LSI Authentication-Based Arabic to English Text Converter

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Abstract

Due to the large amount of Arabic text produced on a daily basis, there is a need to analyze these texts. Following a comprehensive literature review, there become clear several issues related to Arabic text summaries, keyword extraction, and sentiment analyses. These issues occur owing to several factors, such as the structure and morphology of Arabic text, a lack of machine-readable Arabic dictionaries, insufficient tools to manage Arabic text, no standard datasets, inherently cursive scripts, and isolated characters; thus, there is a need to create Arabic text in forms that can be easily read by machine learning, deep learning algorithms, and existing analysis tools. To achieve this, the Arabic texts must be converted into English texts. This paper proposes a lexicon called the AEC-Lexicon for use by all researchers working in Arabic, which is based on the Arabic case system and converts Arabic text into English text. Based on the experimental results of latent semantic indexing (LSI), it was found that texts generated from the proposed work exhibited a significant improvement over existing work (converted Arabic to English texts), considering reading and understanding as well as the relevance to the original Arabic text.

Keywords: Arabic text, Machine learning algorithms, Lexicon, Automatic generated summary

1. Introduction

This section describes the problems in the literature and how the proposed work will overcome these problems. There are six major dialectal groups in Saudi Arabia. The main dialects in Saudi Arabia are the Hejazi dialect and the Nejd dialect, with six million and eight million speakers, respectively [1]. According to the Arab Social Media Report in 2017 [2], there are 2.6 million active Twitter users from Saudi Arabia. Learning Arabic makes one stand out, as there are very few people from the West who speak Arabic, and having command of the Arabic language seems clever and sophisticated [3] because a considerable amount of research has been done on Arabic texts. Arabic summarization is a highly difficult task because the Arabic language is complex with respect to its morphology and structure [4]. Although standard Arabic morphological analysis tools are not available [5], some researchers have utilized existing common Arabic stemming as a workaround [6].

Received: Jul. 7, 2021
 Revised : Sep. 9, 2021
 Accepted: Oct. 5, 2021

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Existing resources for Arabic texts are limited, and the accuracy of existing methods is low owing to Arabic specific (e.g., limited resources, Arabic's morphological complexity, differing dialects) and general linguistic issues (e.g., implicit sentiment, sarcasm, polarity fuzziness, polarity strength, review quality, spam, domain dependence) [7]. Stemming Arabic words is a complex issue in the field of Arabic text classification [8]. As reported in [9] and [10], the issues and challenges in identifying sentiments in informal Arabic language in the context of Twitter and YouTube Arabic content were investigated, which is unstructured in nature. Limited research has been conducted on opinion mining using Arabic Twitter [11] because the majority of the natural language processing (NLP) tools for the Arabic language have been developed for Modern Standard Arabic (MSA) rather than informal Arabic [12]. All machine learning algorithms are available for the English language, so there the above issue does not apply to machine-readable texts.

Thus, there is a strong need to analyze the bulk of Arabic text being created daily, but it is difficult to manage because of the following issues involved in handling Arabic text:

- The complexity of the Arabic language related to structure and morphology [4].
- Due to the inherent complexity of the Arabic language, very little research has been conducted combining Arabic text summarization and text entailment to produce extracts [13].
- Lack of existing Arabic morphological analysis tools [5].
- A limited number of documents with keywords are available online [14].
- There is a lack of techniques for scanning and matching of Arabic texts to identify key phrases [15].
- No gold standard summaries for Arabic and a lack of machine-readable Arabic dictionaries [16].
- Little current research on the automatic classification of text documents due to stemming Arabic [8], Arabic-specific, and general linguistic issues [7]; and existing tools are used for MSA and ignore informal Arabic [11].

The most obvious characteristics of the Arabic language are that Arabic scripts are inherently cursive and that isolated characters are written out, as shown in Figure 1 [17]; thus, there is a need to convert Arabic text into English text for further processing.

Figure 1. A sample of Arabic writing [17].

The primary purpose of the proposed methodology is to address all of the issues discussed. For example, there should be a common and consistent Arabic text that can easily solve the issues relating to machine-readability, the generation of standard summary, and morphology, which can be read by different tools. In this study, Arabic texts were converted into English texts by preparing a lexicon for conversion. The coordinates of existing documents were also compared with the proposed documents using the latent segmenting indexing method, and it was found that the documents produced by the proposed method were highly similar to the Arabic documents. The key contribution of this work is the proposed lexicon, which is based on several generated rules:

- Proposing Simple-Rules (based on the absence of case systems).
- Proposing FKD-Rules based on Fattah, Kasrah, and Dammah.
- Proposing T-Rules based on Tanveen
- Proposing a user-friendly interface for converting Arabic texts into English texts.

2. Related Work

Using the Internet, a study [18] was conducted investigating Arabic and Islamic content containing relevant information from the prophetic narration texts using an artificial intelligence (AI) approach. The authors proposed a semantically driven approach to analyze Arabic discourse following the segmented discourse representation theory (SDRT) framework. It has also been found that discourse analysis can be used to produce indicative summaries of Arabic documents [13]. The authors of [19] proposed a new model for summarization based on clusters resulting from the document clustering extraction of keyphrases. The authors of [20] proposed an approach called Adaboost based on a supervised method to produce Arabic summary extraction. For this study, a set of statistical features were utilized including sentence position, the number of keywords in a sentence, overlap with word title, and sentence length. The proposed approach produces automatic text summarization of

multiple large-scale Arabic documents using a genetic algorithm and the MapReduce parallel programming model [21]. Few studies have been conducted on an approach that ensures scalability, speed, and accuracy of summary generation [13].

