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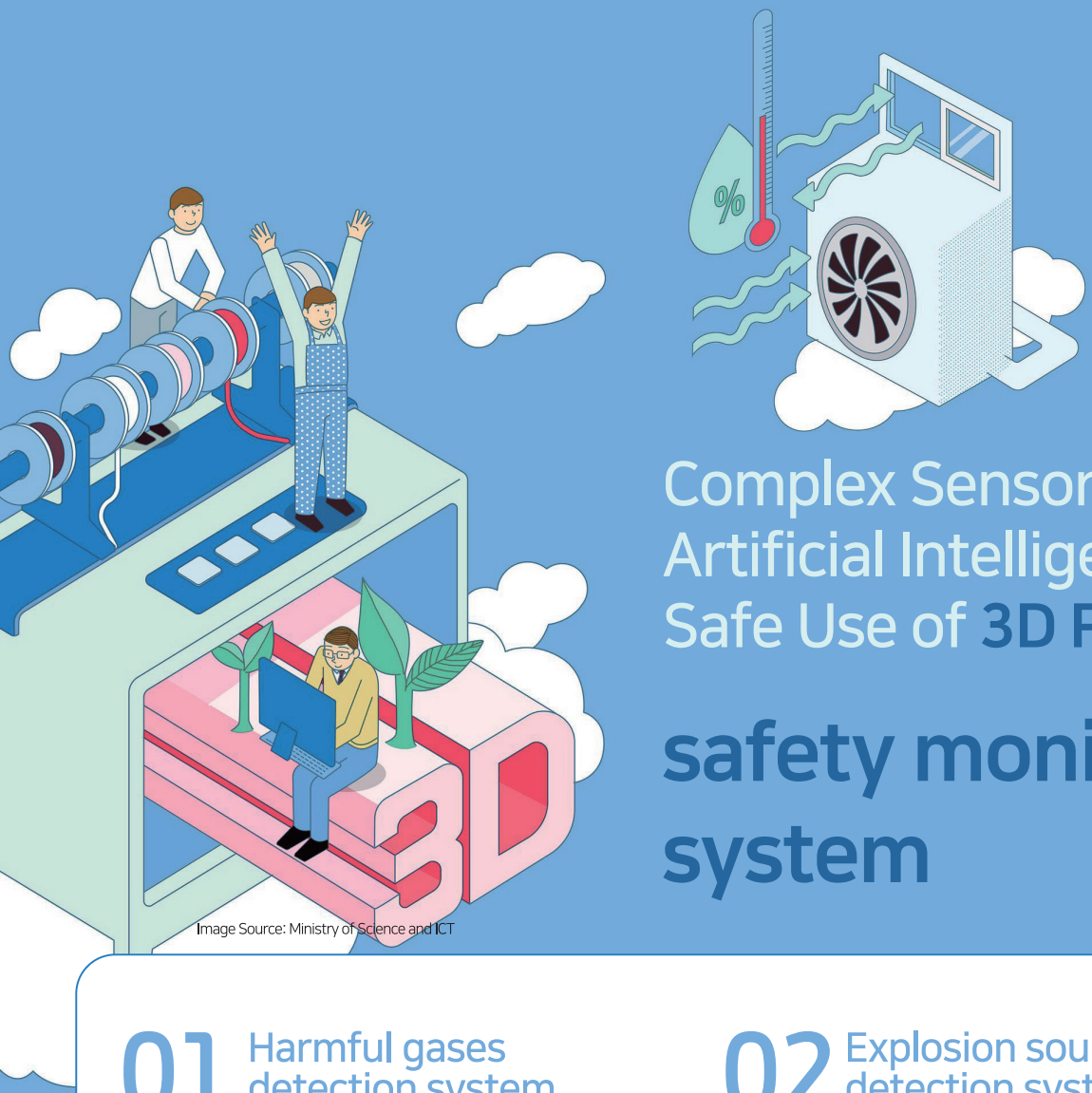

Image Source: Ministry of Science and ICT

Complex Sensor-Based Artificial Intelligence for Safe Use of 3D Printers

safety monitoring system

01 Harmful gases detection system

- VOC (volatile organic compounds) detection data collection
- Formaldehyde detection data collection
- API request linkage for server communication
- Establishment of a monitoring system for data collection/analysis and control

02 Explosion sound detection system

- Data sensing for sound detection
- API request linkage for server communication
- Establishment of a monitoring system for data collection/analysis and control

