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Computer vision to attendance recognition: a bibliometric analysis

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Abstract As the number of scientific publications continues to grow, their content becomes more extensive and research increasingly fragmented. In this context, scientific mapping becomes an essential practice. Bibliometrics offers valuable indicators that can guide studies and help build a coherent set of relevant works. This study highlights the main bibliometric indicators in the field of computer vision, specifically related to the monitoring and recording of student attendance in academic environments. Additionally, it conceptualises the key aspects of bibliometrics and outlines the study scenario. The metadata were extracted from the Web of Science and Scopus databases, considering all publications up to 2024. The results indicate that India is among the most prolific countries in this domain, and the terms "face recognition" and "computer vision" are the most frequently associated. The paper also presents the most cited articles, prominent authors, and consolidates a list of significant works in the area. Furthermore, the search strategy revealed a limited number of studies addressing spoofing, presentation attack detection (PAD), or liveness detection, suggesting a promising direction for future research in strengthening the reliability of attendance validation systems.

Keywords: Computer Vision, Facial Recognition, Bibliometric Analysis, Attendance Monitoring, Monitored Academic Environment, Deep Learning, CNN.

1 Introduction

The number of published academic papers has increased considerably over the past few decades. One of the factors that has driven this increase is related to scientific findings, which can currently be published not only in traditional venues such as journals and conferences but also in predominantly electronic platforms such as preprint repositories and mega-journals. In addition, the speed and volume of publications have increased compared to recent years [Björk, 2015].

The characteristics of writing articles have also changed; the number of characters in the title and text, the number of authors, and the number of references have all increased [Fire and Guestrin, 2019]. These factors increase the time required to analyse the articles.

In this scenario, tools that assist in analysing large volumes of data and help select relevant and suitable articles for a specific field of study are becoming increasingly important. Bibliometrics is a method that helps identify high-impact research and trends in the field of study [Aria and Cuccurullo, 2017; Severiens, 2015]. Furthermore, bibliometrics enables a more transparent and reproducible analysis based on statistical measurements, making the process more objective and reliable [Aria and Cuccurullo, 2017].

This proposal applies bibliometric analysis to investigate the field of Computer Vision (CV), focusing on automatic attendance techniques in academic environments. Computer Vision is a field of Artificial Intelligence that enables artificial systems to interpret and understand images and videos in a way similar to human visual perception. CV has been widely used in different areas, such as autonomous vehicle navigation, facial recognition, robotics, medical diagnostics, security, agriculture, and biology [Chen and Deng, 2020].

Within the CV field, facial recognition allows the identification of individuals in photographs or videos [Kumari Sirivarshitha *et al*., 2023] and, after that, makes other processes, e.g., access control in specific environments. This technology enables the recognition of students or participants in classes or academic events.

In this context, this study aims to map scientific production both quantitatively and qualitatively, identify the most influential authors and terms frequently used, analyse collaboration patterns, and outline key aspects of the field under study. This mapping is justified as it offers a clear overview of the field, which supports knowledge consolidation, guides future research directions, and informs both scholars and practitioners. To better structure the analysis and provide clarity to the study's contributions, the following research questions (RQs) are proposed:

- RQ1: What are the publication trends over time in the field of facial recognition for academic attendance?
- RQ2: Who are the most influential authors, institutions, and countries in this domain?
- RQ3: What are the most frequent terms and thematic patterns found in the selected literature?
- RQ4: What are the main collaboration networks and co-authorship patterns?
- RQ5: Can the 20 most cited and relevant papers in this field be systematically identified and documented, including their DOIs, to create a reliable dataset for a

subsequent, more detailed content analysis?

The main contributions of this study are: (i) A domain-specific bibliometric mapping of computer vision research applied to attendance monitoring systems, an area for which no dedicated bibliometric study was identified; (ii) The integration of publication trends, collaboration networks, keyword co-occurrence structures, and co-citation analyses into a unified analytical framework; (iii) The identification of emerging research opportunities related to presentation attack detection (PAD), liveness detection, and anti-spoofing mechanisms, which remain underrepresented in the current literature; (iv) The construction of a curated dataset of the most influential publications in the field, including citation metrics and DOI information, providing a reference baseline for future systematic reviews and technical investigations; (v) The promotion of open science and research reproducibility through the public release of the complete workflow employed in this study, including the R scripts, data processing procedures, and bibliographic dataset used in the bibliometric analysis. This initiative supports transparency, accessibility, verification, and future extensions of the reported findings, in line with open science practices [Munafò *et al*., 2017].

The article is structured to provide a comprehensive overview of the research process and findings. The Related Works section reviews key studies in bibliometrics, whose methodological insights are used to structure and support the pipeline adopted in this work. The Materials and Methods section describes the data collection procedures, the scientific databases consulted, and the analytical approach using the R programming language. The Results section presents the bibliometric indicators extracted from the dataset. In the Discussion, key insights are highlighted and compared with findings from previous studies. Finally, the conclusion synthesises the main contributions and outcomes of the research.

2 Related Works

The increasing sophistication of bibliometric research has motivated the development of specialised tools and methodological debates. Aria and Cuccurullo [2017] contribute to this discussion by proposing Bibliometrix, an open-source package for the R Language that consolidates the fragmented landscape of bibliometric tools into a reproducible and extensible workflow for data collection, network analysis, and visualisation. Their work aligns with broader efforts to address biases in bibliometric evaluations, particularly those stemming from the choice of data sources. Both Mongeon and Paul-Hus [2016] and Echchakoui [2020] demonstrate that Web of Science and Scopus differ substantially in coverage and representation, and that merging these databases yields more reliable and comprehensive analyses. These contributions collectively underscore the methodological necessity of multi-source and flexible frameworks in bibliometric studies.

Several studies highlight the evolving dynamics of scholarly communication beyond just methodological concerns. Björk [2015] and Shintaku *et al*. [2019] examine the emergence of mega-journals, which are characterised by their broad thematic scope, high acceptance rates, rapid publication cycles, and the increasing importance of altmetrics as supplementary indicators of impact. These studies support the idea that traditional citation-based measures alone are inadequate for capturing the diverse influence of contemporary research. Additionally, Fire and Guestrin [2019] warn that the excessive focus on these metrics has led to systemic issues, such as inflated publication counts, self-citation practices, and longer author lists, which ultimately undermine the validity of widely used indicators.