Arabic text summarization is still a new approach because of the inherent complexity of the Arabic language as well as the lack of a standardized evaluation process, because there are no gold standard summaries for Arabic machine-readable dictionaries [16]. There is a model that presents an Arabic text summarization system (query-based) using Arabic WordNet and an extracted knowledge base [22]. As reported in [23], a weighted directed graph represents each document, with nodes corresponding to sentences and edge weights representing similarities between the sentences. The authors of [24] introduced a new method for Arabic text summarization based on graph theory; however, summarization systems for Arabic are still not as mature or as reliable as those developed for other languages such as English. In [25], the authors addressed the problem of developing an Arabic text summarization system (LCEAS) that produces extracts without redundancy.

Many text classification (TC) research studies have been conducted and tested with on the English, French, German, Spanish, Chinese, Greek, and Japanese languages [26]. Opinion mining is the process of automatically identifying opinions expressed in Arabic texts on certain subjects [27]; however, there is little current research on the automatic classification of text documents in Arabic because of varying spellings of certain words, various ways to write certain combination characters, and short (diacritics) and long vowels. In addition, most Arabic words contain affixes [28]. Mesleh [29] utilized three machine-learning algorithms—support vector machine (SVM), k-nearest neighbor (KNN), and naïve Bayes (NB)—to classify Arabic data collected from Arabic newspapers. The studies [30] and [31] used TC and analyses of Arabic texts to automatically assign texts to predefined categories based on their linguistic features. The NB, KNN, multinomial logistic regression (MLR), and maximum weight (MW) classifiers were used, with the NB classifier implemented as the master and the others as slaves [32]. All tests were performed after preprocessing Arabic text documents. The results showed that the master-slave technique yields a significant improvement in the accuracy of text document classification compared to other techniques [32]. The authors of [7] also used three machine-learning classification techniques, NB, SVM, and decision trees, to improve the sentiment analyzer. Stemmer and document embedding techniques were used for text classification to investigate the

impact of the preprocessing methods on the performance of three machine-learning algorithms: NB, discriminative multinomial naive Bayes (DMNB) text, and C4.5, all of which were used for Arabic text categorization [33]. The results of the sentiment analysis and subjectivity analysis demonstrated that while the use of lexeme or lemma data is useful, there is also a need for individualized solutions for each task and genre [10].

3. Case System

This section provides information about the case system of Arabic, which corresponds to vowels in English. The case endings in Arabic are little patterns (حركات Harakaat) which are appended to the ends of words to indicate their grammatical functions in a sentence. Case endings are usually not written (with one exception) outside of the Qur'an/Bible and children's books; however, newscasters pronounce them, and to speak formal Arabic well, it is important to be familiar with the case system [3,34]:

In the proposed work, three rules were created to update the lexicon: the Simple-Rule, FKD-Rule, and T-Rule. The FKD-Rule is based on Fathah, Kasrah, and Dammah, while the T-Rule is based on Tanween. The following Arabic case systems (الإعراب) will be matched with vowels and some other sounds of Arabic. In Arabic, Fathah is a small diagonal line placed above a letter (َ) and maps to the letter a in English. The Kasrah (ِ) is a small diagonal line placed below a letter (ِ) and represents a short i in English. The Dammah is a small curl placed above a letter (ُ) represented by a u or o in English. Tanween corresponds to the three vowel accents that may be doubled at the end of a word, indicating that the vowel is followed by the consonant n. The signs from left to right indicate (ً ٌ ٍ) (transliterated: *an in un*).

4. AEC-Lexicon

The Arabic to English convertor lexicon (AEC-Lexicon) was developed from different sets of pairs and consists of a set of three categories. Some heuristics from Arabic sounds were used to develop this lexicon. The first set was generated using only simple similar sounding characters from Arabic and English, as mentioned in the transliteration system [35]. The second set was generated from similar sounding characters in Arabic and English using Fathah, Kasrah, and Dammah. The third set was generated from similar sounding characters in Arabic and English using Tanween.

Table 1. All ASC:ESC pairs

ASC: ESC	ASC: ESC	ASC: ESC	ASC: ESC
ا: A	ح: H	ف: F	ن: N
ب: B	خ: KH	ق: Q	و: W
ت: T	د: D	ك: K	ر: R
ث: S	ذ: Z	ل: L	ش: SH
ج: J	غ: GH	م: M	ي: Y

4.1 Simple-Rule

The Simple-Rule consists of simple characters without a case system. This rule consists of a tuple containing a pair denoted ASC:ESC, where ASC means Arabic sound character(s) (i.e., ث س ص) and ESC means relevant English sound character (i.e., S). After processing, 20 pairs of Arabic to English sounds were produced, as shown in Table 1.

4.2 FKD-Rule

The basic case systems used in Arabic which produce sound are A-FKD {FATHAH, KASRAH, and DUMMA} and E-rFKD{A, I, and U}, where “A” is an alternate of FATHAH, “I” is an alternate of KASRAH, and “U” is an alternate of DUMMA. As shown in Eqs. (1) and (2), the dot symbol ‘.’ connects all Arabic characters in ASC with FATHAH, KASRAH, and DUMMA and all English characters in ESC with A, I, and U. Then, they are paired with full colons, as shown in Eq. (3). All pairs were created based on their relation to ASC.A-FKD:ESC.E-rFKD using the following equations:

