Introduction to
Internet of Things (IoT) and 3D Printing
Present Status of Patent Applications in Japan

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What is the Fourth Industrial Revolution "Industrie 4.0"?

Currently, the Fourth Industrial Revolution is progressing worldwide

- First Industrial Revolution: mechanization of factories using hydraulic power and steam engines from the end of 18th century
- Second Industrial Revolution: mass production using electric power based on division of labor in the early 20th century
- Third Industrial Revolution: further automation using electronics and information technology from the early 1970s

What is the Fourth Industrial Revolution "Industrie 4.0"?

▸ Fourth Industrial Revolution: manufacturing revolution based on cyber-physical systems (CPS) today

What is CPS?

In CPS, data from the real world are collected and monitored using sensors, the data are processed and analyzed in cyberspace, such as in the Cloud, and information obtained as a result is returned to the real world.
Almost synonymous with IoT.

Core Technologies of Fourth Industrial Revolution

‣ Internet Of Things (IoT) and Big Data
Various information ranging from operating status of factory machines to traffic, weather, and personal health conditions are converted into data, connected and integrated through a network, and analyzed and utilized to create new added information.

‣ Artificial Intelligence (AI)
A computer is capable of self-learning and making certain decisions without being instructed on all the factors to be focused on for analysis by a human in advance. In addition, with conventional robotics, more complicated work is now possible, and with the development of the 3D printer, space-saved manufacturing of complex workpieces is now possible.

What is the Internet of Things (IoT)?

‣ By collecting data using sensors and integrally processing the data on a network, work and situation analysis is carried out to be utilized in high value-added services and efficient business operation.

‣ It is also possible to analyze big data collected in the IoT using AI, leading to new services.

What is a 3D Printer?

▸ A device for forming a 3D (three-dimensional) object based on 3D digital data.

▸ There are four main techniques in the mechanism for the 3D printer to output a 3D modeled object, depending on usable materials and the object to be modeled.

What is a 3D Printer?

1. Stereolithography Technique:
    A tank is filled with liquid resin that cures when exposed to ultraviolet light. By emitting an ultraviolet laser toward the tank and curing the resin part that has been irradiated, a 3D modeled object is formed. This technique is the oldest, and the devices tend to be expensive.

2. Selective Laser Sintering Technique:
    In place of the liquid resin, the tank is filled with a powdered material. By sintering the material using a high-power laser beam, a 3D object is modeled inside the tank. An object with high-precision finishing and high strength can be obtained.

What is a 3D Printer?

3. Fused Deposition Modeling Technique (FDM):
   ABS resin or the like is extruded from the printer head as a filamentous solution, which is laminated so as to knit a cross-section and is solidified. The technique is widely used in devices for personal use, and although the finish may be rather coarse in terms of 3D precision and surface conditions, the device is cheaper.

4. Inkjet Printing Technique:
   A fine particles are jetted from a nozzle of an inkjet printer to form lamination layers, which are irradiated with ultraviolet light and cured. By repeating this process, a 3D modeled object is formed. The technique uses the principle of the conventional two-dimensional printer.

Status of IoT Applications

FY2016 Patent Application Technical Trends Survey Report
(published by the JPO)

Smart Manufacturing

▸ Smart manufacturing technology is one of the applications of IoT technology and is "a generic term for technology that aims to improve productivity of factories and create new businesses by incorporating information and communications technology and the information processing technology into factory equipment". By collecting and analyzing data not previously fully utilized such as individual manufacturing conditions and log data of manufacturing equipment in production lines, the technology enables improving technologies to improve productivity and production control as well as for offering services.

Status of IoT Applications

Number of JPO applications for smart manufacturing technology
Year of application (year of priority claim): 2005 - 2014

Year of Application	Number of Applications
2005	833
2006	735
2007	599
2008	570
2009	658
2010	622
2011	501
2012	518
2013	587
2014	545

*Cited from FY2016 Patent Application Technical Trends Survey Report (published by JPO)

Status of IoT Applications

- In November 2016, the JPO newly established the cross-sectoral Broad Facet Classification Symbol [*1] (ZIT) for IoT-related technology and started to apply the symbol to Japanese patent documents.

[*1] Broad Facet Classification Symbols enable collection (search) of documents from a cross-sectorial perspective across various fields.