Efforts to overcome these limitations have explored alternative and data-driven approaches to research evaluation. Severiens [2015], for instance, suggests moving beyond retrospective bibliometric indicators by leveraging machine learning to identify intrinsic dimensions of quality, such as methodological rigour and originality. Similarly, domain-focused bibliometric studies, such as Chen and Deng [2020] analysis of convolutional neural networks in computer vision, illustrate how bibliometric methods can track the evolution of specific research fields, uncover emerging applications, and signal transitions from foundational to mature stages of development.

Taken together, these works reveal two converging trajectories in bibliometric scholarship: the refinement of methodological practices through tools, data integration, and critical reflection on metrics, and the expansion of analytical applications to specific domains. In the context of computer vision, previous studies by Chen and Deng [2020], for example, have demonstrated the value of bibliometric approaches for tracking technological evolution. However, these analyses are usually carried out at a broad domain level and do not address specific application scenarios. Notably, there is a dearth of bibliometric studies that focus on facial recognition within academic attendance systems, and there is limited integration of multiple analytical dimensions, such as collaboration networks, thematic structures, and the systematic identification of key publications.

Addressing these gaps, the present study contributes to the literature by providing a domain-specific bibliometric mapping that combines multi-source data with a structured bibliometric workflow. By aligning publication trends, collaboration patterns, and thematic evolution with a curated dataset of highly relevant studies, this work establishes a more comprehensive basis for future research into computer vision applications related to attendance monitoring.

3 Materials and Methods

3.1 Data collection and Article Eligibility Criteria

This paper presents a bibliometric analysis of advances in computer vision and automated frequency recording. To achieve the study's objectives, relevant publications were retrieved from two major scientific databases: (i) Scopus, which covers a wide range of academic disciplines, including science, technology, medicine, social sciences, arts, and humanities. Scopus indexes peer-reviewed journal articles, conference proceedings, books, and book chapters from thousands of different publishers (e.g., IEEE, Springer, ACM, and Taylor Francis) [Elsevier, 2025]; and (ii) Web of Science (WoS),

Table 1. Search expressions and number of papers retrieved from scientific databases.

ID	Search expression	Papers retrieved	
		Scopus	Web of Science
1	”Computer vision” AND Attendance	237	62
2	”Computer vision” AND “Attendance Monitoring System”	23	1
3	“Attendance Monitoring System” AND (“Face Recognition” OR “Face analysis” OR “Facial biometrics”)	94	15
4	”Computer vision” AND “Attendance Monitoring System” AND (“Face Recognition” OR “Face analysis” OR “Facial biometrics”)	20	1
5	”Computer vision” AND “Attendance” AND (“Presentation Attack Detection” OR Anti-Spoofing OR “Liveness Detection”)	4	2
6	”Computer vision” AND “Attendance Monitoring System” AND (“Presentation Attack Detection” OR anti-spoofing OR “Liveness Detection”)	0	0
7	”Computer vision” AND “Attendance Monitoring System” AND (“Face Recognition” OR “Face analysis” OR “Facial biometrics”) AND (“Liveness Detection” OR “Presentation Attack Detection” OR anti-spoofing)	0	0
	Total	378	81

which includes coverage of the physical sciences, biological sciences, health sciences, social sciences, and humanities. WoS indexes journal articles, books, book chapters, conference abstracts, and reference works from different publishers (e.g., Royal Society, Springer Nature, Wiley, and IEEE) [Clarivate Analytics, 2025]. Both databases provide rich metadata and are recognized as key sources of interdisciplinary data in diverse research areas [Mongeon and Paul-Hus, 2016].

The collection of articles from the scientific databases cited was carried out using the search expressions described in **Table 1**, which were designed to ensure both the scope and relevance of the study within the research area. The search terms were applied to the titles, abstracts, and keywords of the articles. Only articles written in English or Portuguese and published in conferences, scientific journals, or magazines were considered for analysis. Additionally, all articles available in the databases up to 2024 were included.

To collect the files, access to the content contracted and made available by the institution was obtained through the portal of the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES) via the Federated Academic Community (CAFe). After network authentication, it was possible to access the Scopus and WoS scientific databases, perform searches using specific queries, export the metadata of the retrieved articles into appropriate file formats, and subsequently carry out data processing and analysis using the R programming language.

3.2 Computational Bibliometric Analysis with R Tools

The collected articles served as research objects for the bibliometric analysis. The R programming language was used in this study due to its open-source nature, adherence to both object-oriented and functional programming paradigms, support for advanced statistical analysis, and its large and active user community.

The Bibliometrix package was employed to extract key indicators and perform the bibliometric analysis, providing a reproducible, structured workflow for scientometric studies [Aria and Cuccurullo, 2017]. First, bibliographic records retrieved from different databases were imported into R using the convert2df() function, which standardizes heterogeneous metadata into a unified data structure.

Then, the datasets were merged using the mergeDbSources() function. Duplicate records were automatically

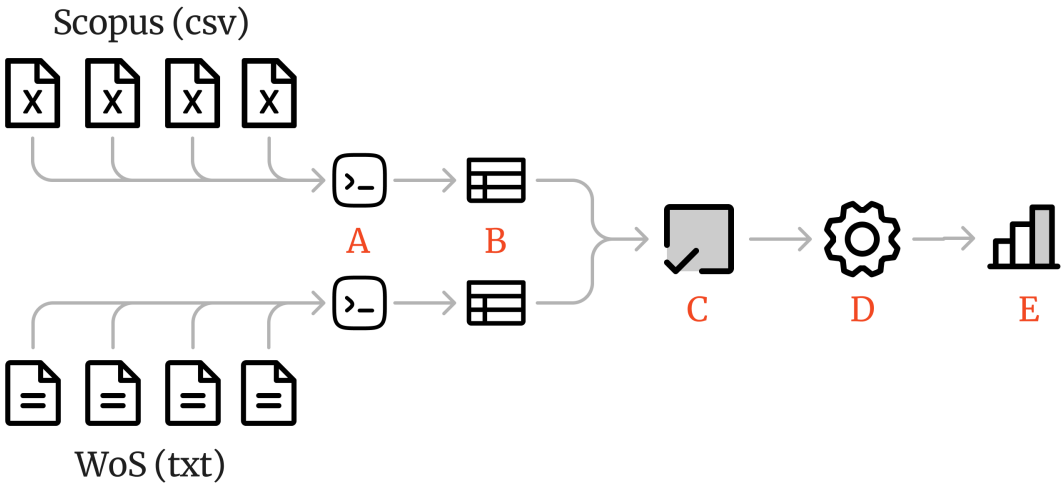

Figure 1. Flow of data processing for articles retrieved from scientific databases: (A) files exported from the databases are converted into an appropriate format using the R programming language; in (B) duplicate records within each database are identified, merged, and removed; (C) data from Scopus and Web of Science (WoS) are combined into a single dataset, ensuring that all remaining duplicates are eliminated; (D) bibliometric indicators are analyzed and extracted from the consolidated dataset; finally, in (E) step the extracted indicators are visualized through charts or summary tables.