$$A\text{-FKD} = \{ \text{أ}, \text{إ}, \text{و} \}, \quad (1)$$

$$E\text{-rFKD} = \{A, I, U\} \text{ (replacement FKD)}, \quad (2)$$

Table 2. All ASC.A-FKD and ESC.E-rFKD pairs

أ: A, إ: I, و: AU,	خ: KHA, ح: KHI, ح: KHU,	ض: ZA, ض: ZI, ض: ZU,	ن: NA, ن: NI, ن: NU,
ب: BA, ب: BI, ب: BU,	د: DA, د: DI, د: DU,	ط: TA, ط: TI, ط: TU,	ه: HA, ه: HI, ه: HU,
ت: TA, ت: TI, ت: TU,	ذ: ZA, ذ: ZI, ذ: ZU,	ظ: ZA, ظ: ZI, ظ: ZU,	و: WA, و: WI, و: WU,
ث: SA, ث: SI, ث: SU,	ر: RA, ر: RI, ر: RU,	ع: A, ع: I, ع: AU,	ي: YA, ي: YI, ي: YU,
ج: JA, ج: JI, ج: JU,	ز: ZA, ز: ZI, ز: ZU,	ك: KA, ك: KI, ك: KU,	و: O,
ح: HA, ح: HI, ح: HU,	س: SA, س: SI, س: SU,	ل: LA, ل: LI, ل: LU,	غ: GHA, غ: GHI, غ: GHU,
	ش: SHA, ش: SHI, ش: SHU,	م: MA, م: MI, م: MU,	ف: FA, ف: FI, ف: FU,
	ص: SA, ص: SI, ص: SU,		ق: QA, ق: QI, ق: QU,

Figure 2. Conversion of Arabic character to English character using A-FKD.

Pair-FKD (A:E)

$$= \bigcup_{i=1}^m \left(\bigcup_{j=1}^m (ASC)_i \cdot (A\text{-FKD})_j : (ESC)_i \cdot (E\text{-rFKD})_j \right). \quad (3)$$

The equation Pair-FKD(A:E) is a pair consisting of ASC.A-FKD and ESC.E-rFKD and represents a tuple, i.e., for Arabic character ‘ب’, the tuple with the English character B becomes (ب: BA, ب: BI, ب: BU), as shown in Figure 2.

Table 2 contains all pairs generated using the FKD-Rule.

4.3 T-Rule

The “T” in T-Rule refers to Tanveen (تنوين) and is also based on the FKD-Rule. Tanveen used in Arabic are A-T {أ, إ, و} and E-rT {AN, IN, UN}, where “AN” is a replacement for أ, “IN” is a replacement for إ, and “UN” is a replacement for و, as shown

Figure 3. Conversion of Arabic character to English character using A-T.

in Eqs. (4) and (5). The dot symbol ‘.’ connects all Arabic characters in ASC with َ, ِ, ُ and all English characters ESC with AN, IN, and UN. They are then paired with semicolons, as shown in Eq. (6). All pairs were created based on relations to ASC.A-T:ESC.E-rT.

$$A-T = \{ \text{َ}, \text{ِ}, \text{ُ} \}, \quad (4)$$

$$E-rT = \{ AN, IN, UN \}, \quad (5)$$

Pair-T(A:E)

$$= \bigcup_{i=1}^m \left(\bigcup_{j=1}^m (ASC_i) \cdot (A-T)_j : (ESC_i) \cdot (E-rT)_j \right). \quad (6)$$

The equation Pair-T(A:E) is a pair of ASC.A-T and ESC.E-rT representing a tuple, i.e., for Arabic character ‘ب’, the tuple with the English character B becomes (ب: BAN, ب: BIN, ب: BUN) as shown in Figure 3.

All pairs generated using the T-Rule are shown in Table 3. In Table 3, the rows with black text have unique sounds, while the remaining colors maintain the same sounds from Arabic to

English.

These rules were implemented in Python because it is an open-source language that is easy to understand, learn, and use. Python also has highly useful libraries for the manipulation and analysis of data. When modern languages (existing) are assessed, the utility of Python-based solutions is remarkable in terms of agility and productivity. Many companies in all regions, including the largest investment banks and the smallest social/mobile web app startups, have used Python to operate their businesses and manage their data [36].

After generating the three rules, they were applied to Arabic sentences. Either the FKD-Rule or T-Rule can be applied first, and then the Simple-Rule may be applied, because applying the Simple-Rule first when converting Arabic texts into English may result in a less readable form. The conversion process is shown in Figure 4.

Quranic Arabic texts from “Surah Ikhlas” (chapter 112 verses 1-4) and “Sura An-Nass” (chapter 114 verses 1-6) have been converted, as shown in Table 4. These results are generated using only FATAH, KASRAH, DUMMA, and TANVEEN.

5. Results

It is worth mentioning that “no generally accepted database for Arabic text recognition is freely available for researchers” [37]. Hence, different researchers investigating Arabic text recognition use different data, and therefore, the recognition rates of the different techniques may not be comparable. The website (<https://www.sujood.co>) was used to prepare Dataset-1, from which there are some collections of prophetic traditions (hadith) that have the desired texts for the proposed approach. This approach was tested on Dataset-1, which contained three forms of different hadith. The first form contained a text in Arabic, the second contained English-converted text, and the

