



Trends in
AR/VR in Maintenance

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Forword

The present monitoring bulletin aims at evaluating the trends on augmented reality (AR), virtual reality (VR) and mixed reality (MR) technologies, and more specifically on their applications to the maintenance tasks.

The Authors

This report has been issued by CENTREDOC on behalf of Armasuisse W+T as part of a pilot phase for a Technology Monitoring activity.

On the strength of a multidisciplinary team of engineers, CENTREDOC provides a comprehensive range of services in the fields of technology, commercially sensitive and strategic monitoring, as well as patent, technical and economic information searches. CENTREDOC also provides consultation services for setting up monitoring systems.



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Executive Summary

Objective Augmented reality has been identified by the Logistics Base of armasuisse (LBA) as a highly relevant digital technology for a near future (next 5 years), and specially its application to the maintenance processes. Virtual reality and mixed reality solutions are also of interest.

The objective of this first bulletin is to understand the historical development and the current state of the augmented reality and related technologies applied to maintenance tasks from an intellectual property point of view.

Methodology Professional databases have been used to retrieve patent and non-patent literature (NPL) publications on the field of AR/VR applied to maintenance and inspection tasks (not specifically in the military domain). A statistical analysis on the number of publications over time, by actor and geographically, has been performed in these data to evaluate the innovation activity in this domain over the past years.

The following pages present the results of this statistical analysis: the evaluation of the maturity of the technology, the identification of the main actors involved in their development, including in particular the swiss actors, and the main innovative countries in AR/VR technology.

Key findings This initial study indicates that the AR/VR technologies are being intensively developed in the last 5 years, and that the peak of activity has not yet been reached.

The IP portfolio is mainly held by Asian companies, some of them well known large companies such as LG and Sony. A Korean company named Frontis claims different AR, VR and MR solutions for supporting maintenance of specifically military equipment. European actors are currently more involved in research activities in earlier phases of development since they are mainly published as scientific non patent literature.

The Swiss patenting and publishing activity is still scarce, and the medical and healthcare domain is the main application field of the AR/VR technologies where Swiss actors are implicated. Germany appears as a potential partner source since the country is the origin of an important number of patent and non-patent publications, after the USA and the Asian countries.

Outlook This initial bulletin has investigated the developments on AR/VR technologies over the last 20 years. It summarizes the current situation.

From this point, future monitoring bulletins aim at evaluating the most recent developments in AR, VR and MR technologies for applications in maintenance tasks, on the basis on patents, scientific publications, and news most recently published.

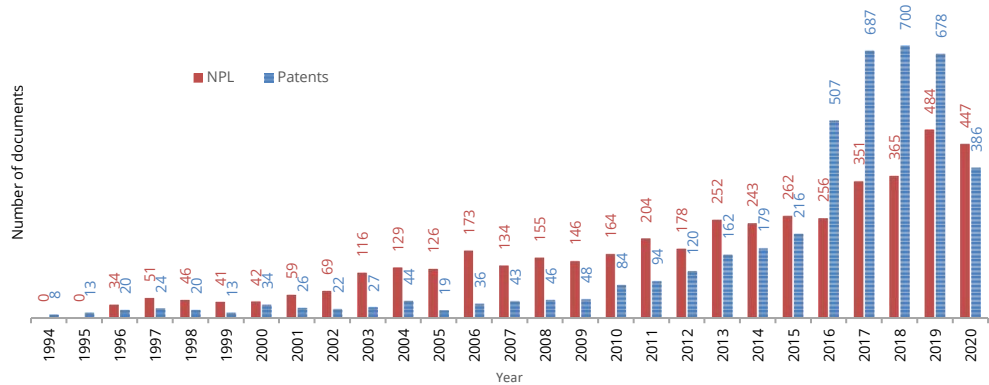
Next bulletin, expected during August 2021, will evaluate the trends from May, June and July 2021.

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AR/VR in Maintenance - Technology Maturity

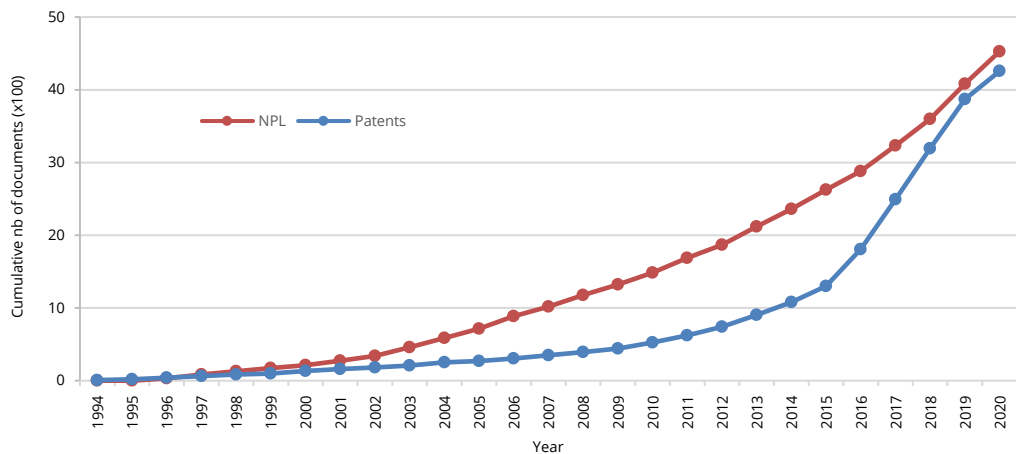
2019	678	447	Growth
Key Figures	Patents	Publications	
Peak year for publication activities	Number of published patents in 2019*	Number of scientific papers in 2020	Technology lifecycle stage

