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# Multilingualism and Multiculturalism in Digital Libraries

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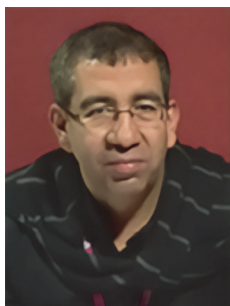
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Abstract: Multilingualism and multiculturalism have become major preoccupations for Library and Information Science (LIS) which has to be as fair as possible to ensure and sustain knowledge diversity as a driver for development. This paper offers a broad overview of multilingualism and multiculturalism embedding into Digital Libraries (DL). We survey studies written in English over the past two decades (from 2002 to 2022) and indexed in one or more of the following databases: Science Direct, Google Scholars, Taylor and Francis, and Emerald Insight. We summarized studies to offer insights and outline opportunities in this area and classify them into five research themes: (i) studies describing Cross-Language Information Retrieval (CLIR) in Digital Libraires, (ii) studies describing building, enriching and using multilingual resources in digital libraries (iii) studies focusing on multilingual digital libraries initiatives, (iv) studies on collaboration, minority languages and ethics issues in digital libraries, and (v) studies on multilingual user needs. This survey aims to identify, collect and categorize the research literature on multilingualism and multiculturalism efforts in Digital Libraries.

1.0 Introduction

As defined in Lesk (2005), Digital Library (DL) is an online collection of (born) digital or digitized materials (books, magazines, audio recordings, video recordings and other documents) that are accessible through the Internet. Multilingual Digital Libraries (MDL) are digital libraries that bring together collections from various countries, regions, and cultures with content in more than one language, or that provide multilingual query access to a monolingual collection. They provide users with access to rare and out-of-print materials on a global scale that might be difficult or impossible to locate in physical libraries.

In recent years, collections of the world's great libraries have been made available to the public through large-scale digitization. The Online Computer Library Center

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(OCLC), dedicated to the public purposes of furthering access to the world's information, produces and maintains WorldCat (Ganster 2010), the largest Online Public Access Catalog (OPAC) in the world. WorldCat itemizes the collections of 72,000 libraries in 170 countries and territories. Multilingual online digital libraries and archival projects collect documents in more than one language and make them available to a wide audience: the Wikisource Project (https://wikisource.org), an online digital library of free content textual sources, the Internet Archive Project (https://archive.org), building a digital library of Internet sites and other cultural artifacts in digital form such as books and audio records, or the Gutenberg Project (https://www.gutenberg.org) offering over 56,000 free written and audio eBooks and especially older works for which copyright has expired in more than 50 under-resourced languages.

The Library of Congress has digitized approximately 164 million items in virtually all formats, languages, subjects, and periods. These collections are broad in scope, including research materials in more than 470 languages and multiple media. The Europeana collection, launched in 2008 and funded by the European Commission, contains over fifteen million digitized paintings, drawings, maps, photos, books, newspapers, letters, diaries, etc., from fifteen hundred institutions. However, the language barrier is a critical issue that multilingual digital libraries must address, as Hudon (1999) describes. Indeed, the gap between the languages of dominant nations or civilizations and other languages has been growing over time.

Of the world's 6000+ languages, only a tiny fraction, a dozen or so, currently enjoy the benefits of modern language technologies such as information retrieval, recommendation systems, or machine translation. A larger but still modest number, close to a hundred, have the so-called Basic Language Resource Kit (BLARK): monolingual and bilingual corpora, machine-readable dictionaries, thesauri, part-of-speech taggers, morphological analyzers, parsers, and the like as explained by Krauwer (2003) and in Arppe et al. (2016). As Scannell (2007) mentioned, over 98% of world languages lack most and usually all of these language resources. These languages lacking technical resources are called under-resourced languages.

Although multilingual digital libraries include content encoded in under-resourced languages, their access and exploration are still limited.

