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Bibliometric analysis for the determination of fields of opportunity for new technological trends: augmented reality as quality control

Análisis bibliométrico para la determinación de campos de oportunidad de nuevas Tendencias Tecnológicas: La realidad aumentada como control de calidad

FERNANDEZ-PEREZ, Vladimir Damian*†, ÁLVAREZ-AROS, Erick Leobardo, MIRANDA-SANCHEZ, Francisco Javier and FERNANDEZ-GOMEZ, Tomás

Universidad Popular Autónoma del Estado de Puebla, Planeacion Estratégica y Dirección de Tecnologia, 21 sur, barrio de Santiago, C.P 72410, Puebla, Pue, México.

ID 1st Author: *Vladimir Damian, Fernandez-Pérez* / **ORC ID:** 0000-0002-3790, **Researcher ID Thomson:** vladimir_dfp@hotmail.com, **CVU CONACYTID:** 699327

ID 1st Co-author: *Erick Leobardo, Alvarez-Aros* / **ORC ID:** 0000-0002-1934-5442, **Researcher ID Thomson:** K-6852-2016, **CVU CONACYT ID:** 3463215

ID 2nd Co-author: *Francisco Javier, Miranda-Sanchez* / **ORC ID:** 0000-0001-711, **Researcher ID Thomson:** qQeu179m1C0dMYjrGocgNKdk3mTImeaz, **CVU CONACYT ID:** 781882

ID 3rd Co-author: *Tomas, Fernandez-Gomez* / **ORC ID:** 0000-0002-0311-5001, **Researcher ID Thomson:** fernandez_gt, **CVU CONACYT ID:** 65262

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Abstract

With the emergence of industry 4.0, innovation was made in terms of emerging technologies, one of them is Augmented Reality as a tool that manages to enhance the new generation of automated factories. This leads to a use by operators or any type of personnel who need interaction with specific information such as: product data sheets, instructions for maintenance procedures, assembly, manufacturing, quality control forms etc. just to mention a few of the applications. They can be handled efficiently and amplifying the degree of ease of these processes by applying AR. Therefore this is the reason why this research is carried out taking into account different environments, the objective is to provide an overview in which fields of opportunity or trends are identified on the use of this pillar of i4.0 within the quality control process, with the intention of showing approaches that motivate scientific research, to achieve this goal, a bibliometric analysis was applied to a database obtained in Scopus, using the R software, with which authors, research topics, journals of interest, keywords, scientific production by year or country were identified. With the intention of finding the most significant information, so the results obtained show 5 potential areas where AR can play an important role within the quality control process demonstrating its suitability to improve processes.

Augmented reality, Quality assurance, Bibliometric analysis, I 4.0, Operational efficiency

Resumen

Con el surgimiento de la industria 4.0, se innovó en cuanto a tecnologías emergentes, una de ellas es la Realidad Aumentada como herramienta que logra potenciar la nueva generación de fábricas automatizadas. Esto conlleva a un uso por parte de operarios o cualquier tipo de personal que necesite interactuar con información específica como: fichas técnicas de producto, instrucciones de procedimientos de mantenimiento, montaje, fabricación, formularios de control de calidad, etc. por mencionar algunas de las aplicaciones. Estas pueden ser manejadas eficientemente y ampliando el grado de facilidad de estos procesos mediante la aplicación de la RA. Por lo tanto esta es la razón por la cual se realiza esta investigación tomando en cuenta diferentes entornos, el objetivo es proporcionar un panorama en el cual se identifiquen campos de oportunidad o tendencias sobre el uso de este pilar de i4.0 dentro del proceso de control de calidad, con la intención de mostrar enfoques que motiven la investigación científica, para lograr este objetivo se aplicó un análisis bibliométrico a una base de datos obtenida en Scopus, utilizando el software R, con el cual se identificaron autores, temas de investigación, revistas de interés, palabras clave, producción científica por año o país. Con la intención de encontrar la información más significativa, así los resultados obtenidos muestran 5 áreas potenciales donde la RA puede jugar un papel importante dentro del proceso de control de calidad demostrando su idoneidad para mejorar los procesos.

Realidad aumentada, Control de calidad, Análisis bibliométrico, I 4.0, Eficiencia operativa

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* Correspondence to the author (E-mail: vladimir_dfp@hotmail.com)
† Researcher contributing first author.