Status of IoT Applications

- In May 2017, the JPO started to subdivide the patent classification of the Broad Facet Classification Symbol ZIT into twelve uses.

- 12 Uses (No. 1)
    1. ZJA: for agriculture; for fishing; for mining
    2. ZJC: for manufacturing
    3. ZJE: for supplying electricity, gas or water
    4. ZJG: for home and building; for home electric appliances
    5. ZJI: for construction

Status of IoT Applications

- 12 Uses (No. 2)

    6. ZJK: for finance

    7. ZJM: for services

    8. ZJP: for healthcare, e.g. hospitals, medical treatments or diagnosis; for social work

    9. ZJR: for logistics, e.g. warehousing, loading, distribution or shipping

    10. ZJT: for transportation

    11. ZJV: for communication

    12. ZJX: for amusements; for sports; for games

Status of IoT Applications

The number of published applications on J-PlatPat (Japan Platform for Patent Information)

- During Nov. 2016 to Feb. 9, 2018, 1132 granted patents of IoT-related technology.

- During Nov. 2016 to Feb. 9, 2018, 377 published applications of IoT-related technology.

- The number of patents and published applications in total is 1509.

*Data extracted by using the NRI Cyber Patent Desk 2

Status of IoT Applications

Classification Breakdown (No. 1)

Classification	Use	1509
0. ZIT	for IoT in general	720
1. ZJM	for services	233
2. ZJG	for home and buildings; for home electric appliances	178
3. ZJT	for transportation	150
4. ZJP	for healthcare; for social work	143
5. ZJV	for communication	94
6. ZJX	for amusements; for sports; for games	86

*Data extracted by using the NRI Cyber Patent Desk 2

Status of IoT Applications

Classification Breakdown (No. 2)

Classification	Use	1509
7. ZJE	for supplying electricity, gas or water	78
8. ZJC	for manufacturing	37
9. ZJR	for logistics	23
10. ZJK	for finance	19
11. ZJA	for agriculture; for fishing; for mining	16
12. ZJI	for construction	14
Number of duplications		284

*Data extracted by using the NRI Cyber Patent Desk 2

Status of IoT Applications

Business-related Inventions
(G06Q given to **FI classification**)

651 out of 1509 applications (43%)

*Data extracted by using the NRI Cyber Patent Desk 2

Status of IoT Applications

Percentages of Business-related Inventions (No. 1)

Classification	Use	Number of Applications	Percentage
0. ZIT	for IoT in general	294	41%
1. ZJM	for services	146	63%
2. ZJP	for healthcare; for social work	90	60%
3. ZJE	for supplying electricity, gas or water	50	64%
4. ZJG	for home and building; for home electric appliances	48	27%
5. ZJV	for communication	41	44%
6. ZJT	for transportation	29	19%

Status of IoT Applications

Percentages of Business-related Invention (No. 2)

Classification	Use	Number of Applications	Percentage
7. ZJX	for amusements; for sports; for games	19	22%
8. ZJK	for finance	18	95%
9. ZJR	for logistics	14	61%
10. ZJA	for agriculture; for fishing; for mining	12	67%
11. ZJC	for manufacturing	11	30%
12. ZJI	for construction	10	71%
Total		782	
Number of duplications		131	

*Data extracted by using the NRI Cyber Patent Desk 2

Status of 3D Printer Applications

Number of JPO applications

Year of application (year of priority claim): 2001 - 2011

Year of Application	Number of Applications
2001	110
2002	127
2003	149
2004	94
2005	110
2006	103
2007	115
2008	84
2009	75
2010	66
2011	36

*Cited from FY2013 Patent Application Technical Trends Survey Report (published by JPO)

Status of 3D Printer Applications

Number of published applications by JPO with the subclass B33Y given to IPC

Year Published	Number of Published Applications
2015 (Aug. 6 –)	41
2016	371
2017	787
2018 (– Feb. 15)	88

B33Y: additive manufacturing, i.e. manufacturing of three-dimensional [3-D] objects by additive deposition, additive agglomeration or additive layering, e.g. by 3-D printing, stereolithography or selective laser sintering. Effective from Jan. 2015.

* Data extracted by using J-PlatPat

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Thank you!

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