identified and removed (remove.duplicates = TRUE). The deduplication process prioritizes the exact matching of Digital Object Identifiers (DOIs). When DOIs are unavailable, duplicates are identified based on matching document titles and publication years. This procedure ensures consistency and reproducibility in the integration of data from multiple sources.

4 Results

Table 1 presents the identity information, search expression and number of articles found by expression in the scientific databases Scopus and Web of Science. To ensure a transparent and reproducible search strategy, a sequential set of seven search queries was designed and applied, progressing from broad to more refined scopes. The initial queries focused on identifying general studies involving computer vision in the context of attendance.

Furthermore, subsequent queries gradually incorporated specific system terms such as ”Attendance Monitoring System” and technical aspects related to facial biometrics, including ”Face Recognition,” ”Face Analysis,” and ”Facial Biometrics.” Finally, the queries integrated terms related to biometric security, such as ”Presentation Attack Detection”, ”Liveness Detection,” and ”Anti-Spoofing.” This stepwise refinement allowed for a systematic narrowing of results—from general applications to more specialised studies that intersect computer vision, facial recognition, and biometric authentication within attendance systems.

To mitigate potential bias in the search process, we expanded the query terms to include synonymous expressions such as ’spoof detection’ and ’biometric fraud’. However, these additional queries did not retrieve any new relevant studies beyond those already identified. This suggests that research explicitly addressing security mechanisms, such as presentation attack detection and liveness detection, is limited within the context of attendance systems.

The final result of the searches in the Scopus database yielded a total of 378 papers, which were exported in Comma-Separated Values (CSV) format. The searches conducted in the Web of Science (WoS) resulted in 81 articles, which were exported in plain text format. Subsequently, bibliometric indicators were extracted following the methodology proposed by Aria and Cuccurullo [Aria and Cuccurullo, 2017].

Figure 1 illustrates the flow of the information processing used to extract bibliometrics indicators: in step (A), the files are opened and the information is converted into data frame type in the R language, while preserving the raw data; step (B) involves combining the data and removing duplicate records from the files, resulting in two variables: one containing Scopus data and the other containing WoS data; in step (C), these two variables are merged into a single dataset containing all information, now free of duplicates; step (D) refers to the analysis and extraction of bibliometric indicators (e.g., most productive authors, most cited articles, most frequently used keywords, and co-authorship correlations) from the consolidated dataset; finally, step (E) represents the visualization of the extracted indicators through charts or summary tables.

In **Figure 1**, step C, the two variables were merged, resulting in 378 records from Scopus and 81 from WoS. Of the total 459 records, 167 duplicates were identified. After removing duplicates, a consolidated dataset of 292 unique

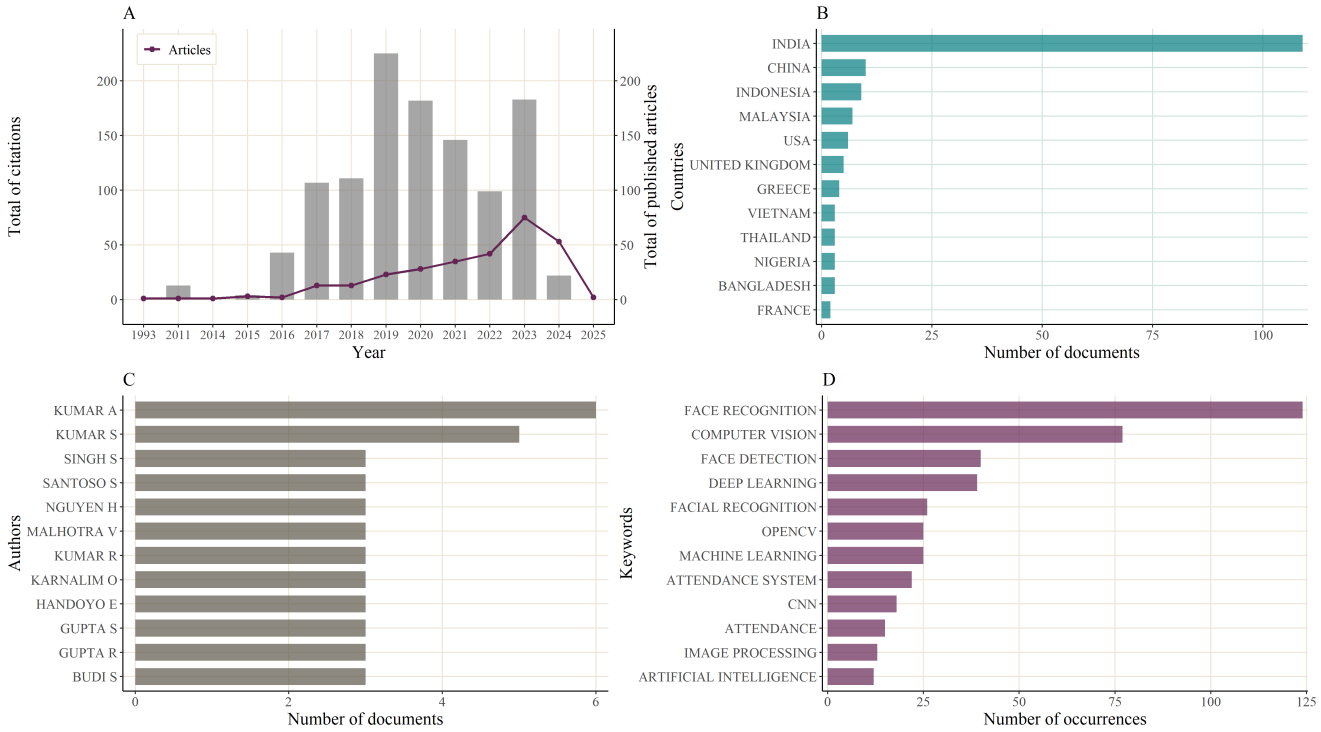

Figure 2. Fundamental bibliometric indicators. (A) shows the total number of citations per year from 2011 to 2024, along with the number of articles published per year; (B) highlights the 12 countries with the highest publication output in the field; (C) lists the 12 most prolific authors; and (D) presents the frequency of the 12 most frequently used keywords in the articles.