Table 3. All ASC.A-T and ESC.E-rT pairs

أ: AN, إ: IN, ؤ: UN	د: DAN, د: DIN, د: DUN,	ض: ZAN, ض: ZIN, ض: ZUN,	ل: LAN, ل: LIN, ل: LUN,
ب: BAN, ب: BIN, ب: BUN,	ذ: ZAN, ذ: ZIN, ذ: ZUN,	ط: TAN, ط: TIN, ط: TUN,	م: MAN, م: MIN, م: MUN,
ت: TAN, ت: TIN, ت: TUN,	ر: RAN, ر: RIN, ر: RUN,	ظ: ZAN, ظ: ZIN, ظ: ZUN,	ن: NAN, ن: NIN, ن: NUN,
س: SAN, س: SIN, س: SUN,	ز: ZAN, ز: ZIN, ز: ZUN,	ع: AN, ع: IN, ع: UN,	ه: HAN, ه: HIN, ه: HUN,
ج: JAN, ج: JIN, ج: JUN,	ش: SAN, ش: SIN, ش: SUN,	غ: GHAN, غ: GHIN, غ: GHUN,	و: WAN, و: WIN, و: WUN,
ح: HAN, ح: HIN, ح: HUN,	ش: SHAN, ش: SHIN, ش: SHUN,	ف: FAN, ف: FIN, ف: FUN,	ي: YAN, ي: YIN, ي: YUN,
خ: KHAN, خ: KHIN, خ: KHUN,	ص: SAN, ص: SIN, ص: SUN,	ق: QAN, ق: QIN, ق: QUN,

Figure 4. Arabic to English complete sentence conversion.

Table 4. Conversion of “Surah Ikhlas” and “Sura An-Nass”

Surah No.	Arabic text	English converted text
Surah No: 114	بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ قُلْ اَعُوْذُ بِرَبِّ النَّاسِ مَلِكِ النَّاسِ اِلٰهِ النَّاسِ مِنْ شَرِّ الْوَسْوَاسِ الْخَنَّاسِ الَّذِي يُّوسْوِسُ فِيْ صُدُوْرِ النَّاسِ مِنَ الْخِيَةِ وَالنَّاسِ	“BISMI ALLHI ALRHMANI ALRHIYMI QUL AAUWZU BIRAB:ALNASI MALIKI ALNASI ILAH:ALNASI MIN:SHAR:ALWASWAASI ALKHANASI ALZIY YUWASWISU FIY SUDUWRI”
Surah No: 112	بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ قُلْ هُوَ اللّٰهُ اَحَدٌ اللّٰهُ الصَّمَدُ لَمْ يَلِدْ وَلَمْ يُوْلَدْ وَلَمْ يَكُنْ لَهٗ كُفُوًا اَحَدٌ	“BISMI ALLHI ALRHMANI ALRHIYMI QUL HUWA ALLHU AHADUN ALLHU ALSMADU LAM:YALID:WALAM:YUWLAD: WALAM:YAKUN:LAHU KUFUWAN AHADUN”

third contained a text in the translated English form. All hadith were taken from the website (<https://www.sujood.co>), where all the texts are publicly available. The first and second text forms are discussed because the primary aim of the proposed method is to convert Arabic texts into English texts. The second form of the text is then compared with the proposed approach. The sample listings of the datasets are presented in Table 5.

After the conversion of Arabic texts to English texts, the existing and manual approaches were compared, and our proposed approach yielded the best readable form. These formulations are presented in Table 6 based on the sample data. In the second column, the red-colored words from the existing approach are less readable, whereas in the third column, the relevant words in green color produced using the proposed approach can be easily read.

5.1 Audio Result

The converted documents were also checked using an online speaking tool (www.fromtexttospeech.com), and the sounds were similar to the original Arabic sounds, to the extent allowed by the developed rules.

5.2 Statistical Measures

The latent semantic indexing approach was applied to determine the accuracy of the existing approach. For this purpose, the vector coordinates of the documents of the Arabic texts, the documents of the existing approach, and documents of the proposed approach were examined. The coordinates of the existing documents and the proposed documents with Arabic text were then compared. A query to determine the coordinates was also required. The documents of all approaches remained in the same order, and Document-6 was taken as a query, as

Table 5. Sample sentences from Dataset-1

Serial No	Arabic text	English converted text (Existing approach)
1	اللَّهُمَّ إِنِّي أَعُوذُ بِكَ مِنْ هَمٍّ يَحْزُنُنِي وَمِنْ فِكْرٍ يَفْلِقُنِي وَعِلْمًا يَشْبِيْنِي “وَشَخْصًا يَحْمِلُ خُبْنًا لِي”	“Allahumma innee a’uzubika min ham ayhzununee, wa min fikr yuqliqunee, wa 3ilm yut3ibunee, wa shakhS yahmilu khubsan-lee”
2	اللَّهُمَّ إِلَيْكَ أَشْكُو ضَعْفَ قُوَّتِي ، وَقِلَّةَ حِيلَتِي ، وَهَوَانِي عَلَى النَّاسِ ، يَا أَرْحَمَ الرَّاحِمِينَ ، أَنْتَ رَبُّ الْمُسْتَظْعِفِينَ ، وَأَنْتَ رَبِّي	“Allahuma inni ashku ilavka du’fa quwati wa qilata heelati wa hawaani ala annaas. yaa arham araahimin, anta rab wa anta rabi”
3	اللَّهُمَّ إِنِّي أَعُوذُ بِكَ مِنْ زَوَالِ نِعْمَتِكَ ، وَتَحَوُّلِ عَافِيَتِكَ ، وَفُجَاءَةِ نِقْمَتِكَ ، وَجَمِيعِ سَخَطِكَ	“Allahumma inni a’udhu bika min zawali ni’matika, wa tahawwuli ’afiyatika, wa fuja’ati niqmatika, wa jami’i sakhatika”
4	اللَّهُمَّ أَذْهِبْ غَيْظَ قَلْبِي	“Allahumma azhib Gaydha Qalbee”
5	رَبِّ اشْرَحْ لِي صَدْرِي وَيَسِّرْ لِي أَمْرِي وَاحْلُ غَمَّةً مِّنْ لِّسَانِي فَقُوهَا قَوْلٍ	“Rabbi IshraHlee Sadree, wa yassirlee amree, waHlul Uqdatan min lisaanee, yafqahuu qawlee”
6	اللَّهُمَّ إِنِّي أَعُوذُ بِكَ مِنَ الْهَمِّ وَالْحُزْنِ وَالْعَجْزِ وَالْكَسَلِ وَالْبُخْلِ وَالْحُبْنِ وَصَلَحِ الدِّينِ وَغَلَبَةِ الرِّجَالِ	“Allahumma innee a3uzubika min alham wa alhuzn wa al3aiz wa alkusl wa albukhl wa aljubn wa galbah aldayn wa Galbah alrijaal”

