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Data steganography in the Holy Quran using diacritics and Vowels Letters

(1) Nooruldeen Subhi Shakir Iraq Commission for Computers & Informatics, Institute for Postgraduate Studies Email: ms202120666@iips.icci.edu.iq

(2) Mohammed Salih Mahdi Business Information College, University of Information Technology andCommunications, Baghdad, Iraq Email: mohammed.salih@uoitc.edu.iq

Abstract

Governments, militaries, organizations, and people all struggle with the challenge of protecting sensitive information sent over public channels. Steganography is a method for establishing covert communication. A lot of steganography methods have been used with text, audio, photos, and videos. Many scholars employed steganography in Arabic manuscripts to exploit the addition, modification, or change of letters or diacritics, however, this resulted in remarkable and suspicious language. This research suggests hybrid steganography methods for Arabic text that use Holy Qur'an as the cover text. The Holy Quran's durability and complexity as a cover in steganography are enhanced by the prohibition against adding, editing, or changing any character or diacritics.. The algorithms use the presence of vowel letters to conceal hidden data parts within Arabic characters. Moreover, examine the presence of specific Arabic linguistic traits denoted as (Arabic Diacritics).

Keywords: Steganography, Arabic Text,Vowel letters, Diacritics, Stego-text

Introduction

Electronic communication is becoming more and more vital as a result of new technologies and their quick development, such as computers, the Internet, mobile phones, and new social media. This is especially true given our growing reliance on the Internet and social media.For the transmission of both classified (secret) and unclassified (non-secret) information, additional channels have been developed. Secret information transmission through the Internet is risky, which is a growing source of worry. Finding innovative communication techniques that ensure the maximum level of confidentiality when sending secret messages is thus becoming increasingly necessary. Secret information has been exchanged via a variety of techniques, including **watermarking** and **steganography**.[1]–[3]

watermark is a digital signal or sample that can also be thought of as a type of digital signature that is directly put into digital data. In order to preserve the copyright ownership of digital statistics, such as text, image, video, and audio.In the system of watermarking, there are two main procedures. Adding the watermark to the original data and removing it from watermarked data, or attacking watermarked data, are both examples of digital watermarking.[4].**Steganography** is a combination of the Greek terms stannous, which means "cover," and graphy, which means "writing." In order to prevent their presence from being revealed by a third party, Steganography is the art of hiding secret communications as well as a technique for concealing sensitive or confidential information and transferring it through a public channel. Steganography's primary objective is to keep people from discovering that there is secret information there Generally[5], [6].every cover has different types there is text-cover, image-cover[7], audio-cover[8], and video-cover[9]. The most challenging and complicated is text steganography, which has been used for a very long timeeven before computers and other modern technology—to transmit messages between secret agents while simultaneously protecting both the sender and the recipient.[10].By utilizing a range of detection techniques, the security objective is to ensure that anyone can’t easily detect the hidden message that is inserted to the stego-text. Three key requirements for steganography techniques should be met: robustness, security, and capacity. **Robustness**is the capability to shield

secret information from destruction when it is sent from the transmitter to the receiver.**Security** is to prevent a third party from finding the concealed information in the stego object, The **capacity**is a measure of how much information a cover text can hide in a given amount of space. [11], [12].Text steganography is, unfortunately,the most difficult fromrest types of steganography because generated stego-cover text needs to be "non-suspected," with no little indication it has been altered to conceal secrecy messages,this objective is most challenging to accomplish in textual than in music or pictures, where little changes to the information can made without changing the origin. In contrast, a small change to a letter in a text could make it unintelligible or grammatically incorrect.[13].Another method for securing information's during data exchange is cryptography. The goal of both cryptography and steganography is the same, but the methods are different. Steganography opposed to cryptography, leave the original information's by embedded it in other mediums, whereas cryptography converts original information to ciphertext.[14]–[20]. Whether or not the original data are subject to encryption, the downside of cryptography is the presence of the original data. Several criteria are used to evaluate robustness in steganography and cryptography. The security of the cryptographic system is compromised when an attacker can access the real data. Alternatively, the steganography system is no longer regarded as safe if the attacker gets access to the secret data.[21]–[27].