Introducction

Currently industry 4.0 has allowed the generation of benefits or improvements for the manufacture of products or the offer of services that are supported by these technologies, these changes are produced quickly, leading to greater requirements of technological knowledge by workers, increasing the degree of complexity of the task. This leads to systems that intensively adopt enabling technologies such as Augmented Reality and virtual reality to reduce these burdens for operators Ho, P., Albajez, J., A., Santolaria, J., & Yagüe-Fabra, J., A. (2022).

When mentioning the technologies that are used within industry 4.0 it can be concluded that there are mature tools, but some others are still under development by manufacturers or academics, where their application is sought in industrial environments a clear example is the Augmented Reality (AR) because it was not until the end of the 90's when it was finally driven by academics and government industry. German. Since then, it has been proposed for use in different stages of manufacturing, such as in assembly processes, creating solutions for the design phases or in quality controls Fernandez, T., M., Fraga, P., Suarez, M., & Vilar, M., (2018).

Augmented Reality is constantly adapting within key companies such as General Electrics, Airbus and Boeing Serván, Mas, Menéndez, & Ríos (2012). As an innovative tool. Used to advance the quality of products and processes as well as reduce error rates. Therefore, AR studies have emerged in the quality sector shown potential results in improving human performance in technical quality control tasks, as well as within TQM achieving autonomy within decision-making by operators. There are currently limited examples of concrete implementation of AR in the quality sector.

Therefore, the objective for this research is to carry out a systemic review of the state of the art of AR in terms of technology used focusing on the context of quality. It is about preparing for the digital transformation of Industry 4.0, which also entails the change in the quality sector, and the adaptation of AR for such control. Research was conducted on the state of AR-based manufacturing applications at plant level in the context of Industry 4.0 to give a holistic view on future challenges.

The research is structured in four sections. Introduction in which the Augmented Reality project is presented as quality control continued by the Systematic Review of the Literature, while the third section describes the methodology applied for the development of RSL. Followed by the results to provide a holistic view on AR utilization in general and AR-based quality control in particular. Ending with the conclusion that proposes trends for future research work.

Literature review

Within this section presents a panorama in which you can visualize the different applications of Augmented Reality because the focus of this article focuses on a bibliometric analysis of this technology as quality control, because its use is currently becoming widespread thanks to the great flexibility of this tool.

It can be said that AR is an enhancer for users, thanks to the ease of presenting real-time information embedded in reality, thus obtaining help in the processes of products or services. This indicates that there are different ways to apply augmented reality, therefore the literature review will be grouped into 3 groups, which are: 1) Industrial applications, 2) The use of AR in education and 3) Application of Augmented Reality in the medical area.

1) Industrial applications

Augmented reality is a technology derived from industry 4.0 which makes it a key tool for increasing operational efficiency, empowering the next generation of factories. Helping operators who need to interact with critical information, but easily managed if AR is used, therefore Fernandez, Fraga, Suarez & Vilar (2018) demonstrate the viability and benefits obtained in conventional companies.

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The validation and testing that are necessary to ensure its quality continue to advance and incorporate new technologies that over time gain importance guaranteeing safety along with quality. For this reason, simulations were created that propose a new framework on augmented reality that takes advantage of the physical environment such as digital, for a new testing methodology that aims to be a bridge between tests in a digital environment and tests in the real world, from a perception of control, in realistic conditions. Genevois, Horel, Renzaglia & laugier (2022). Presenting the data, improving the process with virtual information.

The authors Shafique, Khawaja, Sabir, Qazi & Mustaqim (2020) present the concept of the internet of things, conducting a review of the literature, obtaining as a result the emerging scenario for 5G technology, using cellular networks as a key to the wide application of AR, creating discussions about the changes in the implementation that 5G can have on the high flow of data and its transit on platforms known as clouds. Since currently this type of online services are on the rise thanks to their growing popularity due to the possibility of having an internet connection from anywhere this gives Augmented Reality a capacity to be used practically anywhere.