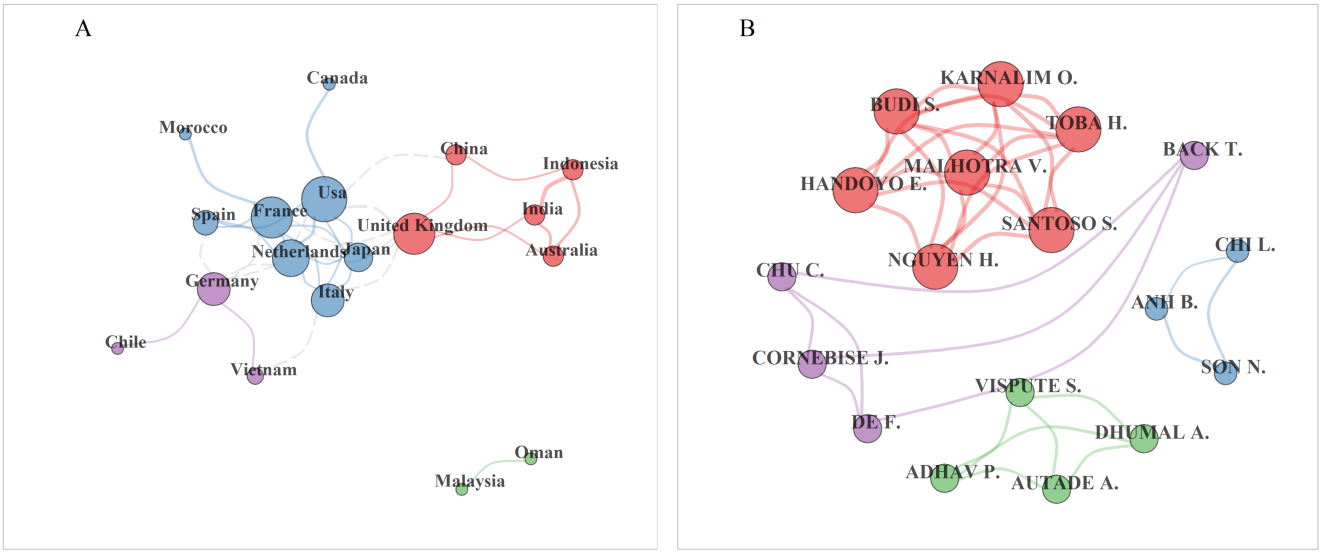

Figure 3. Indicators of (A) collaboration among countries and (B) authors' collaboration.

records remained.

Bibliometric indicators were extracted from the consolidated records. **Figure 2** presents these indicators as follows: (A) displays the analysis of the total number of citations in the series up to 2024, with the first citations recorded in 2011 and a peak observed in 2019; the articles (represented by a continuous line chart) were first published in 1993, followed by a hiatus, and resumed in 2011, reaching a total of 75 publications by 2023. **Figure 2** (B) highlights the 12 most productive countries in the research area, with India standing out, contributing approximately 109 published works, followed by China with 10 publications. The (C) label in **Figure 2** shows the 12 most productive authors, highlighting Kumar A. and Kumar S. Lastly, (D) illustrates the most frequently occurring keywords, with "face recognition" appearing in 123 articles and "computer vision" in 77 occurrences. The predominance of these terms suggests that attendance monitoring research remains strongly centered on identity recognition tasks, whereas topics related to biometric trustworthiness and attack resilience receive considerably less attention.

Other important indicators include collaboration between countries and collaboration between authors, as they can provide insights into the dynamics of scientific production and its global relevance. In this context, **Figure 3** represents the collaboration network based on the 30 most relevant samples. The (A) label shows the formation of four distinct groups where collaborations occur, highlighting both the most interactive countries (e.g., United Kingdom, USA, France, Netherlands) and the most isolated ones (e.g., Chile, Malaysia). The analysis reveals distinct regional clusters with differentiated research focuses and methodological preferences. Cluster 1 (red), formed by the United Kingdom, Australia, India, Indonesia, and China, was predominantly driven by India, whose publications concentrated on face recognition attendance and security. This group employed a set of well-established techniques and tools, such as Convolu-

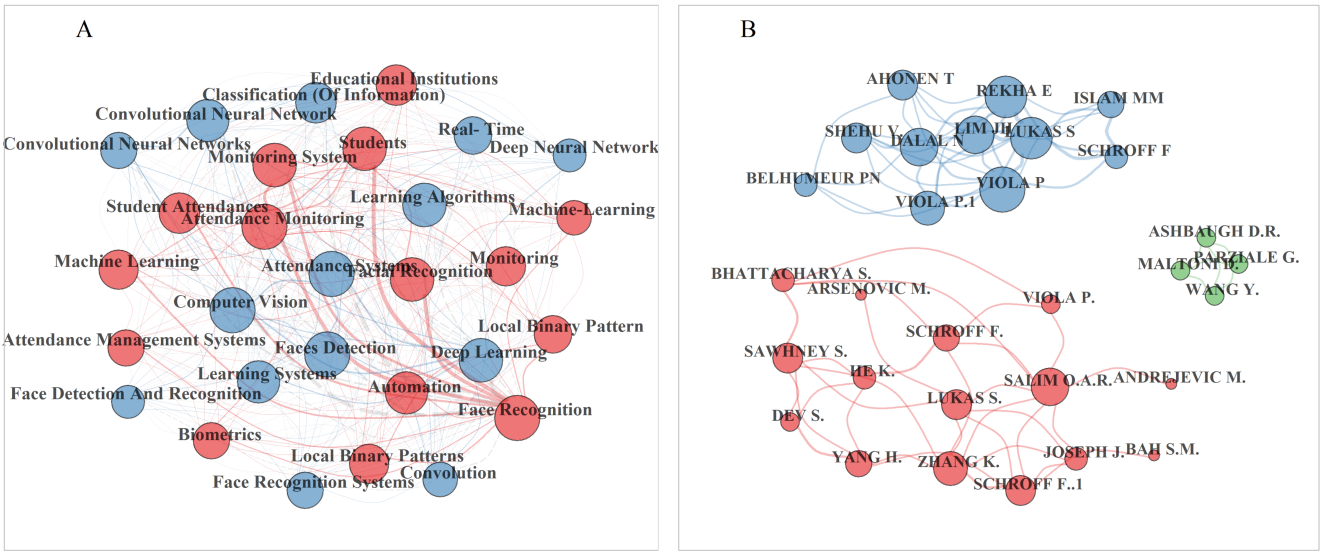

Figure 4. Bibliometric indicators from the 30 most relevant articles regarding keyword co-occurrence in (A), and authors' co-citation relationships in (B).

