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Research on Physics of Photography: A Bibliometric Study (2000-2020)

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Research on Physics of Photography: A Bibliometric Study (2000-2020)

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Abstract. The purpose of this study is to analyse physics on photography research and see its trends to find the opportunity for further research. A bibliometric analysis was used in this study. The search results from the Scopus database were extracted using the *VOSviewer* software. A total of 432 documents related to physics of photography were analysed and mapped. The results mapped the trend of documents across years, language, countries, affiliation, type, sources, authors, and key words. The results have also indicated two major clusters and one minor cluster in researching on physics of photography. The first cluster (green colour) was photography as an application. The second cluster (red) was photography specified into high-speed photography and modern photography. The third cluster (blue) was technology of photography in connecting with competition. A proposed model for future research is also illustrated. Thus, it can be an opportunity for further researchers to conduct research related to this area.

1. Introduction

Photography consists of two Greek words, namely (*phōs*), which means light and (*graphê*), which means line or image [1,2]. Literally, Photography can mean "drawing with light" [1-3]. Photography itself can be defined by using various perspectives, both from art, science, and activities or activities. In essence, Photography is a process of recording certain light or electromagnetic waves on a specific medium (in the form of chemical or electronic media) into an image that is permanent (durable). Epistemologically the word photography was introduced by "Sir John Herschel in a lecture at the Royal Society London, on March 14, 1839, causing the word photography to be known in the world today" [4]. The term Photography was also first written by Johann von Maedler in the German newspaper *Vossische Zeitung* in 1839 [4].

Photography as a science refers to the fields of pure science, such as mathematics, chemistry, physics and computers, which are the basis for the existence of photography from its early days to the present day. The working mechanism of the camera, the dynamics of exposure and the development of the chemical medium of film or digital must be properly balanced and used in such a way by photographers to produce images according to their needs [5].

Physics in photography has a fundamental role that provides a fundamental influence in the development of photography. The existence of lenses has been known since antiquity, but in writing, the lens was introduced in Ancient Greece, in Aristophanes' play *The Clouds* (424 BC) which



mentions a burning-glass (a convex lens used to focus sunlight to create fire) [6]. Next, Seneca the Younger (3 BC) describes the magnifying effect of a round glass filled with water. The development of scientific lenses in their application in photography was published by Arab Muslim scientist Abu Ali al-Hasan Ibn Al-Haitham (965-1038), who wrote a book entitled *Kitab al-Manazir* (Book of Optic), which discusses the first optical theory and main. Haitham explained that the lens in the human eye forms an image on the retina. The spread of lenses did not occur until the invention of glasses in Italy in the 1280s [6].

On the inside of the camera, the working mechanisms are several mechanical mechanisms that are designed in such a way as to be able to adjust the exposure time and open the diaphragm gap to allow the entry of a certain amount of light according to the needs of image formation on peer media (both film and digital media) in a dark room. The prominent role of physics in making a working system for regulating light entering the camera is measuring light using a light meter.

Photographic film is one of the fundamental things that put chemistry in photography. Film in photography is a plastic sheet coated with an emulsion (light-sensitive silver halide salt bonded by gelatine) with variable crystal size, determining the degree of reaction sensitivity to light, contrast, and film resolution. When the emulsion is exposed to sufficient light, it forms an invisible image. The subsequent chemical processing of this reaction allows the formation of images that appear both negatively and positively through a process called film development [7].

Photography could also be a way to explain some physical concepts through images. During last year, we started an elective course: "physics of photography" with the main output as the project to practice our capacity to take good pictures, create something new, and explain concepts at once. We discovered that it is straightforward to interpret a physical concept through shapes, body and colours; it is beneficial to translate physics into something more achievable by "science-outsiders". It was very challenging at the start but fascinating and satisfying when people understand we are talking, for example, about gravity with a given picture [8].

On the other hand, through the course "literacy of physics", we emphasise the use of bibliometric analysis in exploring the idea of physics research through library research. By combining the essence of these two courses, this bibliometric study was conducted. Therefore, through this bibliometric analysis, the purposes of the research were analysing the publication output, document sources, and language sources, publication distribution of countries and institutes, top authors, publication patterns, and the visualisation of research trends on physics of photography.

2. Method

This study adopted a bibliometric study [9-12]. The data were retrieved from the Scopus Database. The data collection was conducted on August 2021. The keywords used in data searching were: "TITLE-ABS (*physics AND photography*)" and resulted in 699 documents. After the filtering process for the year 2000-2020, finally, the authors analysed 432 documents. These documents were downloaded in .csv and .ris format to be processed using *VOSviewer* to visualise and analyse the trends in the bibliometric form [13].