Lora, Sotoca & Chover (2022) show a theoretical framework, where users' perceptions can be found regarding the quality of the application of augmented reality through digital embeddings in physical environments, compared to the exposure of the same concepts through a conventional video. For this it is necessary to emphasize the importance for users to be able to visualize graphic information embedded on physical objects and an electronic medium capable of displaying information in real time, the experiments carried out delivered as results that the integration of the product in the environment as well as its spatial presence in users, generated a positive effect, within the users since they determined that the information presented is useful.

Cinematography and other digital content creators have innovated by integrating three-dimensional (3D) technology. The applications of Augmented Reality are aware of the advantages, possibilities and new means of expression for this technology.

The development of electronic and information technologies as indicated (Perek, Mielczarek & Makowski 2022) allows to achieve a better quality of 3D image recorded along with many possibilities for its correction. Therefore, it is necessary to carry out a search that allows to identify typical errors of stereoscopic vision related to the depth of image during a recording. Therefore, an independent and non-invasive system is presented that supports filming in the process of calibration of cameras, as well as the analysis of 3D depth, seeking to increase the quality of the materials created for use within Augmented Reality.

The research carried out by Li, Tsai, Lee (2022) state that the investigation of the visual threshold of parasitic light for three types of VR HMD devices for a virtual reality screen, proposes a qualitative model that demonstrates its feasibility and effectiveness, so the effectiveness of the model was 90%, demonstrating its suitability to be used in different applications based on visual perception and that serves as a basis for the design of future HMD optical systems and quality control. Therefore managing to become a critical indicator of image quality applicable for the design of Virtual Reality or Augmented Reality content.

2) The use of AR in education.

Digital tools are beginning to be incorporated into teaching, seeking to improve student performance. Finding Augmented Reality with a tool capable of being incorporated into the classroom, managing to provoke a revolution in the way of learning the subjects to be studied, generating motivation by applying this technology as a creative resource and taking it as a means of presenting information. The use of this technology promotes greater motivation aimed at study, increasing performance towards learning topics. Marín, Cabero & Gallego (2018).

In recent decades, there has been an evolution of technological applications that have managed to develop new forms of applications with the intention of addressing learning through Augmented Reality, this technology offers a new educational approach that helps students develop critical skills and deeper understanding of the concepts underlying scientific research.

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The AR manages to enrich the reporting of learning opportunities helping to face the challenge of science for all Lazoudis & Agogi (2011) created the project "Science Center To Go" whose main objective is the presentation of an initiative in science teaching, in educational environments, formal and informal with the intention of facilitating at the same time that it measures the benefits of the exposure of educational material through said technology correctly focused on your compression level.

The degree of acceptance of a learning approach based on Augmented Reality, based on the use of the Science Center To Go system, created by Larsen, Buchholz, brosda, Bogner (2011) focuses on a qualitative evaluation centered on the teacher taking into account the student along with the degree of technical acceptance as well as the pedagogical effectiveness of the system, indicating that acceptance is high in general and that its pedagogical effectiveness is positively valued. Showing that meaningful system evaluation in a real school setting demands a large measure of prototypes with excellent robustness to achieve significant reliability.

On the other hand, with the arrival of the Covid-19 pandemic, visits to places of interest were highly restricted, making the tasks of engineering students almost impossible to be fulfilled, Sivanesan, Lu Ng, Xir Lim, Kai Tan, Yew, Goh (2021) suggest a remedy for the problems that students commonly face, using Augmented Reality as a tool, of interaction that helps solve problems in real time through information embedded in reality through digital resources. Through the analysis of the work sites measuring the effectiveness of the tasks, achieving encouraging results that indicate a significant improvement, concluding that there is room for its implementation and innovation in engineering teaching processes.

The pandemic that began in 2021, caused distance learning to be denoted as critical since it faced various application problems, because it was necessary to find a balance between high quality education and its participation in practical learning Villanueva, Zhu, Liu, Du, Huang, Peppler, Ramani (2021) present a robotics toolkit called RobotAR, that seeks to be incorporated as a query application for the creation of Augmented Reality makerspaces.

This software behaves like a voice assistant that can be incorporated for a teleconsultation. Achieving a better concentration in the areas of interest within the workspace helping the student to solve problems.

