

ARTIFICIAL INTELLIGENCE AND ROBOTICS IN LIBRARY SERVICE

Lami Akawu, Katamba Abubakar Saka & Garba Shambo Mohammed

Introduction

One of the most significant characteristics of people is their intelligence. It has been described as the ability to reason, comprehend, think abstractly, communicate, remember, know, plan, be creative, and solve problems. It is a skill that includes the capacity for understanding, learning, problem-solving, abstract thought, reasoning, and planning. This shows the capacity to understand, make sense of, or decide what to do. The capacity to think, acquire knowledge and skills, remember information, and use it when necessary are all components of intelligence. Human intelligence is linked to the capacity to receive or infer information, retain it as knowledge, and apply it to adaptive actions within a context or environment. Humans can thus think, see patterns, understand concepts, plan, solve problems, make choices, remember knowledge, and communicate via language. In a similar vein, a machine-based system may be created to mimic human talents. Computers are used as vital tools to carry out jobs that humans are typically proficient at thanks to artificial intelligence (AI). The functions of the human brain, such as programming, comprehending language, and using common sense thinking, may now be carried out by computers. It is claimed that these computer systems have some kind of artificial intelligence.

Machines that display the traits associated with human intelligence and behaviour—such as reasoning, meaning-finding, generalisation, and experience-based learning—are referred to as artificially intelligent. It also refers to a broad category of computer tools and associated technologies designed to mimic human intelligence, encompassing learning, reasoning, problem-solving, language comprehension, and perception through the senses of sight or hearing. In every aspect of life, machines, computers, and other technical gadgets are taking the place of people. Like other institutions, libraries have been influenced by the advancement of technology. The library's function as a repository has changed to that of an essential hub for knowledge exchange and exploration. Libraries are encouraged to utilise a variety of information and communication technologies to enhance the efficacy and efficiency of their services, given the labour-intensive duties involved in gathering, processing, organising, and disseminating information sources and resources, as well as improving the user experience. With the emergence of artificial intelligence, which is driving the development of libraries, information technology advancements continue at a quick

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pace. Therefore, the goal of integrating AI and robotics into libraries is to enhance automation, service, and operational efficiency.

Concept of Artificial Intelligence

A variety of technologies are included under the umbrella term of Artificial Intelligence (AI). When drafting a study proposal for the US Dartmouth Summer Study Conference in 1955, John McCarthy came up with the term, which he defined as "the science and engineering of making intelligent machines" that could act like people (Akerkar, 2012). The capacity to respond to circumstances, interpret signals, assign relative priority to various variables for a scenario, and identify similarities and differences across situations are all characteristics of an intelligent system. An intelligent computer (system) can reason, grasp natural language, observe and analyse visual stimuli, acquire new ideas and tasks, and make insightful conclusions. As a result, intelligence is the culmination of all facts and information gained by education and life experience. Accordingly, an intelligent system should have traits that are known to be related to intelligence. According to Frankenfield (2023), Artificial Intelligence (AI) refers to the ability of computers to mimic human thinking processes by allowing them to reason, learn, and make decisions in a manner like humans. The focus of artificial intelligence is on simulating the knowledge structure that humans utilise to solve issues. It completes tasks like human beings. According to Das and Islam (2021) and Bhorkar (2024), Artificial Intelligence (AI) refers to the capacity of a computer-controlled machine or an enabled digital computer to replicate human intellectual traits in its operation.

The computer is capable of learning, thinking, interacting with the environment, and problem-solving—all the cognitive processes that are typical of human brains. Such a contraption mimics the capabilities of the human mind and is electronically operated with the help of a computer. According to Russell and Norvig (2003), the machine is a fully aware and intelligent computer programme that has an inherent advantage over humans in terms of understanding the surroundings and maximising the success of challenging tasks. According to the definitions, artificial intelligence (AI) is a computer system that exhibits intelligent behaviour by assessing its surroundings to make logical decisions or carry out certain tasks, like cleaning a library. Accurate information processing, digital content management, cataloguing, and improving accessibility to both electronic and physical resources are all made possible by artificial intelligence (AI) and associated technologies, sometimes referred to as information handling tools. Expert systems, Natural Language Programmes (NLP), pattern recognition, robotics, image processing, and text mining are examples of AI-

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related technologies that could improve library operations and services. These technologies use AI models and algorithms to carry out tasks like reference services, book sorting and shelving, information discovery, and retrieval.

According to Kumar (2023), the AI system is developed to analyse data, recognise pattern and make decision. AI can be used to Catalogue and categorise library resources, which could enhance accessibility and use of library resources. Frankenfield (2023) affirmed that AI tools are used to organise and make vast collections of knowledge accessible. With AI technologies, a library can provide users with opportunities to explore, find and interact with digital information. Beyond routine operational capability enhancement, AI-enabled library can improve user experience, analyse user behaviour and preferences, to recommend relevant resources. This has made the library an indispensable centre of knowledge dissemination and discovery thereby transforming the entire operations and interactions of library and its users.