3. Results and Discussion

3.1 Publication output, document sources, and language sources

Based on a search using the Scopus Elsevier database obtained 432 documents related to the study of physics of photography. The publications devoted to the physics of photography research from 2000 to 2020 are demonstrated in Figure 1. The number of documents across the year has fluctuated. The record of documents was 44 in 2012. Starting from 2017, the trend raised slowly. It can be predicted that the number of articles in 2021-2025 will increase dramatically.

Meanwhile, the number of articles based on sources indicated the dominance of articles in the journal (256 documents). It was followed by a conference proceeding (146) and a book (19). The book

series and trade journal accounted for the fewest sources of documents. Meanwhile, all documents in this domain used a hundred percent of English as a paper language.



Figure 1. The documents trend of photography physics (2000-2020)

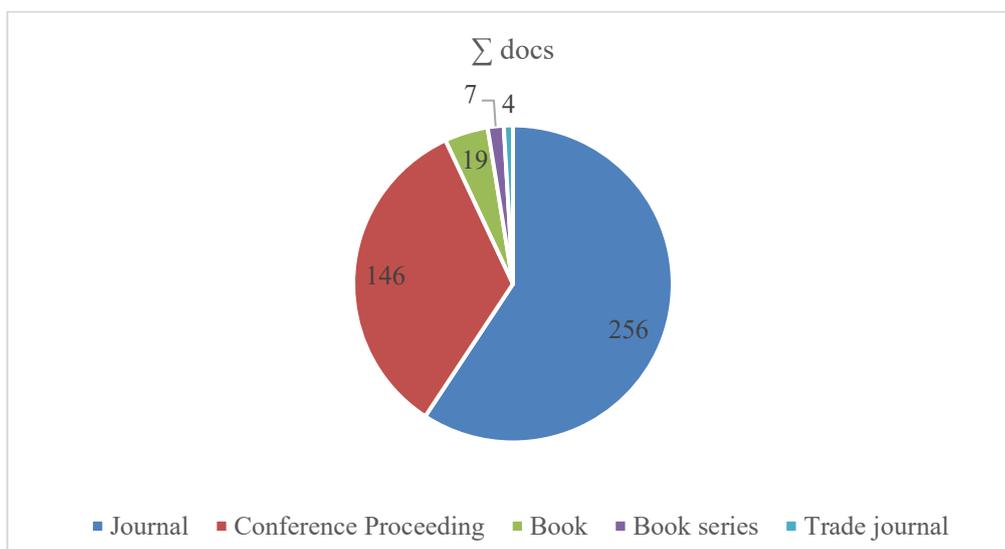


Figure 2. The number of documents based on source categories

3.2 Publication distribution of countries and institutes

Based on the number of documents across countries, the USA's dominance was clear, with 142 documents from 2000 to 2020. In the second and third position were UK and China with 59 and 57 documents, respectively. The countries such as Japan, Germany, France, and Canada contributed with 11 to 23 documents in the last decade. The remained countries were Russia, Australia, India, and Iran resulted in less than ten documents.