Therefore, an evaluation was carried out about the use of augmented reality within the activities carried out within study centers, with the intention of improving the educational service Egaji, Ashar & Griffiths (2021). Showing statistically that there are 5 fundamental factors for obtaining an increase in the absorption of knowledge, therefore it is very important to create activities and plans that help a good implementation of Augmented Reality in education, because it is a tool capable of motivating the student by improving their productivity.

3) Augmented Reality application in the medical field

Augmented Reality is positioned as a disruptive tool capable of enhancing medical processes by increasing their effectiveness, therefore the authors Ho, Albajez, santolaria & Yagüe-Fabra (2022) through a systematic review of the literature managed to generate an analysis with which they managed to observe that the current trend demonstrates a low use of Augmented Reality in quality control processes in the medical area, Therefore, this creates a field of opportunity for the creation of new methodologies to achieve a development that helps solve problems.

The role of technology for 3d reconstruction within the field of medicine is booming, due to its rapid implementation in different areas such as esophagogastria, therefore Robb, Scrimgeour, Boshier, Przedlacka, Balyasnikova, Brown, Bello & Kontovounisios (2022) highlight the gaps in the literature or the implications for future research. Through the application of a review of scientific articles which aims to create a visualization of trends and fields of opportunity within the study area, the authors conclude by saying that the information collected is insufficient, which is why they mention that the study for the application of 3d reconstruction in esophagogastric, is a field of opportunity since there is very little information which should motivate the generation of new knowledge.

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Currently, devices capable of displaying Augmented and Virtual Reality are implemented in research with the intention of being applied in a wide range of medical uses. There are significant gaps in the evaluation of such devices as well as the difficulty of a regulatory assessment. Therefore the authors (Beams etc. 2022). They address these gaps to demonstrate safety along with the effectiveness of the devices, by describing technical aspects. In order to highlight current efforts in communities and illustrate the connections between evaluation challenges and the intended uses of Augmented Reality devices in the medical area.

Medical techniques such as intubation today are more important than before, therefore it is important to emphasize the importance of the domain and the challenge it presents for the intubation process. Where a group was properly trained by means of RA, where the authors Imach, Kolbel, Bohmer, Kiepke & Ahnert (2022) highlight the importance of training since a significant increase in the quality of the operation was demonstrated. Demonstrated that the combination of Reality Increases in combination with medicine is able to show benefits in technical results which great greater efficiency on the part of medical personnel.

Therefore, computer-aided solutions are currently changing surgical practices on an ongoing basis. As an example Jud, Fotouhi, Andronic, Aichmarir, Osgoog, Navad & Farshad (2020). They mention that AR is a disruptive technological tool capable of innovating in surgical techniques, while substantially increasing its use in this area. Therefore the intention to find the state of knowledge and application in orthopedic surgery is of interest due to its possible uses as an instrument for training or future surgical education.

Another AR application seeks to reduce the chances of falling in an elderly person, through randomized controlled training which will evaluate the effects of training through augmented and virtual reality. For this purpose, groups were recruited with the intention of evaluating the effects of the intervention in people with a variety of motor and cognitive deficits. Authors Mirealman, Rochester, Reelick, Nieuwhof, Pelosin, Abbruzzese, Dockx, Nieuwboer & Hausdorff (2013) concluded that the intervention that combines training with such technology reduces the risk of falls by improving mobility along with cognitive function.

Therefore, it can be shown that AR in rehabilitation is a treatment that was established for patients with movement dysfunction, which currently introduces 2 recent technologies, which are virtual reality and augmented reality with the intention of using them in this field, for which the authors Heffrnan, Abdelmalek & Nunez (2021) review the evidence of efficacy of rehabilitation administered by the 2 technologies mentioned above in patients with peripheral vestibular disorders.

Therefore, thanks to the review of the aforementioned literature, it was possible to create Table 1, which contains concepts grouped by author with the intention of generating a panorama in which the benefits or uses of AR can be identified as part of the process that seeks to increase the level of quality, in different areas of application.