03 3D Printer Access Safety Management System

- Collection of access data for access detection
- API request linkage for server communication
- Establishment of a monitoring system for data collection/analysis and control

04 Risk situation decision system using artificial intelligence

- Storage/management of collected data
- Establish a risk situation judgment/ notification system based on data collected using artificial intelligence
- Sending an alarm text message in case of danger, warning light control, Action command function such as ventilation control

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http://kounosoft.com

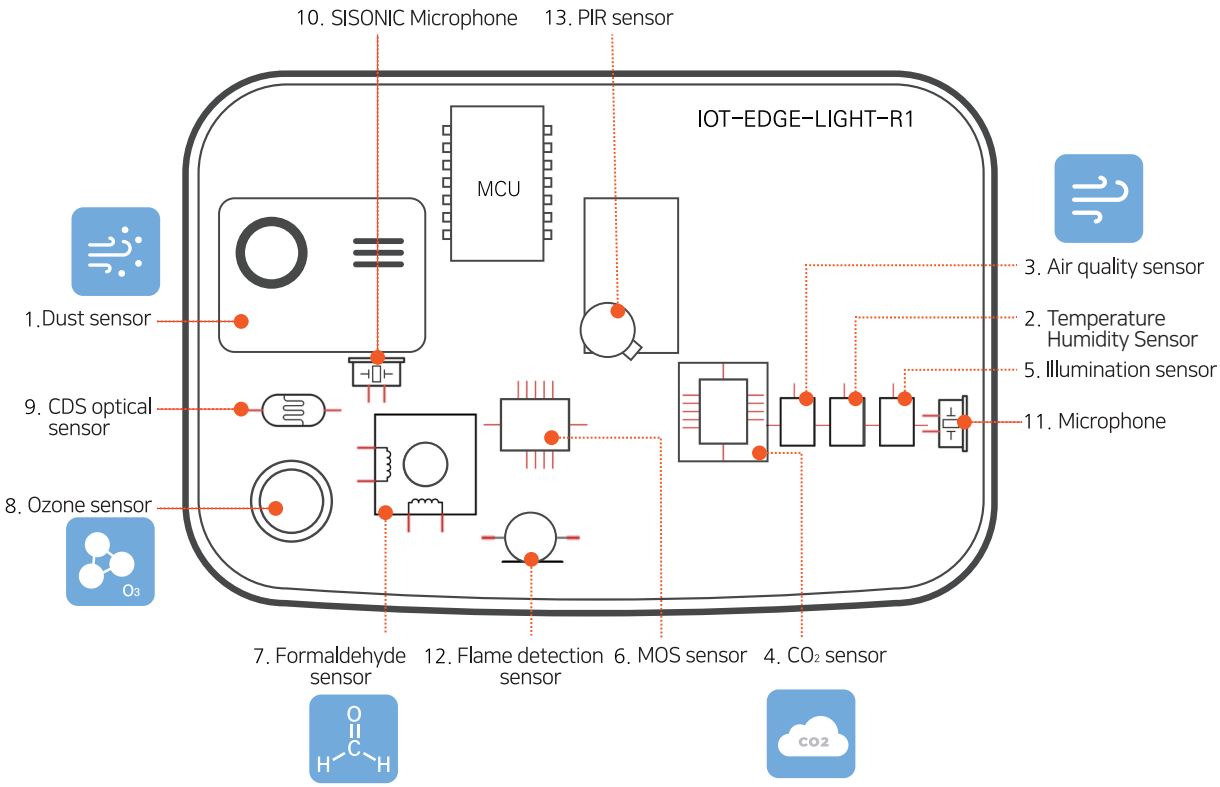
Core technology

1. AI risk situation prediction algorithm based on multi sensor data

- Use real-time monitoring sensor information to extract and store meaningful information and visualize it in server system dashboard
- The server uses artificial intelligence to determine VOC values, access, dangerous situations, etc., and notifies users
- On-site system control in dangerous situations
- Storage/integrated management of sensor data, etc. in DB

2. Complex sensor terminal device for recognizing dangerous situations (13 sensors integrated)

- Equipped with 13 sensors, data is continuously transmitted to the server every period of time



IoT Edge Light configuration diagram

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3. Example of Representative Sensor Spec

Ozone sensor

Category	Specifications
Model name	MQ131
Interface	Analog
Power	DC 5V
Preheating time	Requires more than 48 hours
Hight concentration measurement range	10ppm ~ 1000ppm
Measurement Environment	20℃±2℃, 55%±

