2026 آب
Aug 2026
مجلة دراسات في الإنسانيات والعلوم التربوية
Journal of Studies in Humanities and Educational Sciences
Print ISSN 3006-3256 Online ISSN 3006-3264
العدد A14
No. 14A

Recognizing the Passive Voice of Diacritized Arabic Triliteral Verbs in Machine Translation: A Comparative Study of Google Translate and Microsoft Translator

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Abstract

This paper investigates how the diacritic patterns of the passive voice of Arabic triliteral verbs are identified by machine translation (MT) systems when translating from Arabic to English. The passive voice is often constructed by means of diacritics in Arabic due to the lack of prepositional words that express relations between subject and object. This study uses a comparative analysis to investigate how accurately the diacritics of the triliteral passive voice of the verbs are identified by Google Translate and Microsoft Translator when translating thirty Arabic sentences and to evaluate the output by comparing it with the model solutions to verify that the passive voice was translated correctly and to determine the reliability of the translation tools. The results showed that Google Translate had an accuracy rate of 96.7% (i.e. 29 correct translations out of 30) and Microsoft Translator had an accuracy rate of 3.3% (i.e. one correct translation out of thirty). The translation errors that were made by Microsoft Translator were the misuse of the passive voice as gerunds, imperative moods and noun phrases.

Keywords: Arabic morphology, passive voice, triliteral verbs, diacritics, machine translation, Google Translate, Microsoft Translator

التعرف على صيغة المبني للمجهول في الأفعال العربية الثلاثية المشكولة في الترجمة الآلية: دراسة مقارنة بين "ترجمة جوجل" و"مترجم مايكروسوفت"

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ملخص

تبحث هذه الورقة البحثية في كيفية تحديد أنماط التشكيل في صيغة المبني للمجهول للأفعال العربية الثلاثية عند الترجمة الآلية من العربية إلى الإنجليزية. غالبًا ما تُبنى صيغة المبني للمجهول في اللغة العربية باستخدام علامات التشكيل نظرًا لقلة حروف الجر التي تُعبّر عن العلاقة بين الفاعل والمفعول به. تستخدم هذه الدراسة

تحليلًا مقارنًا للتحقق من دقة تحديد علامات التشكيل في صيغة المبني للمجهول للأفعال الثلاثية بواسطة مترجمي جوجل ومايكروسوفت عند ترجمة ثلاثين جملة عربية، وتقييم المخرجات بمقارنتها بالحلول النموذجية للتحقق من صحة ترجمة صيغة المبني للمجهول وتحديد موثوقية أدوات الترجمة. أظهرت النتائج أن مترجم جوجل حقق معدل دقة بلغ 96.7% (أي 29 ترجمة صحيحة من أصل 30)، بينما حقق مترجم مايكروسوفت معدل دقة بلغ 3.3% (أي ترجمة صحيحة واحدة من أصل 30). تمثلت أخطاء الترجمة التي ارتكبها مترجم مايكروسوفت في سوء استخدام صيغة المبني للمجهول كأسماء فعلية، أو صيغة أمر، أو عبارة اسمية. الكلمات المفتاحية: الصرف العربي، المبني للمجهول، الأفعال الثلاثية، علامات التشكيل، الترجمة الآلية، ترجمة جوجل، مترجم مايكروسوفت

الكلمات المفتاحية: الصرف العربي، صيغة المبني للمجهول، الأفعال الثلاثية، الحركات الإعرابية، الترجمة الآلية، ترجمة جوجل، مترجم مايكروسوفت.

1 Introduction

Arabic is a highly inflected language. Many important grammatical distinctions can be indicated through variations in the vowel patterns of individual words without the aid of particles. In triliteral verbs, changes in diacritical marks indicate a switch from the active voice to the passive, so that knowledge of the diacritical marks is crucial in translating from the Arabic.

One of the challenges that a machine translation system has to deal with is that some information is embedded within the verb, and does not have a direct equivalant on the surface of the English sentence. If this information is not identified, the translated voice of the utterance, and consequently the semantic interpretation of the sentence, will be lost. This is particularly true in the case of passive triliteral verbs. A relatively small change in vowels can change the grammatical interpretation of the entire verb.

This study is an attempt to find out the extent to which the passive voice patterns of diacritized Arabic triliteral verbs are translated into English using Google Translate and Microsoft Translator. In addition to evaluating the performance of the two Machine Translation (MT) tools, this study explores the role that morphological analysis and diacritic recognition may play in achieving better machine translation outcomes. A number of sentences that contain passive forms of the verb were used in this study to evaluate the performance of the two tools in terms of retaining the grammatical voice and maintaining the accuracy of the output translations.

1.1 Research Problem

This paper investigates the ability of contemporary Machine Translation (MT) systems to recognize the diacritics that mark the Arabic passive voice for the triliteral roots and to translate them accurately from Arabic to English. The Arabic passive constructions have been a point of weakness in MT since the passive meaning is indicated with changes in the internal vowels of the words rather than with the presence of a particular auxiliary verb. In order for an MT system to preserve the diacritics of the triliteral root and hence to preserve the passive voice and the word order of the output translation, this study aims to investigate and

evaluate the performance of two of the most popular online machine translation tools, namely Google Translate (GT) and Microsoft Translator (MT).