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Author	Conceptualization
Perek, Mielczarek & Makowski (2022)	The development of electronic and information technologies allows to achieve a better quality of recorded 3D image along with many possibilities for its correction.
(Lora, Sotoca & Rain 2022)	An application was developed for the exhibition and sale of ceramic molds.
Zhang, Omrani, Yadav & Fjeld (2021).	Creation of time-reversing imaging algorithm, post-image segmentation and volumetric visualization module.
(Beams etc. 2022)	To highlight current efforts in communities and illustrate the connections between evaluation challenges and the intended uses of medical augmented reality devices. We concluded that more research is needed to evaluate the safety and efficacy of such devices in all use cases.
Jud, Fotouhi, Andronic, Aichmarir, Osgoog, Navad & Farshad (2020).	provides a summary of the current state of knowledge and research of augmented reality in orthopedic surgery presented in the literature, and a discussion presenting the keys to the observations necessary for the seamless integration of Augmented Reality into future surgical practice
Lazoudis & Agogi (2011)	I created the project "Science Center To Go" whose main objective is the presentation of an augmented reality technology initiative in science education
Genevois, Horel, Renzaglia & laugier (2022).	Simulations were created that propose a new framework on augmented reality that leverages the physical and digital environment, for a new testing methodology that aims to be a bridge between looping vehicle testing and real-world testing.
Larsen, Buchholz, brosda, Bogner (2011).	Research covers the degree of acceptance with a learning approach vased in augmented reality using Science Center To Go, Larsen, Buchholz, brosda, Bogner (2011). Focusing on a qualitative evaluation centered on the teacher and the student along with the degree of technical acceptance as well as the pedagogical effectiveness of the system.

Table 1 Concepts by author
Source: Own elaboration

Therefore, the wide variety of applications of Augmented Reality can be visualized within industrial, medical or academic processes, in order to increase its quality, since this tool is used as a control capable of being decisive with respect to quality that through information embedded in reality provides truthful information in real time helping the user to make efficient decisions, therefore, the use of AR is important for the improvement of the skills of human resources, as a disruptive tool that seeks to increase efficiency.

Through an improvement in learning, by providing easy-to-use didactic material with the intention of motivating learning and training, which is why it is considered as a new methodology capable of increasing knowledge. This means that it is not only used as a quality control tool, but also as a method that manages to improve teaching techniques or production processes.

Methodology

Within the section called methodology, we proceeded to perform a bibliometric analysis of the topic Augmented Reality as Quality Control, after which trends were identified, thanks to the most cited documents, as well as the main authors on the subject, as well as the journals with greater importance by quantity of scientific production, making a focus on documents called scientific articles, of relevant authors, within the area of interest. The intention of bibliometric analysis is to provide data related to the research topic, seeking relevance, important institutions as well as groups of researchers.

A database obtained from Scopus was used, validating data correctly, such as the correction of spelling mistakes, elimination of blank spaces, taking into account initials that allow a standardized analysis when performing a search within Scopus. Through the use of images, graphs or tables, we proceeded to show the relevant results found after the bibliographic analysis.

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Analyzing the information obtained from the database through the R software, which is a computer program that allows you to take a CSV file, and obtain relevant information that characterizes the same database, this computer program is able to display information such as authors, organizations, search range, number of citations, amount of scientific production per author, Production by country etc. Information that helps to perform an optimized delimitation that allows to identify fields of opportunity.

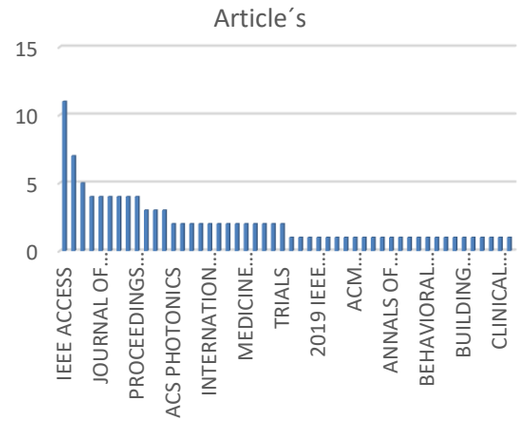
The following keywords were used: Agumented reality, Industry 4.0 and Quality control for the search of information in title, abstract or keywords used by the author, with a search period of 2 decades between 2002 and 2022 with a total of 203 results. The starting year taken was 2002 since it seeks to cover from the most cited documents that can be from the oldest to the most current that can touch on trending topics. Looking for scientific articles of interest and with the characteristic of being able to be cited.