tional Neural Networks (CNN), Haar Cascade, Local Binary Patterns Histograms (LBPH), OpenCV, Python, and Raspberry Pi. In contrast, cluster 2 (blue) led by the United States, together with France, the Netherlands, Italy, Japan, Spain, Canada, and Morocco, directed its efforts mainly toward classroom attendance systems and broader security applications. Their methodological choices emphasised CNN, Yolov5, Android-based implementations, Closed-Circuit Television (CCTV), and Tkinter, suggesting a tendency toward real-time and mobile-oriented solutions. A third cluster (purple), comprising Germany, Vietnam, and Chile, concentrated on surveillance and classroom monitoring. Here, Vietnam led in terms of publication volume, whereas Germany stood out through stronger international collaborations. The group's methodological emphasis on Generative Adversarial Networks (GAN), CCTV, Firebase, Presentation□attack detection, and fraud/tampering reflects an orientation toward more innovative and data-driven approaches. Finally, cluster 4 (green), spearheaded by Malaysia, maintained a strong focus on security surveillance, relying primarily on Support Vector Machine (SVM), CNN, Raspberry Pi, and Python, which indicates a preference for lightweight and embedded system implementations.

On the other hand, **Figure 3** (B) illustrates the groups formed by authors who collaborate the most frequently, contributing to the identification of research cooperation patterns, influential researchers, and interdisciplinarity. The clusters show a strong cooperation among authors. Cluster 1 (red), comprising Budi S., Handoyo E., Karnalim O., Malhotra V., Nguyen H., Santoso S., and Toba H., focused primarily on Computer Vision and face detection applied to classroom attendance systems. In parallel, cluster 2 (purple) formed by Back T., Chu C., Cornebise J., and De Fauw J., established a collaboration in Computer Vision with a specific emphasis on ophthalmology, employing machine learning approaches. Cluster 3 (blue) was formed by Son N., Chi L., and Anh B., who directed its research toward attendance and education, while also integrating methods from data mining and deep learning. Similarly, the group 4 (green) of Vispute S., Adhav P., Autade A., and Dhumal A. concentrated on attendance systems, with particular attention to face recognition and deep learning techniques. Taken together, these clusters highlight a strong pattern of intra-cluster collaboration, while simultaneously revealing a limited degree of external cooperation across groups, suggesting a research landscape that is thematically cohesive but structurally fragmented.

In the charts shown in **Figure 3** and **Figure 4**, it is important to note that the largest circles represent the most connected or most cited elements, while the smallest circles indicate lower levels of connection. The solid lines indicate direct collaboration links, with thinner lines representing less frequent interactions and thicker lines indicating authors who frequently publish together. Finally, dotted lines may represent occasional collaborations or rarely occurring references. Another important issue is that the arrangement of the clusters is made automatic by the *networkPlot* function from the Bibliometrix package; likewise, the label position of each node is centred on it.

The analysis of keyword co-occurrence helps identify frequently used terms in publications, detect trends, and uncover potential research gaps or opportunities [Echchakoui, 2020], as shown in **Figure 4** (A). Beyond recurring keywords such as face recognition, facial recognition, attendance monitoring, and students, the studies also highlighted terms like deep learning, computer vision, face detection, learning systems, convolutional neural networks, and attendance systems. Variations in spelling (e.g., machine-learning vs. machine learning) reflect differences in how authors report these concepts. Overall, the map reveals two main thematic clusters. Cluster 1 (red) emphasises applications of facial recognition for attendance control, with keywords including face recognition, machine learning, and attendance monitoring, often linked to automation and fraud prevention in educational and corporate contexts. Cluster 2 (blue) concentrates on the foundations of computer vision and deep learning, highlighting terms such as computer vision, deep learning, and convolutional neural networks, and encompassing approaches integrating IoT and multi-camera architectures. Both clusters recurrently reference seminal authors such as Viola, Schroff, and Deng, evidencing the influence of facial detection algorithms and CNN-based models.

The co-citation network illustrated in **Figure 4** (B) provides insights into frequently co-cited articles across different areas, as well as the identification of the most influential works based on their collaborative connections [Echchakoui, 2020], e.g., Lukas S., Viola P., Lim J. H., Islam M., Rekha E., and Dalal N. The results show that the co-citation and reference analysis identified three distinct thematic clusters. Cluster 1 (red) focuses on facial recognition using deep learning, with key authors such as Viola, Schroff, and Bhattacharya, linked to applied attendance-control solutions. Cluster 2 (blue) is dominated by classical real-time face detection works (Viola & Jones) and traditional descriptors, with strong contributions from Ahonen and Dalal, reflecting hybrid approaches between conventional methods and recognition. Finally, Cluster 3 (green) encompasses research on fingerprint and 3D biometric systems, featuring authors like Wang, Maltoni, and Parziale, indicating a specialised core outside the facial domain.

On the other hand, **Table 2** highlights the 20 papers with the highest number of individual citations, illustrating the overall influence and recognition of their respective areas within the field of study [Echchakoui, 2020]. In this sense, the highlighted works can directly contribute to understanding the foundations, main findings, and methods used in computer vision, particularly in relation to automated attendance monitoring and recording.

Table 2 presents the most cited articles within the scope of the search, organized by authors' names, year of publication, total number of citations received during the research period, and the Digital Object Identifier [International DOI Foundation, 2025], which provides direct access to each article in its respective repository.

