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Application of odd hexagonal graceful labeling in cryptography

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Abstract
Cryptography is regarded as a scientific discipline that achieves security by converting sensitive information into an unintelligible form that cannot be interpreted by anybody other than the transmitter and intended recipient. There are numerous cryptographic schemes, each with its own affirmative and weak qualities. This paper provides an overview of polyalphabetic cypher techniques that are currently in use for both encryption and decryption of messages. The purpose of this research is to determine the pattern of odd hexagonal graceful labelling of U-star graph $U(S_n)$ and apply it to cryptography polyalphabetic cipher. The polyalphabetic cipher table obtained from the labelling of U-star graph $U(S_n)$is used for message encryption and decryption.

Keywords: Cryptography, graceful labelling, odd hexagonal graceful labelling, encryption, decryption, $U(S_n)$ polyalphabetic cipher table

Introductions

Graceful labeling in graph theory finds its application in various fields such as coding theory, radar, astronomy, security designs, missile guidance, communication networks, X-ray crystallography, and database management. In this chapter we study the application of odd hexagonal graceful labeling in cryptography using $U(S_n)$ polyalphabetic cipher table. Cryptography is an art and science [3]. It is playing a major role in information and security division. The main aim of the cryptography is protecting the data from unauthorized users or hackers. Cryptography is a subject that contains two parts one is encryption and another one decryption [10]. Encryption is a process of converting the plain text to cipher text using some keys [10]. Decryption is a process of converting the cipher text to plain text using the keys [10]. Encryption is an effective way to achieve the security of data. The word of encryption came in mind of King Julius Caesar because he did not believe on his messenger so he thought to encrypt the data or message by replacing every alphabet of data by 3rd next alphabet [3]. The process of Encryption hides the data in a way that an attacker cannot hack the data. The main purpose of encryption is to hide the data from unauthorized parties from viewing, altering the data. Encryption techniques is achieved by using the mathematical operations and shifting techniques. The Simple data is known as Plain text and the data after encryption is known as Cipher text. Cryptography is categorized into two, namely classical cryptography and modern cryptography. Classical cryptography consists of several types, one of which is cryptography polyalphabetic [3]. Cryptography polyalphabetic cryptography is constructed based on substitution, in particular, using many variables [10]. The graph used in this study is a U-star graph with $n \geq 2, n \in N$. This study aims to determine the pattern of odd hexagonal graceful labeling on U-star $U(S_n)$ [10] and its application to cryptography. Cryptography polyalphabetic cipher [3] is cipher constructed based on substitution, specifically using many letter substitution of the alphabet.

Materials and Methods

Application of odd hexagonal graceful labeling on graph U-star $U(S_n)$

Application of odd hexagonal graceful labeling on U-star $U(S_n)$ for cryptographic polyalphabetic cipher utilize the table of $U(S_n)$ polyalphabetic cipher [3]. The $U(S_n)$ polyalphabetic cipher table is a table constructed from a combination of letters. The table is used as a key in encrypting a message. The graph used to form the polyalphabetic cipher table [10] is a graph U-star $U(S_n)$ with n = 12. The graph $U(S_n)$ was chosen because the number of vertices is same as the number of letters in the alphabet plus dots (.) and dash (-). This paper deals with the formation of the $U(S_n)$ polyalphabetic cipher table [10] for the graph $U(S_n)$ with $n = 12$ such that the degree of each vertex at the center of the star graph S_{12} is $n + 1$ [10]. The graph $U(S_{12})$ is shown below.

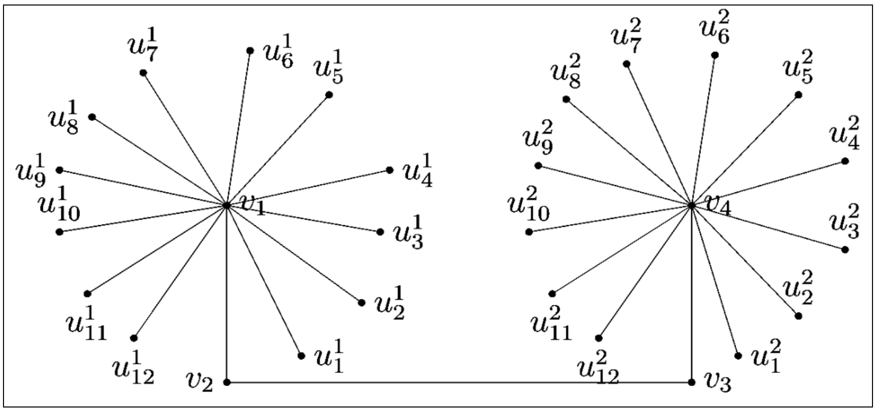

Fig 1: U-star $U(S_n)$

The below figure shows the odd hexagonal graceful labeling of the graph $U(S_{12})$ [10].