RELATED WORK on ARABIC TEXT STEGANOGRAPHY

The Qur'an the Holy Book for more than one-third of the world's population and is written in the traditional Arabic language, yet only a few text steganography techniques are employed for Arabic texts and English texts are the most commonly used language for text steganography.[11],For over 1.7 billion Muslims, Arabic is their primary language. The number of locale and global speakers in the Arab'scountry is 422 million. Arabic rises to the fifth-ranked position in terms of usage worldwide. It'swritten from right to left, and there are 28 different letters in it.[28],Arabic has several characteristics that might be utilized to conceal hidden text. In Arabic, kashida, diacritics, dotted letters, and the Unicode approach are the most often used concealment methods. [2].The authorTayyeh et al., 2019[11]offered a way for hiding the secret information before and after the prescribed sun and moon letters of the Holy Quran which is a combination of diacritical marks, grammatical rules, and Unicode methods. Authors took words from the original text that begin with "al"; they concealed one bit (1) if the sun letter follows (ال) in the word and one bit (0) if the moon letter follows (ال) in the word. According to the established rules of Arabic diacritics, a hidden pair of bits are concealed when a diacritic appears after the sun or moon letters in a word. If the diacritic is (Fatha), bit (1) is concealed, and a bit (0) is concealed if the other diacritics appear.there is technique that rely on Arabic extension characters.Gutub & Alaseri, 2020[29]provided a methodIn order to increase security, it is intended to improve the merging strategy by adding Kashida letters in some places while leaving others ambiguous. This theory might assume that Kashida places are only used in about half of its content, if not even that, in an effort to increase ambiguity. Two changes were proposed; the first used half of the Kashida locations, and the second used two thirds of the locations that showed interesting features. Bi-location, or half-Kashida locations, assumes that data is hidden in one Kashida location while the other is turned off, i.e., one location is taken into consideration and the other is ignored. As an alternative to the bilocation approach, two locations—one on and one off—that are intended to have higher capacities and acceptable security levels are being studied.the author inAl-Dini et al., 2021[30] in Arabic letters There is a letter marked as a special letter in Arabic. These special letters are 'ا' Alif, 'د' Dal, 'ذ' Thal, 'ر' Ray, 'ز' Zay, and 'و' Waw. they appear at the beginning or end of a word, these particular characters in Arabic language are private. When they appear in the middle of a word, these unusual letters cannot be related to the letter next to them. The effectiveness of these special letters was utilized by the author algorithm. The method consists of three separate situations since it is based on the combinations of zero-width characters (ZWC), zero-width joints (ZWJ), and PS.

1. If the letters are unusual letters, the author adds the letters ZWC.
2. To conceal a pair of secret message bits, the author inserts a combination of ZWJ characters between letters that are joined to the following letter or that are isolated from one another.
3. When words are separated by spaces, the author inserts a PS character to conceal one bit of a hidden

message. Pseudo-space (PS), on the other hand, is a character that does not display when printing it.Khekan et al., 2021b [31]The author used the Arabic language's thesaurus and the dots feature of Arabic letters to conceal a number of secret messages within plain text, which allowed him or her to transmit the message through email or social media without drawing attention to the message's secret content or arousing suspicion. One of the more recent techniques in this area for enclosing the secret information inside the ordinary text is the use of Arabic alphabet points. Changing the secret text to be concealed to the binary system and inserting it using the compression technique T-5BE, which is beneficial for lowering the volume of the secret message by 37%, are two methods for concealment. This method compares each word in turn from the plain text with the concealed portion, where the total of the word's litter dots serves as the fundamental unit of analysis. In this case, the word has a hidden bit with a value of if the sum of letters dots in the word is odd (0). and if the word has an even number of litter dots, this indicates that a hidden bit with the value of the word's litter dots is present (1).the author inAlanazi et al., 2022[5]provided a method to include hidden information into Arabic text using Unicode characters, i.e., by adding the generic and context forms of the Arabic character in Unicode, ZWJ, ZWNJ, MSPs, and Kashida. Each letter of the cover text was used by writers to cloak secret bits 1 and 0 by employing different Unicode general and contextual forms, including that of the white space between words according to the future secret bits 1 or 0. The drawback of the recommended technique is that the cover text's visual appeal is degraded when the kashida is applied within the Arabic text's connected letters to hide a concealed portion.

