wang_2020_a_topic_based_patent_analytics_approach_for_exploring_technological_trends_in_smart_manufacturing

Year

2020

Author(s)

Juite Wang and Chih-Chi Hsu

Title

A topic-based patent analytics approach for exploring technological trends in smart manufacturing

Venue

Journal of Manufacturing Technology Management

Topic labeling

Manual

Focus

Secondary

Type of contribution

Established approach

Underlying technique

Manual labeling assisted by associated documents

Topic labeling parameters

\

Label generation

Each topic was labeled based on the high-ranked noun-phrases (terms) and patent documents that were highly correlated with the topic from the document-topic matrix

Also, two smart manufacturing experts with more than five years of industry experience in manufacturing were invited to examine and refine the labeling results.

Topic 1 Smart connection technologies	Topic 2 Production traceability technologies	Topic 3 Smart sensing technologies	Topic 4 Cyber-physical systems	Topic 5 Fault detection & classification	Topic 6 Manufacturing data analytics	Topic 7 Manufacturing automation and robotics
Local data collection (0.037)	Risk (0.022)	Electrode (0.013)	Internet of things (0.104)	Fault detection (0.025)	Machine learning (0.056)	Data analysis (0.057)
Crosspoint switch (0.028)	Location information (0.014)	Station (0.013)	Gateway (0.032)	Operating system (0.015)	Industrial machine (0.022)	Cloud numerical control (0.018)
Multiple output (0.028)	Industrial communication flow (0.011)	Solid electrolyte layer (0.009)	Field device (0.03)	Virtual metrology (0.014)	Artificial intelligence (0.016)	Schedule (0.017)
User equipment (0.027)	Supply chain (0.011)	Self-diagnosis (0.007)	Cloud platform (0.025)	Control module (0.013)	Label (0.015)	Production line (0.015)
Internet of things (0.022)	Electronic device (0.01)	Analytical unit (0.006)	Cloud server (0.019)	Abnormality (0.013)	Measurement data (0.013)	Network infrastructure (0.014)
Computing cloud (0.011)	Data packet (0.009)	Particle sensor (0.006)	Embedded system (0.016)	Anomaly (0.012)	Big data (0.011)	Robot (0.012)
Data acquisition module (0.008)	Smart tag (0.009)	State machine (0.006)	Public key (0.012)	Recipe (0.012)	Predictive model (0.007)	Internet of things (0.01)
Detection device (0.007)	Industrial robot (0.008)	Predictive maintenance (0.006)	Receiver device (0.01)	Advanced process control (0.012)	Image data (0.006)	Simulator (0.009)
Sensor device (0.007)	Electronic tag (0.006)	Gas sensor (0.005)	Data processing system (0.009)	Diagnostic (0.011)	Classifier (0.006)	Quality control (0.008)
Beacon (0.007)	Tag read (0.004)	Sensor network (0.005)	Operation information (0.008)	Metrology data (0.01)	Neural network (0.006)	Resource allocation (0.007)

(continued)