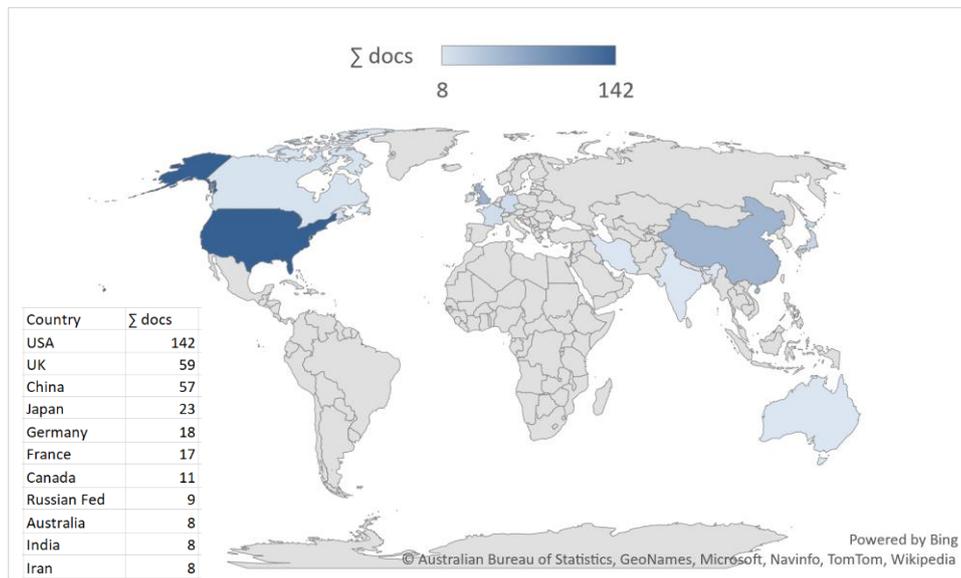


Figure 3. Top countries that researching on physics of photography

Department of Physics, University of Cambridge is the most affiliation that researching on physics of photography. Institutions from the USA, the UK, China, and Japan were also dominated among those respective countries. China Academy of Engineering Physics and Southwest Institute of Fluid Physics Mianyang from China contributed to the second position, followed by Georgia Institute of Technology from the USA with nine documents in the third rank (see Table 1).

Table 1. Number of documents based on affiliation

Affiliation	Number of documents
Department of Physics, University of Cambridge	26
China Academy of Engineering Physics	12
Southwest Institute of Fluid Physics <i>Mianyang</i>	12
Georgia Institute of Technology	9
The University of Manchester	8
University of Colorado Boulder	6
Los Alamos National Laboratory	6
<i>Amirkabir</i> University of Technology	6
Imperial College London	6
The University of Tokyo	6
The Royal Institute of Technology KTH	5
A-Star, Institute of High-Performance Computing	5
CNRS Centre National <i>de la Recherche Scientifique</i>	5
Chinese Academy of Sciences	5

3.3 Top authors in researching on physics of photography

In terms of the most productive authors, Table 2 indicates the top authors researching the physics of photography. Kontis and Proud were the most productive authors on this topic. In the second rank, there were Jaberri, Tadjfar, Thadhani, and Zare-Behtash with six documents in the last decade. Moreover, Figure 4 indicates all those top authors, their co-authorships, and the most influenced

authors on the physics of photography. It was clear that Proud, Wang W, Kontis, Jaberri were the leader of their clusters.

Table 2. Top authors on physics of photography

Author	Number of documents
Kontis, K.	8
Proud, W.G.	8
Jaberri, A.	6
Tadjfar, M.	
Thadhani, N.N.	
Zare-Behtash, H.	
Hertzberg, J.	5
Klaseboer, E.	
Khoo, B.C.	4
Li, J.	
Xiao, Z.F.	

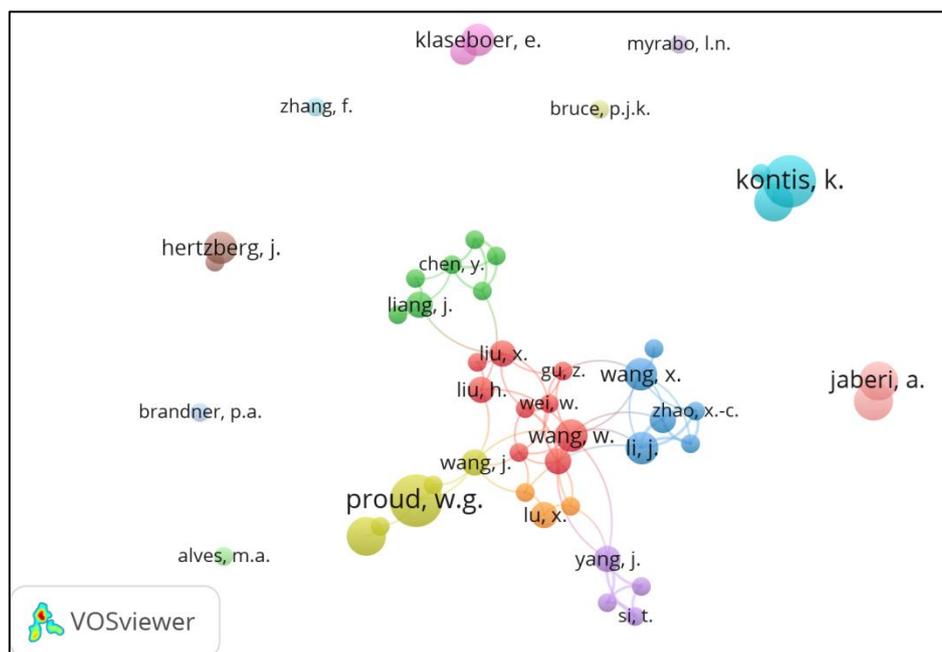


Figure 4. Top authors, co-authorships, and the most influenced authors on physics of photography

