Intelligent Systems and Novel Coronavirus (COVID-19): A Bibliometric Analysis

Mostafa Al-Emran and Ibrahim Arpaci

Abstract In late 2019, a novel coronavirus (COVID-19) was determined in Wuhan, China. The newly emerged epidemic has spread rapidly, with an increasing number of confirmed cases worldwide. While intelligent systems have been immensely tested and implemented across a wide range of health problems, the emergence of COVID-19 requires the need to use these systems in detecting, identifying, and preventing its outbreak. By using the bibliometric analysis approach, this research aims to provide a holistic view on the state-of-the-art research concerning intelligent systems and COVID-19 by analyzing the most used keywords, most cited articles and journals, most productive countries and institutions, most cited authors, and the role of intelligent systems during the COVID-19 outbreak. The results indicated that the existing research studies on intelligent systems during the COVID-19 outbreak have mainly concentrated on the use of machine learning algorithms in identifying and diagnosing the potential COVID-19 cases and predicting its extinction time. However, the number of articles published on the role of intelligent systems during COVID-19 pandemic is relatively few, suggesting that research in this field is still in its early stages, and more intensive research is required.

Keywords Intelligent systems · Artificial intelligence · Machine learning · Novel coronavirus · COVID-19

M. Al-Emran
Faculty of Engineering & IT, The British University in Dubai, Dubai, UAE
e-mail: mustafa.n.alemran@gmail.com

I. Arpaci
Department of Computer Education and Instructional Technology, Tokat Gaziosmanpasa University, Tokat, Turkey
e-mail: ibrahim.arpaci@gop.edu.tr

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1 Introduction

In December 2019, a novel coronavirus (COVID-19) was determined in Wuhan, China [1]. It is imperative to report that the number of confirmed cases of COVID-19 has exceeded those of severe acute respiratory syndrome (SARS) [2]. As of today (June 11, 2020), the number of confirmed cases becomes 7,404,092, and more than 416,598 death cases were recorded worldwide [3]. Both SARS and COVID-19 spread quickly through countries, infect humans and animals, and employ the same mechanism to enter and infect the body cell [2].

While intelligent systems, including artificial intelligence (AI) applications and machine learning algorithms, have been vastly tested and employed across various sectors in general [4–7] and the healthcare sector in specific [8], the newly emerged epidemic requires the need to use these systems in detecting, identifying, and preventing its outbreaks. It is argued that AI techniques would cause a paradigm shift in the healthcare sector, and this might assist the employment of these techniques to the existing COVID-19 outbreaks [2]. While the involvement of public health officials and specialist epidemiologists cannot be substituted, AI techniques can serve to manipulate the rapidly emerging data to support the public health experts in complex decision-making [9]. Besides, AI techniques might help in developing more precise symptom screening to predict the probability of COVID-19 infection [9].

In light of these arguments, the purpose of this research is to provide a holistic view on the state-of-the-art research concerning intelligent systems and novel coronavirus (COVID-19) by analyzing the most used keywords, most cited articles and journals, most productive countries and institutions, most cited authors, and the role of intelligent systems during the COVID-19 outbreaks through the use of a bibliometric analysis approach.

2 Method

This research follows a bibliometric analysis approach for analyzing COVID-19 related literature. Bibliometric analysis is a statistical approach used to determine the intellectual structure and improvement of a scientific domain [10]. The bibliometric analysis is usually used to determine the development of publications over time, the most dominant scholars, the most effective studies, and the subjects related to a particular research domain [11]. To draw a comprehensive picture of the COVID-19 and the intelligent systems/techniques used during its outbreak, the bibliometric analysis has been used in this research through the VOSviewer tool. To analyze the extant literature on COVID-19, the relevant articles were collected from the Web of Science database on 16th March 2020.
3 Results and Discussion

3.1 Most Used Keywords

The bibliometric mapping analysis suggested that the most used author keywords in the analyzed studies were “2019-ncov” (f = 9), “coronavirus” (f = 8), and “Wuhan” (f = 3). Figure 1 illustrates the most used author keywords in the analyzed studies. Further, the bibliometric analysis with full counting indicated that “disease” (f = 11), “analysis” (f = 9), “affected bone” (f = 6), “range” (f = 5), “oral cavity” (f = 5), and “ace2” (f = 5) were the most used words in the abstracts of the analyzed studies. Figure 2 illustrates the most used words in the abstracts. These results would assist scholars in finding a sufficient number of COVID-19 articles by referring to the aforementioned keywords rather than simply searching for “COVID-19” or “novel coronavirus”.

Fig. 1 Most used author keywords
3.2 Most Cited Articles and Journals

As shown in Fig. 3, the bibliometric mapping analysis results showed that studies conducted by Hui et al. [12] (11 citations), Corman et al. [13] (9 citations), Ji et al. [14] (9 citations), Wang et al. [15] (6 citations), and The Lancet [16] (4 citations) were the most cited articles. The increasing number of citations for these articles stems from the fact in which these articles have provided a comprehensive understanding of the COVID-19 outbreaks at the time where most researchers are in need of this information.

Further, the results revealed that “The Lancet” (12 articles, 6 citations), “Eurosurveillance” (10 articles, 11 citations), and “Journal of Medical Virology” (8 articles, 14 citations) were the most cited journals. The identification of the most productive journals would assist scholars in finding COVID-19 related articles or publishing their prospective research studies.