Proposed method

The Arabic alphabet consists of 28 letters and three vowel symbols (ي – و – ا), whose forms vary according to where they appear in anArabic word. The four places for Arabic characters are (start, end, middle, and isolated)[13], table 1 shows an exampleof Arabic letter shapes and other letter shapes with their Unicode depending on their position.
and incorporate various distinct diacritics that are viewed as optional superfluous (additional) characters in the text.it is not often used nowadays, Except for the adornment of Arabic text, preserved calligraphy of the Holy Quran, and Islamic religious literature, [32]. Figure 1 shows the eight main diacritics in the Arabic language,

Original	contextual forms				Letter name
	Isolate	End of word	Middle of word	Beginning of word	
0627 ا	65165 ا	65166 ـا			Alef
0648 و	65261 و	65262 ـو			Waaw
064A ي	65265 ي	65266 ـي	65268 ـيـ	65267 يـ	Yea

table 1 example of Arabic letter shapes depending on their position
and the three vowelsletters

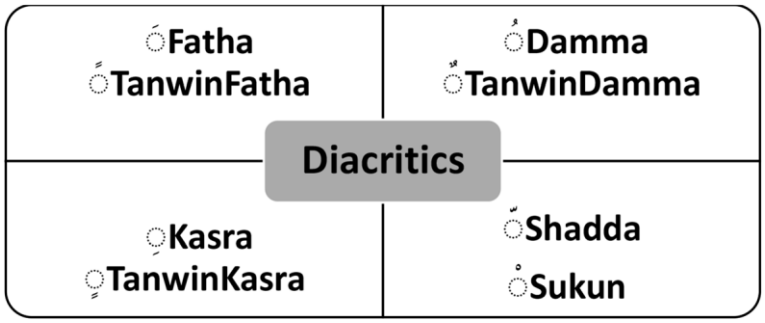

Figure 1 the eight main diacritics in the Arabic language

Non-ASCII characters are supported by the worldwide character encoding standard known as Unicode. All languages spoken in the world and their distinctive character sets are supported by Unicode, which uses (16) bits. Because some languages, like Chinese and Arabic, require extra position bits than the other languages. At the same time, Persian, Urdu, Pashto, Sindhi, and Kurdish are included in the Unicode table for characters in a language like Arabic..[33]. thisresearch the suggested algorithms employ the grammar rule to cover up secret binary data in Arabic text of the Arabic language with the Arabic diacritics (Harakat).it hides a peer of bits in each word that have any vowel Arabic character (ا – و – ي) flowed by any diacritics depending on the roles that we made to hide the secret message.

Hiding process for proposed Algorithm

This algorithm hides two bits in each word with a vowel Arabic letter (ا – و – ي) flowed by diacritics The following Algorithm 1 and Figure 2 will demonstrate the hiding process.

