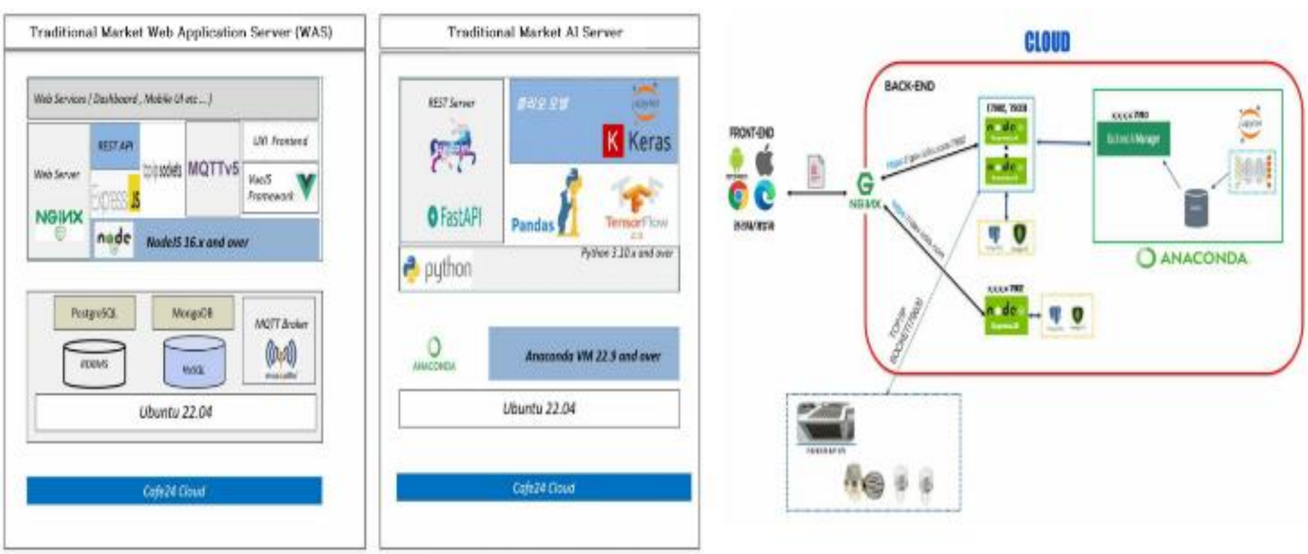

Figure 1: WAS, AI Server Framework and Configuration Diagram

The WAS/DB server is a Linux operating system, and the environment was established by establishing a database and a web server. Through Berkeley socket server construction, sensors and devices were implemented to be accessible, data transmission and control protocols, and dashboard access REST APIs were developed. Developed AI server communication module and rule base logic, and developed management DB module and NoSQL DB module related to data and device control records. The AI server is a Linux operating system identical to WAS/DB, and implements an AI virtual environment and package. A program to generate temporary learning data and verification data was developed, and data loading/analysis/preprocessing was implemented. Logic was implemented to generate/evaluate/save/verify/ predict the model accordingly. A REST API was developed for using the model prediction service, and a test was performed to find an algorithm with high prediction probability and parameter values optimized for learning. The dashboard was planned and designed for user convenience, and the design was published through HTML and CSS conversion. React-based web app (SPA) layout logic was developed, and server connection function and data state processing chart logic were developed. The deep learning algorithm for AI modeling development is summarized in Figure 2 as follows.

Developed base web app (SPA) layout logic, server connection function and data status processing chart logic. The deep learning algorithm for AI modeling development is summarized in Figure 2 as follows. Pandas was used for data analysis and processing, and TensorFlow V2 (keras) was used as a deep learning library. The activation function was swish, the performance of the model was optimized for Adam, the performance was measured with MSE, the model method was Functional API, and the model storage format was Sequential API (LSTM)/HDF5.

Libraries and algorithms used in deep learning

Ⅰ. Data analysis and processing : Pandas
Ⅱ. Deep learning library : TensorFlow V2 (keras)
Ⅲ. Activation function : swish
Ⅳ. Performance of the model : Adam optimization
Ⅴ. Performance Measure : MSE
Ⅵ. Model method and storage format: Functional API, Sequential API (LSTM)/HDF5

Data - Temporary learning data and verification data

Ⅰ. Training data : 43,800 (5 years) -> 61,320 (7 years)
Ⅱ. Verification data: 10,248 (17%)
Ⅲ. Layer : input (1), hidden (3), output (1) > hidden node (units) : 30
Ⅳ. learning parameter
> Epochs : 300(Functional), 100(LSTM)
> Batch : 32(Functional), 50(LSTM)

Figure 1: AI Modeling and Deep Learning Algorithms

Table 2: Sensor Data Transmission Packet (Client -> Server) Specifications

Size	2 bytes data header	1byte	1byte	2byte	25byte	1byte
Items	$$	ID	Location	Error	Data (TVOC, SMELL, NH_3, CH_4, average value x 2 bytes, maximum value x 2 bytes, temperature, humidity, atmospheric pressure)	checksum