In an increasingly globalized context, multilingual digital libraries face a range of highly challenging issues considering the diversity of knowledge encoded in different languages, particularly those encoded in vulnerable and under-resourced ones. This study aims to identify, collect and categorize the research literature on multilingualism and multiculturalism efforts in Digital Libraries. It also aims to identify trends in processing multilingual content in digital libraries and the unattended facets by researchers in this area.

This paper is structured as follows: Firstly, the methodological approach undertaken for conducting the review is outlined. The identified main research topics regarding Multilingual Digital Libraries literature are described. Finally, we conclude by identifying major challenges and opportunities that will affect the impact of multilingual technologies on digital libraries.

2.0 Background

Supporting multilingualism and Cross-Language Information Retrieval (CLIR) in digital libraries has long been recognized as necessary in providing universal access to digital content (Hudon 1997, 1998; Barát 2008; Oard 1997; Bian and Chen 2000; Peters and Sheridan 2001). Indeed, the gap between the languages of dominant nations or civilizations and other languages has been growing over time. Several research works (Alder et al. 2016; Beghtol 2005; Dahlberg 1992; López- Huertas 2016 and Mustafa El Hadi, 2015) have called for cultural and linguistic diversity. A few studies reviewed the way multilingualism was treated in digital libraries. In 1997, Borgman focused on recording the multilingual issues involved in designing Digital Libraries whereas Douglas (1996) reviewed the state of the art in multilingual text retrieval and access.

3.0 Methodology and Scope

We survey studies conducted over the past two decades to bring together research efforts and seek to provide insight into the major developments in the multilingual and multicultural digital libraries field. The review includes papers written in English from 2002 to 2022 and indexed in one or more of the following databases: Science Direct, Google Scholars, Taylor and Francis, and Emerald Insight. In order to approximate the publication trends in the field, we used very broad queries. Search terms used were: "multilingual digital libraries", "multilingual information retrieval", "multilinguality", "multilingualism", "multiculturalism", "Cross-Language Information Retrieval" both alone and in conjunction with various Boolean combinations were run on. Articles on digital libraries, multilingual information retrieval or cross-language information retrieval individually are excluded from the review. After a manual validation aiming to select only returned papers that are in the intersection of multilinguality and digital libraries on the returned results and de-duplication, 83 publications were reviewed. The identified literature was further analyzed and categorized into 5 main research topics detailed in section 4. We specially described in this paper publications that were
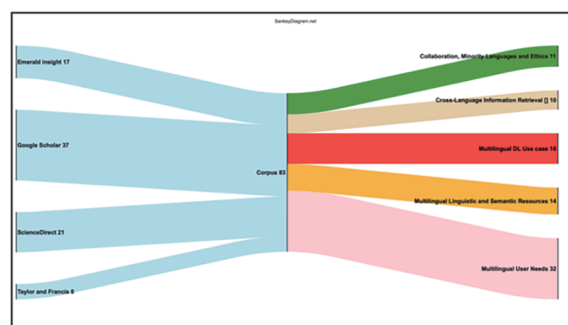
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Figure 1: Sankey diagram showing the publications reviewed in our literature on multilingual digital libraries.

cited by several research works and then considered as major references for multilinguality in DL.

4.0 Reviewed literature on multilingual digital libraries

Figure 1 presents detailed results of our literature search. A total of 83 publications were obtained from Google Scholar, Emerald Insight, Science Direct, and Taylor and Francis. We found that many (N=32) offered opinions or discussion of multilingual user needs in digital libraries (represented by pink flow), 16 studies (represented by red flow) describing multilingual digital libraries initiatives and use cases over the World, another 14 research papers about building, enriching and using multilingual resources in digital libraries (represented by orange flow), 11 publications described studies that discussed collaboration, minority languages and ethics (represented by green flow), and 10 research works discussing last trends on cross-language information retrieval in digital libraries.

4.1 Cross-Language information retrieval studies

Several research works aimed to support the multilingual information requirements for cross-language information retrieval with digital library systems. In a recent study, Pontes et al. (2020) describe a cross-lingual named Entity Linking System (XEL) connecting Named Entities (Nes) from documents in a source language to external knowledge bases in another (target) language. The XEL system was applied and evaluated with several language pairs including English and various low-resourced languages of different linguistic families such as Croatian, Finnish, Estonian, and Slovenian.