Hiding Algorithm: hiding secret message bits in the Arabic text cover
Input: cover text (sura), secret message
Output: stego text
Step 1: converting secret message to binary string
Step 2: set a pointer (bit) to the first 2 bits in the binary code
Step 3: convert cover text (Quran sura) to an array
Step 4: set a pointer (cover) to the first word in the sura
Step 5: While not the end of the binary code do the flowing
Step 5.1: read 2 bits from the binary code
Step 5.2: **If** read = **"11"** then get a word from the sura that have a letter **(ا)** and flowed by diacritic "Fatha "or diacritic **"**shadda "
step 5.3: if found then changing Unicode of letter **(ا)** To indicate the word hiding **"11"**
step 5.3.1: increase pointer (bit) by 2
Step 5.4: **If** read = **"10"** then get a word from the sura that have a letter **(ا)** and flowed by any diacritic except "Fatha "or diacritic **"**shadda "
step 5.5: if found then changing Unicode of letter **(ا)** To indicate the word hiding **"10"** step 5.5.1: increase pointer (bit) by 2
Step 5.6: **If** read = **"00"** then get a word from the sura that have a letter **(و)** or have the letter **(ي)** and flowed by diacritic "Fatha "or diacritic **"**shadda "
step 5.6: if found then change the Unicode of the letter **()** or have the letter **(ي)To** indicate this word hiding **"00"**
step 5.6.1: increase pointer (bit) by 2
Step 5.7: **If** read = **"01"** then get a word from the sura that have a letter **(و)** or have the letter **(ي)** and flowed by any diacritic except "Fatha "or diacritic **"**shadda "
step 5.8: if found then change the Unicode of the letter **(و)** or have the letter **(ي)To** indicate this word hiding **"01"**
step 5.8.1: increase pointer (bit) by 2
End While Loop
Step 6 :generate the Stego - Text
End hiding Algorithm