Formaldehyde sensor

Category	Specifications
Model name	ME2-CH2O
Interface	Analog
Power	DC 5V
detection gas	CH2O
Measurement Range	0ppm ~ 5ppm
Maximum detection concentration	20ppm

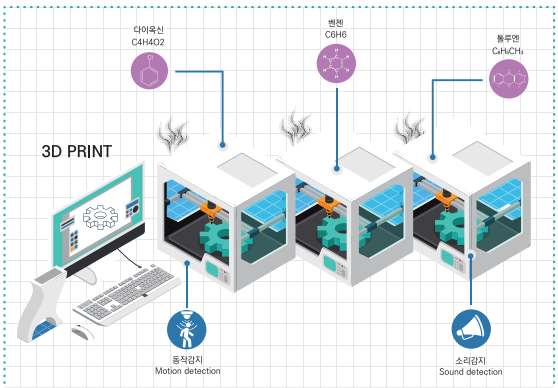
CO_2 Sensor

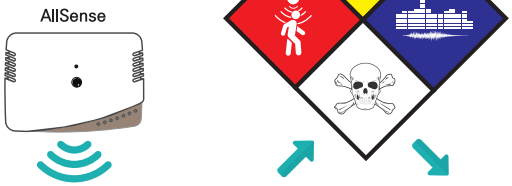
Category	Specifications
Model name	SCD40
Interface	12C
Power	DC 3.3V, 5V
rated current	115mA, 175mA
operating temperature	-10℃ ~ 60℃
Sensor type	Carbon Dioxide (CO2)
Measurement Range	400 -2000 ppm

Air quality sensor

Category	Specifications
Model name	SGP40
Interface	12C
Power	DC 3.3V
rated current	2.6mA
Measurement Range (raw)	0 ~ 65535 ticks
Measurement Range (processed)	0 ~ 500 VOC Index points
Measurement time	<60s

4. 3D printer safety monitoring system diagram



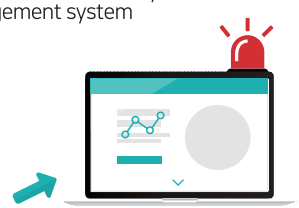


Harmfmul gases detection safety notification system

Explosion sound recognition notification system

3D printer access safety management system

DB



web/ app monitoring system

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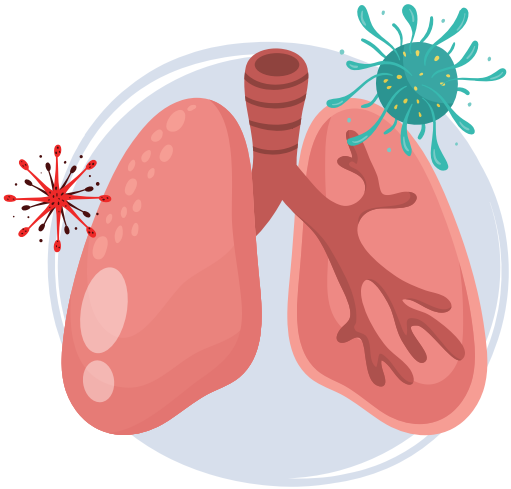
The need for a 3D printer safety monitoring system



3D pens used in elementary school classes emit toxic substances

Many elementary schools are conducting after-school programs offering 3D pen crafting classes. However, since the principle of 3D printers, which are known to emit carcinogenic substances, has been directly applied, merely changing the form to a pen, the safety has not been verified. Professor Ham Seung-heon from Gachon University Gil Hospital's Department of Occupational and Environmental Medicine stated, "If we only consider the amount of harmful substances emitted, pens emit much less than printers. However, printers can be left running without the user being present in the space, whereas 3D pens are operated by hand, inevitably bringing the body close to the device during printing.
Moreover, when concentrating, there is a risk of inhaling harmful substances directly by bringing the nose close."
Professor Ham Seung-heon emphasizes the **need for ventilation before, during, and after use.** If ventilation is insufficient, the smell of paint may become strong, leading to headaches with prolonged use. The smell of paint is characteristic of volatile organic compounds. If you experience headaches, it could indicate inhalation of harmful substances, **so you should immediately stop working.**