Zhang et al. (2015) studied and analyzed semantic associations among elements in a multilingual corpus. They proposed to optimize the semantic organization of multilingual corpus by linking the corpus elements into a semantic link network. This enhances the text-based applications of multilingual corpus such as corpus linguistics study, dictionary search, machine translation and cross-lingual information retrieval.

Chen et al. (2012) studied the mapping analysis of terms from different Knowledge Organization Systems (KOS) in different languages in the domain of Chinese art. The study takes the terms from the Art & Architecture Thesaurus developed by The Getty Research Institute in the US, and the controlled vocabularies from the National Palace Museum in Taiwan participating in the Digital Archives Sub-Project of Antiquities in the National Palace Museum under Taiwan e-Learning and Digital Archives Program. Their research results demonstrate six types of term equivalence to varying degrees, which are: exact equivalence, exact equivalence (cross ref.), inexact equivalence, partial equivalence (species-genus relationship), non-equivalence (culture uniqueness), and non-equivalence (beyond the scope).

Larson et al. (2002) presented a method to create both customized bilingual dictionaries and multilingual query mappings from a source language to many target languages to support the multilingual information requirements for cross-language information retrieval within digital library systems. They described a multilingual conceptual mapping resource with broad coverage derived from the 10+ million titles online in the library catalog of the University of California. The resource is created statistically via maximum likelihood associations from words and phrases in book titles of many languages to human-assigned subject headings in English.

Jung (2013) used multilingual folksonomies to discover useful matchings between multilingual tags (e.g., among "Korea" in English, "*Coréia*" in Portuguese and "*Corée*" in French).

In Stankovic et al. (2012), the authors described the main features of Biblisa, a tool that offers various possibilities for enhancing queries submitted to large collections of TMX documents generated from aligned parallel articles residing in multilingual digital libraries of e-journals. The queries initiated by a simple or multiword keyword in Serbian or English can be expanded by Biblisa, both semantically and mor-

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phologically, using different supporting monolingual and multilingual resources, such as wordnets and electronic dictionaries.

Wang et al. (2004) proposed a query-translation approach that enables a cross-language information retrieval service to be more easily supported in digital library systems that only contain monolingual content. A query-translation engine called LiveTrans is used to process the translation requests of cross-lingual queries from connected digital library systems. The engine exploits multilingual Web resources used as bilingual corpora. The obtained results show the feasibility of and great potential for creating English-Chinese CLIR services in existing digital libraries and new applications in cross-language Web searching.

4.2 Building, enriching and using multilingual resources

Multilingual resources of various kinds (e.g., thesauri, ontologies, classification schemes) play an integral part in making Digital Libraries collections accessible. Most libraries and other cultural heritage institutions use controlled vocabularies, such as thesauri, to describe their collections.

Niininen et al. (2017) studied the process of multilingual concept scheme construction and the challenges involved. They addressed concrete challenges faced in the construction process especially those related to equivalence between terms and concepts. Their analysis is based on the experience acquired during the establishment of the Finnish thesaurus and ontology service Finto as well as the trilingual General Finnish Ontology YSO. Mitchell et al. (2014) discussed the relationships between entities in the context of classification systems that involve multiple translations and/or multicultural implementations.

Several research works have focused on the automatic building of multilingual resources. Andonovski et al. (2019) described the structure of an aligned Serbian-German literary corpus (SrpNemKor) contained in the digital library Bibliša. The goal of the research was to create a benchmark Serbian-German annotated corpus searchable with various query expansions. Fraisse et al. (2018) proposed and experimented a new approach for building multilingual parallel corpora for a large number of under-resourced languages. It consists of collecting all the translations worldwide of one fictional text by means of collaboration between volunteers, researchers, scholars, digital libraries, and especially national archives. The paper reports on 10 parallel corpora pairing English with Arabic, Basque, Bengali, Bulgarian, Dutch, Hungarian, Polish, Russian, Turkish and Ukrainian.