Result

Main database information	
Timespan	2002:2022
Sources (Journals, Books, etc)	146
Documents	203
Average years from publication	3.57
Average citations per documents	14.1
Average citations per year per doc	3.362
References	9632
Document types	
article	116
conference paper	65
editorial	2
letter	1
review	19
Document contents	
Keywords Plus (ID)	2165
Author's Keywords (DE)	717
Authors	
Authors	995
Author Appearances	1033
Authors of single-authored documents	4
Authors of multi-authored documents	991
AUTHORS COLLABORATION	
Single-authored documents	4
Documents per Author	0.204
Authors per Document	4.9
Co-Authors per Documents	5.09
Collaboration Index	4.98

Table 1 Database characteristics
Source: Own elaboration based on information obtained through R

A bibliometric analysis was carried out, using a database obtained through Scopus, with a total of 203 documents, with an average of documents published per year of 3.57, at the same time it is important to note that the database is composed of 116 articles, 65 conference documents, 2 editorials, 1 letter and 18 reviews, in the same way it can be observed that the total of authors participating in the database was 995.



Graphic 1 Relevant sources of information by number of articles published
Source: Own elaboration based on information obtained through R

Within graph 1 the behavior of the main scientific journals with respect to their production is appreciated, which is within the range of 2002 to 2022, this delimitation helps to identify relevant sources of information for research, this means that these journals were the ones that represented the main interest to carry out the bibliographic review. Therefore the 6 most important sources of information are presented.

-
- Ieee access
- Applied sciences (switzerland)
- Journal of healthcare engineering
- Journal of medical internet research
- Journal of physics: conference series
- Cirp proceeded

Table 2

Therefore, from the third place, a decrease in production can be seen because it is reduced from 4 items to only 1. Therefore, we focus on the bibliometric review of the top 6.

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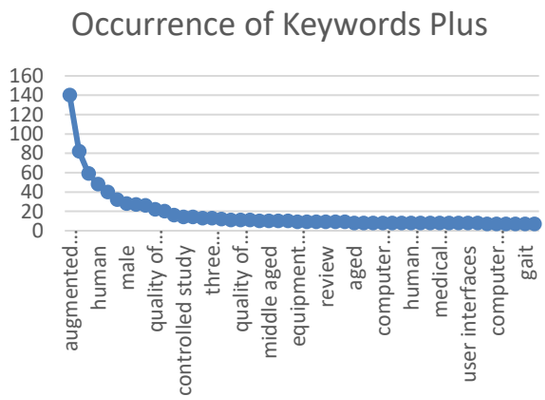
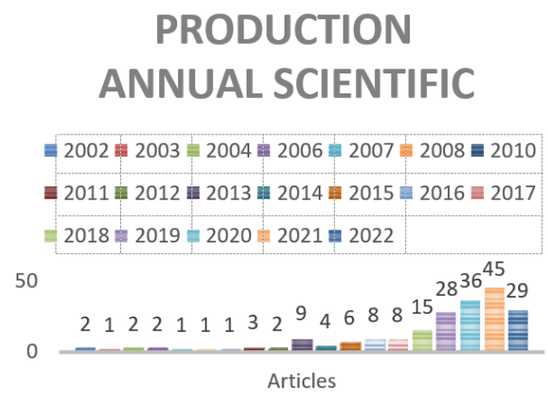
This information is of utmost importance because it helped the research with the delimitation of the sources of research, focusing on the most significant with the intention of giving weight to the article through the analysis of the main sources of information with the intention of identifying fields of opportunity.



Graphic 2 Occurrence of Keywords plus
Source: Own elaboration based on information obtained through R.

The use of Keywords plus is a tool that helps us with the search for information, because it allows us to focus on topics related to the articles published by the authors, at the same time that we can see what is the main trend of research within the database.

When performing the analysis based on the results obtained by R, it can be deduced that the topic "augmented reality" is positioned as the most used term, although the results suggest complementing future research with the term "virtual reality" because these 2 terms have the highest use, while in third place is the term "quality control", This indicates that the authors are relating the terms "augmented reality and virtual reality" as a disruptive instrument capable of being used as a tool with the aim of increasing quality controls, due to the benefits of its implementation. The focus of inquiry within the top 3 is growing and with an important relationship to the main research topic, which shows the scientific interest in the dissemination and development of currents of thought.