Table 6. Text comparison of existing and proposed approaches

Serial No	Existing approach	Proposed approach
1	“Allahumma innee a’uzubika min ham ayhzununee, wa min fikr yuqliqunee, wa 3ilm yut3ibunee, wa shakhS yahmilu khubsan-lee”	ALLHM ANY AAUWZU BIK MIN-HAM.YAHZUNUNIY WAMIN-FIKRI YUQLIQUNIY.WAILMAA YUTIBUNIY.WASHAKHSAA YAHMILU KHUBSAA LIY
2	“Allahuma inni ashku ilavka du’fa quwati wa qilata heelati wa hawaani ala annaas. yaa arham araahimin, anta rab almustadafeena wa anta rab”	ALLHM.ILAYKA ASHKUW.ZUAFU QUWTIY. WAQILTU.HIYLATIY. WAHAWAANIY.ALAY ALNASI YAA ARHAMA ALRAHIMIYNA ANTA RAB-ALMUSTAZAFIYNA WAANTA RABY
3	“Allahumma inni a’udhu bika min zawali ni’matika, wa tahawwuli ’afiyatika, wa fuja’ati niqmatika, wa jami’i sakhatika”	ALLAHUMA.INIY AAUWZU BIK MIN.ZAWAALI NIAMATIKA.WATAHAWWULI AAFIYATIKA.WAFUJAAATU.NIQMATIKA.WAJAMIYI SAKHATIKA
4	“Allahumma azhib Gaydha Qalbee”	ALLHUM.AZHIB GHAYZA QALBIY
5	“Rabbi IshraHlee Sadree, wa yassirlee amree, waHlul Uqdatan min lisaanee, yafqahuu qawlee”	RAB.ASHRAH.LIY SADRIY WAYASR.LIY AMRIY WAAHLUL AUQDATU MN LSAANIY YAFQAHUWA QAWLIY
6	“Allahumma innee a3uzubika min alham wa alhuzn wa al3aiz wa alkusl wa albukhl wa aljubn wa galbah aldayn wa Galbah alrijaal”	ALLAHUMA.INIY AAUWZU BIK MIN.ALHAM.WAALHUZNI WAALAJZI WAALKASALI WAALBUKHLI WAALJUBNI WAZALAI ALDAYNI WAGHALABATU.ALRIJAALI

shown in Table 7. In addition, the similarity distance of each document was determined using a specific query.

5.2.1 Vector coordinates of documents

The main objective was to identify the coordinates of each document and query. Singular value decomposition (SVD) can determine the points or coordinates of a document and query. Using SVD, three matrices S, V, and U, can be determined by a

matrix and used for further processing. To determine the values of these variables, SVD requires a matrix consisting of rows and columns of integers and different text documents as inputs. A feature matrix can be obtained by calculating the frequency of each word. This means a feature matrix is initially created from all the documents before the SVD is calculated. Subsequently, the supporting variables S, V, and U are calculated using the NumPy library. The coordinates of all the documents were

Table 7. Queries document from all datasets

Query from dataset	Document No from dataset	Text of selected document
Query (Arabic documents)	Document-6	اللَّهُمَّ إِنِّي أَعُوذُ بِكَ مِنْ الهمِّ وَالْحُزْنِ وَالْعَجْزِ وَالْكَسَلِ وَالْبُخْلِ وَالْحَيْنِ وَصَلِّ عَلَى الدِّينِ وَعَلَى رِجَالِ
Query (Existing approach)	Document-6	“Allahumma innee a3uzubika min alham wa alhuzn wa al3ajz wa alkusl wa albukhl wa aljubn wa galbah aldayn wa Galbah alrijaal”
Query (Proposed approach)	Document-6	“ALLAHUMA INIY AAUWZU BIK MIN ALHAMI WAALHUZNI WAALAJZI WAALKASALI WAALBUKHLI WAALJUBNI WAZALAI ALDAYNI WAGHALABATU ALRIJAALI”

Table 8. Coordinates of all documents all datasets

Doc-No	Arabic X	Arabic Y	Proposed X	Proposed Y	Existing X	Existing Y
1	-1.38872E-16	6.4016E-17	8.4641E-16	9.0951E-19	-0.31422	0.219757
2	-0.985261873	0.044420577	0.98526187	0.04442058	-0.28588	0.207485
3	-4.17806E-16	-1.08385E-16	9.645E-17	1.0961E-18	-0.29549	0.170587
4	-8.27432E-17	2.33523E-16	8.2149E-17	-9.72E-17	-0.02333	-0.02504
5	3.1507E-16	7.12019E-17	-1.099E-15	-1.881E-17	-0.10085	0.080281
6	2.06014E-16	4.21434E-17	-6.323E-16	1.8952E-19	-0.64589	0.343129
7	-0.029725105	-0.956431375	0.02972511	-0.9564314	-0.1016	0.033962
8	-0.016770068	-0.27385777	0.01677007	-0.2738578	-0.18761	0.036649
9	-0.167423851	-0.060957415	0.16742385	-0.0609574	-0.11867	0.07706
10	-0.007967295	-0.067468161	0.0079673	-0.0674682	-0.49471	-0.86389

determined from S, and these coordinates were merged with the query to obtain the query coordinates. Finally, a cosine similarity function was applied to these coordinates to identify the documents closest to the queries [38].