Topic 8 Remote monitoring and control	Topic 9 Cloud-based service technologies	Topic 10 Industrial internet network management	Topic 11 Powder-bed fusion technologies	Topic 12 Material extrusion technologies	Topic 13 Products and apparatus made by additive manufacturing	Topic 14 Additive manufacturing for tool and mold making
Defect (0.034)	Control application (0.024)	Bus controller (0.033)	Three-dimensional article (0.027)	Filament (0.03)	Platen (0.013)	Mold (0.031)
Time series data (0.03)	Query (0.022)	Bus terminal (0.018)	Lens (0.011)	Housing (0.028)	Rotor (0.013)	Shell (0.018)
Input data (0.016)	Cache (0.022)	Industrial internet field (0.014)	Fixture (0.01)	Reservoir (0.015)	Feed material (0.01)	Build chamber (0.018)
Output data (0.016)	Cloud service (0.018)	Time slice (0.012)	Curable material (0.009)	Preform (0.014)	Stator (0.009)	Internal passage (0.015)
Process condition (0.013)	Data stream (0.011)	Configuration information (0.011)	Layer of build (0.008)	Feedstock (0.009)	Winding (0.009)	Slice (0.012)
Sensor network (0.012)	Machine to machine (0.01)	Best master clock (0.006)	Metallic powder (0.007)	Solvent (0.008)	Film (0.009)	Fibre (0.011)
Industrial asset (0.012)	Summary report (0.01)	Remote terminal (0.006)	Cartridge (0.007)	Matrix material (0.008)	Roller (0.009)	Cell (0.01)
Hot spot (0.008)	Beacon badge (0.009)	Service oriented automation (0.006)	Ophthalmic lens (0.007)	Column (0.007)	Blade (0.008)	Liquid metal (0.01)
Test data (0.008)	Cloud service control (0.006)	Cryptographic key (0.005)	Printhead (0.007)	Deposition head (0.006)	Circuit board (0.008)	Lattice structure (0.008)
Industrial control device (0.007)	Service architecture (0.006)	Heterogeneous field device (0.005)	Enclosure (0.007)	Extrusion head (0.006)	Coil (0.008)	Aperture (0.007)

Topic	Description	Representative patents and probabilities
1. Smart connection technologies	Methods and systems related to managing and acquiring data made available in real time and transmitting them with specific network protocols	US20180048713A1(0.827) WO2018203923A1(0.786) US20180255377A(0.750)
2. Production traceability technologies	Techniques related to real-time tracking manufacturing parts, inventory and assets and monitoring status of jobs or work orders	EP3136316A1(0.833) US20140240249A1(0.763) US20040100383A1(0.773)
3. Smart sensing technologies	Techniques related to sensor and measurement technologies to gather data and monitor actions through the production environment, including self-evaluation of the validity of measurement data	US20110030451A1(0.875) US20170299543A1(0.813) WO2015166751A1(0.795)
4. Cyber-physical manufacturing technology	Systems and methods to facilitate implementation of a cyber-physical system for assessing and/or predicting manufacturing problems	WO2018025477A1(0.845) US20180054376A1(0.795) US20160321081A1(0.763)
5. Fault detection and classification	Techniques related to detection and classification of faults for evaluating manufacturing quality and health status of industrial assets and improving manufacturing operations based on collected data, especially in process control	US20180143248A1(0.804) US20070100487A1(0.775) US20170220008A1(0.775)
6. Manufacturing data analytics	Techniques related to using artificial intelligence and big data analytics to build model for improving manufacturing performance, such as predicting outcomes and analyzing operational risks and security	US20180322234A1(0.786) US20160004794A1(0.763) US20170157767A1(0.750)
7. Industrial automation and robotics	Techniques, systems or apparatus to facilitate factory automation and adapted for organizing, planning and scheduling industrial assets	EP2783812A2(0.888) US20080300705A1(0.804) US20180121815A1(0.795)
8. Remote monitoring and control	Methods and systems for monitoring and controlling locally or remotely for improving manufacturing quality and performance to the unpredictable environmental changes	EP3260849A1(0.845) EP3343421A1(0.827) US20080300709 A1(0.810)
9. Cloud-based service technologies	Methods and systems related to using cloud computing technologies to manage, allocate and control manufacturing resources and capabilities	EP3343372A1(0.882) EP3346381A1(0.871) EP3057007A1(0.833)
10. Industrial Internet network management	Techniques related to network-specific arrangements or communication protocols for supporting connecting resources of the IoT and network security in the manufacturing environment	EP3261296A1(0.895) EP3261275A1(0.882) EP3261298A1(0.859)
11. Power bed fusion technologies	Techniques related to power bed fusion additive manufacturing, such as processes, apparatus, material and data acquisition and processing	EP3254784A1(0.940) EP3064295A1(0.932) EP3153253A1(0.906)

