DETERMINATION OF TECHNOLOGY FRONTS AND DYNAMICS OF CHANGE IN 3D PRINTING USING TECH MINING AND LDA ANALYSIS

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INTRODUCTION

3d printing is one of the technologies that aim at transforming the way manufacturing operations are designed and managed all over the world. The opportunities this technology has to offer go well beyond manufacturing, and its influence spans widely divergent areas such as education and the design and building of medical implants. There are several methods and techniques for 3d printing: depending on the printing material, for example, the technical differences between methods and devices can be highly significant. This makes 3d printing a multidisciplinary field where solutions to electromechanical, physiochemical or mechanical design problems often come as a result of the reconfiguration and/or recombination of developments from other – non necessarily adjacent – technical areas.

This paper presents a new approach for determining the "technology fronts" underlying the development of 3d printing technology, using Latent Dirichlet Allocation (LDA) combined with tech mining techniques for the identification and dynamic characterization of the main fronts where actual technology solutions are put into practice.

METHODOLOGY

The starting point is a dataset containing 22,034 (after removing duplicates) 3d printing patents downloaded from Patseer database, using the following query, run on days 22, 23 and 24 (data had to be sliced because of download limits set by the database) of February 2018:

TA: (three w0 dimens* w0 print*) OR (additive w0 manuf*) OR (3D print*) AND PRD:([1985-01-01 TO 2017-12-31])

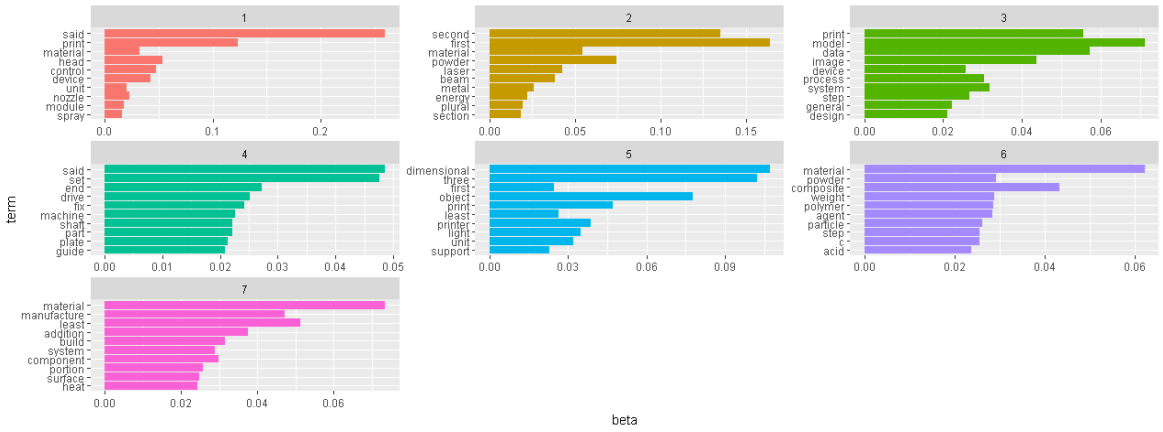

Fig. 1 Topic structure corresponding to year 2014 (7 topic solution).

The dataset was split in 7 time intervals and patent claims corresponding to each interval were exported to Vantage Point ® software, where term cleaning and Natural Language Processing (NLP) techniques were used to extract the main terms describing the technological activity in 3d printing. Top 300 terms (ranked according to the number of documents where each term got a tfidf value higher than 0.03) from each time interval were analyzed by LDA technique using R package "topicmodels" (figure 1), and a fairly stable 7-topic structure was observed across time, which allowed us to build a set of indicators with which to characterize the dynamics of change of these technological topics.

RESULTS

The interpretation of the topics was conducted by extracting the patents with the highest weight on each of the topics from the dataset, and studying their technological features with expert assistance. We detected a stable structure of topics that can be tracked across time (figure 2) to study their dynamics of change.

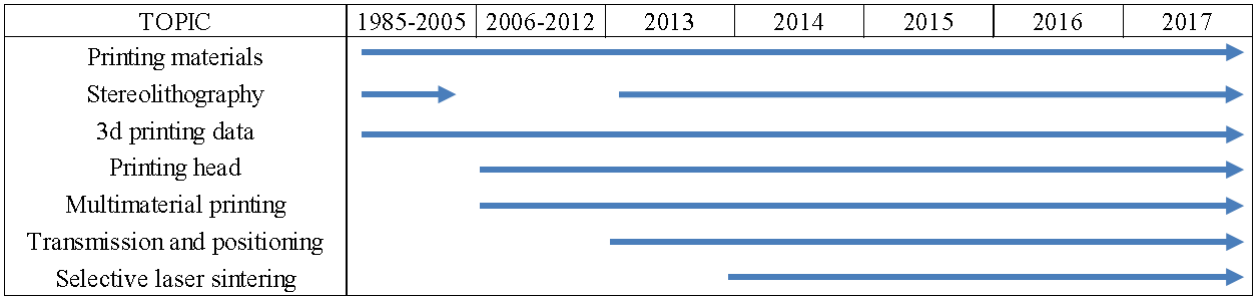

Fig. 2 Recurrent topics across the full interval analyzed.

The results show that the development of new materials and the methods for automatic obtaining and processing of 3D printing data are present in all the years analyzed, while SLS, transmission & positioning and printing head positioning mechanics gain relevance in the latter years. Forward and backward citation analysis of each topic shows that transmission & positioning and SLS topics increase their dynamism and relevance, and results of text mining analysis bear out these trends, showing increasing divergence in the relevance of the main technology concepts each topic deals with, as well as a noticeable emergence of new concepts. IPC analysis shows a significant and almost simultaneous increase in the amount of new IPC's per patent in 3d printing data, printing materials and SLS topics, the latter two possibly pointing at an increasingly

relevant technology area of development of new materials for laser-melting based 3d printing techniques, as other evidences we are collecting may point at.

CONCLUSIONS

This work presents a method for the identification and dynamic characterization of "technology problems" underlying a broad technology field. Topic modeling technique is used for delimiting these "technology problems", while a set of indicators based on patent data and text mining procedures is proposed for studying the dynamics of change in technologies. Our indicators point at laser-based printing techniques, together with mechanic transmission & positioning solutions and methods for obtaining 3d printing data, as "hot" areas where significant changes may be undergoing.