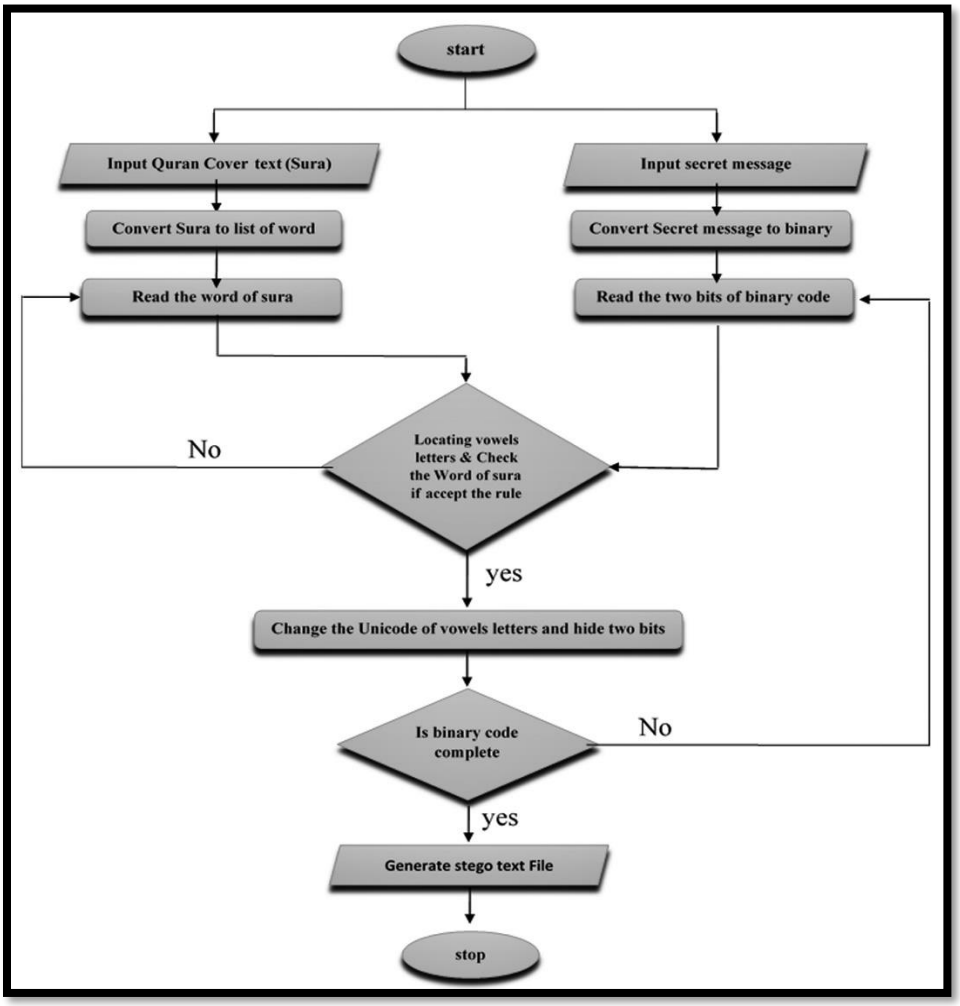

Figure 2 flowchart for Algorithm 1

Extraction process

After the hiding algorithm is finished and the stego text is sent to the receiver it should there is another algorithm to extract the hide bits The following Algorithm 2 and Figure 3 will demonstrate the Extraction process.

Extraction algorithm: extract secret message

Input: stego text
Output: secret message
Step 1: set a pointer to the first word in the stego text
Step 2: While not the end of the stego text do the flowing
Step 2.1: read one word from stego text that has vowels letter its Unicode was changed
Step 2.2: **if** the letter (ا) found flowed by diacritic "Fatha "or diacritic "shadda " then we have two bits of secret the message of "11"
elseif the letter (ا) flowed by any diacritic except "Fatha " or diacritic " shadda " then we have two bits of the secret message of "10"
elseif the letter (و)orthe letter (ي) flowed by diacritic "Fatha " then we have two bits of the secret message of "00"
elseif the letter (و)orthe letter (ي) flowed by any diacritic except "Fatha " then we have two bits of the secret message of "01"
End while loop
Step 3: convert binary secret message to the text
End Extraction Algorithm

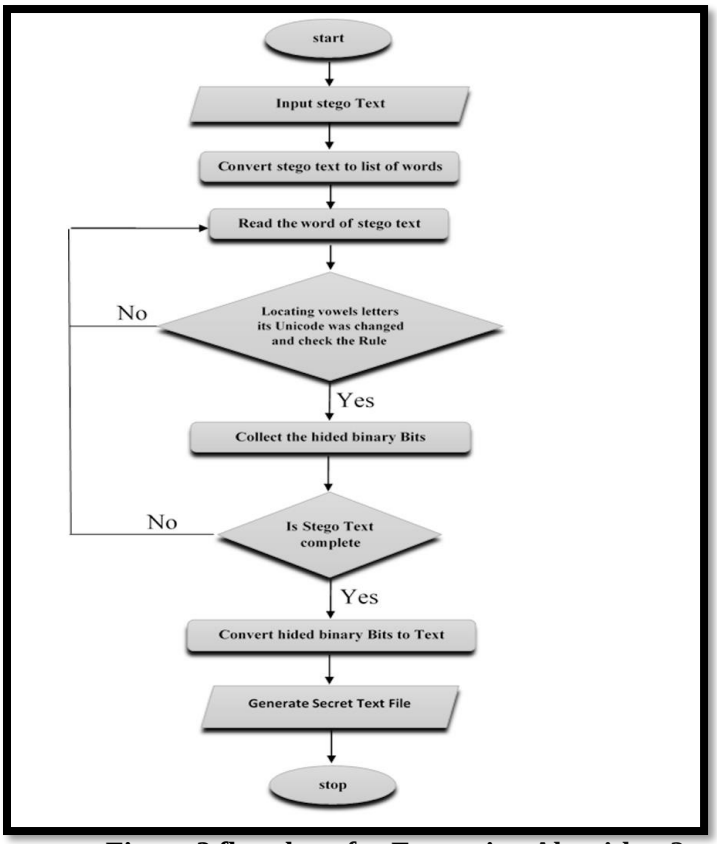

Figure 3 flowchart for Extraction Algorithm 2

Results and Analysis

This section discusses the experimental results.The algorithms that have been suggested use the Holy Quran surahs as a cover to conceal the secret message in Arabic texts. The Holy Quran's surahs have compulsory diacritics, which increases the size of the cover file. The Sura Al-Fatiha cover media are used in this algorithm. Figure 4 shows the cover Text