Source: Health Chosun News

Diagnosed with rare cancer due to 3D printer use

It is estimated that 3D printers have been supplied to more than half of elementary, middle, and high schools nationwide since 2015. However, **the filament used in 3D printers is classified as a Class 1 carcinogen, with reproductive toxicity, and is being dentified as a cause of cancer.**
However, **there are currently no safety management measures** in place for this issue. Teachers working at science high schools who have extensively utilized 3D printers in their classes have applied for recognition of work-related injuries, citing an extremely rare cancer that accounts for only 0.16% of all cancer cases.
According to a self-conducted survey by the Ministry of Education, out of 5754 schools surveyed, symptoms were experienced in 274 schools, accounting for 4.8%. Among the 114 symptomatic ndividuals, **headaches, respiratory irritation, dizziness, and memory impairment were reported.**

Source: Health Chosun News

Ventilation

Wearing gloves

Wearing a mask

MSDS

MSDS Check
(Materials and raw materials)

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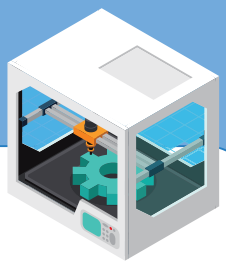
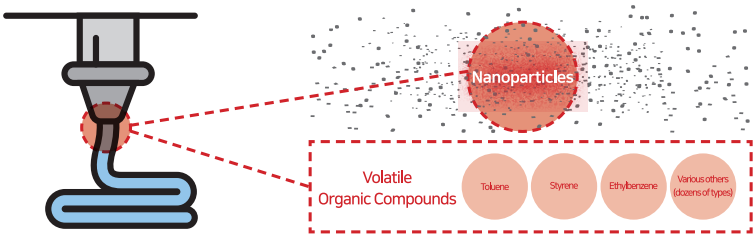


Hazardous Substances Generated When Using a 3D Printer

What are the main hazardous substances that occur during 3D printing operations?

➡ 1. particulate matter, including nanoparticles
2. Volatile Organic Compounds when using a 3D printer

▶ Entry-level 3D printers that primarily use plastic filaments such as PLA and ABS generate nanoparticles and volatile organic compounds during the process of melting the material at high temperatures.



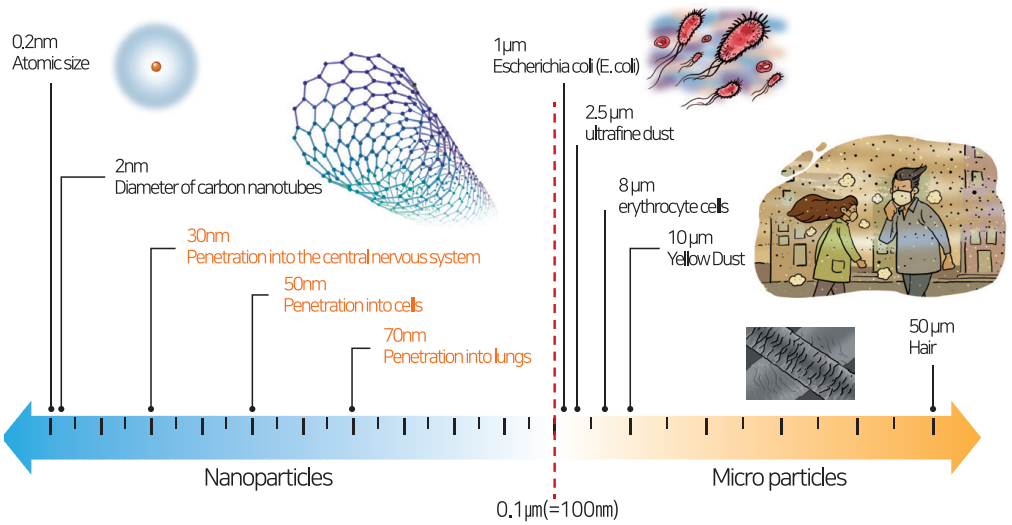
※ May vary depending on filament type and manufacturer.

1. Nanoparticles (Nanoparticle, Ultra fine particle, etc.)

Nanoparticles refer to fine particles with a diameter of less than 0.1 micrometers (μm)* and are particles smaller than ultrafine dust (2.5 μm).