From S, the coordinates of all documents corresponding to Arabic texts (column-1 in Table 5), texts converted using the existing approach (column-1 in Table 6), and texts converted using the proposed approach (column-2 in Table 6), were determined, as shown in Table 8. These coordinates were merged with relevant queries from Table 8 to find the query coordinates, which are shown in Table 9. The data provided in Table 8 represent 10 documents from the Arabic, proposed, and existing texts, and the accuracies are shown in Figure 5.

5.2.2 Similarity distance of documents from the query

LSI, which was proposed by [39,40], is an efficient information retrieval algorithm [41]. In LSI, there is a cosine similarity measurement between the coordinates (X, Y) of a document vector and the coordinates (X, Y) of a query vector correspond-

Table 9. Query coordinates from all documents

Coordinates	Arabic query	Proposed query	Existing query
X,Y	-0.022388, -0.756423	0.033842, -0.7614	-0.65167, 0.3559

ing to how closely the document matches the query (e.g., if this value is one, the document matches the query 100%; if it is 0.5, the document matches the query 50%; and if it is 0.9, the document matches the query 90%). The important step now is to find the coordinates of each document and query. SVD can determine these coordinates, determining the three values S , V , and U using a matrix. This matrix consists of rows and columns containing integers, for which the inputs are different text documents. A feature matrix can be obtained by calculating the frequency of each word. A feature matrix is initially created from all the documents before the SVD is calculated. Subsequently, the supporting variables S , V , and U are calculated using NumPy. The coordinates of all the documents are

Figure 5. Comparison of existing and proposed approaches with Arabic text based on coordinates.

determined from S and are merged with the query to obtain the query coordinates. Finally, a cosine similarity function is applied to these coordinates to find the documents that best match the query.

It is clear that LSI uses the cosine similarity measure to rank the data with respect to the query and to find the points (X, Y) of each document with respect to the query coordinates (X, Y) using Eq. (7). LSI will also determine the query coordinates for Arabic text, Arabic to English converted text using the

proposed technique, and Arabic to English converted text using the existing technique. These query coordinates are shown in Table 9.

$$\text{Similarity}(A, B) = \frac{\sum_{i=1}^n A(i) * B(i)}{\sqrt{\sum_{i=1}^n A(i)^2} \sqrt{\sum_{i=1}^n B(i)^2}}. \quad (7)$$

Table 10 depicts the similarity distance of a sample of 10 Arabic documents that were queried, including queries for the proposed and existing methods.

As shown in Table 11, it is clear that the values of the 2nd column (proposed work) are most similar to the Arabic text, and the values from the 3rd column (existing approach) have many different values. Figure 6 illustrates the comparison of the existing and proposed methods with the Arabic text. The figure clearly shows that the line for the proposed method is much closer to the line for the Arabic text than the line for the existing method is.

In Table 10, the document is 100% closer to the query if the value is one, 50% closer to the query for a value of 0.5, and 90% closer for a value of 0.9. For the Arabic text and the proposed approach (green color), D7, D8, and D10 are close to their queries, whereas for the existing approach (gray color), D1, D2, D3, D6, and D9 are close to their queries, as shown in Table 11. This table represents the proposed method's text converted into English, which is similar to the existing English-converted text.

6. Conclusion

It was concluded that using the proposed work, all Arabic texts such as Arabic stop words, dictionaries, online reviews, tweets,

Table 10. Distance of all documents of datasets from their relevant query

Documents	Arabic	Proposed	Existing
D1	-0.391582646215	0.0433259292082	0.993919277857
D2	-0.0154648277095	-0.000640494192478	0.991839130391
D3	0.279630504392	0.0330440114234	0.999721682081
D4	-0.932286912287	0.79168449571	0.247472435013
D5	-0.249189850556	-0.0273075914125	0.985180590511
D6	-0.22931184731	-0.0446988765309	0.999932316216
D7	0.999998904667	0.999910958682	0.984310426495
D8	0.999501678847	0.999859788963	0.953227104676
D9	0.36976960257	0.383502674056	0.997116046374
D10	0.996134343355	0.997327099051	0.0200963618144

Table 11. Closest documents to relevant query

Approaches	Close to query w.r.t points
Arabic text documents	D7(0.999998904667), D8(0.999501678847), D10(0.996134343355)
Proposed text documents	D7(0.999910958682), D8(0.999859788963), D10(0.997327099051)
Existing text documents	D1(0.993919277857), D2(0.991839130391), D3(0.999721682081), D6(0.999932316216)

Figure 6. Comparison of proposed work and existing work based on similarity distance.

lexicons, Quranic text, and hadith text can be easily converted into English texts, allowing for several types of analyses that require English text as input. Researchers can also use this lexicon to convert Arabic datasets into English texts.