1.2 Research Objectives

1. To investigate the accuracy of translating the passive voice of diacritized Arabic triliteral verbs from Arabic into English using Google Translate and Microsoft Translator
2. To compare the performance of the two systems in preserving the passive voice in the English output
3. To identify the most frequent translation errors that occur when the systems fail to recognize passive triliteral verbs
4. To show the importance of Arabic diacritics and morphological analysis in the correct translation of passive triliteral verbs

1.3 Hypotheses

Based on the rules governing Arabic passive triliteral verbs and the methodology followed in this study, the following hypotheses are formulated

1. Google Translate and Microsoft Translator differ in their ability to translate diacritized Arabic passive triliteral verbs into English accurately
2. Microsoft Translator is expected to produce more structural errors than Google Translate when translating Arabic passive triliteral verbs into English
3. The failure to recognize the passive pattern of Arabic triliteral verbs leads to inaccurate translations in the form of active structures, gerunds, imperative forms, or nominal phrases
4. Accurate recognition of Arabic diacritic patterns contributes to preserving the passive voice in the English translation

1.4 Research Questions

1. How accurately does Google Translate translate diacritized Arabic triliteral verbs in the passive voice into English
2. How accurately does Microsoft Translator translate diacritized Arabic triliteral verbs in the passive voice into English
3. Which of the two systems performs better in preserving the passive voice in the English translation
4. What kinds of translation errors result from the failure to recognize passive morphology in Arabic triliteral verbs

1.5 Significance of the Study

We attempt to address an open question in the Arabic-English machine translation literature that has not been investigated rigorously yet. It is fundamental to Arabic language and machine translation. The Arabic passive voice is formed using vowel diacritical marks and vowels that are closely tied to the morphology of the words. We evaluate the performance of Google Translate and Microsoft Translator in preserving the grammatical voice when the input is a complex case of Arabic morphology. Finally, our evaluation may be used to support other machine translation tools, and is likely to yield better results when large amounts of diacritized and undiacritized Arabic datasets are used.

1.6 Limitations of the Study

The present study is subject to the following limitations

1. The study is restricted to the Arabic triliteral verbs. The quadriliteral verbs and derived forms are excluded from the study.
2. This study only dealt with the passive voice, excluding the active voice and other grammatical structures. The samples of active voice and other structures were excluded in order to make the task of identifying the passive morphology as simple as possible.
3. The analysis is limited to diacritized Arabic input. Since our objective is the vowelization of the passive voice, we were limited to the analysis of verbs that have vowel markings.
4. The dataset used in this study is limited to 30 Arabic sentences. Thus, the experimental results obtained in this study must be interpreted with care.
5. This study is concerned with translation in one direction only, that is from Arabic to English and makes no reference to translations from English into Arabic or into other languages.
6. The assessment of translation accuracy is only possible up to the level of detection of passive voice and the target language. The naturalness of the output, as well as the appropriateness for the context of the text, has not been examined in depth.
7. These findings are only valid for this particular subset of the Arabic machine translation task, which is limited to passive diacritic marked triliteral verbs, and the two machine translation systems chosen for this research.

2.1 Arabic Morphology and the Root–Pattern System

There is a large number of studies dedicated to the study of the morphological structure of Arabic language. They all agree that the morphological structure of Arabic is root-and-pattern, like the other Semitic languages and not like the other

language families. A root (a sequence of 3 consonants) provides the lexical content of a word in Arabic, and the patterns of vowels and syllables are used to derive the inflected and derived forms of the word. Arabic morphology is therefore very different from the concatenative morphology of Indo-European languages where every word is a derivation of a base by the addition of prefixes and/or suffixes. Understanding the morphology of Arabic language implies necessarily knowing its roots and patterns (Martínez et al., 2014; Yaghi & Yagi, 2004)

A typical example illustrating this system is the triliteral root **ك-ت-ب (k-t-b)**, which conveys the general meaning related to writing. From this root, Arabic generates several lexical items through different morphological patterns, such as:

1) كَتَبَ(kataba)– "hewrote"
2) كُتِبَ(kutiba) – "it was written"
3) كِتَاب(kitaab) – "book"
4) مَكْتُوب(maktuub) – "written"

There are a lot of derived words that share the same consonantal root, so the difference in form comes down to the vowels and morphemes that mark the grammatical functions and word classes. The fact that many derived words share the same root and that the difference in the derived words is due to differences in the vowels and morphemes that mark the grammatical functions and word classes suggests that the vowels of the roots carry grammatical meaning (Martinez et al., 2014)

Almost all languages of the world follow a linear concatenative morphology model where morphemes are concatenated together by either prefixing or/and suffixing a root (base) with specific set of features. These features remain the same throughout the word and do not change when morphemes are attached to the root. Arabic and other Semitic languages, however, are non-concatenative in nature where the majority of the morphological information is conveyed through the intra-word changes of the word structure, which mainly occur through the alteration of vowels, and also through changes in syllable structure. For example, even a slight change in the vowels in a word can drastically change the grammatical meaning of the word (Habash, 2010).

Root and pattern is a root and pattern system used in Arabic morphology and is frequently used in the computational literature. Many natural language processing Systems such as part-of-speech tagging, parsing and machine translation rely on this system. Root and patterns are necessary to derive the linguistic properties of the Arabic words and to minimize the amount of possible variations in the analysis and the translation. (Habash, Rambow, & Roth, 2009)

The root-and-pattern morphology of the Arabic root and pattern morphology is highly regular and productive. This is the reason that the root-and-pattern morphology has become the backbone of the Arabic verb system and hence this study will depend on it when dealing with the voice in the Arabic verbs.

