ROBOTS IN LOGISTICS: RESEARCH ISSUES AND TRENDS

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ABSTRACT

Robots are being used a lot in logistics these days. In line with this trend, many researchers are studying robots in logistics. This research identifies the research topics and trends in such research works over the past 20 years. To do this, a Latent Dirichlet Allocation, a topic modeling approach, was applied. A total of 16 topics are extracted, and the analysis shows that these topics are related to both application areas and the robot-related technologies. Also, the topics regarding the robot-related technologies can be divided into the mechanical ones and the control/optimization algorithms. When it comes to the application areas of robots in logistics, most of the existing research articles are focusing on the transportation part. Finally, the change in the ratio of these 16 topics by year is investigated and summarized.

1   INTRODUCTION

Latest advances in technologies enable robots to be easy to operate, and able to navigate autonomously (Alterovitz et al., 2016). In line with this trend, many industries are adopting robots in their fields, including logistics. Since processes of logistics are all sequential, delays or errors incurred by humans can cause a significant bottleneck in the entire process. However, robots have advantages such as an intrinsic immunity to the virus, working fast without getting tired, and making no mistakes. While there have been some review papers about smart logistics (Ding et al., 2021), logistics 4.0 (Winkelhaus & Grosse et al., 2020), and technological trends in logistics, they are too broad and not focusing on robots. To fill this gap, we mainly focused on two topics: robot and logistics and aimed to examine what studies are being conducted in the academic world by using Latent Dirichlet Allocation (LDA).

2   METHODOLOGY

LDA is a generative probability model introduced by Blei et al. (2003) for topic modeling. Starting with random probability distribution, LDA fits the distribution of given data. It works by observing the words in each document and updating the topic probability distributions over words conditioned on the observed words. Consequently, the topic's probability distribution of each document, the word's probability of each topic, and the topic assignment for each word in each document are obtained. We collected data from Scopus DB and we limited the period from 2001 to 2020. The keywords were "robot and logistics". Finally, we obtained 1,261 records.

3   RESULTS

By conducting the hyper-parameter tuning using the perplexity index, the number of topics was set to 16. Then, the LDA was applied to the collected data by running Python 3.9.7 with the required packages. The identified 16 topics were summarized as shown in Table 1.

Table 1. Research topics regarding the robots in logistics

#	Topic	#	Topic
1	Human robot interaction	9	Vehicle routing algorithm
2	Machine learning	10	Intelligent system in hospital
3	Agricultural product supply chain management	11	Cellular automaton model
4	Path planning algorithm	12	Radar for autonomous vehicles
5	Unmanned vehicles (agv, uav)	13	Wireless power transfer of unmanned vehicles
6	Deep learning	14	3D data exploration application
7	Control system for transportation optimization	15	Kinematics analysis in logistic robot
8	Motion control system in robotics	16	Fuzzy logic for intelligent process

Also, Figure 1 shows how the weight of topics in each year changes. Before 2010, research on Topic 5(unmanned vehicles) occupied a large proportion, but after 2010, research on Topic 7 (Control system for transportation optimization) has increased.
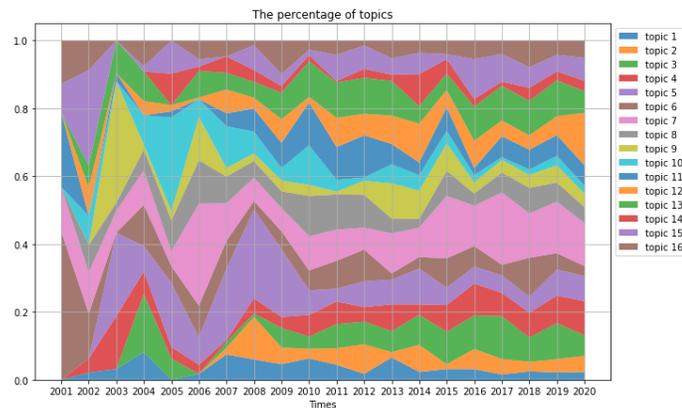

Figure 1. Ratio of articles on each topic from 2001 to 2020

4   CONCLUSION

To check the research trends regarding the robots in logistics, the LDA based topic modeling was conducted. The 16 latent research topics were identified, and the trend change in research topics was analyzed. To further analyze the research trend, several different techniques such as the content analysis need to be applied as a future research work.

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REFERENCES

Alterovitz, R., Koenig, S., & Likhachev, M. 2016. "Robot Planning in the Real World: Research Challenges and Opportunities". *AI Magazine*, 37(2), 76-84.

Ding, Y., Jin, M., Li, S., & Feng, D. 2021. "Smart Logistics Based on The Internet of Things Technology: An Overview". *International Journal of Logistics Research and Applications*, *24*(4), 323-345.

Sven Winkelhaus & Eric H. Grosse. 2020. "Logistics 4.0: A Systematic Review Towards a New Logistics System", *International Journal of Production Research*, 58:1, 18-43.

Blei, D. M., Ng, A. Y., & Jordan, M. I. 2003. "Latent Dirichlet Allocation". *Journal of machine Learning research*, 3(Jan), 993-1022.