*100 nanometers (nm)

※ (Ministry of Environment) a material that distributes at least 50% of the three-dimensional exterior dimensions of particles with a size of at least one dimension of 1 nanometer to 100 nanometers



출처: 과학기술정보통신부

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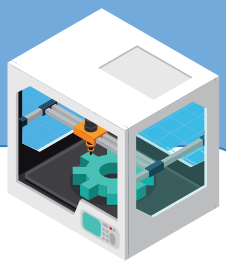
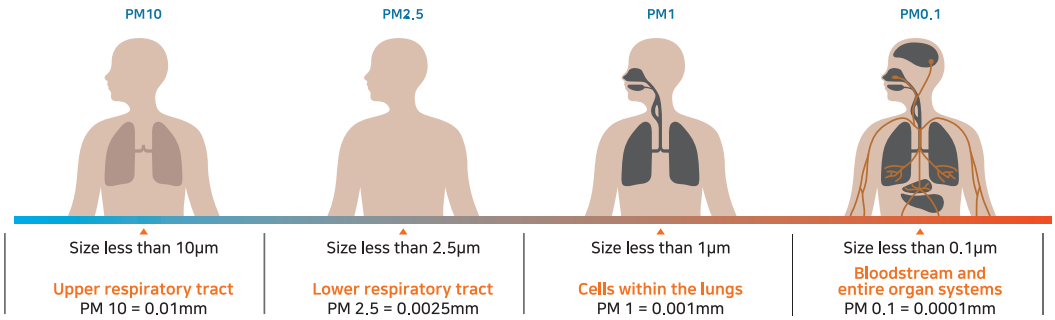
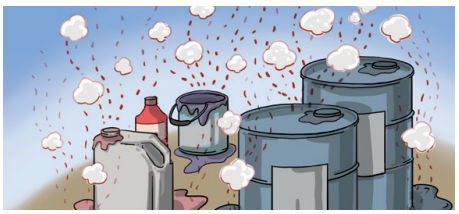


Although there are not many studies on the effects of nanoparticles on health, caution is needed as it is known that the smaller the particle size, the deeper the body can enter when breathing and cause various abnormalities.



2. Volatile Organic Compounds (VOCs)

Volatile Organic Compounds (VOCs) refer to a group of organic compounds that easily evaporate into the air as liquids or gases. They are commonly found in organic olvents and other products.



▶ The U.S. certification agency UL has created and utilized standards for allowing fine particles and volatile organic compounds emitted during 3D printing operations.

* Underwriters Laboratories (UL): Product safety testing and certification authority

<Standards for acceptance of hazardous substances released during 3D printing operation (based on office)>

Examination items	Maximum Allowable Emissions
Total Particle Emission (Total Particles)	3×10^{11} particles/h (2×10^{10} particle/g)
Total volatile organic compounds (TVOC)*	10.4 mg/h (based on the office)
Formaldehyde	0.187 mg/h (based on the office)

* Allowable emissions for 80 substances, including total volatile organic compounds, formaldehyde, etc

출처: 과학기술정보통신부

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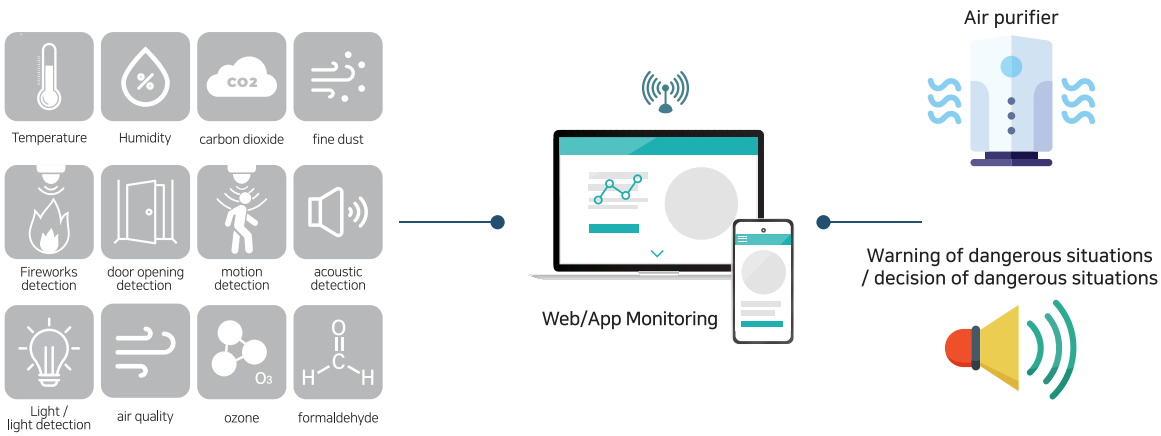
3D printer safety monitoring system demonstration content

1. Collect various data to monitor complex situations and alert situation events (hazardous gas increase, explosion sound, etc.)