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ (1) الْحَمْدُ لِلَّهِ رَبِّ الْعَلَمِينَ (2) الرَّحْمَنِ الرَّحِيمِ (3) مَلِكِ يَوْمِ الدِّينِ(41) إِيَّاكَ نَعْبُدُ وَإِيَّاكَ نَسْتَعِينُ (5) اهْدِنَا الصِرّطَ الْمُسْتَقِيمَ (6) صِرَطَ الَّذِينَ أَنْعَمْتَ عَلَيْهِمْ غَيْرِ الْمَغْضُوبِعَلَيْهِمْ وَلَا الضَّالِّينَ (7)

Figure 4 shows the cover Text (sura Al-Fatiha)

Based on the suggested Algorithm's Hiding technique,it search for a word that hasthe letter (ا) and flowed by diacritic “ Fatha “ or diacritic “ shadda “ to hide two bits of “11” and if flowed by any diacritic except “ Fatha “ or diacritic “ shadda “ To hide 2 bits of “10”, and search for a word that has the letter (و) or letter (ي) and flowed by diacritic “ Fatha “ to hide two bits of “00” and if flowed by any diacritic except “ Fatha “ To hide 2 bits of “01” (**Bear in mind that if one of these letters comes in the middle of a word, it must be preceded by one of the separationletters**) and Figure 5 will show how to hide the secret code “11111010000010010110100” in Surat Al-Fatiha

Stego cover	بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ (1)الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ (2)الرَّحْمَٰنِ الرَّحِيمِ (3)مَالِكِ يَوْمِ الدِّينِ (4)إِيَّاكَ نَعْبُدُ وَإِيَّاكَ نَسْتَعِينُ (5)اهْدِنَا الصِرّطَ الْمُسْتَقِيمَ (6)صِرَطَ الَّذِينَ أَنْعَمْتَ عَلَيْهِمْ غَيْرِ الْمَغْضُوبِ عَلَيْهِمْ وَلَا الضَّالِّينَ (7)									
Spatial letters	بِسْمِ	اللَّهِ	الرَّحْمَنِ	الرَّحِيمِ	الْحَمْدُ	لِلَّهِ	رَبِّ	الْعَالَمِينَ	الرَّحْمَنِ	الرَّحِيمِ
Word was changed		■			■			■		
bits		11			11			10		
Spatial letters	مَالِكِ	يَوْمِ	الدِّينِ	إِيَّاكَ	وَإِيَّاكَ	نَسْتَعِينُ	اهْدِنَا	الصِرّطَ	الْمُسْتَقِيمَ	صِرَطَ
Word was changed		■	■		■		■			
bits		00	01		00		10			
Spatial letters	الَّذِينَ	أَنْعَمْتَ	عَلَيْهِمْ	غَيْرِ	الْمَغْضُوبِ	عَلَيْهِمْ	وَلَا	الضَّالِّينَ		
Word was changed	■				■		■			
bits	11				01		00			
Stego Text	بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ (1)الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ (2)الرَّحْمَٰنِ الرَّحِيمِ (3)مَالِكِ يَوْمِ الدِّينِ (4)إِيَّاكَ نَعْبُدُ وَإِيَّاكَ نَسْتَعِينُ (5)اهْدِنَا الصِرّطَ الْمُسْتَقِيمَ (6)صِرَطَ الَّذِينَ أَنْعَمْتَ عَلَيْهِمْ غَيْرِ الْمَغْضُوبِ عَلَيْهِمْ وَلَا الضَّالِّينَ (7)									

Figure 5. The concealing process.of the secret message ‘11111010000010010110100’ in Surat Al-Fatiha means the Unicode of letters (ا,و,ي) is changed in the word to hides 2 bits

To reveal the concealed message (secret bits) from stego text as in the previousexample,The extraction Algorithm will read the stego text word by word and check if the Unicode of vowel letters (ا,و,ي) are changed and by which diacritic its flowed To know which 2 bits it'shiding. Figure 6 will show how its works