2.2 The Triliteral Verb System in Arabic

Morphology of Arabic language is based on triliteral root system. The passive voice in Arabic is formed with some modifications in the pattern of the internal vowels instead of using auxiliary verbs. For example, the root of ك ت ب *(k-t-b)* yields the following forms: كَتَبَ *(kataba) write (masc. third person)* كُتِبَ *(kutiba) was written (passive, third person) C Katie* ب *(kaatib) a writer* كِتاب *(kitaab) book*. In general, the root of the word keeps the original semantic content and the pattern acts as a means to describe the grammatical and lexical function of the derived word, as mentioned by Martinez et al. (2014)

Derived forms Some derived forms of triliteral roots convey different interpretations of the root. Derived forms are produced by applying the so-called verb patterns to the triliteral root, keeping the first and last root consonants while replacing the second consonant in the pattern by one of the root consonants and changing the pattern accordingly. For example, the root of ‘‘د ر س’’ is the derived verb “دَرَسَ” (*darasa*) “*to study*” and “دَرَّسَ” (*darrasa*) “*to teach*”. For derived forms see the section on Arabic Morphology. Derived forms are part of the Arabic language morphological structure, but triliteral root patterns appear more frequently in the Arabic language and therefore are of great importance in the analysis of the language and also in the design and implementation of the Systems that utilize computational methods for analyzing the language. (Habash, 2010)

This paper will discuss the system of vowels that are used in Arabic triliteral verbs to show the difference between the active and passive voice, which is an essential part in our research because there are many cases where the active and passive voice of Arabic triliteral verbs differ in vowels only. For example, the word كَتَبَ *kataba* means “*he wrote*” while كُتِبَ *kutiba* means “*it was written*”. Therefore, the key for determining the difference between the active and passive moods in the triliteral verbs in Arabic language is the diacritical system. So by using the triliteral verbs in the machine translation system is very helpful in checking the accuracy of the diacritical system of the machine translation system in order to evaluate the ability of the machine translation system to recognize and translate the passive voice of the Arabic language to the English language.

2.3 Passive Voice in Arabic Verbal Morphology

In the active voice the subject of the sentence is the performer of the action, while in the passive voice the subject is the receiver of the action and the doer or the agent is either not mentioned or is not known. While the passive voice in English is formed using an auxiliary verb and the past participle, the passive voice in Arabic

is formed by a change in the form of the verb root. In the Arabic language the root of the verb remains the same but the vowel pattern is changed to show the passive (Habash, Rambow, & Roth, 2009); (Alkuhlani & Habash, 2011)

The unchanged root in triliteral verbs exemplifies this. Using the root (q-t-l) for illustration, we see that the pattern of the verb shifts from an active to a passive voice:

1) *قَتَلَ (qatala) = "he killed"*
2) *قُتِلَ (qutila) = "he was killed"*

Voice in Arabic is heavily dependent on the intonation patterns of the words, and hence Morphology becomes a crucial factor in understanding the Arabic Grammar (Ryding, 2005; Habash, 2010). The passive voice is used when the doer of the action is unknown. The passive voice is frequently used in formal writing, in science, in journalism, and in explanatory text. In these cases, the action is not as important as the focus of the action or object being acted upon. This is a feature of the passive voice that is difficult for computer recognition to identify and is one of the reasons that morphology of the passive voice, including selection and projection of vowels, are so fine grained and a source of difficulty for natural language processing and machine translation research ((Habash, 2010); (Habash, Rambow, & Roth, 2009))

Identifying passive voice correctly is an important factor in the Arabic language processing and machine translation. This paper investigates how machine translation approaches deal with the passive voice of Arabic triliteral verbs and their accuracy in translating them into the English language.

2.4 Morphological Formation of Passive Triliteral Verbs

The passive in Arabic is formed by changing the internal pattern of the triliteral verb without the use of auxiliary verbs. Since the roots are invariant, and it is only a matter of changing the pattern of the vowels, the passive voice is fully productive in Classical and Modern Standard Arabic, both in the past and in the present tense. The passive is used when the subject is affected by the action expressed by the verb and in cases when the doer of the action is either not mentioned or is not easily understood. The choice of vowels for the passive voice in Arabic is solely a matter of diacritics, and therefore it is essential to understand the connection between the roots, the diacretics of the vowels, and the meaning of the verb, in order to construct the passive voice correctly.

2.4.1 Passive Pattern in the Past Tense

In the past tense, the passive form of triliteral verbs generally follows the morphological pattern:
1) *فُعِلَ*
This pattern involves the following vowel structure:

- ***ḍamma*** *(ُ) on the first radical*
- ***kasra*** *(ِ) on the second radical*
- ***fatḥa*** *(َ) on the third radical*

These are called vowel changes. Vowel changes are used to change the active voice to the passive voice by keeping the root of the verb unchanged. For example:

Table 1: Passive Pattern in the Past Tense

Active form	Passive form	Meaning
كَتَبَ *(kataba)*	كُتِبَ *(kutiba)*	*it was written*
قَتَلَ *(qatala)*	قُتِلَ *(qutila)*	*he was killed*
فَتَحَ *(fataḥa)*	فُتِحَ *(futiḥa)*	*it was opened*
ضَرَبَ *(ḍaraba)*	ضُرِبَ *(ḍuriba)*	*he was beaten*

These roots do not change and the vowel pattern changes to indicate that the verb is in the passive mood. One more time, Arabic morphology expresses something that in other languages is expressed by the syntax (i.e., the morphology expresses something that would otherwise be expressed by the relationships between phrases). This is called the pattern of the verb built for the unknown agent (Ryding, 2005, p.44; Habash, 2010, p.11).