Baca et al. (2015) give an overview of the history, development, and structure of the electronic thesauri produced and maintained by the Getty Research Institute (GRI). They described the evolution of the Art and Architecture Thesaurus (AAT), the Getty Thesaurus of Geographic Names (TGN), and the Union List of Artist Names (ULAN) as multilingual, cross-cultural knowledge organization systems (KOS).

Other research works are based on the use of multilingual resources to improve access and retrieval of multilingual documents. Monroy et al. (2010) described an approach for enhancing access to a collection of ancient technical documents, illustrations, and photographs documenting archaeological excavations. The proposed approach is based on the use of a multilingual glossary along with an ontology.

4.3 Multilingual digital libraries initiatives

Wu and Chan (2019, 2022) described two case studies of two multilingual digital libraries: The World Digital Library and the Digital Library of the Caribbean. Their study enriches the literature by providing a more comprehensive sustainability framework for multilinguality. The proposed framework illustrates the challenges and strategies for gaining sustainability of multilingual digital libraries into 11 aspects: creation, leadership, collaboration, content, metadata, translation, funding, technology, preservation, staffing and copyright.

The successes of the Digital Library of the Caribbean as an open access, multi-institutional, multilingual, inclusive and international digital library were also studied by Ascensio (2017) and previously by Wooldridge et al. (2009), who have explained the methods and factors that have led to the Digital Library of the Caribbean's success in building the necessary infrastructure.

Another recent multilingual digital library initiative was described by Bergamaschi et al. (2021): the DigitalMaktaba project, presenting the first steps for designing an innovative workflow and tool for the automatic extraction of knowledge from documents written in multiple non-Latin languages (Arabic, Persian and Azerbaijani languages). The tool leverages different OCR tool, text processing techniques and linguistic corpora in order to provide both a highly accurate extracted text and a rich metadata content, overcoming typical limitations of current state-of-the-art systems.

In Europe, Stiller et al. (2013) studied and presented the multilingual interactions through Europeana: the European digital library, archive and museum for cultural heritage. Challenges and recommendations for the implementation of multilingual access features are presented and discussed.

In India, the digital library initiatives and policy of the government towards digital library development are described in Jeevan (2004), Ghosh (2009), Jain and Babbar (2006), Bhattacharya (2004), Keralapura (2009), Suku and Pillai (2005). In Ghosh (2009), the authors examined the developments in Electronic Theses and Dissertations (ETD) repositories, in particular PhD thesis repositories, in India. The au-

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thor proposed the construction of a repository of extensive doctoral research and an Indian portal to enable the preservation of scientific and technological research materials in the country and a global view of Indian institutional research assets. In a more recent work, Bhat (2017) presented a survey of the digital collection of the National Digital Library of India highlighting the need to reach every nook and corner of India to allow the digitization of multilingual and multicultural Indian heritage and historical record.

Johnson (2013) provides a situation report on the state of libraries and information services in Armenia. The author describes their development, outlines the international development assistance that they have received during the last twenty years, and indicates some of their future needs.

He and Wu (2012) examined multilingual resources and services in academic libraries in China. Their results highlighted the problem of lack of adoption of translation-based technologies such as cross-language information access and machine translation in improving the usages of multilingual collections and services.

Dżurak and Kasprzyk (2010) described the metamorphosis of Polish academic libraries since the fall of communism in 1989. The authors focused on the University of Warsaw Library (UWL), which played a leading role in modernizing library practices and served as an example of progress that was followed by many academic libraries.

In Slovenia, Rozic-Hristovski et al. (2003) described the example of the Central Medical Library (CMK) at the Faculty of Medicine of the University of Ljubljana. The MyLibrary portal includes important functionality, most notably multilingual support.