Stego cover	بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ (1)الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ (2)الرَّحْمَٰنِ الرَّحِيمِ (3)مَالِكِ يَوْمِ الدِّينِ (4)إِيَّاكَ نَعْبُدُ وَإِيَّاكَ نَسْتَعِينُ (5)اهْدِنَا الصِّرَطَ الْمُسْتَقِيمَ (6)صِرَطَ الَّذِينَ أَنْعَمْتَ عَلَيْهِمْ غَيْرِ الْمَغْضُوبِ عَلَيْهِمْ وَلَا الضَّالِّينَ (7)									
Spatial letters	الرَّحِيمِ	الرَّحْمَنِ	الْعَالَمِينَ	رَبِّ	لِلَّهِ	الْحَمْدُ	الرَّحِيمِ	الرَّحْمَنِ	اللَّهِ	بِسْمِ
Word was changed	☐	☐	■	☐	☐	■	■	☐	■	☐
bits			10			10	11		11	
Spatial letters	صِرَطَ	الْمُسْتَقِيمَ	الصِّرَطَ	اهْدِنَا	نَسْتَعِينُ	وَإِيَّاكَ	إِيَّاكَ	الدِّينِ	يَوْمِ	مَالِكِ
Word was changed	☐	☐	☐	■	☐	■	☐	■	■	☐
bits				10		00		01	00	
Spatial letters			الضَّالِّينَ	وَلَا	عَلَيْهِمْ	الْمَغْضُوبِ	غَيْرِ	عَلَيْهِمْ	أَنْعَمْتَ	الَّذِينَ
Word was changed			☐	■	☐	■	☐	☐	☐	■
bits				00		01				11
Stego Text	11111010000100101101 00									

Figure 6. The extraction process of a Hedin message from stego-text where the Unicode of vowel letters (ا,و,ي) was changed

One of the difficult methods for data concealment is text steganography. Text formatting and size may change when data is embedded in a text document. Consequently, it enhances the possibility of being quickly found. As a sacred book, the Noble Qur'an cannot be altered by adding letters or changing the shape of existing letters. For this reason, the majority of steganography techniques, including linguistic, Kashida, and shifting points steganography, are not used on the Arabic text of the Holy Qur'an. The Holy Qur'an surah, however, is a vast cover hiding text since the Holy Qur'an is rich with diacritics and many peculiar characters.A successful steganography strategy aims to enhance embed overhead capacity and high non-perception from the invader, The suggested technique is a hybrid algorithm that improves the hidden message's capacity by combining Unicode approaches, Arabic text grammar rules, and diacritics. The Equation Formula determines the capability of the algorithm.

capacity = sum of binary bits in secret message/sum of bitsin stego-text

flowing table 2 will show the embedded ratio

cover name	Cover-size kB	Capacity of Algorithm (bit)	Ratio (b/kB)
AlFatihah	0.5	34	68

AlBaqarah98.8	4670	47.2	
Al'Imran56.4	2790	49.4	
AnNisa0.3	22	73.3	
AlMa'ida45.7	2208	48.3	
AlAn'am48.5	2144	44.2	
Yusuf	28.2	1078	38.2
Alroum	13.1	652	49.7
Al'Ankabot	16.1	796	49.4

Total Average Capacity = 51.9

Table 2. Computed Embed Ratios

Conclusion

In this research, a unique strategy for enhancing the impressibility and embedding capability is proposed, which combines Arabic grammar with diacritics using a Unicode-based methodology. The text steganography approach based on vowels letters (ي - و - ا) in Holy Qur'an text, which is the most widely used Arabic text, has been utilized to apply the suggested strategy. Within the term, these letters are redundant. The algorithm used diacritics without using its Technique by adding, shifting, or deleting them; because of the use of lesser letter change and in different places, the algorithm is robust against conventional attacks. The algorithm used the Unicode-based method to change any of the letters (ي - و – ا), so the secret message will be strong against the copy and pest of the text.

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