2.4.2 Passive Pattern in the Present Tense

In the present tense, the passive voice of triliteral verbs generally follows the morphological pattern:
1) *يُفْعَلُ*
This pattern includes the following vowel structure:

- ***ḍamma*** *(ُ) on the prefix* **يـ**
- ***sukūn*** *(ْ) on the first radical*
- ***fatḥa*** *(َ) on the second radical*

These modifications signal that the action expressed by the verb is received by the subject rather than performed by it. Examples include:

Table 2: Passive Pattern in the Present Tense

Active form	Passive form	Meaning
يَكْتُبُ *(yaktubu)*	يُكْتَبُ *(yuktabu)*	*it is written*
يَقْتُلُ *(yaqtulu)*	يُقْتَلُ *(yuqtalu)*	*he is killed*
يَفْتَحُ *(yaftaḥu)*	يُفْتَحُ *(yuftaḥu)*	*it is opened*

The changes for the Arabic passive in the present tense are determined by the morphology rules governing the changes to the prefix and internal vowels of the pattern, with the root consonants remaining unaltered. The locations of the vowels in the pattern are indicated by diacritical marks. Voice marking of a verb is an important phenomenon in the area of computer science and NLP research, because it is crucial for a machine translation system to be able to identify the voice of the verb it encounters, in order to determine whether the verb is in the active or passive voice. In order for a machine translation system to be able to identify a passive triliteral verb in the Arabic language, it is essential that it has a good understanding of the vowel patterns of the passive voice in the present tense of the Arabic verb.

2.5 The Role of Diacritics in Identifying Passive Voice

Vowel diacritics in Arabic are used to show pronunciation and to clarify grammatical forms. The commonly used vowel diacritics in Arabic are fatḥa (ً), ḍamma (ٌ), kasra (ٍ) and sukūn (ْ). The shadda (ّ) is a conjunct diacritic. In casual writing the diacritics are almost always omitted, but they are crucial to the identification of the verb pattern and therefore to the interpretation of the word (Habash, 2010; Ryding, 2005).

Habash, Rambow & Roth (2009): “In the Arabic verbs the diacritics (vowels) can change the tone and thus the pronunciation and even the meaning of the word, as the vowel pattern in the verb conveys some of the grammatical information.” An example of triliteral verbs derived from the root ق-ت-ل *(q-t-l):*

1) قَتَلَ — *qatala — “he killed”*
2) قُتِلَ — *qutila — “he was killed”*

Without diacritics, the form قتل may be read in different ways:

1) قَتَلَ — *qatala — “he killed”*
2) قُتِلَ — *qutila — “he was killed”*
3) قَتْل — *qatl — “killing”*

The ambiguity of vowel patterns and inflectional forms in Modern Standard Arabic is a major obstacle for machine translation and Arabic Natural Language Processing. There are two major sources of ambiguity in the Arabic language that arise from the vocalization and inflectional patterns of MSA words and have been inherited by other dialects. Firstly, it is possible to have different vowel patterns and thus, different inflectional forms that are written with the same spelling, and secondly, it is also possible to have the same spelling for words with different vowel patterns and forms. This ambiguity is largely responsible for the difficulties faced during the translation of the Arabic language and choosing the right set of vowels and forms is crucial for a proper translation.

2.6 Morphological Ambiguity in Undiacritized Arabic Text

Short vowels are often omitted in Modern Standard Arabic and most written forms of colloquial Arabic. Although the diacritics are kept in pedagogical resources and Arabic linguistics, modern unvowelled written forms of Arabic are far more common. As Habash (2010) and Habash et al. (2009) pointed out, the result is high morphological ambiguity, in that a single written form can have several possible pronunciations.

Tense, mood and voice are indicated by the vowel patterns. Because the vowels are dropped, the reader has to depend heavily on the morphology, as well as the grammatical and semantic information in the words to figure out the meaning (Ryding, 2005)

This is clear in the triliteral form قتل, which can be read as:

1) قَتَلَ — *qatala — "he killed"*
2) قُتِلَ — *qutila — "he was killed"*
3) قَتْل — *qatl — "killing"*

While a human reader can easily guess the intended word because of the surrounding context, this becomes a major problem in machine translation. A single word recognition error in a sentence can lead to a complete misinterpretation of the sentence (Habash, 2010; Habash, Rambow, & Roth, 2009)

For example:

- قُتِلَ الرَّجُلُ — "The man was killed"

If the passive form is not recognized, it may be mistranslated as:

1) *"Kill the man"*
2) *"Killing the man"*

Knowledge of the vowel pattern of triliteral verbs is important to know the structure of the Arabic language and for analysis and translation.

2.7 Arabic Morphology and Machine Translation

Machine Translation (MT) is a subfield of natural language processing (NLP) in computer science. Machine translation or MT is a computer-based automatic translation of human language. Commercial MT systems rely heavily on statistical machine translation (SMT) approach and are often implemented using the well-known neural machine translation (NMT) architecture that has been developed over the last decade (Koehn, 2020). Although the recent developments in NMT have achieved many remarkable improvements, highly inflected languages such as Arabic are still a major challenge for commercial MT systems.

