Computerized Lexicography: New Horizons in the Age of Artificial Intelligence

KIRAM Guamra *,

Laboratory of Pragmatics and Discourse Analysis, Faculty of Arts and Languages, University of El Oued, (Algeria)

guamra-kiram@univ-eloued.dz

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Abstract

This article explores the profound transformations that have occurred in the lexicography industry due to the digital revolution and artificial intelligence technologies, showing how computerized dictionaries have become essential tools for natural language processing, enhancing access to linguistic information, and preserving linguistic heritage. The article addresses the challenges facing this industry, such as managing the complexities of language and providing comprehensive linguistic data, and anticipates its future amid the rapid advancement of artificial intelligence and the emergence of more intelligent and interactive electronic dictionaries. The article also examines the role of computerized dictionaries in developing advanced linguistic applications, including voice assistants and instant translation systems, and their impact on facilitating linguistic communication in the digital.

Keywords: Natural Language Processing, Electronic Dictionaries, Computational Linguistics, Linguistic Data, Machine Translation , Language Digitization.

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* - *Author correspondant.*

INTRODUCTION

In the age of the digital and information revolution, the Arabic language faces unprecedented challenges and opportunities. On the one hand, maintaining its status as a living and influential language requires the development of modern linguistic tools that keep pace with rapidly advancing technological developments. On the other hand, the digital space offers enormous potential to serve the Arabic language and facilitate its use in various fields. In this context, the electronic dictionary emerges as an essential tool for serving the Arabic language and meeting the needs of users in the information age.

Researchers and linguists have paid increasing attention to the issue of computerizing the Arabic dictionary and investing in computational linguistics in the electronic dictionary industry, with the aim of overcoming the linguistic and technical problems facing traditional dictionaries. As (Abdullah Abu Al-Haif, 2004) points out the importance of computerizing the Arabic dictionary to keeping pace with the requirements of the times, (Nabil Ali, 2001) emphasizes the need to develop an Arab cultural discourse compatible with the information age.

In this context, the importance of computational linguistics in building electronic dictionaries becomes clear, as natural language processing techniques can be employed to analyze linguistic data and extract the necessary information to create accurate and comprehensive lexical entries. Mazen Al-Wa'ar and Muhammad bin Ahmed have highlighted the role of computers and software in developing the Arabic language and facilitating its application in various fields.

Recent years have witnessed a remarkable development in the field of the electronic dictionary industry, with the emergence of many dictionaries that rely on modern technologies to present linguistic information and provide advanced search options for users. In this context, reference can be made to the efforts made in developing the Dictionary of Contemporary Arabic Language by (Ahmed Mukhtar Omar, 2008), which represents a qualitative leap in the Arabic dictionary industry.

Despite the many advantages that electronic dictionaries provide, there are some challenges facing their development, such as the issue of linguistic borrowing and managing modern terminology. (Muhammad bin Nafe' Al-Mudhyani Al-Anzi , 2016) ; Youssef Amriri, 2020) addressed this issue in their studies on the Rich Shining Dictionary.

It is worth noting that the electronic dictionary is not limited to providing definitions of words, but can also include other information such as pronunciation, linguistic roots, and different uses of the word. (Saeed Yaqtin, 2016) pointed out the importance of electronic dictionaries offering comprehensive information about words.

In this context, reference can be made to the efforts made in developing the (Electronic Quranic Encyclopedia, 2023), which represents a model of the specialized electronic dictionary that aims to serve the Holy Quran and its sciences.

In this article, we seek to review the importance of the electronic dictionary in supporting the Arabic language and facilitating its use in various fields, with a focus on the challenges facing its industry and offering suggestions for its improvement. This article addresses the radical transformations in the Arabic dictionary industry, focusing on the computerization of the Arabic dictionary and the impact of the information age on the Arabic language. It also examines the role of computational linguistics in developing electronic dictionaries and explores linguistic borrowing in modern Arabic lexicography. The article aims to analyse the impact of computer technologies on the Arabic dictionary industry, evaluate the effectiveness of electronic dictionaries, explore the challenges and opportunities facing the Arabic language in the digital age, and provide a prospective vision for this industry.