Topic	Description	Representative patents and probabilities	Technological trends in smart manufacturing
12. Material extrusion technologies	Techniques related to processes, apparatus, data acquisition/processing and adaptive material for material extrusion additive manufacturing processes	US20180250737A1(0.932) EP3081364A1(0.921) US20170050363A1(0.917)	
13. Products and apparatus made by additive manufacturing	Techniques related to products and apparatus made by additive manufacturing in various industries such as electronics, auto and aerospace	WO2017179748A1(0.958) EP2858076A1(0.956) EP2754516A2(0.95)	135
14. Additive manufacturing for tool and mold making	Techniques related to making tools and molds using additive manufacturing for cost reduction and rapid manufacturing	EP3342572A1(0.948) EP2716390A2(0.946) WO2018182686A1(0.929)	Table A2.

Motivation

\

Topic modeling

LDA

Topic modeling parameters

α: {0.05, 0.1, 0.5, 1, 5, 10}

β: {0.05, 0.1, 0.5, 1, 5, 10 }

K: {10, 30}

Tenfold cross validation

Best values: α: 0.5, β: 0.12 and K: 14.

Nr. of topics

14

Label

Manually assigned noun-phrases (multi word labels)

Label selection

\

Label quality evaluation

\

Assessors

\

Domain

Paper: Patent analytics

Dataset: Patent data

Problem statement

This paper aims to identify technological topics in smart manufacturing by using patent data, investigating technological trends and exploring potential opportunities. The latent Dirichlet allocation (LDA) topic modeling technique was used to extract latent technological topics, and the generalized linear mixed model (GLMM) was used to analyze the relative emergence levels of the topics. Topic value and topic competitive analyses were developed to evaluate each topic's potential value and identify technological positions of competing firms, respectively.

Corpus

Origin: United States Patent and Trademark Office (USPTO), European Patent Office (EPO) and World Intellectual Property Organization (WIPO) patent databases

Nr. of documents: 5,521

Details:

- patent data that have a wide coverage of various technological categories in smart manufacturing from Jan 2006 to Dec 2018
- Keywords: "Industry 4.0," "smart manufacturing," "smart factory," "Industrial Internet of Things," "Industrial Internet," "cyber-physical production" and "cyber-physical logistics.", "cyber-physical

system," "artificial intelligence," "machine learning," "additive manufacturing," "augmented reality," "virtual reality," "cloud computing," "prognostics and health management," "data science," "Internet of things," "embedded systems," "sensor network" and "robotics,", "manufacturing," "production," "machine" and "factory"

Document

A patent document

Pre-processing

- POS tagging
- noun phrase extraction to identify keywords from title and abstract
  - The identified noun phrases represent a short summary of the information contained within a patent document
- lemmatisation
- tokenisation
- high-frequency words (e.g. invention, specification and claim) and general academic words (e.g. research, data and document) are removed.
- synonyms are replaced by a unique term or phrase. For example, the IoT, Industrial Internet of Things (IIoT) and "industrial Internet of Things" are replaced with "Internet of Things."
- every phrase in the noun-phrase list is carefully examined to make sure that only meaningful phrases are used in subsequent analyses.

```
@article{wang_2020_a_topic_based_patent_analytics_approach_for_exploring_technol
ogical_trends_in_smart_manufacturing,
    author = {Juite Wang and Chih-Chi Hsu},
    date-added = {2023-04-12 15:08:25 +0200},
    date-modified = {2023-04-12 15:08:25 +0200},
    doi = {10.1108/jmtm-03-2020-0106},
    journal = {Journal of Manufacturing Technology Management},
    month = {sep},
    number = {1},
    pages = {110--135},
    publisher = {Emerald},
    title = {A topic-based patent analytics approach for exploring technological
trends in smart manufacturing},
```

```
url = {https://doi.org/10.1108%2Fjmtm-03-2020-0106},
volume = {32},
year = 2020}
```

#Thesis/Papers/FS