Arabic is an inflected language and the grammar of Arabic words can be seen as part of the language itself. In verbs, the tense, aspect, mood, number, gender and voice are expressed through different patterns of roots and vowels as well as through vocalization. For example:

1) كَتَبَ — kataba — "he wrote"
2) كُتِبَ — kutiba — "it was written"

All these studies arrived at the same conclusion, that the root of the verb remains the same and that the vowel patterns simply change the inflection of the voice of the verb (Habash, 2010; Habash, Rambow, & Roth, 2009)

One of the main challenges facing the Arabic Machine Translation (MT) is that the majority of the written Arabic text is created without using diacritic marks. This means that all the MT systems have to deal with the undiacritized text. So, they have to use context clues and statistical probability to guess which form is appropriate. Even deep learning based neural MT systems such as those that are used in Google Translate and Microsoft Translator are prone to produce frequent errors in translating verbs in the undiacritized Arabic input which in turn leads to distorting the meaning of the whole sentence. (Darwish, 2002; Koehn, 2020)

Morphology is important for Arabic Machine Translation (MT) in this case. The passive voice of triliteral verbs is formed mainly through vowel change. So looking at how the forms are translated in MT systems gives us a better idea of how the morphology of Arabic is translated.

2.8 Previous Studies on Arabic Verb Translation and Machine Translation

1. Habash, 2010: Arabic Verb Translation as a Linguistic Challenge

Arabic verb translation is a significant problem in computational linguistics. Arabic language is highly inflected, and a lot of linguistic information is embedded within each word. Also, the addition/removal of a few vowels can significantly affect the

translation of the verb in terms of the tense, voice and the meaning of the translation, which is an additional challenge.

2. Darwish (2002): Arabic Morphology and Ambiguity

Darwish investigated the influence of Arabic morphology on lexical and morphological ambiguity of words. Her experimental results showed that even fully vowelized words may have more than one possible analysis and that ambiguity of words must be resolved before they can be translated by a machine translation system.

3. Habash and Sadat (2006): Morphological Preprocessing

Preprocessing has been investigated by Habash and Sadat in the context of Arabic machine translation. The study reveals that using morphological segmentation and parsing at the preprocessing stage leads to better translations and alleviates more instances of ambiguity, which is preserved in the output proportionally to the preserved relationships in the input sentence.

4. Diab (2009): The Role of Diacritics

Diab presented some statistics on the Arabic language, saying that most Arabic language text is written without diacritics and that this lack of diacritics leads to ambiguity and a lot of difficulties for NLP Systems such as machine translation. He then explained the purpose and the significance of the research that he had conducted on building an automatic diacritization system for Arabic text processing.

6. NMT and Arabic Morphology

Today's state-of-the-art neural machine translation (NMT) models are achieving a high level of fluency and quality in their outputs. Referring to a large number of studies such as Bentivogli et al. (2016) and Koehn (2020), Arabic remains one of the challenging languages. Arabic language, in particular, has complex morphology, where many grammatical differences are indicated by different vowelization and by different suffixes.

7. Jawad and Al-Hadhrami (2016): Translating Triliteral Verbs

The research paper by Jawad and Al-Hadhrami examines the translation of Qur’anic triliteral verbs that include extra morphemes. They came to the conclusion that the Arabic verb morphology is still a challenge in machine translation as the grammatical components of the word are hidden within the vowels of the word.

8. Research Gap in Passive Triliteral Verbs

Arabic machine translation has been widely studied in the literature. There is, however, no investigation into the passive triliteral verbs using diacritic patterns. The passive voice in Arabic is recognized through changes in the internal vowels. If the passive voice is not recognized, the translation outcome would be the active voice in the target language or even that of imperative or nominal forms.

9. Relevance of the Present Study

This study is aiming to show the extent to which Google Translate and Microsoft Translator represent and recognize diacritical marks and the passive morphological structure of the Arabic verbs (Arabic passive triliteral verbs). The research in this regard is rare. Therefore, this study aims at bridging this gap.

2.9 Theoretical Framework of the Present Study

Arabic Verb Conjugation, Root Patterns and Machine Translation This sub-section is a continuation of the previous sub-section on Arabic morphology and diacritics. This sub-section will discuss some other aspects of the Arabic language related to the verb. In Arabic, triliteral roots have a root and pattern structure. The vowels in the pattern carry information related to the voice and therefore the mood of the verb. Since the written form of modern Arabic is usually unvowelled, ambiguity is very high and translation programs can easily fail to translate the correct form of the verb. For this reason, passive triliteral verbs were chosen as a benchmark to evaluate the performance of machine translation programs in translating the morphology of the verb in the Arabic language. The Arabic language has been studied extensively in the literature, especially in the context of machine translation. See (Ryding, 2005; Habash, 2010; Habash, Rambow, & Roth, 2009; Darwish, 2002; Koehn, 2020)

3 Methodology

3.1 Research Design

This study aims to compare the performance of Google Translate and Microsoft Translator in translating Arabic passive triliteral verbs into English. It adopts a comparative design based on both qualitative and quantitative analysis. The qualitative side focuses on identifying the types of errors made by each system when dealing with passive verb forms, whereas the quantitative side measures the overall accuracy of the translated output. The study also examines the extent to which each system can recognize the passive voice through Arabic diacritical marking. In this respect, successful rendering of the passive structure is treated as an indicator of the system’s ability to process Arabic morphological patterns and produce grammatically acceptable English translations

3.2 Data Selection

The dataset consists of thirty short Arabic sentences containing fully diacritized passive triliteral verbs. These sentences were selected from widely used Arabic dictionaries and lexical sources. Attention was limited to triliteral verbs because they represent the basic and most frequent verb pattern in Arabic, whereas quadriliteral and derived forms involve additional morphological complexity and therefore fall outside the scope of this paper. Each example was constructed as a minimal sentence centered on the passive verb in order to reduce contextual interference and allow the translation systems to deal directly with the passive form itself. The translated output was then compared with a human reference translation

3.3 Translation Systems Examined

This study examines two widely used online machine translation systems, namely Google Translate and Microsoft Translator, in order to compare their performance in translating Arabic passive triliteral verbs into English. Both systems are based on neural machine translation and have been developed on large multilingual datasets. They are among the most frequently used tools in online translation practice. The choice of these two systems is based on their accessibility, popularity, and widespread use by students, translators, and general users. In the present study, they are tested on fully diacritized Arabic passive triliteral verbs in order to examine how far each system can recognize passive morphology and preserve it accurately in English translation.