Although Arabic text can be converted into English in a readable manner using these case systems, this readability can also be improved by using other case systems, such as Maddah / ّ /, Dagger Alif / ّ /, Shaddah / ّ /, etc. Future works will focus on converting Arabic texts to English texts by inverting the pairs ASC:ESC to ESC:ASC, ASC.A-FKD:ESC.E-rFKD to ESC.E-rFKD:ASC. A-FKD and ASC. A-T:ESC.E-rT to ESC.E-rT:ASC.A-T with the inclusion of the remaining case systems.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

References

- [1] H. K. Aldayel and A. M. Azmi, "Arabic tweets sentiment analysis: a hybrid scheme," *Journal of Information Science*, vol. 42, no. 6, pp. 782-797, 2016. <https://doi.org/10.1177%2F0165551515610513>
- [2] F. Salem, "Social media and the internet of things towards data-driven policymaking in the Arab world: potential, limits and concerns," MBR School of Government, *The Arab Social Media Report No. 7*, Dubai, UAE, 2017.
- [3] Arabic Language blog, "Arabic Diacritics (Al-Tashkeel)," 2011 [Online]. Available: <https://blogs.transparent.com/arabic/2-arabic-diacritics-al-tashkeel>.
- [4] S. Rose, D. Engel, N. Cramer, and W. Cowley, "Automatic keyword extraction from individual documents," in *Text Mining: Applications and Theory*. Chichester, UK: Wiley, 2010, pp. 1-20. <https://doi.org/10.1002/9780470689646.ch1>
- [5] M. K. Saad, "The impact of text preprocessing and term weighting on Arabic text classification," Ph.D. dissertation, The Islamic University of Gaza, Palestine, 2010.
- [6] A. Conchillo, L. Cercaci, D. Ansorena, M. T. Rodriguez-Estrada, G. Lercker, and I. Astiasaran, "Levels of phytosterol oxides in enriched and nonenriched spreads: application of a thin-layer chromatography- gas chromatography methodology," *Journal of Agricultural and Food Chemistry*, vol. 53, no. 20, pp. 7844-7850, 2005. <https://doi.org/10.1021/jf050539m>

- [7] A. E. D. A. Hamouda and F. E. Z. El-taher, "Sentiment analyzer for Arabic comments system," *International Journal of Advanced Computer Science and Applications*, vol. 4, no. 3, pp. 99-103, 2013. <https://doi.org/10.14569/IJACSA.2013.040317>
- [8] R. Elhassan and M. Ahmed, "Arabic text classification review," *International Journal of Computer Science and Software Engineering*, vol. 4, no. 1, pp. 1-5, 2015.
- [9] S. AlOtaibi and M. B. Khan, "Sentiment analysis challenges of informal Arabic," *International Journal of Advanced Computer Science and Applications*, vol. 8, no. 2, pp. 278-284, 2017. <https://doi.org/10.14569/ijacsa.2017.080237>
- [10] M. Abdul-Mageed, M. Diab, and S. Kubler, "SAMAR: Subjectivity and sentiment analysis for Arabic social media," *Computer Speech & Language*, vol. 28, no. 1, pp. 20-37, 2014. <https://doi.org/10.1016/j.csl.2013.03.001>
- [11] G. Alwakid, T. Osman, and T. Hughes-Roberts, "Challenges in sentiment analysis for Arabic social networks," *Procedia Computer Science*, vol. 117, pp. 89-100, 2017. <https://doi.org/10.1016/j.procs.2017.10.097>
- [12] A. Alowisheq, S. Alhumoud, N. Altwairesh, and T. Albuhairi, "Arabic sentiment analysis resources: a survey," in *Social Computing and Social Media*. Cham, Switzerland: Springer, 2016, pp. 267-278. https://doi.org/10.1007/978-3-319-39910-2_25
- [13] S. Lagrini, M. Redjimi, and N. Azizi, "Automatic Arabic text summarization approaches," *International Journal of Computer Applications*, vol. 164, no. 5, pp. 31-37, 2017. <https://doi.org/10.5120/ijca2017913628>
- [14] N. El-Fishawy, A. Hamouda, G. M. Attiya, and M. Atef, "Arabic summarization in twitter social network," *Ain Shams Engineering Journal*, vol. 5, no. 2, pp. 411-420, 2014. <https://doi.org/10.1016/j.asej.2013.11.002>
- [15] H. M. Najadat, I. I. Hmeidi, M. N. Al-Kabi, and M. M. B. Issa, "Automatic keyphrase extractor from Arabic documents," *International Journal of Advanced Computer Science and Applications*, vol. 7, no. 2, pp. 192-199, 2016. <https://doi.org/10.14569/ijacsa.2016.070226>
- [16] L. M. Al Qassem, D. Wang, Z. Al Mahmoud, H. Barada, A. Al-Rubaie, and N. I. Almoosa, "Automatic Arabic summarization: a survey of methodologies and systems," *Procedia Computer Science*, vol. 117, pp. 10-18, 2017. <https://doi.org/10.1016/j.procs.2017.10.088>
- [17] M. S. Khorsheed and H. Al-Omari, "Recognizing cursive Arabic text: Using statistical features and interconnected mono-HMMs," in *Proceedings of 2011 4th International Congress on Image and Signal Processing*, Shanghai, China, 2011, pp. 1540-1543. <https://doi.org/10.1109/CISP.2011.6100511>
- [18] E. Atwell, C. Brierley, K. Dukes, M. Sawalha, and A. B. Sharaf, "An artificial intelligence approach to Arabic and Islamic content on the Internet," in *Proceedings of NITS 3rd National Information Technology Symposium*, Riyadh, Saudi Arabia, 2011, pp. 1-8. <https://doi.org/10.13140/2.1.2425.9528>
- [19] H. N. Fejer and N. Omar, "Automatic multi-document Arabic text summarization using clustering and keyphrase extraction," *Journal of Artificial Intelligence*, vol. 8, no. 1, pp. 1-9, 2015. <https://doi.org/10.3923/jai.2015.1.9>
- [20] R. Belkebir and A. Guessoum, "A supervised approach to Arabic text summarization using Adaboost," in *New Contributions in Information Systems and Technologies*. Cham, Switzerland: Springer, 2015, pp. 227-236. https://doi.org/10.1007/978-3-319-16486-1_23
- [21] R. S. Baraka and S. N. Al Breem, "Automatic Arabic text summarization for large scale multiple documents using genetic algorithm and MapReduce," in *Proceedings of 2017 Palestinian International Conference on Information and Communication Technology (PICICT)*, Gaza, Palestine, 2017, pp. 40-45. <https://doi.org/10.1109/PICICT.2017.32>
- [22] I. Imam, N. Nounou, A. Hamouda, and H. A. A. Khalek, "An ontology-based summarization system for Arabic documents (OSSAD)," *International Journal of Computer Applications*, vol. 74, no. 17, pp. 38-43, 2013. <https://doi.org/10.5120/12980-0237>
- [23] A. T. Al-Taani and M. M. Al-Omour, "An extractive graph-based Arabic text summarization approach," in *Proceedings of the International Arab Conference on Information Technology (ACIT)*, Nizwa, Oman, 2014.
- [24] N. Alami, M. Meknassi, S. A. Ouatik, and N. Ennahahi, "Arabic text summarization based on graph the-