AI and Robotic Technologies in Libraries

The transformative power of AI is being felt across a wide range of fields, as industries and organisations employ AI in the performance of tasks carried out by humans. Like other fields, libraries are adopting AI technology to perform library functions and services. Their integration into library functions and services is driving innovation, improving efficiency, enhancing accessibility and improving user experience within the library. Optimal character recognition is used in robotics, AI cognitive applications and natural interface applications swiftly search for books, scan documents, convert them into digital text, and provide users with access to a range of information sources. As a result of the integration of new technology with traditional library operations, libraries are now able to handle complex datasets that place computational demands on the human brain (Mupaikwa, 2023). When expert systems, natural language processing, pattern recognition, robotics, chatbots, and analytic systems are combined, artificial intelligence (AI) adds a new level of service delivery. These technologies can perform tasks like sorting and shelving library materials if they are properly configured and integrated. With the use of user-friendly interfaces, they may help customers find books or get information. Along with thinking, they are also able to comprehend visuals, sounds, other media things and can respond to enquiries from a self-generated or pre-stored knowledge base with ease thanks to reasoning.

Expert System: A computer-based system that enhances human experts' capacity to make decisions is referred to as an expert system in the context of artificial intelligence. This computer system was created to simulate human expert performance and decision-making abilities. When a human expert is needed to solve an issue, the

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system leverages information from a knowledge base. Facts and guidelines stored in the software comprise the knowledge base, which includes all the information demands and searching behaviours of library patrons that the librarian uses to make decisions. According to Njuku (2022), the system's inference and reasoning procedures employ the coded knowledge that experts provide to respond to requests or queries. Expert systems, regardless of their kind, are programmes created to carry out tasks or solve problems in specialised fields. Therefore, an expert system might either provide users access to databases and pertinent information, categorise resources, retrieve materials, or respond to user enquiries.

Natural Language Processing (NLP): This area of artificial intelligence focuses on comprehending human language. It is the capacity of a computer software to comprehend written or spoken human language. The goal of natural language processing is to comprehend, analyse, and produce language that people naturally use (Mali et al., 2021). Such a computer software comprehends the primary linguistic ideas in a query or response. NLP's capabilities include information retrieval, information mining, machine translation, voice recognition, linguistic methods, and speech synthesis.

Pattern Recognition: The capacity of a machine to recognise and classify a variety of data to make decisions is known as pattern recognition. By closely matching incoming stimuli to previously remembered stimulus patterns, it recognises objects or repetitive actions (Mali et al., 2021). Pattern recognition is the act of using qualities to match incoming input with information that has previously been recorded in a database. Finding patterns in data helps make predictions, organise information, and enhance the decision-making process. Computer algorithms that are intended to examine and interpret data are at the core of a pattern recognition system. Data input may be words, text, photos, or sounds, while patterns include sound waves, tree species, fingerprints, faces, barcodes, QR codes, handwriting, or character images.

Machine learning: An application of artificial intelligence called machine learning enables a system to carry out certain tasks efficiently without the need for explicit instructions by relying on patterns and inference. The majority of these patterns are the outcome of BIG DATA operations. To uncover patterns, trends, and associations—particularly those pertaining to human behaviour and interactions—the discipline of big data examines methods for methodically analysing, extracting information from, or otherwise handling data sets that are too large to be handled conventionally.

Application of AI and Robotic Technologies in Library Services

Robot is a machine that can perform series of actions automatically based on computer programme. Abram (2019) defined a robot as an “automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be fixed in a place or mobile for use in automation applications”. Arents and Greitans (2022) noted that robots are being used to automate manufacturing processes, on many production floors, thereby, transforming and improving the sector of manufacturing. Today, robots are not only used in industries or manufacturing companies but also in service organisations such as library to perform variety of tasks or operations. A number of libraries around the world are deploying different robotic technologies for internal operations and services. Calvert (2017) reported that libraries in Germany and France among others, designed and developed robot that were used for locating and retrieving items in the library. Beyond automated storage and retrieval system, libraries can employ shelf reading robot, telepresence and humanoid robots, chatbots and voice activated system to perform library functions and enhance user experience.