3.4 Procedure

1. The procedure of the study followed a number of clear and systematic steps in order to investigate how machine translation systems recognize the passive voice of Arabic triliteral verbs marked with diacritics
2. To ensure a fair comparison, the same Arabic input was entered into both systems
3. The dataset consists of simple Arabic sentences containing fully diacritized passive triliteral verbs
4. These sentences were constructed to provide clear and unambiguous examples of the passive voice structure
5. The Arabic sentences were first entered into Google Translate, and the English output was recorded
6. The same sentences were then entered into Microsoft Translator, and the English output was also recorded
7. Each output was compared with a human reference translation
8. For every sentence, three versions were presented: the reference translation, Google Translate output, Microsoft Translator output.
9. The purpose of this procedure was to assess the accuracy of passive voice recognition and its preservation in English translation
10. Particular attention was given to cases in which the Arabic passive form was rendered as an active structure, imperative form, gerund phrase, or nominal expression in the translation
11. This procedure made it possible to compare the two systems and examine how each one handled Arabic passive triliteral verbs

3.5 Evaluation Criteria

1. The goal of the experiment was to evaluate the translation output produced by the two machine translation systems used in this study
2. A clear standard was adopted to judge each translation as either correct or incorrect
3. A translation was considered correct if it was grammatically acceptable in English and preserved the passive voice of the Arabic triliteral verb
4. Example of a correct translation

قُتِلَ الرَّجُلُ — The man was killed

5. A translation was considered incorrect if it changed the passive structure into another grammatical form or failed to convey the intended meaning of the source sentence
6. One common error involved confusing the passive form with active, imperative, or gerund constructions, as shown in examples such as

قُتِلَ الرَّجُلُ — Kill the man — Killing the man

7. Another type of error appeared when the output was rendered as a nominal phrase instead of a passive verbal structure
8. A further error was recorded when the translated output was incomplete or grammatically disorganized
9. On the basis of these criteria, the results were classified into accurate and inaccurate translations
10. This evaluative framework was used to compare the accuracy of Google Translate and Microsoft Translator in translating diacritized passive triliteral verbs

4 Data Presentation

Due to the extensive nature of the dataset, the materials supporting the findings of this study have been deposited in Google Drive and are openly accessible at the following link: https://docs.google.com/document/d/1uezmSqQ5xF6jzYn3mDkfe32RykRiRm80/edit#heading=h.b86uqeia82wg

Or Scan the QR to visit the link and review the data presentation:

5 Results and Discussion

5.1 Translation Outputs of the Examined Systems

To evaluate how each machine translation system performs when translating the passive voice of the Arabic triliteral verb, the Arabic sentences used in this study were translated using Google Translate and Microsoft Translator. The output generated by each of the machine translation systems was compared to the reference translation to determine if the passive voice of the Arabic verb was preserved

Table 3: Comparison of Translation Outputs for Passive Triliteral Verbs

Arabic Sentence	Correct Translation	Google Translate	Microsoft Translator
قُتِلَ الرَّجُلُ	*The man was killed*	*The man was killed*	*Killing the man*
كُتِبَ الدَّرْسُ	*The lesson was written*	*The lesson was written*	*Lesson books*
فُتِحَ البَابُ	*The door was opened*	*The door was opened*	*Open the door*
غُلِقَ المَحَلُّ	*The shop was closed*	*The shop was closed*	*Shop closure*
سُرِقَتِ السَّيَّارَةُ	*The car was stolen*	*The car was stolen*	*The car was stolen*
ضُرِبَ الطِّفْلُ	*The child was beaten*	*The child was beaten*	*Hitting the baby*
أُكِلَ الطَّعَامُ	*The food was eaten*	*The food was eaten*	*Eat food*
شُرِبَ المَاءُ	*The water was drunk*	*The water was drunk*	*Drink water*
سُمِعَ الصَّوْتُ	*The sound was heard*	*The sound was heard*	*Hearing the sound*
حُمِلَ الصُّنْدُوقُ	*The box was carried*	*The box was carried*	*Carry the box*

The output produced by the two systems is presented in Table 3, where it can be observed that there is a clear discrepancy between the two. As it is evident from the table, Google Translate preserves the passive voice in the output for all examples except one. However, Microsoft Translator often fails to recognize the passive morphology of the verbs, and as a result, the output translation does not preserve the passive voice that was present in the input Arabic sentence.

Translation errors: passive translated to gerund phrase The passive in the source text is translated to a gerund phrase in the output text as seen in the following examples: Killing the man or Hearing the sound.

Translation errors: imperative translated to verbless nominal phrase Translation errors result in imperative moods in the output text as shown in the following examples: Open the door or Carry the box.

Translation errors: imperative translated to verbless nominal phrase The output text translates the whole sentence into a nominal phrase, leaving the source verb untranslated in the following examples: Shop closure or Lesson books.

The errors appear to arise from Microsoft Translator's inability to identify the morphology of the diacritics on the Arabic passive triliteral verbs. This is likely the result of the software using lexical approximations that are grammatically incorrect. The findings of this paper show that for an exact translation of the passive voice to be given, it is essential to understand the morphological structure of words and in particular for the Arabic language. The passive voice of the triliteral verbs in the Arabic language are constructed using specific vocalization patterns within the verb.