I. DEVELOPMENTS AND CHALLENGES OF THE ELECTRONIC ARABIC LEXICON

Arab linguists have long been aware of the need to care for the Arabic language and be alert to the dangers that threaten it amid modern challenges. They recognized the necessity of updating the Arabic language to keep pace with these developments, which requires the use of dictionaries and lexicons in new and contemporary forms, taking advantage of the innovations of civilization and its rapidly advancing sciences. Such progress cannot be achieved without carefully planned efforts based on various computational linguistic applications. These applications largely depend on the lexicon, leading to the emergence of the electronic or computerized lexicon, a new type of dictionary that has witnessed significant development in its structure, entry content, and the advanced services it provides to users, exploiting the vast capabilities of computers for storing lexical information, rapid searching, retrieval, and multimedia data processing.

This computerized lexicographical industry has developed rapidly and now competes seriously with paper-based dictionaries. Many activities have emerged to serve lexical studies, foremost among them the conversion of dictionaries from paper to digital formats. The experience of "Al-Ghani Al-Zahir" by Abdul Ghani Abu Al-Azm represents a qualitative leap in the history of Arabic dictionaries, moving from paper to digital. From this standpoint, this study examines the impact of globalization on the Arabic dictionary and the effect of automated computing on the modern lexicographical industry. The importance of this study lies in its focus on the structure of the Arabic language, its vocabulary, and lexicon, which for many centuries has reflected the awareness and care of the Arab nation toward its language.

Thanks to advances in digital systems and language computing, lexicography has become a multifaceted science with established theories guiding the foundations of its industry. Lexical studies occupy a large part of linguistic research, and these studies have achieved tangible progress manifested in automated dictionaries, which retain the usability of their classical predecessors but are more developed and accessible for researchers and learners.

The computerization of the Arabic dictionary has also facilitated the lexicalization of the rich Arabic vocabulary, thanks to digital software that allows management according to desired lexical purposes (Abdullah Abu Al-Haif, 2004).

This computerization demonstrates the Arabic language's capacity to be processed automatically at the lexical level and its ability to engage effectively with modern electronic tools (Siddiqi Abdul Wahab, 2011).

I.1. The Arabic Language and Automated Computing:

In light of the rapid developments the world is witnessing, the theory of informatics and computing has posed new cognitive challenges for language studies. Many researchers have focused on computerizing the Arabic language, including the Tunisian scholar Mohammed bin Ahmed, who presented a scientific vision of the Arabic language, computer systems, and software.

These attempts demonstrate serious efforts to adapt computer technologies to the Arabic language in a way that respects its characteristics, structure, and script, while enhancing automated interaction between humans and computers. This is evident in studies on Arab computational thinking and the development of the Arabic lexicon's ability to be computerized, addressing both linguistic and technical challenges.

I.2. Importance of the Computer in the Lexicographical Industry:

The computer plays a central role in modern lexicography, as it is equipped to analyze lexical patterns and respond to a wide range of vocabulary-related queries. It provides essential services to linguistic researchers, including:

-. Facilitating Search Methods (Hypertext)

Hypertext has revolutionized research methods by automatically organizing linguistic units through intelligent storage, arrangement, and retrieval, enabling efficient lexical updates and targeted information extraction. This system organizes data with flexibility, allowing even seemingly deleted data to be recovered. Moreover, digital language banks, as shown in Figure 1, go beyond isolated words to include entire texts, which facilitates the study of vocabulary in context and in relation to grammatical structures, significantly enhancing the research process.

Corpus of Contemporary American English https://www.english-corpora.org/coca/	British National Corpus. http://www.natcorp.ox.ac.uk/	International Corpus of Arabic https://www.bibalex.org/ica/en/About.aspx	Quranic Arabic Corpus https://corpus.quran.com/

Figure 1. Digital language banks examples

- Supporting Words with Appropriate Media

A modern electronic lexicon transforms words from static definitions into dynamic, multimedia experiences using advanced computer technology. Words are enhanced with sounds, images, and animations, providing a richer understanding. When a word is spoken, the system automatically processes its lexical information, organizing it for classification, storage, reference, and retrieval. The static word is converted into a dynamic visual representation, similar to a television image, where the spoken text is accompanied by corresponding images and sounds. This approach employs algorithmic graphical methods and leverages spelling and grammar checking technologies to ensure accuracy. Furthermore, the computerized lexicon processes word meanings deeply, utilizing multiple modalities such as images, multimedia films, cartoons, and real-life scenes. It applies contextual models to place entries appropriately, regardless of lexicon size, enhancing traditional explanation methods and illuminating word meanings with clarity.