- ory,” in *Proceedings of 2015 IEEE/ACS 12th International Conference of Computer Systems and Applications (AICCSA)*, Marrakech, Morocco, 2015, pp. 1-8. <https://doi.org/10.1109/AICCSA.2015.7507254>
- [25] F. T. Al-Khawaldeh and V. W. Samawi, “Lexical cohesion and entailment based segmentation for Arabic text summarization (ICEAS),” *World of Computer Science & Information Technology Journal*, vol. 5, no. 3, pp. 51-60, 2015.
- [26] B. Pang and L. Lee, “Opinion Mining and Sentiment Analysis,” *Foundations and Trends in Information Retrieval*, vol. 2, no. 1-2, pp. 1-135, 2008. <https://doi.org/10.1561/15000000011>
- [27] G. Badaro, R. Baly, H. Hajj, N. Habash, and W. El-Hajj, “A large scale Arabic sentiment lexicon for Arabic opinion mining,” in *Proceedings of the EMNLP 2014 Workshop on Arabic Natural Language Processing (ANLP)*, Doha, Qatar, 2014, pp. 165-173.
- [28] L. Fodil, H. Sayoud, and S. Ouamour, “Theme classification of Arabic text: a statistical approach,” in *Proceedings of the 11th International Conference on Terminology and Knowledge Engineering*, Berlin, Germany, 2014.
- [29] A. M. A. Mesleh, “Chi square feature extraction based SVMs Arabic language text categorization system,” *Journal of Computer Science*, vol. 3, no. 6, pp. 430-435, 2007. <https://doi.org/10.3844/jcssp.2007.430.435>
- [30] S. Al-Harbi, A. Almuhareb, A. Al-Thubaity, M. S. Khorshed, and A. Al-Rajeh, “Automatic Arabic text classification,” in *Proceedings of the 9th International Conference on Textual Data Statistical Analysis (JADT)*, Lyon, France, 2008.
- [31] M. N. Al-Kabi, A. H. Gigieh, I. M. Alsmadi, H. A. Wahsheh, and M. M. Haidar, “Opinion mining and analysis for Arabic language,” *International Journal of Advanced Computer Science and Applications*, vol. 5, no. 5, pp. 181-195, 2014. <https://doi.org/10.14569/ijacsa.2014.050528>
- [32] Z. A. Abutiheen, A. H. Aliwy, and K. B. Aljanabi, “Arabic text classification using master-slaves technique,” *Journal of Physics: Conference Series*, vol. 1032, article no. 012052, 2018. <https://doi.org/10.1088/1742-6596/1032/1/012052>
- [33] R. Alshammari, “Arabic text categorization using machine learning approaches,” *International Journal of Advanced Computer Science and Applications*, vol. 9, no. 3, pp. 226-30, 2018. <https://doi.org/10.14569/ijacsa.2018.090332>
- [34] Arabic learning resources: Arabic media vocabulary [Online]. Available: https://arabic.desert-sky.net/g_cases.html.
- [35] QAMUS, “Arabic transliteration,” 2002 [Online]. Available: <http://www.qamus.org/transliteration.htm>.
- [36] “Why Python for Big Data? | Continuum.”
- [37] H. A. Al-Muhtaseb, S. A. Mahmoud, and R. S. Qahwaji, “Statistical analysis of Arabic text to support optical Arabic text recognition,” in *Proceedings of the International Symposium on Computer and Arabic Language & Exhibition (ISCAL)*, Riyadh, Saudi Arabia, 2007, pp. 1-16.
- [38] S. M. Saqib, K. Mahmood, and T. Naeem, “Comparison of LSI algorithms without and with pre-processing: using text document based search,” *ACCENTS Transactions on Information Security*, vol. 1, no. 4, pp. 44-51, 2016.
- [39] S. Deerwester, S. T. Dumais, G. W. Furnas, T. K. Landauer, and R. Harshman, “Indexing by latent semantic analysis,” *Journal of the American Society for Information Science*, vol. 41, no. 6, pp. 391-407, 1990. [https://doi.org/10.1002/\(sici\)1097-4571\(199009\)41:6<391::aid-asi1>3.0.co;2-9](https://doi.org/10.1002/(sici)1097-4571(199009)41:6<391::aid-asi1>3.0.co;2-9)
- [40] D. M. Blei, A. Y. Ng, and M. I. Jordan, “Latent Dirichlet allocation,” *The Journal of Machine Learning Research*, vol. 3, pp. 993-1022, 2003.
- [41] N. Phadnis and J. Gadge, “Framework for document retrieval using latent semantic indexing,” *International Journal of Computer Applications*, vol. 94, no. 14, pp. 37-41, 2014. <https://doi.org/10.5120/16414-6065>

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