Graphic 3 Annual scientific production
Source: Own elaboration based on information obtained through R

The time range for research was from 2002 to 2022, this indicates that the boom in computing and electronics that began in the 2000s, encouraged the development of the research topic "Augmented Reality as Quality Control", perhaps not with this name, but with related topics, since computing and the adoption of ICTs with the advance of time gesture a prosperous environment for use of new technologies, within the area of quality control, which is of utmost importance since with the arrival of industry 4.0 technologies such as AR and VR are taken to add to the creation of value.

In 2013 it can be seen that a significant increase begins within scientific production, with a total of 9 articles published, from that year and within the following decade the number of publications increased to a maximum of 45 disclosures in 2021, this indicates that there is an exponential growth, which gives us the green light for the investigation of trends, which indicates that it is ideal to enter this field of opportunity, to disseminate relevant information.

Being confirmed by the section of references in which it is appreciated that the articles used for the present investigation are within the range of years mentioned above, due to the great technological advance presented in the last decade due to the adoption of new technologies such as mobile devices which gave the AR a low-cost means that has managed to massify in society which gives A platform capable of enhancing such technology by eliminating the need for specific technologies for its implementation.

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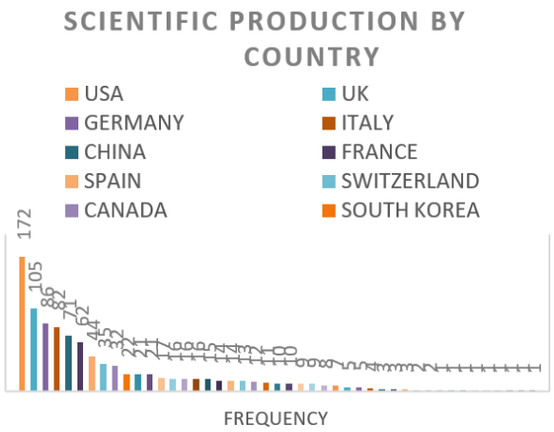


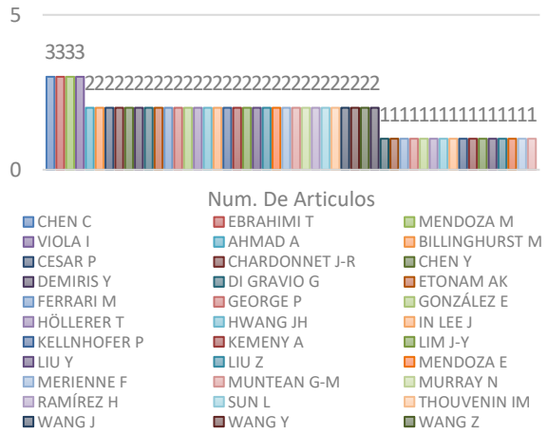
Graphic 4 Scientific production by country
Source: Own elaboration based on information obtained through R

A useful instrument that supports the approach of the search of literature for research, is the review of scientific production by country, shown in graph 5, because it shows us the contribution, managing to visualize the behavior and geographical position of the exponents, with the intention of immersing us in a search focused on the main actors of interest, forming an exploration that allows to find fields of opportunity, because each country has an approach adapted to its own needs.

Within the interpretation of graph 5, it can be seen how the United States is positioned as the largest producer of scientific literature, due to its high rate of industrialization, this causes it to have a high technological degree for the use of new technologies in quality controls, on the other hand it can be seen that the representation of the European Union has 3 representatives to the United Kingdom followed by Germany and Italy, These countries are important exhibitors in the field of Industry 4.0 which is reflected in their scientific production.

On the other hand, China ranks fifth, positioning itself as the only Asian country within the top 7, which shows that China's broad and rapid economic growth is also reflected in its scientific production, which despite being located in fifth place, is positioned as a country of interest for possible future studies. On the other hand, France and Spain occupy the 6th and 7th place respectively, remembering that the European countries mentioned within the top 7 are the main exponents within the area of manufacturing in the European continent through technological innovation because they lead in the implementation of I4.0 worldwide.