2. Data collection, analysis, and development process for recognizing harzardous gases conditions

01

Safety-related data collection

1. Gas-related
2. Fire-related
3. Safety-related

02

Exploratory data analysis

- Examination of data variability according to safety occurrence characteristics
- Data cleansing and preprocessing
- Data review (understanding distribution and trends of input variables)

03

Derivation of key factors

flame, CO_2, motion, Body temperature

↓

key factors Labeling flame&motion

Feature Selection

04

Development of predictive models

Training Data → SVM CNN RNN LSTM

Development of predictive models

05

Evaluation of predictive models

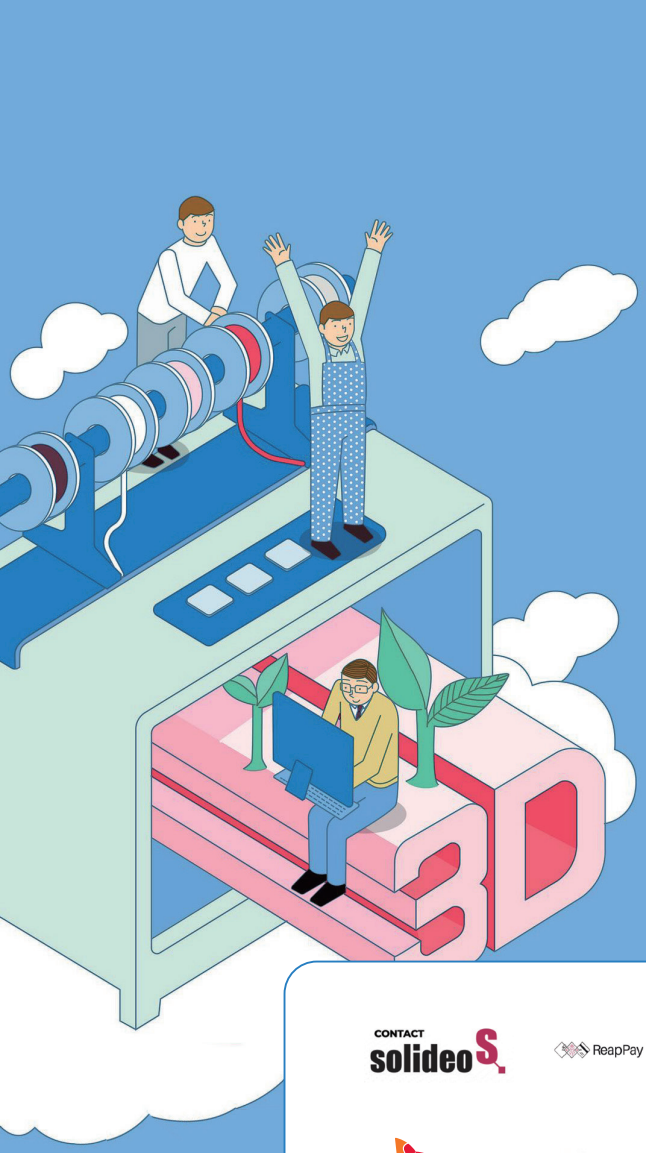
Test Data → SVM CNN RNN LSTM

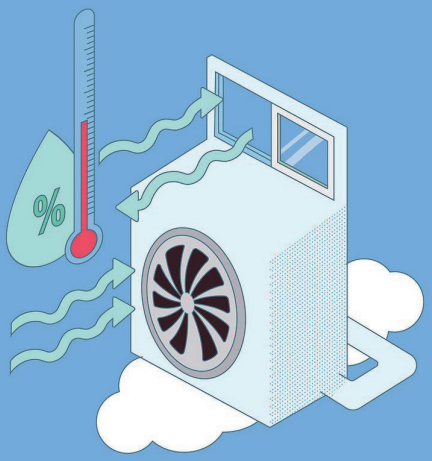
Application of the developed predictive model

06

Application and utilization of predictive models

New Data → champion model → prediction generation





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http://kounosoft.com

Business partners

KOUNOSoft

Hi Seoul Certified Excellent Company

(02841) Korea University Industry-Academic Hall,
145 Anam-ro, Seongbuk-gu, Seoul

Tel . 02-3291-2200 | E-mail. info@kounosoft.com