4.4 Collaboration, Minority Languages and Ethics in Digital Libraries

Chou (2012) presented a framework to keep global digital libraries sustainable and ethical. The author proposes a workflow to create and maintain digital libraries as ecosystems and includes a flowchart for visual presentation. He argues that collaboration, interoperability and sustainability are key to the vision of digital libraries to communicate with each other. In the same way, Görtz et al. (2012) also argue that cooperation between institutions is essential to support access to multilingual content.

Thanos et Casarosa (2017) described the key role of the DELOS Network of Excellence, funded by the European Commission, in establishing digital libraries as a research field in Europe. The main objectives of DELOS are research, whose results are in the public domain, and technology transfer, through cooperation agreements with interested parties. Other research works highlighted the importance and the need to rely on collaborative and crowdsourced approaches for sustaining linguistic and cultural diversity in digital library

collections. Fraisse et al. (2019) proposed a new open, inclusive and sustainable model for preserving and sustaining knowledge diversity. Budzise-Weaver et al. (2012) studied four American multilingual digital libraries (Project Gutenberg, Meeting of Frontiers, The International Children's Digital Library, and the Latin American Open Archives Portal) and highlighted the collaboration and crowdsourcing characteristics that participated in sustaining their multilingual services.

In a recent study, Wu and Chen (2022) explored ethnic minorities' needs for multilingual information access to public digital cultural services. Narenthiran and Ravichandran (2016) examined five libraries in Tamil Nadu; out of five selected libraries, none has completed both cataloging and digitization. The authors conclude that it is time for the National Mission of Manuscript to coordinate and initiate these important left-out activities to gear up. For all the manuscript libraries should be provided grants by governments for infrastructures for cataloguing and digitization.

In Gäde (2014), the author studied country and language level differences in multilingual digital libraries. She investigated the question of the identification of country and language level differences in user interactions as a crucial step for designing effective multilingual digital libraries. Matusiak and Munkhmandakh (2009) described a digitization project undertaken to preserve and expand access to endangered Mongolian newspapers and periodicals. Issues and difficulties are compounded in the development of international digital libraries that use non-Latin characters. The authors described the Greenstone, an open-source digital library software suite offering multilingual support and used to create a digital archive of these rare Mongolian publications.

Another reviewed research related to minority language and digital libraries is by Nichols et al. (2005). The authors describe a system for building digital libraries that is well adapted for creating and distributing local information collections in minority languages. The system can build multilingual documents available in structured collections and allows users to access them via multilingual interfaces.

4.5. Multilingual User Needs

Eden (2015) provides a concise overview of user studies for digital library development. It incorporates an overview of usability tools and techniques, outlines recent research on designing for a positive user experience, and provides many tips on the accessibility and usability of online digital resources. Wu et al. (2012) studied academic users' multilingual needs when interacting with digital libraries. They concluded that users from different countries or who speak different languages show significant differences in their multilingual needs and expectations of digital libraries. Vassilakaki and Garoufallou (2013) reviewed issues in user-centered studies and user behavior. They concluded that few

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research works have focused on the user and aimed to explore users' behavior and expectations when interacting with multilingual digital libraries. Thus, further research is needed to improve the awareness of multilingual user's needs.

5.0 Conclusion

This survey identified, collected and categorized the research literature on multilingualism and multiculturalism efforts in Digital Libraries into five research themes: (i) studies describing Cross-Language Information Retrieval (CLIR) in Digital Libraires, (ii) studies describing building, enriching and using multilingual resources in digital libraries (iii) studies focusing on multilingual digital libraries initiatives, (iv) studies on collaboration, minority languages and ethics issues in digital libraries, and (v) studies on multilingual user needs. It also identified trends in processing multilingual content in digital libraries and the unattended facets by researchers in this area.

In summary, we find a steady interest in multilingual digital libraries for many languages other than English. Our review of recent studies conducted over the last two decades (from 2002 to 2022) shows that (1) the field still needs research efforts in terms of multilingual tools and resources and (2) researchers in the community need more access to datasets to be able to develop robust methods to address multilingual digital libraries tasks.

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