5 Discussion

This study provides a comprehensive overview of the state of the art in the field of computer vision applied to attendance recognition, based on the bibliometric findings. The analysis enabled both a quantitative and qualitative mapping of the sci-

entific production, allowing for the identification of the most influential authors, the most frequently used keywords, and prevailing patterns of collaboration. Furthermore, the study highlights key conceptual contributions that shape current research directions and provide insights into the development of this interdisciplinary field.

The results also highlight a gap in the literature concerning bibliometric analyses focused on particular application contexts within computer vision. While previous studies have generally addressed broad technological developments, they have rarely examined specific domains such as facial recognition for academic attendance. By focusing on this context and integrating temporal trends, collaboration networks and thematic structures, this study helps bridge the gap between general bibliometric overviews and application-oriented insights.

In contrast to earlier bibliometric studies that explored computer vision as a comprehensive technological field, such as the work of Chen and Deng [2020] on convolutional neural networks in computer vision, the present study focuses on a specific application domain. This narrower perspective facilitates the identification of application-driven research

Table 2. Most cited articles within the search scope.

Nº	Author	Year	Title	Source	DOI	Total citations
1	HARIKRISHNAN J; SUDARSAN A; SADASHIV A; REMYA A A	2019	Vision-Face Recognition Attendance Monitoring System for Surveillance using Deep Learning Technology and Computer Vision	IEEE	10.1109/ViTECoN.2019.8899418	71
2	WINARNO E; AMIN I; FEBRUARIYANTI H; ADI P; HADIKURNIAWATI W; ANWAR M	2019	Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera	IEEE	10.1109/ISRITI48646.2019.9034596	45
3	VARADHARAJAN E; DHARANI R; JEEVITHA S; KAVINMATHI B; HEMALATHA S	2017	Automatic attendance management system using face detection	IEEE	10.1109/GET.2016.7916753	42
4	TYNCHENKO V; STASHKEVICH A; MUZYKA P; LEONTIEVA A; DEGTYAREVA K	2023	Effective energy management tools: inventory management and monitoring of energy consumption by personnel	EDP Sciences	10.1051/e3sconf/202345801011	40
5	DE F J; KEANE P; TOMASEV N; VISENTIN D; VAN D D G; JOHNSON M; HUGHES C; CHU C; LEDSAM J; BACK T; PETO T; REES G; MONTGOMERY H; RAINE R; RONNEBERGER O; CORNEBISE J	2016	Automated analysis of retinal imaging using machine learning techniques for computer vision	F1000 Research	10.12688/f1000research.8996.2	33
6	GUPTA N; SHARMA P; DEEP V; SHUKLA V	2020	Automated Attendance System Using OpenCV	IEEE	10.1109/ICRITO48877.2020.9197936	30
7	JONES F; ALLEN C; ARTETA C; ARTHUR J; BLACK C; EMMERSON L; FREEMAN R; HINES G; LINTOTT C; MACHÁCKOVÁ Z; MILLER G; SIMPSON R; SOUTHWELL C; TORSEY H; ZISSERMAN A; HART T	2018	Time-lapse imagery and volunteer classifications from the Zooniverse Penguin Watch project	Nature Sci Data	10.1038/sdata.2018.124	29
8	KUMAR M; RAMESH G; PAREEK P; DEEPAK H; BABU J	2023	Robotic Attendance Scheme in the Classroom Using Artificial Intelligence and Internet of Things	IEEE	10.1109/ICAISC58445.2023.10200650	26
9	DANG T	2023	Smart Attendance System based on improved Facial Recognition	Journal of Robotics and Control (JRC)	10.18196/jrc.v4i1.16808	26
10	YUSOF Y; NASIR M; OTHMAN K; SULIMAN S; SHAHBUDIN S; MOHAMAD R	2018	Real-Time Internet Based Attendance Using Face Recognition System	International Journal of Engineering and Technology	10.14419/ijet.v7i3.15.17524	22
11	SRIVASTAVA M; KUMAR A; DIXIT A; KUMAR A	2020	Real Time Attendance System Using Face Recognition Technique	IEEE	10.1109/PARC49193.2020.236628	21
12	REKHA E; RAMAPRASAD P	2017	An efficient automated attendance management system based on Eigen Face recognition	IEEE	10.1109/CONFLUENCE.2017.7943223	20
13	LIM J; TEH E; GEH M; LIM C	2017	Automated classroom monitoring with connected visioning system	IEEE	10.1109/APSIPA.2017.8282063	20
14	AGARWAL P; SHUKLA V; GUPTA R; JHAMB S	2019	Attendance Monitoring System Through RFID, Face detection and Ethernet Network: A Conceptual Framework for Sustainable Campus	IEEE	10.1109/ISCON47742.2019.9036209	15
15	BHATTACHARYA S; NAINALA G; DAS P; ROUTRAY A	2018	Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environment	IEEE	10.1109/ICALT.2018.00090	14
16	ALGHAMDI J; ALHARTHI R; ALGHAMDI R; ALSUBAIE W; ALSUBAIE R; ALQAHTANI D; RAMADAN R; ALQARNI L; ALSHAMMARI R	2020	A Survey On Face Recognition Algorithms	IEEE	10.1109/ICCAIS48893.2020.9096726	14
17	SHENVI D; SHET K	2021	CNN Based COVID-19 Prevention System	IEEE	10.1109/ICAIS50930.2021.9396004	14
18	CLARKE S; PARMESAR K; SALEEM M; RAMANAN A	2022	Future of machine learning in paediatrics	BMJ Journals	10.1136/archdischild-2020-321023	13
19	AKAY E; CANBEK K; ONIZ Y	2020	Automated Student Attendance System Using Face Recognition	IEEE	10.1109/ISMSIT50672.2020.9255052	13
20	AMBRE S; MASUREKAR M; GAIKWAD S	2020	Face Recognition Using Raspberry PI	Springer Nature	10.1007/978-3-030-38445-6_1	13

trends, collaboration patterns, and security-related gaps, particularly the limited attention given to presentation attack detection, liveness detection, and anti-spoofing mechanisms. These gaps are difficult to observe in large-scale analyses covering the entire computer vision landscape. Therefore, the contribution of this study lies not in proposing a new bibliometric methodology but in providing a domain-oriented knowledge structure that complements broader bibliometric investigations and supports future research in secure attendance monitoring systems.