Publications



A very intense publication activity is taking place since 2015. The technology was first discussed in scientific publications before any significant patent activity took off in 2010

Maturity



S-curve indicates the technology is still in a growing phase. The increase is especially steep for patent publications.

*Patent data in 2020 and 2021 is incomplete due to the 18 months publication delay

Conclusion	➔ Augmented reality, and in particular its application for maintenance tasks, is a technology being intensively developed nowadays.
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AR/VR in Maintenance - Players

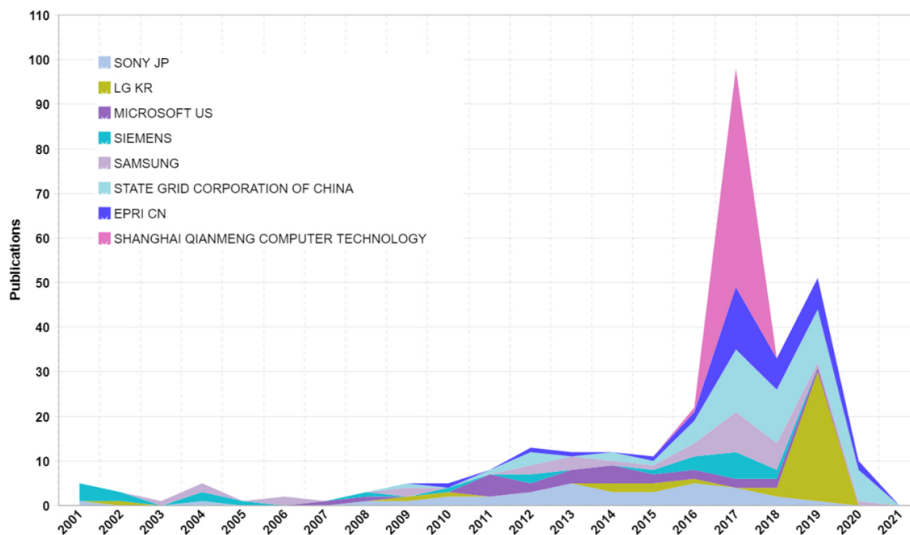
Key Figures	State Grid Corp. (CN)	Beihang Univ. (CN)	Frontis (KR)	EU Univ.
	Ranks 1 st in number of patents	Ranks 1 st in number of scientific publications	Company active in AR for military maintenance	Important NPL activity

Top 5 players

AR in Maintenance Patents		AR in Maintenance Publications	
State Grid Corporation (CN)	58	Beihang University (CN)	71
Shanghai Qianmeng Computer Tech (CN)	50	Chinese Academy of Sciences (CN)	48
LG (KR)	41	Technical University of Munich (DE)	43
SONY (JP)	39	Politecnico di Milano (IT)	33
Electric Power Research Inst., EPRI (CN)	36	Huazhong Univ. of Sci. and Tech. (CN)	33

Top 5 is dominated by **Asian** players, especially regarding to patent filing. Two European universities have important research activities in the field of AR. Specific applications on the maintenance of **military** equipment are claimed by Korean company Frontis. Companies like Airbus, Thales or Boeing own a few patents concerning the maintenance of equipment assisted by AR.

Patent activity



The main players have started their patenting activity in 2010, with a considerable increase since 2015. The Chinese company Shanghai Qianmeng Computer Tech (2nd in the publication ranking with 50 patents) has patented almost 100% of their portfolio in 2017.

Conclusion

- Large Chinese, Japanese and Korean companies dominate the patenting panorama.
- European universities have an important role in AR research area.