AI and Robotic Technologies in Circulation

Li et al. (2019) opined that much of the world’s knowledge remains between the pages of printed books. Library acquires this knowledge in a variety of print and non-print formats. The pressure of processing these resources to provide quick access remains tedious and labour-intensive. This could result in some items being mis-shelved. In several times, patrons have misplaced books within the library. Library resources are only useful if they are accessible. Robotic technology can be used to scan library collection on the shelves and re-shelf all items that have been misplaced or mis-shelved. Shelf-reading robot can scan the entire collections of the library, identifying and re-shelving misplaced items appropriately. The librarian robot is a user-centred robot, designed to assist users to locate and retrieve books from the shelf. This system is a user-robot interaction with sensor-based navigation and book recognition. This type of robot performs library routine activities without breaking the library workflow and rules (Zheng, 2019).

Zheng (2019) also mentioned the Singapore National Library's usage of Robocat for book stacking. Robots can automatically search shelves for radio frequency-identifying tags implanted in collections, according to Tella and Ajani (2022). To find books that are missing from the shelves and improperly shelved, it compares the digital

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data gathered with the library's collection database using a self-localization algorithm. The capability of shelf-reading robot to locate an item in library collection that is presumably missing or not found is impressive. Lian (2019) noted that book locations are integrated with the library Catalogue from the daily scan, thereby enabling the user to easily locate the book requested. In addition, chatbot deployed in circulation can facilitate library transactions which include charging, discharging, renewal and reservation of book.

Due to a number of digital services provided to patrons and large quantity of printed resources acquired by academic library, Abram (2019) emphasized that robotic batch scanning-based system could be used to allow real-time browsing for print resources through a web interface. The user initiates a conversation through comprehensive access to the printed material system and make request for an item from the robot, the item is retrieved and delivered to another robotic system that will open the item, using optical character recognition (OCR) software, convert the printed document into digitized format which can be stored and delivered to the user or searched electronically. Users may view text pictures, search for and evaluate complete text created from the images using the comprehensive access to printed material system. Humanoid robots can sense their surroundings, identify faces, interpret emotions, and interact with people, depending on the software (Nguyen, 2020). This technology is able to comprehend user needs and do further analysis on user activity and personal data. This information is used to suggest information items to users and to provide timely and relevant services. A personalised and user-friendly solution may be obtained by using AI technologies that are now in use to provide suggestions based on customers' past searches and borrowing habits. By identifying sensitive content, it may also provide more accessibility to digital assets thereby enabling libraries to democratise the non-sensitive parts.

AI and Robotic Technologies in Reference

Reference services focus on establishing contact between users and right resources, thereby assisting users in their use or quest for resources. The emergence of AI technology has transformed reference service from offering human assistance to digital solution, which can perform human intellectual tasks. AI and robot have the potential to perform a number of tasks in reference as well as other functions of the library. Isiaka et al (2023) affirmed that AI technology has complemented the work of reference librarian by providing automated response to queries. Robot such as chatbot is programmed with ability to speak. The humanoid robot developed by Foanoke County Library in United States, could perform a number of activities which include

answering question, greeting and sharing of story (Zheng, 2019). Specific purpose robot has emerged in library, carrying out specific function of the library. The talking robot also known as chat robot is an emerging technology that is being integrated into library website to provide virtual assistance that can answer users' questions and assisting with research inquiries. Users usually entered question using natural language in brief text responses, providing interactive experience that mimic a human conversation, while responding to queries (Zheng, 2019).

Another useful technique for delivering information in digital contexts is the use of chatbots. In order to provide real-time virtual reference services, a comparable intelligent talking robot was installed in the library at Tsinghua University. According to Yao (2015), online reference services, which span social networking and mobile environments and utilise various AI technologies, are offered outside regular business hours. The system functions as a reference librarian in several places on various terminals at the same time thereby enabling users to access the collection and engage in highly interactive and intelligent resource collection participation (Zheng, 2019). Information is constantly available online, however because of content saturation, important information may be obscured by navigational search results. Relevant information might be obtained and provided to the user in a succinct conversational message with the help of the chatbot reference librarian. This kind of library operation provides immediate access to information and support.

AI and Robotic Technologies in Cataloguing, Indexing and Abstracting

Creating and maintaining bibliographic entries of library resources play a significant role in organising and retrieving information. Artificial intelligence has the potential to enhance cataloguing in libraries by lowering human work, boosting accessibility, and enhancing accuracy of activities done. Chowdhury (2019) noted that AI technologies such as machine learning algorithms and natural language processing (NLP) play a key role in automating cataloguing and classifying operations. AI algorithms can automatically develop and build metadata for various types of documents (text, photos, and multimedia) from which bibliographic information like author's name, publication date and topic keywords are formed for digital and other resources. It evaluates data to provide relevant search results, allowing users to discover the resources they need. Luo (2018) claimed that AI algorithms can automatically assess and categorise enormous volumes of digital material, assign relevant metadata tags, and arrange resources effectively. Natural Language

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Processing (NLP) approaches allow AI systems to extract crucial information from textual resources, thereby facilitating accurate indexing and retrieval (Luo, 2018).