3.3 Most Productive Countries and Institutions

The bibliometric mapping analysis results also indicated that China (25 articles, 42 citations), the USA (14 articles, 15 citations), England (9 articles, 20 citations), Germany (7 articles, 20 citations), and Italy (7 articles, 11 citations) were the most
productive countries. These results stem from the fact in which these countries were the most infected environments by COVID-19 [3], and the scholars in these countries are continually working on finding the appropriate drug or vaccine to hinder its outbreaks.

In addition, the Chinese Academy of Sciences (4 articles, 7 citations), Charité University Medicine Berlin (3 articles, 20 citations), Alfaisal University (3 articles, 11 citations), Ningbo University (3 articles, 11 citations), and Wuhan Institute of Bioengineering (3 articles, 11 citations) were found as the most productive institutions in publishing COVID-19 related articles.

### 3.4 Most Cited Authors

As illustrated in Fig. 4, the bibliometric mapping analysis results suggested that Huang et al. [17] (20 citations), Chan et al. [18] (13 citations), Zhu et al. [1] (10 citations), and Zhou et al. [19] (8 citations) were the most cited co-citation authors. It is imperative to mention that these are the citations received from the Web of Science database. In fact, these citations are much higher in the Scopus database or Google Scholar.
3.5 Role of Intelligent Systems During COVID-19 Outbreaks

The applications of intelligent systems, including AI techniques to the current COVID-19, such as predicting the extinction time, potential risk groups, and location of the next outbreak, may cause a paradigm shift in the healthcare sector [2]. There were important studies on the use of intelligent systems in detecting the older versions of coronavirus such as SARS-CoV [20]. For example, Quek et al. [21] used an intelligent medical decision support tool based on fuzzy neural networks to screen the potential SARS-CoV patients. Besides, Yang [22] developed a new approach for building non-orthogonal decision trees for mining protease data in order to examine the specificity of cleavage activity of SARS-CoV and employ the resulted patterns for efficient inhibitor design to fight the virus.

Despite its new outbreaks, there are some completed and ongoing studies on the application of intelligent systems to the current COVID-19 epidemic [9]. In that, two independent research groups reported that they had used AI algorithms to find possible treatments, such as stopping the COVID-19 from replicating in humans’ bodies [23]. In another ongoing study, Rao and Vazquez [24] aimed to employ machine learning algorithms to identify potential COVID-19 cases based on travel
history data collected via a phone-based survey. The findings might help in early identifying the potential COVID-19 cases and classifying them as high, moderate, minimal, and no risk groups. Hu et al. [25] used AI techniques for predicting the extinction time of COVID-19 across China. In that, clustering algorithms were used to classify nine provinces to build the transmission structure based on the data obtained from WHO. Multiple-step forecasting was conducted to predict the dynamic transmission curves. Their results suggested that the COVID-19 epidemic will be over by the mid of April across China, given that there is no second transmission. In another study, Peng et al. [26] used AI to analyze the COVID-19 diagnosis association index to improve diagnosis accuracy. Four AI techniques (i.e., SRLSR, ARMED, GFS, and RFE) were employed based on 32 diagnosed and 85 undiagnosed cases from Taizhou Hospital, Zhejiang. Their results suggested that the most important attributes in an accurate prediction were Eosinophil count and rate, WBC, Amyloid-A, and COVID-19 RNA.

4 Conclusion

The main purpose of this research is to provide a holistic view on the state-of-the-art research indexed in the Web of Science database with regard to intelligent systems and novel coronavirus (COVID-19) by analyzing the most used keywords, most cited articles and journals, most productive countries and institutions, most cited authors, and the role of intelligent systems during the COVID-19 outbreaks. This has been accomplished through a bibliometric analysis approach.

It can be derived from the results that research on the topic of COVID-19 is still evolving, and tens of publications are getting published every day. The recently published articles on the topic of COVID-19 are significantly contributing to the understanding of the COVID-19 outbreaks at the time where most scholars are intensively working on the problem. However, the number of articles published on the role of intelligent systems during COVID-19 outbreaks is very few, suggesting that research in this field is still in its early stages. Given that the research into the COVID-19 was started in 2020, this also indicates that the role of intelligent systems is still scarce.

The extant research studies on intelligent systems during the COVID-19 outbreaks have mainly concentrated on the use of machine learning algorithms in identifying the potential COVID-19 cases [24], predicting the extinction time of COVID-19 [25], and diagnosing the COVID-19 cases [26]. In spite of all these trials, more intelligent systems through AI techniques are required to provide more insights into the COVID-19 epidemic.

In conclusion, the role of intelligent systems in predicting or identifying the COVID-19 outbreaks is still in its development stage, and more intensive research is required. These results agree with the conclusions drawn in a recent study, which suggested that AI techniques have not yet been impactful against COVID-19 [27]. The need for more research stems from two main reasons. First, there is still much
to be examined through machine learning algorithms by predicting the infections using different attributes other than those identified in the previous literature. Second, the growing number of death cases day-by-day increases the possibilities in finding more effective solutions by medical informatics researchers.

It is believed that this study would provide valuable insights into the research published on the topic of COVID-19 and intelligent systems. The conclusions of this bibliometric analysis can assist scholars in understanding the current status of intelligent systems and motivating them to develop more effective systems that could help in detecting, identifying, or preventing the COVID-19 outbreaks.

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