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AR/VR in Maintenance – Swiss Players

Key Figures	Swisslog	Healthcare	26	50
	Logistics company with AR solutions	Main patent application field	Patents Number of patents from Swiss companies	Publications Number of publications from Swiss actors

Patent assignees in CH

26 patents have been identified belonging to Swiss companies:

- [Swisslog Holding AG](#): **logistics** company in Buchs (CH) specialized in the automation of processes. They integrate AR-based solutions.
- Companies in the **healthcare and medical** domain: Lonza, Varian Medical Systems, Smith & Nephew Orthopaedics, Andrew Alliance SA and MindMaze Holdings.
- Other companies with various applications of AR technologies: Logitech, Leica Geosystems AG, Tycoon Promotion SAGL, Tyco Fire & Security GmbH, OVD Kinegram AG, Tesa SA.
- ETHZ and EPFL: Swiss federal institutes carried out collaborations with companies in the field of AR/VR.

Swiss companies in NPL

50 publications have been identified where at least one affiliation is located in Switzerland:

- Most of the affiliations are **academic** players, such as EPFL and ETHZ, University of Bern, University of Zürich, Università' della Svizzera italiana, University of Applied Sciences Bern.
- CERN: 9 publications on AR/VR specifically on maintenance.
- Only two companies are present: ABB and Hocoma AG (company in the healthcare domain).

Conclusion

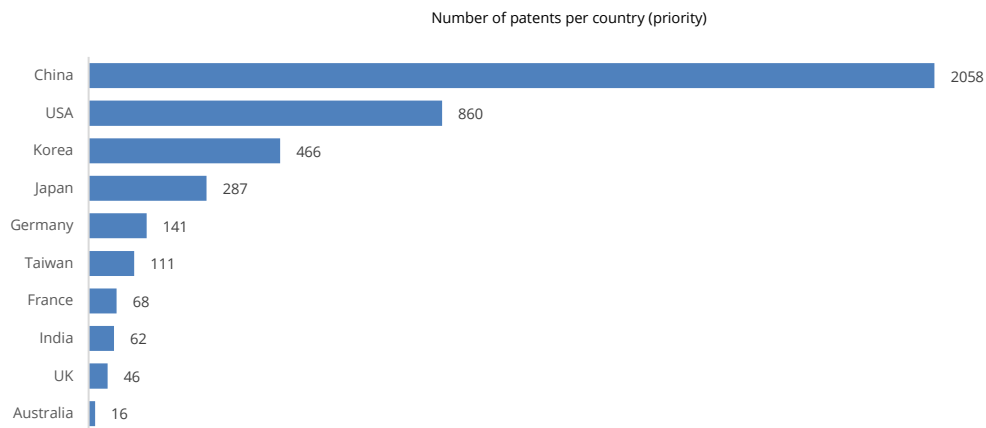
- The majority of Swiss companies with published activity on AR/VR are related to the medical and healthcare domain.

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AR/VR in Maintenance - Geographical distribution

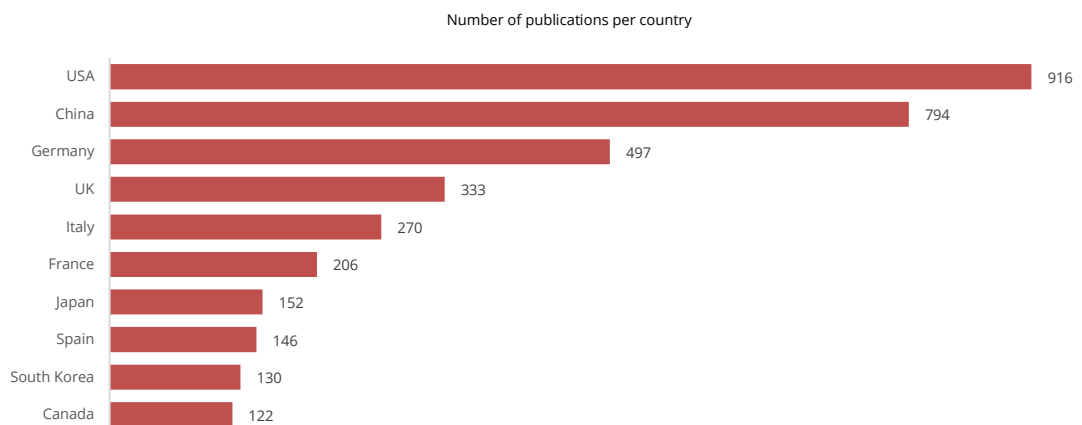
	China	USA	Korea	Germany
Key Figures	Ranks 1 st in number of patents and 2 nd in publications	Ranks 2 nd in number of patents and 1 st in publications	Ranks 3 rd in number of patents	Ranks 3 rd in number of publications

Patents



China, US and Korea are the top 3 countries of origin of patents. The first European country to appear is Germany in the top 5.

Publications



Scientific literature has been mainly published by institutions in the US, China and Germany. Other European countries have also played an important role in the NPL publishing activity.

Conclusion

- ➔ Developments of AR technology have taken place mainly in the US and China.
- ➔ European countries are more active in publishing scientific articles than patents.