The relatively small corpus identified in this study (292 unique documents) also contrasts with the substantially larger datasets commonly reported in broad computer vision bibliometric investigations. This difference reinforces the niche and application-oriented nature of attendance monitoring research, while simultaneously highlighting the value of focused analyses capable of uncovering thematic gaps and research opportunities that may be diluted in larger-scale studies.

In this context, the searches corresponding to IDs 5, 6, and 7 in **Table 1** returned either very few or no results. This scarcity, particularly when incorporating terms such as "liveness detection", "presentation attack detection", and "anti-spoofing", indicates that the existing literature on automated attendance systems seldom addresses the critical issue of presentation attacks. Rather than signalling an unexplored gap in the field, these results highlight that studies on attendance monitoring have largely prioritised face recognition and biometric identification, while giving limited attention to mechanisms that ensure the authenticity of the detected face.

After completing the searches, data export from the platforms used, i.e., Scopus and Web of Science (WoS), followed the guidelines recommended by [Aria and Cuccurullo, 2017]. However, some initial issues were encountered during the merging of databases and the extraction of bibliometric indicators in BibText format for both datasets. These included cases where certain files could not be opened in the RStudio IDE, and others in which information from multiple columns was incorrectly merged into a single column during the conversion to the dataframe format. To resolve these problems, the CSV format was used for Scopus and the TXT format for WoS.

Examining the general metadata of the articles revealed some critical gaps: 20 articles had no keywords, 21 had no DOI information, and 96 had no corresponding author details. Such inconsistencies could affect bibliometric analyses, particularly those involving keyword frequency and citation tracking. To mitigate this issue, missing keywords and DOIs were manually retrieved using the titles of the articles and the authors' information, ensuring that the dataset was complete and consistent for subsequent analyses. Only two papers with low citations (two citations) had no DOIs found. As the corresponding author information was not used in the bibliometric procedures, its absence did not affect the results. These findings emphasise the importance of data curation in bibliometric studies and highlight the need for improved metadata standardisation in scientific publishing.

When considering the databases used, it is important to note that, while platforms such as IEEE Xplore and the ACM Digital Library are highly relevant to computer science and engineering, they are not widely used in large-scale bibliometric studies. This is primarily due to constraints related to metadata standardisation, particularly with regard to citation structures and reference formatting. These constraints may hinder interoperability with bibliometric tools such as the R package Bibliometrix. By contrast, Web of Science and Scopus provide highly structured, curated and standardised datasets, which explains their widespread adoption in bibliometric research. Furthermore, both databases index content from major publishers and digital libraries, including IEEE and ACM, thereby allowing indirect coverage of a substantial portion of the relevant literature. Our findings further support this (**Table 2**), showing that a significant proportion of the most cited publications originate from IEEE venues, indicating that core contributions in the field have been effectively captured. However, the exclusion of direct queries to specialised databases may introduce bias, particularly regarding conference proceedings and emerging topics that may not yet be fully indexed. As Mongeon and Paul-Hus [2016] highlights, while WoS and Scopus offer robustness and comparability, no single database is comprehensive, which reinforces the importance of interpreting bibliometric results in the context of database selection.

Figure 2 (A), which uses the consolidated database and extracted indicators, shows a prolonged gap in publications in the study area between 1993 and 2011. Since 2012, there has been consistent growth in the number of publications, peaking at 75 articles in 2023 before declining to 53 in 2024. Citations across various knowledge domains remained at or above 100 from 2017 to 2023, but dropped significantly in 2024. To provide further context for these findings, evidence from the Stanford AI Index reports (2017–2025) [Stanford Institute for Human-Centered Artificial Intelligence (HAI), 2025] suggests that artificial intelligence research has grown steadily and increasingly since the mid-2010s, largely due to advances in machine learning and deep learning. Within this broader trend, computer vision has remained a central and rapidly evolving subfield, strongly influenced by dissemination through conferences and the widespread use of preprint repositories. However, these characteristics may lead to discrepancies in database coverage over time, particularly in recent years, as not all contributions are immediately indexed in major bibliographic databases such as Scopus and Web of Science. Furthermore, the dynamic evolution of terminology and research focus within the field may impact the effectiveness of search strategies over time. Therefore, the apparent decrease observed in 2024 is more plausibly explained by a combination of indexing delays, publication practices in computer vision and sensitivity of search queries, rather than a genuine reduction in scientific activity.

Figure 2 (B) and (C) further reveal that Indian researchers have played a prominent role in this field. Exploring the work of these authors can provide valuable insights and contribute to a deeper understanding of the topic. Although journals from Western countries dominate indexing in databases like WoS and Scopus [Mongeon and Paul-Hus, 2016], India has emerged as a remarkable and distinctive contributor, as illustrated in **Figure 2** (D). The study by Mongeon and Paul-Hus [2016] presents the ranking of indexed articles by country, in which, despite India occupying the 11th position in WoS and the 6th in Scopus—behind the United States, China, and the

United Kingdom—the country surpasses others in the number of publications specifically in this field. This prominence may be partly associated with national initiatives preceding the IndiaAI Mission—such as the 2018 National Strategy for Artificial Intelligence, the 2019 AIRAWAT cloud-computing proposal, and the 2021 Responsible AI Principles—which expanded research infrastructure and fostered applied innovation, likely driving the country's substantial research output in this domain [Kathuria *et al*., 2024].

Additionally, India's prominence in publication output is partially explained by structural and policy-related factors, particularly its large-scale investment in digital identity and biometric systems through the Aadhaar program. As Rao and Nair [2019] discuss, Aadhaar is the world's largest biometric identification system, covering over 1.2 billion individuals and providing a centralized infrastructure for authentication across public and private services. This nationwide platform has fostered research and innovation in identity verification and attendance monitoring systems. The scale of Aadhaar, coupled with government-driven digital transformation and real-world challenges such as fraud prevention, population-scale identification, and administrative efficiency, has established India as a leading research hub in this field.

Finally, **Figure 2** (D) presents the most frequently cited keywords. These terms not only enhance the precision and scope of literature searches but also highlight potentially unfamiliar concepts or emerging techniques worth further investigation—such as CNN, Deep Learning, and OpenCV.