I.3. Reducing Distance and Time

The electronic dictionary is not subject to any distance or time constraints, which facilitates research and accelerates the retrieval of information. It provides the required data quickly and accurately; for example, a computer can look up a word in a dictionary containing five hundred thousand entries in less than a second. Lexicographers can obtain data directly from databases stored on computers or the Internet and process it simultaneously. Among the features offered by computerized dictionaries are: rapid text modification, easy and fast retrieval, low cost of storing and accessing information, and the availability of comprehensive data that facilitates work anywhere, at any time. Computers enable operations to be accelerated and updated, through deletions or additions, which allows lexicographic work to be continuously refined and improved (Samsuri et al., 2024).

I.4. The Electronic Dictionary

The electronic dictionary, a term combining the familiar "dictionary" with "electronic"—an adjective indicating its computerized nature—represents the digital evolution of its paper-based predecessor. Essentially a vast automated database, it stores linguistic units meticulously along with essential information such as pronunciation, morphology, and specific meanings, all within high-capacity digital memory. Managed by precise software, this sophisticated tool provides an automatically organized repository of extensive vocabulary, designed for clear explanation and rapid retrieval, thereby fundamentally reshaping access to and understanding of language (Samsuri et al., 2024).

I.5. Types of Electronic Dictionaries

Just as traditional dictionaries vary, electronic dictionaries also come in different types, classified based on several considerations. The simplest classification of electronic dictionaries can be summarized as follows: machine-oriented dictionaries and human-oriented dictionaries

Human-oriented electronic dictionaries, in their modern form, are thoughtfully categorized based on key features: the organization of entries by root, the dictionary's specific function (whether for translation or education), and the type of content it

offers, ranging from purely textual to rich multimedia, web-based resources, or CD-ROM formats. Considering these aspects, electronic dictionaries can be broadly classified. Firstly, there are electronic linguistic dictionaries, which present a selection of vocabulary where each entry provides fundamental linguistic details such as word definition, morphological and grammatical properties, spelling, and various meanings illustrated with examples. Secondly, visual dictionaries offer a curated collection of images and videos, systematically arranged by topic (such as plants, animals, or transportation), providing a different avenue for vocabulary acquisition and understanding (Balalaieva, 2021).

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I.6. Machine-Oriented Electronic Dictionary

Machine-oriented electronic dictionaries serve technological interaction in specific ways. Some are designed for internet connectivity, often facilitating machine translation on international networks, with access sometimes requiring payment or subscription, while others exist as free or collaborative online projects. Another category includes dictionaries downloaded onto digital storage media, such as CD-ROMs or flash drives, which require a computer for operation. Many machine-oriented dictionaries are now accessible on mobile phones, providing greater portability and speed, unconstrained by distance or time. This type often retains a traditional format, allowing for printing and offline use. A notable example is the "Al-Wafi Translator", an Arabic-English dictionary that operates independently of an internet connection, offering bidirectional translation and the ability to save translated text, thereby streamlining the researcher's work through its automated functionalities.

I.7. Importance of the Electronic Dictionary

The electronic dictionary is an invaluable asset to the Arabic language. More than just a tool, it forms an integral part of the linguistic landscape, acting as a vast

and rapid database essential for teachers, students, researchers, translators, and other professionals. Its significance lies in its capacity to decode information, retrieve it quickly, and present it in written form, complete with phonetic breakdowns, word analysis, spell checking, summaries, translations, and automated searches. It creates databases and converts coded data into accessible texts, enriched with explanations for human comprehension. Additionally, it provides user-friendly interfaces that facilitate retrieval and offer appealing on-screen displays.

Learners and researchers prefer electronic versions because of their ability to search, display, and present information using diverse media, including text, images, sound, video, and animations. Its rapid updating capability allows the dictionary to evolve alongside the Arabic language, making it a major asset for enriching lexicography. Ultimately, the electronic dictionary is a necessity for the modern Arabic speaker in today's information-driven world, especially given the advanced state of dictionary industries in other global languages compared to Arabic electronic resources. Providing such dictionaries is essential for strengthening the role of the Arabic language in the face of competition from foreign languages, emphasizing our responsibility to develop and expand these resources, considering their cultural, strategic, and economic importance (Sulaiman et al., 2022).