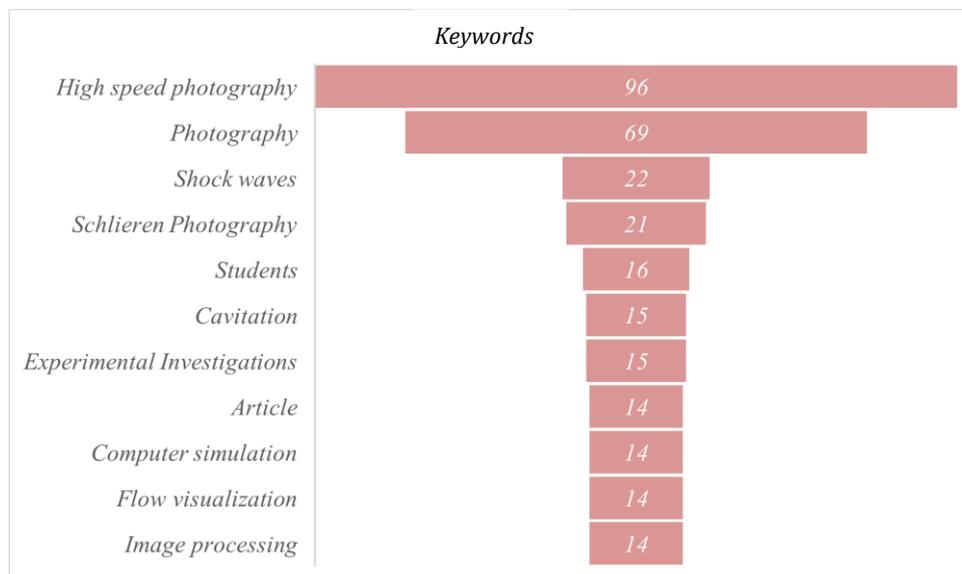
3.4 Publication patterns: source titles (journal or proceeding)

Table 3 illustrates the most contribution journal or proceeding on the research on physics of photography. AIP Conference Proceedings was a leading conference series that contains articles in this domain. Meanwhile, the Journal of Applied Physics and Physics of Fluids was also the leading journal covering this topic in their content as the second and the third rank. The remaining journals were Applied Physics Letters, Physics of Plasmas, Physics Teacher, Australasian Physical Engineering Sciences in Medicine, Review of Scientific Instruments, Japanese Journal of Applied Physics, and Physics Education (see Table 3).

Table 3. Number of physics of photography documents (2000-2020) across source titles

Sources	Number of documents
AIP Conference Proceedings	71
Journal of Applied Physics	28
Physics of Fluids	24
Proceedings of SPIE The International Society for Optical Engineering	15
Applied Physics Letters	10
Physics of Plasmas	9
Physics Teacher	9
Australasian Physical Engineering Sciences in Medicine	7
Review of Scientific Instruments	7
Japanese Journal of Applied Physics	6
Physics Education	6

Furthermore, the following Figure 5 lists the most keywords used by the authors in researching the physics of photography. It was clear that the term ‘high-speed photography’ and ‘photography’ frequently appeared in the Scopus database. The term ‘shock waves, ‘Schlieren photography’, and ‘students have also coloured the research on photography in physics. Schlieren photography is “a visual process used to photograph the flow of fluids of varying density” [14,15]. This type of photography was invented by the German physicist August Toepler in 1864 to study supersonic motion, and it is widely used in aeronautical engineering to photograph the flow of air around objects [14].

**Figure 5.** Top keywords research on physics of photography during 2000-2020

3.5 Visualisation of research trends on physics of photography based on vosviewer software

From 432 documents related to photography in physics in the Scopus database, the researchers visualised the research trends on this topic supported with *VoSViewer* software. This effort helps find the novelty of the research on this domain. Figure 6 specifies the whole picture of research on the physics of photography. Researchers worldwide produced two primary clusters indicated with green and red and one minor cluster (blue). The first cluster (green colour) was photography as an application. The second cluster (red) was photography specified into high-speed photography and

modern photography. The third cluster (blue) was the technology of photography in connecting with the competition.