In addition, machine learning and natural language processing can evaluate library data and categorising content. AI technologies, notably machine learning and natural language processing algorithms, are applied to identify and classify library resources effectively, therefore providing metadata which increases the accuracy of search and recall, and makes it simpler for users to discover information. Furthermore, the technologies assess the content of books, papers and other resources, in such a manner that each item categorised is put and stocked correctly. Thus, AI systems can analyse metadata, extract essential information from documents, and classifies materials properly, with this ability, AI technologies can be used to search and build a list of keywords that matches query, and return the document to the user.

Impact of AI and Robotic Technologies in Library Service

Organisation and accessibility of information is core to library and library staff. Therefore, librarians have continued to explore and adopt innovative ways to enhance their services. Application of AI and Robotic Technologies in libraries facilitates effective resource utilisation, improves user experience, and streamlines processes. Traditional library services have been transformed. The transformative effect of this technology has been profound since its introduction, with unprecedented levels of accessibility to library resources.

AI and Robotic Technologies have been used to Catalogue and manage metadata. So, automation of tedious tasks, such as metadata tagging, adding descriptive labels to resources, and content classification. Free up librarians' time for other tasks, such as collection development and user engagement initiatives. The use of AI and Robotic Technology in the library can enhance the effectiveness and efficiency of library routine and repetitive tasks thereby ensuring that library workflow is streamlined to allow librarian to focus on complex inquiries and personalised interactions. AI and Robotic Technologies deployed can analyse user borrowing history, ratings on library resources, and search queries to suggest new relevant books, articles, or other resources that would satisfy the information needs of users. AI also contributes to library management of information retrieval and search optimisation. Indeed, these technologies offer positive enhancements to library services; however, Schreur (2020) argues that the use of AI in libraries can reduce the need for library staff.

Virtual Reference Assistance: the use of AI and Robotic Technologies has facilitated remote communication between users and librarians by providing instantaneous

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assistance, support and access to information. Real-time or instant response from this technology enhances user experience by efficiently engaging and exploring information sources. Simple questions and responses that range from: Need help? Finding a specific book or navigating a research database? are intelligently answered. Chatbots powered by AI can answer users basic inquiries, guide users through library policies, assist with research inquiries and facilitate library transactions. Virtual assistants are services available beyond traditional library operating hours of morning to evening.

AI and Robot driven Technologies enhance user engagement by providing personalised suggestions based on user preferences, search history, and content analysis. The use of these systems is effective in connecting users to needed information. In addition, AI and ML applications applied in different functions of the library provide easier means of navigating the library content.

Natural Language Processing (NLP) deployed can analyse the context of user search, identify synonyms, related concepts, and even the sentiment behind their query, resulting in a more relevant and accurate search results thereby saving the time of the user and possible frustration. Similarly, AI and Robot driven Technologies used in the library help to analyse vast amounts of textual data, like scholarly articles or historical documents to identify patterns and trends, and relationships in the content as well as uncover seemingly disparate research areas.

AI and Robotic Technology have broken down language barriers in the use of resources through translation service. They can be used to translate library resources into multiple languages by making information accessible to many users.

Benefits of AI in library services

1. AI and robotic technologies integrated in library provides instant and virtual assistance, supportive services such as answering enquiries, guiding users as well as improving discoverability and information exploration.
2. The use of AI and robotic technologies to automate library operations has improved the efficiency and effectiveness of library routine tasks, such as cataloguing and organisation of library resources. Librarians can rely on these technologies to assist in reducing the manual daily routine task of registering, shelving and cataloguing resources, thereby making resources available to patrons more quickly.

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3. AI-driven technologies deployed in a library enhance information retrieval and search optimisation. The capability of AI and robotic technology in analysing large quantity of data, leads to effective search and retrieval of information for library users.
4. The application of AI and robotic technologies in libraries increases the quality of service and operational efficiency, while improving accessibility to information and user-friendliness. This has enhanced user satisfaction.
5. AI assists the library in integrating datasets with other libraries and also creates a seamless exchange of data and research across disciplines.
6. AI and robotic technologies deployed in a library enhance the accuracy of library processes. AI technologies are less prone to human errors so as to ensure that Catalogue entries are consistent and precise. This leads to improved search results and a better user experience. It can also offer tailored recommendations to patrons and enable successful interactions with the library at any time.

Conclusion

The implementation of AI in library services presents numerous opportunities for the future. As AI technologies continue to expand, libraries may harness breakthroughs in machine learning, natural language processing, and computer vision to further optimise operations, service delivery and improve user experience. By integrating AI-driven solutions, libraries may adapt to growing user expectations and maximise resource use to stay relevant in the digital era.

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