On the other hand, the bibliometric analysis shown in **Figure 3** (A) reveals that international collaboration plays a predominant role in the field of computer vision applied to attendance monitoring. Strong cooperative ties were observed among countries such as the United States, France, Germany, the Netherlands, Spain, Italy, and Japan, suggesting a continuous exchange of knowledge and technological advancements in the area. The four clusters reveal complementary research directions: Cluster 1 (red - India, UK, China) drives large-scale deep learning attendance systems, Cluster 2 (blue - USA, France, the Netherlands) advances crowd analytics for real□time monitoring, Cluster 3 (purple - Germany, Vietnam, Chile) focuses on security and anti□spoofing strategies, and Cluster 4 (green - Malaysia, Oman) maintains classical methods for low□resource contexts. Despite shared foundations in computer vision and face recognition, integration across clusters remains limited. Future research may benefit from prioritizing studies from Clusters 1 and 2, while also incorporating findings from Cluster 3 to support the development of secure and robust anti-fraud attendance validation systems.

Regarding authorship, **Figure 3** (B) highlights key collaboration networks among researchers. Notable examples include the group formed by Toba H., Santoso S., Budi S., Malhotra V., Handoyo E., Nguyen H., and Karnalim O., as well as the network involving Vispute S., Adhav P., Dhumal A., and Autade A. These clusters illustrate strong interaction patterns and may indicate specialisation in specific subtopics within the domain. The cluster analysis highlights three groups (1, 3, and 4) directly focused on student attendance validation, emphasising attendance, computer vision, and biometrics, with key contributions from authors such as Budi S, Son N, and Vispute S. In contrast, Cluster 2 (purple) is centred on medical applications in ophthalmology and, despite its use of computer vision, has limited applicability to the educational context. Therefore, Clusters 1, 3, and 4 represent the most relevant foundation for advancing attendance validation systems, aligning more directly with the needs of this project.

The keyword co-occurrence analysis (**Figure 4** (A)) reveals that the term "Face Recognition" occupies a central position, being strongly interconnected with related areas such as computer vision, deep learning, real-time, and facial recognition. This highlights a prominent research trend, reflecting both the technological convergence and the clear emphasis on facial recognition methods. The literature on attendance control through computer vision appears to evolve along two complementary paths: one focused on the practical development of robust and cost-effective systems, and another centred on methodological advances in deep learning and network architectures. Such a duality suggests that, while applied solutions have achieved notable levels of accuracy, challenges related to robustness under adverse conditions, privacy, and algorithmic bias remain relevant. In addition, the recurrence of seminal authors suggests the consolidation of established techniques, whereas the incorporation of IoT and Edge Computing may signal a trend toward decentralisation and scalability in these systems.

In terms of author co-citation, **Figure 4** (B) shows notable interdependence among the works of Lukas S., Lim J. H., and Rekha E., as well as among Islam M.M., Chintalapati S., and Schroff F. These co-citation patterns suggest that their contributions have significantly influenced the theoretical and practical development of the field. The analysis also points to a segmentation between facial and non-facial approaches: Clusters 1 (red) and 2 (blue) are primarily associated with facial recognition — the former oriented toward deep learning models and the latter toward classical techniques — whereas Cluster 3 (green) focuses on fingerprint biometrics. This distribution may indicate that, while traditional methods continue to support low-cost, low-latency applications, recent developments tend to converge on deep architectures for enhanced robustness and scalability. Moreover, the limited presence of bridging authors across clusters suggests a relative lack of integration between research streams, which could open opportunities for multimodal fusion and bibliographic normalisation to mitigate fragmentation.

The network visualizations (**Figure 3** and **4**) were generated using the Bibliometrix package with standard parameters to ensure consistency and reproducibility. Although alternative tools and parameter tuning (e.g., VOSviewer or CiteSpace) may produce different clustering structures and graphical layouts, the results obtained in this study were consistent with the underlying bibliometric relationships, such as co-occurrence frequencies and collaboration patterns. While a formal sensitivity analysis of visualization parameters was not conducted, as it falls beyond the scope of this work, it is recommended for future methodological investigations.

In line with these findings, **Table 2** presents the articles most frequently cited within the scope of the research area proposal by this work, providing a structured reference for essential reading and supporting further exploration of the field.

From a practical perspective, it is important to highlight that writing scripts in the R language may pose challenges for users with limited programming experience. However, the "Bibliometrix" package includes a feature called "biblioshiny", which enables the extraction of indicators and standard visualisations through a user-friendly interface. This functionality eliminates the need for programming skills, requiring only the upload of the data file to be analysed. This feature enhances the accessibility of bibliometric analysis and reinforces the applicability of this methodology across diverse research profiles and academic backgrounds.

6 Conclusion

As the volume of scientific publications grows and research becomes increasingly fragmented, scientific mapping emerges as an essential practice. In this context, the use of the Bibliometrix package within the R programming environment offers a fast and efficient means of generating relevant bibliometric indicators. It also enables the visualisation of data through default or customised charts, and the creation of tables containing essential metadata.

This study analysed the metadata of articles retrieved from the Scopus and Web of Science databases, considering all publications available up to 2024. The analysis revealed key indicators, such as the most frequently used keywords and the most influential authors. It also identified co-citation and co-occurrence patterns and a set of the most cited papers in the field. This provides a curated dataset for future studies and contributes to a broader understanding of the research landscape in computer vision applied to attendance recognition.

Future studies could extend the analysis by incorporating additional databases (e.g., IEEE Xplore and ScienceDirect), adapting their metadata formats to integrate with Bibliometrix, and refining or expanding the search expressions to enhance the analysis. A central finding of this study is the limited presence of research addressing presentation attack detection (PAD), liveness detection, and anti-spoofing mechanisms within attendance monitoring systems. While the prevailing literature focuses on facial recognition, there is a notable absence of security-oriented validation techniques. This discrepancy indicates that contemporary attendance monitoring solutions predominantly prioritize identification performance over biometric trustworthiness. Consequently, a significant research opportunity emerges at the intersection of computer vision, biometric security, and educational technology, particularly in the development of attendance validation systems that are both accurate and resilient against fraudulent attempts.

Declarations

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Authors' Contributions

JF contributed to the conceptualization, investigation, data collection, and formal analysis. JM and FO were responsible for data curation, validation, and visualization. All authors contributed equally to the analysis and writing of the manuscript. All authors have read and approved the final version of the manuscript.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets and R script used to perform the bibliometric analyses reported in this study are publicly available at: `https://github.com/jpfolador/cv_attendance_bibliometric_analysis` The repository contains the metadata used in the study, the duplicate-removal workflow, and the code required to reproduce the analyses and visualizations presented in this manuscript.

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