No	Items	Use	Size	Range	Remarks
1	$$	Wi-Fi/LTE communication start header	2byte		0x2424
2	ID	MSU ID	1byte	0~256	
3	Location	[Market, Zone] Code Ex) Zone3 Subdivision1 (0x31)	1byte	0~256	0x10 : Zone 1 0x20 : Zone 2 0x30 : Zone 3 0x40 : Zone 4 0x01 : Subdivision 1 0x02 : Subdivision 2
4	Error	Error content	2byte	0~65535	0x01 : TVOC sensor error 0x02 : SMELL sensor error 0x03 : NH3 sensor error 0x04 : H2S sensor error 0x05 : CH4 sensor error

5	Data	Gas sensor average value, maximum value data	2bytex10	0~65535	
		Temperature, Humidity	2bytex2	0~65535	
		atmospheric pressure	1byte	0~256	
6	Checksum	checksum for communication error checking	1byte	0~256	

Table 3: Control Device Data Transmission Packet (Client -> Server) Specifications

Size	2 bytes data header	1byte	1byte	1byte	1byte	1byte
Items	$$	ID	Location	Code	Volume	Checksum

No	Items	Use	Size	Range	Remarks
1	$$	Wi-Fi/LTE communication start header	2byte		0x2424
2	ID	CTL ID	1byte	0~256	
3	Location	[Market, Zone] Code Ex) Zone3 Subdivision1 (0x31)	1byte	0~256	0x10 : Zone 1 0x20 : Zone 2 0x30 : Zone 3 0x40 : Zone 4 0x01 : Subdivision 1 0x02 : Subdivision 2
4	Code	Device Code	1byte	0~256	0x01 : Sewage odor prevention facility 0x02 : Food waste prevention facility 0x03 : Restaurant odor prevention facility
5	Mode	CTL 상태	1byte	0~256	0x00 : stop 0x01 : Action 0x02 : Error 0x03 : Complementary
6	Volume	Motion count	1byte	0~256	Motion intensity (0~100)
7	Checksum	checksum for communication error checking	1byte	0~256	

4. Conclusions

In conclusion, this study aimed to develop a system for real-time monitoring and management of odors in traditional markets. The research methods involved building a real-time sensing device, developing odor monitoring sensors and control devices, and implementing a dashboard protocol. An AI server and server framework were also developed to analyze the collected data and make predictions.

The results of the study showed the successful configuration of the protocol and AI virtual server. The sensor and control device data transmission packets were established, and the WAS/DB server environment was set up. The AI server implemented an AI virtual environment and package, and a program for generating learning and verification data was developed. The deep learning algorithm for AI modeling was implemented using TensorFlow and various optimization techniques.

The developed system has the potential to effectively monitor and manage odors in traditional markets. By utilizing real-time data, the system can provide timely alerts and facilitate preventive measures to control and mitigate odors. The AI modeling component enhances the system's predictive capabilities, allowing for proactive odor management.

Further improvements and refinements can be made to the system, such as expanding the dataset for better model training and incorporating feedback mechanisms from users and stakeholders. Additionally, integrating the system with existing odor prevention facilities and implementing it in real-world traditional markets would provide valuable insights and practical applications.

Overall, this research contributes to addressing the issue of odor management in traditional markets and provides a foundation for further advancements in odor control technology.

References

Abe, H., Kanaya, S., Takahashi, Y., & Sasaki, S. I. (1988). Extended studies of the automated odor-sensing system based on plural semiconductor gas sensors with computerized pattern recognition techniques. *Analytica chimica acta, 215*, 155-168.

Banerjee, R., Tudu, B., Bandyopadhyay, R., & Bhattacharyya, N. (2016). A review on combined odor and taste sensor systems. *Journal of Food Engineering, 190*, 10-21.

Grodniyomchai, B., Chalapat, K., Jitkajornwanich, K., & Jaiyen, S. (2019, July). A deep learning model for odor classification using deep neural network. *In 2019 5th International Conference on Engineering, Applied Sciences and Technology (ICEAST)* (pp. 1-4). IEEE.

Jung, J. S., Kim, D. C., Lee, H. C., Yeon, S. W., & Yeon, I. J. (2016). A Study on the Odor Compounds Emitted using Odor Contribution Analysis - Focus on the Ochang Scientific Industrial Complex Area -. *Journal of Environmental Science International, 25*(9), 1329~1339.

Kanakam, P., Hussain, S. M., & Chakravarthy, A. S. N. (2018, April). Smart-trace: A future security aid using body odor sensing of an individual with IoT. *In Proceedings of 3rd international conference on internet of things and connected technologies (ICIoTCT)* (pp. 26-27).

Kanakam, P., Hussain, S. M., & Chakravarthy, A. S. N. (2018, April). Smart-trace: A future security aid using body odor sensing of an individual with IoT. *In Proceedings of 3rd international conference on internet of things and connected technologies (ICIoTCT)* (pp. 26-27).

Matsuoka, H., Nakamura, K., Hirai, K., Nagata, T., & Ichifuji, Y. (2022, October). Iinioi Cloud: A platform for Sensing and Analyzing Odor. *In 2022 IEEE 11th Global Conference on Consumer Electronics (GCCE)* (pp. 239-240). IEEE.

MOE. (2019). Environmental statistics of odor.

NIER (2019). Study of on-site applicability evaluation of the living odor management standard model, NIER-RP2019-242, 1-32

Yoon, J. S., & Lee, T. J. (2022). LSTM-based Fire and Odor Prediction Model for Edge System. Journal of Information Processing Society. *Computer and Communication Systems, 11*(2), 67-72.