Therefore, the research focuses on the scientific production of the top 7, because they are the main countries by number of publications, this indicates that the delimitation for the search for trends focused on the main actors worldwide, found within the Scopus database.



Graphic 5 Most relevant authors by published articles
Source: Own elaboration based on information obtained through R

In the research, through the use of the information shown in graph 6, it is possible to appreciate the maximum and minimum production by each author, thanks to the inquiry it can be interpreted which authors are interesting to make a review of their production, with the intention of scrutinizing trends or works that can provide relevant information due to the wide range of articles.

When focusing on the first 4 positions, we find Chen, Ebrahimi, Mendoza and Viola, it is appreciated that there is a variety with respect to the authors, when conducting a review of the scientific production, it can be seen that Mendoza and Chen are positioned as the 2 authors who within their scientific production take the theme of Augmented Reality as a quality tool either within processes with the intention of increasing productivity manufacturing or as a way to increase the efficiency of lean tools.

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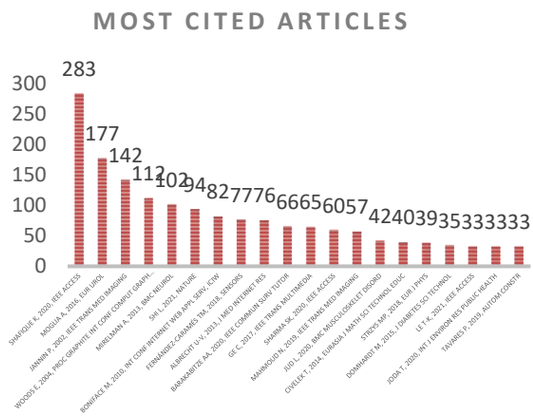
While Ebrahimi and Viola, focus on increasing the quality of the images used by Augmented Reality, in order to optimize the information displayed, along with the way in which this technology interacts with it, offering an improved level of immersion. This indicates that there are trends that can cause significant scientific production, because even one of the articles in which Chen participated is focused on the medical area, this shows us that the range of applications can be very extensive since it is an innovative tool capable of enhancing knowledge in different areas of application.

This helps to provide the research with an approach that could be said to be diverse by having information generated in different geographical points, this helps to identify trends or the way in which the authors approach the subject of study.



Graphic 6 Most cited articles
Source: Based on R

Conclusions

Augmented reality is a very useful technological tool for the industry, due to the tendency to optimize or analyze the needs of each organization achieving a dynamic adaptation to new forms of quality control, therefore the authors define that due to the adoption of new emerging technologies currently used in industry 4.0 Fernandez, Fraga, Suarez & Vilar (2018) AR will be able to boost efficiency through innovative methods.

This technology is capable of offering new ways of performing tests within dense, safe, economical and reconfigurable environments, demonstrating that the methods are capable of preserving real data by increasing them with consistent virtual information according to Genevois, Baptiste, Renzaglia & Laugier (2022), this gives an innovative advantage with the ability to increase the quality of the processes, Through the conjunction of technologies seeking to show data in real time that help the operator in their performance. Future developments include the ability to increase feedback from critical scenarios both in industry and everyday life.

Due to the RSL and the analysis of the current development of AR technology, it was obtained as a result the potential research areas on the topic of applied AR in the quality sector in the context of industry 4.0 could be one of the following topics:

1. Within the transformation of traditional quality Lean tools into a virtual quality tool by identifying and implementing AR technology when feasible.

2. Integration of Augmented Reality in the help for manual metrology activities where its operational suitability is demonstrated within a process as well as the prevention of human errors, reduce configuration time, guarantee the accuracy of metrology data, as well as in assembly processes.

3. Within the standardization of the representation of knowledge relevant to quality or information for data formats, making AR systems compatible with manufacturing information systems.

4. During the development for the adaptation of solutions based on Augmented Reality in the quality sector following the international design focused on ISO standards, closing the gap between industrial and academic implementations. In addition, this human-centered model could also drive the adoption of AR technology not only for the quality sector, but also for manufacturing in general or services, even reaching the medical area.

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For the integration of AR solutions with other enabling technologies of Industry 4.0, due to the need to obtain information in real time, which helps streamline production processes, which can range from the area of engineering, education, medicine or even in everyday life, this just to mention some of the areas where it could work.

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