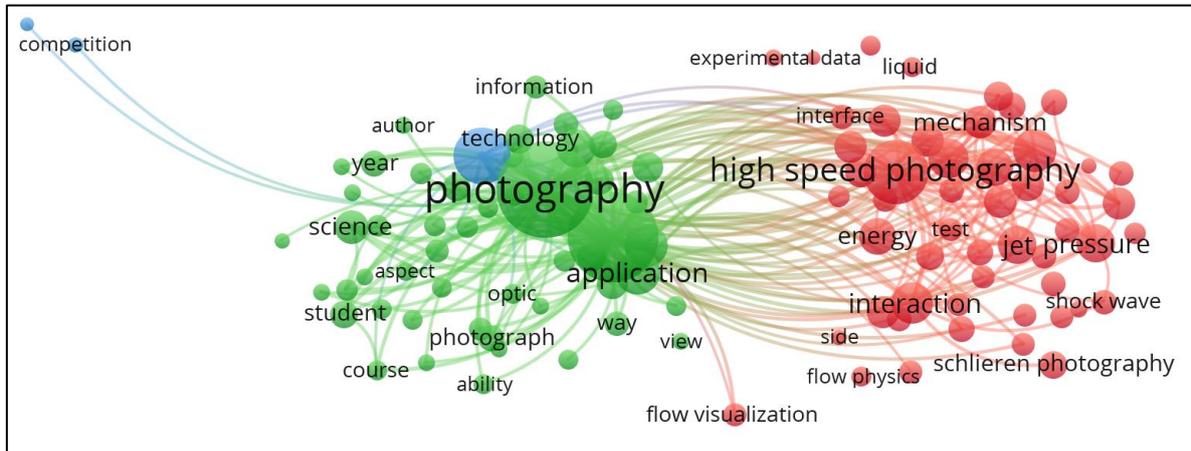


Figure 6. The whole picture of research on photography physics during 2000-2020

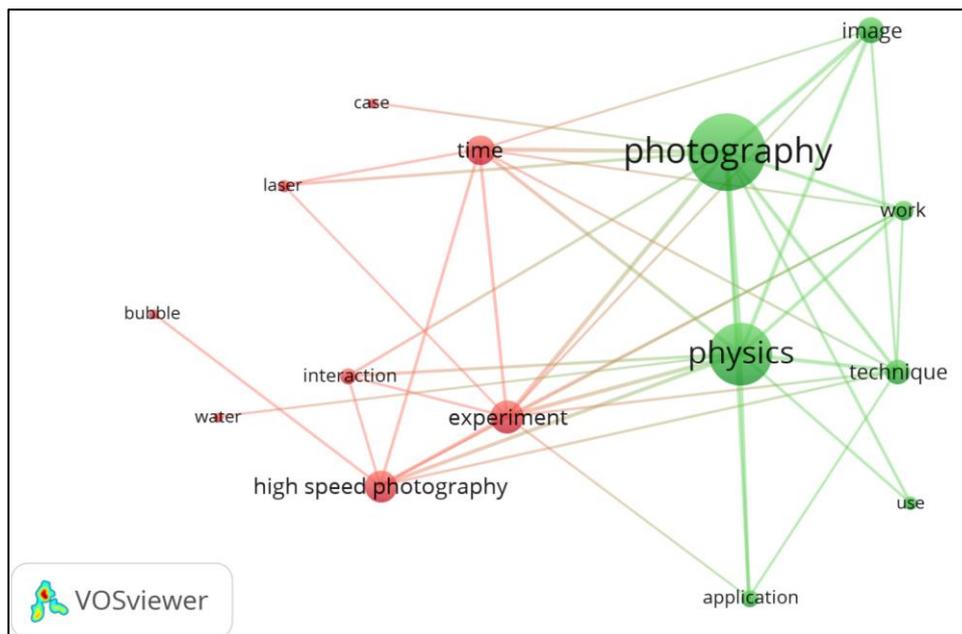


Figure 7. Simple proposed model of network visualisation on physics of photography

Finally, the authors offered the simple proposed model of research on the physics of photography. Figure 7 indicates the relationships among the critical variables in researching photography in physics through network visualisation. The figure has also illustrated main variables and supporting variables and the link strength among those variables.

4. Conclusion

Research trend on physics of photography research was performed through this bibliometric research. The authors indicated some significant points regarding the research on the physics of photography in the last two decades. The number of documents across the year was fluctuated, which were dominated by articles in the journal. The USA contributed the most documents on physics of photography. Meanwhile, the Department of Physics, University of Cambridge, was the most institution that

contributed to this topic. Then, the visualisation of research trend on physics of photography resulted in two major clusters and one minor cluster:

1. Photography as an application.
2. Photography is specified into high-speed photography and modern photography.
3. Technology of photography in connecting with competition.

The authors have also proposed a simple proposed model of research on physics of photography. This model will give a new lens and new direction on the future research of photography physics.

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