5.2 Error Pattern Analysis

List of errors found in the outputs of the two machine translation tools and comparison* After checking the results provided by the two machine translation tools, the following list of errors was recorded. Most of the errors and trends recorded in the output of Microsoft Translator have been highlighted. While Google Translate usually keeps the passive voice of the Arabic triliteral verbs recorded in the source through the diacritical patterns, the output of Microsoft Translator usually drops the diacritical patterns and produces an arbitrary grammatical structure for the sentence.

Based on the data provided by the translation output errors, four particular patterns of errors were pinpointed.

Table 4: Error Types in Microsoft Translator Outputs

Error Type	Example	Frequency
Gerund phrase	*Killing the man*	*7*
Imperative construction	*Open the door*	*8*
Nominal phrase	*Shop closure*	*11*
Lexical misinterpretation	*Lesson books*	*3*

In the following table we list the types of errors we observed to be the most frequent in Microsoft Translator outputs. - Nominal phrases (11 hits): - Gerunds (7 hits): - Lexical errors (3 hits): Passive voice (a common construction in Arabic) is also one of the major causes of inaccuracies in Microsoft Translator output.

1- Passive Voice Interpreted as a Gerund Phrase

One of the most frequent errors involved incorrectly transforming a passive construction into a gerund or a participial phrase. For instance:

- قُتِلَ الرَّجُلُ

Correct translation:

- *The man was killed.*

Microsoft Translator output:

- *Killing the man.*

Similarly:

- سُمِعَ الصَّوْتُ

Correct translation:

- *The sound was heard.*

Microsoft Translator output:

- *Hearing the sound.*

In this example, the verb is translated as a continuous action, rather than as the passive report on the completion of an action. The passive construction of the source sentence is therefore lost in translation.

2- Passive Voice Interpreted as an Imperative Construction

Another frequent error in this area of English grammar is mistakenly marking a passive verb as an imperative. Example:

- فُتِحَ البَابُ

Correct translation:

- *The door was opened.*

Microsoft Translator output:

- *Open the door.*

Similarly:

- حُمِلَ الصُّنْدُوقُ

Correct translation:

- *The box was carried.*

Microsoft Translator output:

- *Carry the box.*

In these examples the translation is from an explanatory to an imperative form and the function of the sentence is changed to instruct the reader.

3- Passive Voice Interpreted as a Nominal Phrase

In a small number of cases the system produced a nominal phrase instead of a verbal clause. For example:

- غُلِقَ المَحَلُّ

Correct translation:

- *The shop was closed.*

Microsoft Translator output:

- *Shop closure.*

Another example is:

- صُنِعَ الجِسْرُ

Correct translation:

- *The bridge was built.*

Microsoft Translator output:

- *Bridge making.*

These phrases use vocabulary items which are associated with the original verb, but do not replicate the typical constructions of the passive voice.

4- Lexical Misinterpretation of the Verb

A final type of error involved the production of translations that were lexically related to the verb but structurally incomplete or inaccurate. For example:

- كُتِبَ الدَّرْسُ Correct translation:
- *The lesson was written.* Microsoft Translator output:
- *Lesson books.*

This type of translation shows that the system recognizes the lexical root of the words, but is not able to recognize the morphological structure that indicates the verb conjugation.

5.3 Summary of Observed Error Patterns

Upon examining the results of the Microsoft Translator translations, it appears that the System fails to recognize the passive morphology indicated in the diacritics of the Arabic triliteral verbs.

In the next example we see that Google Translate seems to understand the passive of the sentence better and preserves the passive voice in the output English translation. As we see in this example, the translation outcome is heavily dependent on the morphological analysis of the Arabic verb.

This sub-section summarizes the results quantitatively by presenting the frequency of correct and incorrect translations produced by each machine translation approach.

5.4 Accuracy Comparison of the Translation Systems

An analysis of the quantitative measures of the performance of the translators is carried out to better understand the output produced by Google Translate and Microsoft Translator. The correctness of the output generated by both translators is verified with respect to the criteria defined in the Methodology section. Therefore, an output that maintains the passive voice and is semantically correct with respect to the input sentence is considered correct, whereas an output that changes the voice or, in general, a translated phrase that does not respect the grammar of the input sentence is considered incorrect.

The dataset consists of 30 Arabic sentences with triliteral verbs in the passive voice and with diacritics. For each sentence, we have the translations produced by both machine translation systems. This gives us 60 translations to investigate.

Qualitative analysis of results: In the previous analysis we carried out quantitative analysis of the accuracy of the translations provided by the two translation tools for the sample of translations that we provided. Based on that quantitative analysis it is quite clear that the two systems are not equal in terms of the accuracy of the translations they provide. Based on that quantitative analysis Google Translate provided 29 correct translations out of 30 translations and thus achieved an accuracy rate of 96.7% in relation to that sample of translations. On the other hand Microsoft Translator was able to provide only 1 correct translation out of 30