II. STUDY AND ANALYSIS OF THE ELECTRONIC "AL-GHANI AL-ZAHIR" DICTIONARY

II.1. Definition of "Al-Ghani Al-Zahir"

This is a modern Arabic electronic school dictionary, written by lexicographer Abdul Ghani Abu Al-Azm and published in 2013 by the Moroccan Al-Ghani Foundation with support from the Mohammed bin Rashid Al Maktoum Foundation. It comprises four medium-sized volumes, totaling approximately 3,600 pages, and contains definitions for 30,000 entries and terms, as well as more than 195,000 derived words. It is intended for students, teachers, researchers, journalists, and anyone interested in learning the language, regardless of their cultural background or linguistic education (Alrashdan et al., 2024).

II.2. Analyzing the "Al-Ghani Al-Zahir" Dictionary's Approach

This detailed description of the "Al-Ghani Al-Zahir" dictionary's methodology highlights several key aspects of modern Arabic lexicography. Abu Al-Azm's adoption of a phonetic alphabetical arrangement, prioritizing spoken forms over root abstraction, aligns with user-centered design principles, facilitating easier lookup. The dictionary's extensive entries, formatted with bolding and type distinctions, aim for comprehensive coverage across linguistic categories.

The lexicographer's emphasis on clear definitions, employing relational and logical methods, alongside labels explaining grammatical and usage contexts, underscores the importance of accessible meaning conveyance. Additionally, the dictionary fulfills a cultural and educational role, including geographical and historical information, etymological notes, and field-of-use classifications, catering to a diverse audience and enriching their linguistic and cultural understanding.

While acknowledging the limitations arising from the absence of a historical Arabic dictionary, this study emphasizes the critical importance of modern, user-friendly electronic dictionaries in developing linguistic resources and strengthening the Arabic language in the digital era (Mel'cuk and Polguère, 2018).

CONCLUSION

This study highlights the pivotal role of modern Arabic digital dictionaries, exemplified by Al-Ghani Al-Zahir, in meeting the evolving linguistic needs of students and researchers in the digital age. The transition from paper to digital does not merely represent a cultural achievement but reflects a natural evolution driven by the demands of modern technology. The relationship between the Arabic language and computers has become one of integration, as modern technologies have provided Arabic with a computerized and technological dimension. Researchers in the field of electronic dictionaries aim to harness the efficiency of computers to process language automatically, enabling users to perform linguistic tasks with greater accuracy and speed.

The internet, as a primary medium of communication in the modern era, reinforces the necessity of computerizing Arabic to manage information, transfer files, and access data efficiently. This process contributes to the broader project of computerizing the Arabic lexicon. In this context, the Al-Ghani Al-Zahir dictionary serves as a pioneering model that provides and simplifies linguistic information for learners. It occupies a central place in computational linguistics, acting as a bridge for Arabic to attain parity with other global languages. Furthermore, it represents an educational and cultural discourse that connects users with the linguistic information needed for academic and everyday purposes.

The Arab digital dictionary also plays a vital role in preserving and revitalizing the verbal heritage of the Arabic language. As a technological and linguistic innovation, it establishes a solid foundation for creating Arabic lexical resources grounded in both theoretical principles and technical experimentation. These resources respond to the needs of linguistic communities and computational applications, including machine translation and automatic text processing. Additionally, the Al-Ghani Al-Zahir dictionary contributes to reducing the lexical gap between Arabic and other languages that have advanced significantly in digital lexicography.

With its large storage capacity and advanced database technologies, the electronic dictionary combines classical and modern content, offering multilingual and multimedia features that ensure accuracy, comprehensiveness, and a rich variety of examples. Its educational value lies in its function as a scientific and pedagogical tool, enabling users to refine their linguistic expressions and deepen their understanding of the language. Ultimately, Al-Ghani Al-Zahir marks a qualitative leap in Arabic lexicographical research, establishing a distinctive lexicographical school with its own principles, structure, and methodology. It has also contributed to enriching both the lexicographical industry and the learning process by facilitating faster and more efficient access to linguistic information.

PERSPECTIVE

Looking ahead, the development of Arabic electronic dictionaries, such as Al-Ghani Al-Zahir, should continue to be supported through collaborative academic and technological initiatives. Future efforts must focus on integrating artificial intelligence and machine learning tools to enhance semantic search, automatic translation, and contextual analysis. Such advancements would ensure that the Arabic language not only adapts to the digital age but also asserts its role as an influential language in global communication, education, and technology. The continuity of these projects promises a future in which Arabic becomes not merely a preserved heritage but a dynamic, interactive, and innovative linguistic system.

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