



SAPIENZA
UNIVERSITÀ DI ROMA

2019

**17th INTERNATIONAL CONFERENCE ON
SCIENTOMETRICS & INFORMETRICS**

ISSI2019

with a Special STI Indicators Conference Track

2-5 September 2019

Sapienza University of Rome, Italy

PROCEEDINGS

VOLUME II

PROCEEDINGS OF THE 17TH CONFERENCE OF THE INTERNATIONAL SOCIETY FOR SCIENTOMETRICS AND INFORMETRICS

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- © Edizioni Efesto - ISBN 978-88-3381-118-5 - August 2019
Printed in Italy

Editors: *Giuseppe Catalano, Cinzia Daraio, Martina Gregori,
Henk F. Moed and Giancarlo Ruocco*

Graphic cover design: *Francesco Manzo* | graframan.com

Cover photo: ©*Fayee* - stock.adobe.com

Global overview of patenting landscape in unmanned aerial vehicles

Gorry Philippe¹ and Maxim Kotsemir²

¹philippe.gorry@u-bordeaux.fr

GREThA UMR CNRS 5113, Department of Humanities and Social Science, University of Bordeaux, Pessac (France)

²mkotsemir@hse.ru

Institute for Statistical Studies and Economics of Knowledge, National Research University Higher School of Economics, Moscow (Russian Federation)

Introduction

Unmanned Aerial Vehicle (UAV) or “drone” is defined as an aircraft without pilot on-board. While UAV originated in military applications after World War II, their use is recently expanding to commercial, scientific, recreational, agricultural and other applications. Market forecasts estimated UAVs to be a multi-billion dollars market within the next five to ten years (OECD International Forum on Transport, <https://www.itf-oecd.org>). Studying the UAVs development is interesting to understand combinatorial innovation and the economics interplay of defense and civil research.

Literature review

Although, UAVs is a high-tech field, few scholars have studied the dynamic of this today promising economic sector through patent indicators. Their research works are dedicated to specific aspects (see here as examples of such studies in e.g. Shiuie and Chang, 2010; Liu et al., 2016; Kim et al., 2016). Our paper fills the gap in the analysis of the key technological domains and the key players in this field through patent landscaping. The current study is also the opportunity to use original data visualizations of the results of our analysis.

Methodology of the research

Our patent analysis was based on the worldwide collection of INPADOC (International Patent Documentation; EPO worldwide legal status database) using the Orbit (Questel®) SAS patent research platform. Patent bibliographic data were analyzed and visualized with the Orbit built-in analytic functions for the different information fields (priority or publication date and country, applicant name).

The data was derived at December 2017 and all metrics were based on patent family and priority date. The time span of our analysis covers 1995 – 2017 years. To detect the corpus of patent families for our study we run a complex query of keywords related with UAVs based on the set of keywords proposed in Kotsemir (2019) for the comprehensive analysis of UAVs publication trends in Scopus database. In the patent search, we run the combination of UAV-related adjectives like “unmanned” “unpiloted” and “unhabituated” plus terms like

“aerial vehicle”, aircraft, drone, “air vehicle”, “helicopter” and also terms like “quadrotor”, quadcopter”, “flying drone” etc. in the following bibliographic search fields: title, abstract and claims. In our query search we consider all word forms (i.e. singular and plural) of the searched keywords.

Results

Our analysis shows that until 2012 we can see quite stable dynamics of patenting in fields of UAVs but in 2014 – 2016 there was a burst of patent activity (Figure 1).

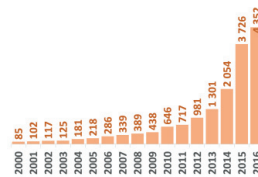


Figure 1. Number of UAV patent families by publication years in 2000 – 2016

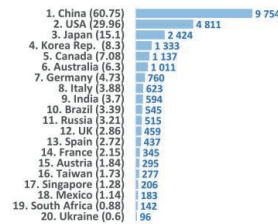


Figure 2. Top-20 countries by number of UAV patent families for publication years 2000 – 2016

The leading country in patent activity in UAVs is China, contributing to 60.7% of all patent families in UAVs for 2000-2016 publication years (Figure 2). Far behind China is the USA with almost 30% of contribution to global volume of patents in UAVs. Other quite important players in UAV patenting are Japan and South Korea. European countries lag far behind country-leaders with less than 5% of global number of patents for 1996 – 2015. We should note here that all BRICS countries are among top-20 countries by number of patents in

UAVs. Also, Asian countries show much stronger patent activity than European ones. Figure 3 and Table 1 provide the sub-technological domains of global UAV R&D using the 35 domains defined by WIPO (World Intellectual Property Organisation) based IPC (International Patent Classification) codes. Key tech domains of global UAV patent landscape for 1996 – 2015 are “Transport” and “Control”. It is the most “hot topic” in UAV patent activity. Other technical domain of importance is “Measurement”.

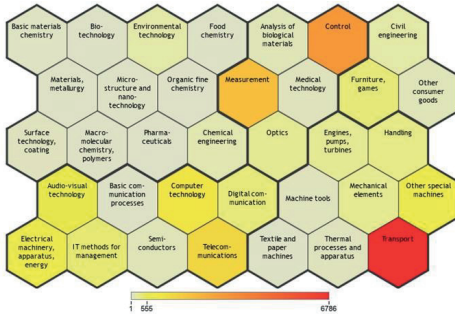


Figure 3. UAV patent families by WIPO Technology domains for 1996 – 2015

Note. Technological domains with the highest number of patent families are colored in red and orange.

Table 1. Top-10 Technology domains in UAV patents for 1996 – 2015

Technology domain (Number of patent families)
1. Transport (6 886);
2. Control (3 262);
3. Measurement (2 083);
4. Telecommunications (1 419);
5. Computer technology (1 050);
6. Other special Machines (728);
7. Electrical machinery, apparatus, energy (702);
8. Audio-visual technology (550);
9. IT methods for management (384);
10. Furniture, games (252)



Figure 4. Treemap clustering of technology segmentation concepts in UAV patent landscape (fragment)

Figure 4 shows the cluster of the underlying technical concepts in UAVs by measuring the shortest distance between the concepts and arranging them in hierarchical clusters. The topic segments of UAV patents are concentrated in topics related with parts

of UAVs (like its engine, main body etc.) and also with tools (and methods) control of UAV (landing, flight etc.) (Table 2).

Table 2. Example of segment “Main body” (yellow segment in Fig. 4) in the technology segmentation treemap cluster map

Segment content (technology concepts)	N. of PFs
Battery	145
Chassis	131
Engine	148
Fuselage	1082
Landing Gear	291
Main Body	139
Power	139
Power Supply	144
Tail	180
Unmanned Aerial Vehicle Body	195
Wing	365

Note: “N. of PFs” means “number patent families”.

Conclusions

Our research provided the overview of global patent landscape in field of UAVs for 1996 – 2016. China is the dominating country in patent activity. The “hot” technology domains of UAV patents are “Transport” and “Control”. Topical segments of UAV patent landscape are concentrated by parts of UAVs, its control, and different aspects of application of UAVs. In the development of the study analysis of the leading firms and their collaboration through network analysis will be presented as well their competitive position using topographic map based on vector model of concepts extracted through semantic analysis. Further work should also include econometric modelling integrating other indicators such as research intensity measured by publications (Kotsemir, 2019) and macroeconomic indicators such GDP and defense budget.

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