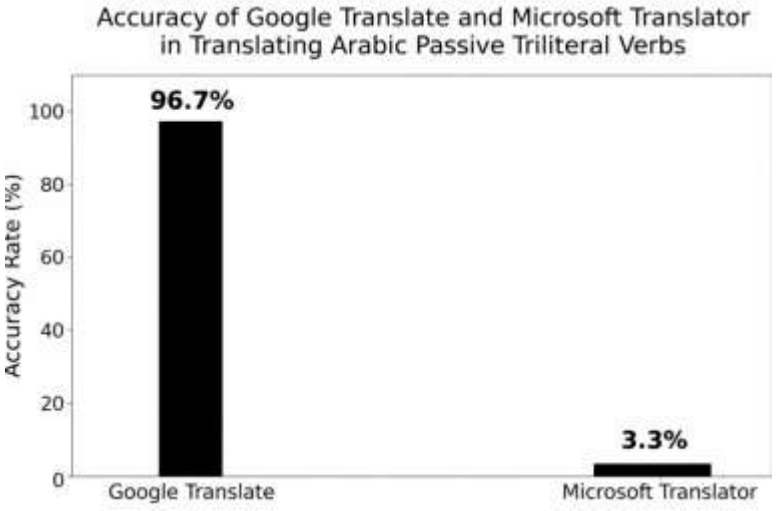
translations and thus achieved an accuracy rate of only 3.3% in relation to that sample of translations.

Table 5: Accuracy Comparison of the Translation Systems

Translation System	Correct Translations	Incorrect Translations	Accuracy Rate
Google Translate	29	1	96.7%
Microsoft Translator	1	29	3.3%

Table 5 indicates that Google Translate achieves a high accuracy in passive voice of triliteral verbs in Arabic with diacritics except for a few exceptions. On the other hand, Microsoft Translator achieves a very low rate of accuracy in translating the passive voice of Arabic triliteral verbs.

Figure 1:



Possible explanations of what caused the error include: A) difference in the handling of Arabic morphology (diacritics) by the translation systems. B) A better recognition of the passive voice morphology of Arabic verbs which is important for an adequate translation of these verbs into English.

5 Discussion

The study examined how accurately Google Translate and Microsoft Translator translate Arabic passive triliteral verbs marked with diacritics. The results showed a clear difference between the two systems. Google Translate usually preserved the passive voice of the Arabic verb, while Microsoft Translator often changed it, which led to changes in the grammatical structure and meaning of the sentence.

This difference is related to the morphological complexity of Arabic. In Arabic, passive voice is often expressed through internal vowel patterns and diacritics, so the system must identify these forms correctly before producing the translation. In this study, Google Translate showed better ability to recognize these morphological signals and preserve the passive voice in English.

By contrast, Microsoft Translator frequently failed to detect the passive form and often translated the verb as a gerund, imperative, or noun. This suggests that it relied more on the root meaning than on the full diacritical pattern needed to identify the passive voice.

The findings confirm that diacritics play a major role in Arabic NLP and machine translation. A system that recognizes diacritic patterns more accurately is more likely to preserve grammatical meaning and produce better translations. Therefore, the study highlights the need to improve morphological processing in Arabic machine translation systems.

6 Conclusion

1. This study investigates whether any of the Machine Translation (MT) engines can detect the passive voice of Arabic triliteral verbs bearing diacritical marks and translate them accurately from Arabic to English. It makes a comparison between two widely used MT engines: Google Translate (GT) and Microsoft Translator (MT) to see how each engine detects and translates the morphological patterns for passive voice in the Arabic verbs.
2. The main objective of this study is to check the accuracy of translating Arabic passive triliteral verbs into English using two online machine translation tools, namely, Google Translate and Microsoft Translator. A comparative analytical approach was adopted in this study to identify the degree of correctness of the two tools in translating the passive voice marked with Arabic diacritical signs. The quantitative results are given in Figure 1 and Table 5. The differences between the results are clear.
3. There are many common errors that are being committed by the Microsoft Translator. Some of these common errors are: - Translating passive sentences into gerund phrases, imperative sentences and nominal sentences. - Many lexical errors. The reason behind these errors is apparently that the system is unable to detect the diacritics of the Arabic triliteral verbs which are used to indicate the passive voice of a sentence.
4. The outcome of the study was to emphasize the importance of the morphological analysis and the diacritic restoration in the Arabic machine translation. The Arabic language has many complexities, particularly in its verbs where the grammatical information is expressed through vowel patterns. For this reason, the translation system must be able to recognize and interpret these vowel

patterns so that the input language retains the grammatical information when it is translated into the output language.

5. Our study is to our knowledge the first quantitative exploration from a broad perspective; that is, the general mechanisms employed by today's state-of-the-art machine translation systems for morphologically complex languages. While neural machine translation has seen rapid progress in the recent years and has led to remarkable improvements in translation quality, there are still a number of open challenges to be addressed, particularly when it comes to dealing with grammatical information hidden within the internal morphological structure of words.

6. The study discussed the use of diacritic marks as a criterion for evaluating the ability of machine translation to handle morphological complexities. The researchers found that the recognition of diacritics is a criterion that can be used in evaluating the performance of the machine translation systems, as it gives an idea about how these systems handle the diacritized forms of the passive voice. The researchers also mentioned that the translation model of these systems does not handle well the grammatical structure of the Arabic language.

7. The researchers suggest conducting further research in this area, with the end goal of having more Arabic roots and more verbs for analysis. the long term goal is to work with a larger set of Arabic verbs, which will cover more derived forms of the verb, and quadriliteral roots. The larger the set of verbs that we can work with, the more information we can gain about the specific performance of machine translation systems for each of the possible morphological patterns found in the Arabic language. Also, analyzing the performance of the systems on undiacritized text would be better, since undiacritized text is much more common in the available written corpus of Arabic.The researchers concluded that some machine translation systems are able to translate correctly Arabic passive triliteral verbs with diacritics, while other systems do not have a full comprehension of the morphology of diacritics that distinguish between the grammatical voice of Arabic verbs. Hence, further research is needed in the area of morphological analysis and machine translation of the Arabic language.

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