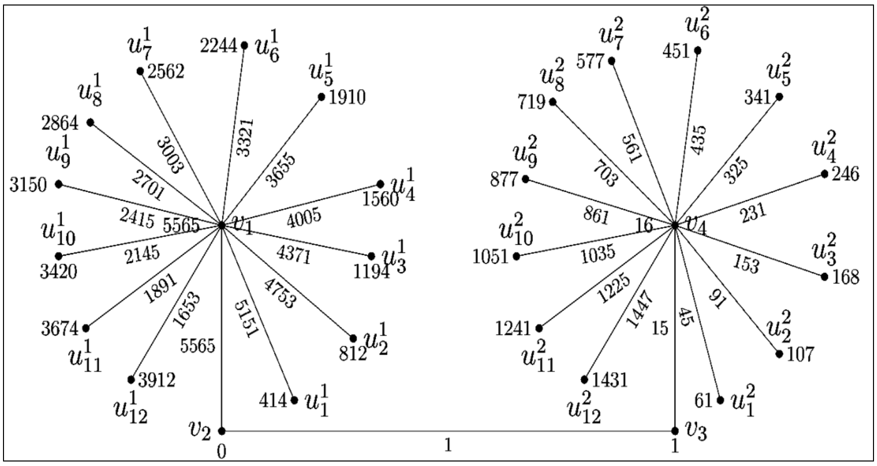

Fig 2: Odd hexagonal graceful labeling of $U(S_{12})$

Here we replace the labels of the vertices and edges into letters and punctuation marks. The vertices v_1, v_2, v_3 and v_4 are transformed to A, (-), (·) respectively. The remaining vertices are labelled with alphabets C to Z in the ascending order. Also, the edge labels are transformed into alphabets from A to Z and (·) in the ascending order. The results of the label transformation obtained are shown in the below figure.

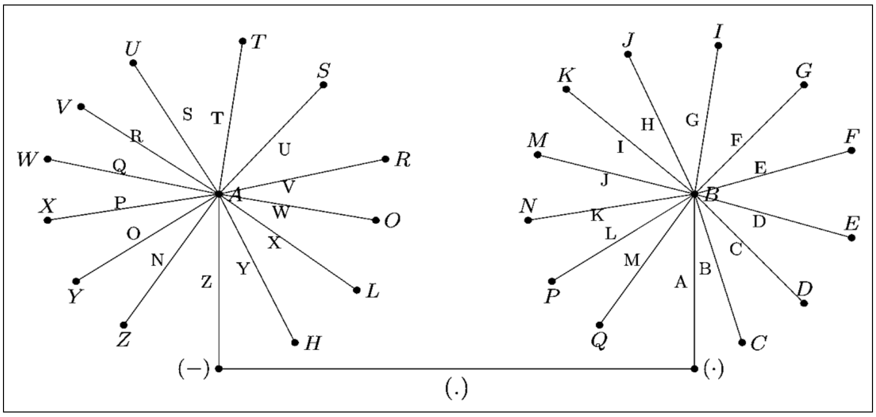

Fig 3: Label transformation of $U(S_{12})$

Labels on each side that are directly related to a vertex are written into the $U(S_n)$ Polyalphabetic cipher table [10]. The $U(S_n)$ polyalphabetic cipher table must have different letters or punctuation marks. It is intended that the ciphertext obtained is more random and avoids the possibility of multiple meanings in the message decryption process. The still empty blocks are filled with letters or punctuation marks that have not been used in other blocks. The results are obtained in table 1. Furthermore, table 1 will be used as a key in encryption and decryption of messages.

Results and Discussion

Encryption and description

Encryption

Consider the plaintext to be encrypted, for successive letters of the plaintext take successive column of $U(S_n)$ polyalbhabetic cipher table and encipher the corresponding alphabet using its corresponding row. Choose the first letter of the plaintext, consider the first column and the row heading that matches the corresponding alphabet, the letter at the intersection of plaintext (column) and corresponding matching alphabet (row) is the enciphered letter.

Suppose the plaintext to be encrypted is Bombardment. Here the first alphabet to encipher is B. So use the first column and the corresponding matching alphabet row B from the table 1, we get alphabet A at its intersection. Similarly, we have the second letter to be enciphered is O. Now use the second column and the corresponding matching alphabet row O from the table 1, we get V at its intersection. The rest of the plaintext is enciphered in the similar fashion. We get the resulting ciphertext, which is shown below.

Ciphertext: AVLDVQIDLGW

Decryption

Decryption is performed by finding the position of the ciphertext in table 1 and then using the corresponding row's label as the plaintext.

Now incase of ciphertext AVLDVQIDLGW, the alphabet A for decryption is in the first position so go along the first column which has A in the first position in the table 1. We have A in the B heading row. Hence B is the first letter of the plaintext. Now choose the second alphabet V. Since it is in the second position, go along the second column of the table and find the position of V. We have V in the O heading row, which is the second letter of the plaintext. Continuing in this way we get the original plaintext

Bombardment: The below table obtained from odd hexagonal graceful labeling of the graph $U(S_{12})$ for message encryption and decryption can be used to send secret messages by soldiers in Indian army and sending official messages from one country to other by higher officials etc.

Table 1: $U(S_{12})$ polyalphabetic cipher table

A	Z	Y	X	W	V	U	T	S	R	Q	P	O	N
B	A	B	C	D	E	F	G	H	I	J	K	L	M
C	B	C	D	E	F	G	H	I	J	K	L	M	A
D	C	D	E	F	G	H	I	J	K	L	M	A	B
E	D	E	F	G	H	I	J	K	L	M	A	B	C
F	E	F	G	H	I	J	K	L	M	A	B	C	D
G	F	G	H	I	J	K	L	M	A	B	C	D	E
H	Y	X	W	V	U	T	S	R	Q	P	O	N	Z
I	G	H	I	J	K	L	M	A	B	C	D	E	F
J	H	I	J	K	L	M	A	B	C	D	E	F	G
K	I	J	K	L	M	A	B	C	D	E	F	G	H
L	X	W	V	U	T	S	R	Q	P	O	N	Z	Y
M	J	K	L	M	A	B	C	D	E	F	G	H	I
N	K	L	M	A	B	C	D	E	F	G	H	I	J
O	W	V	U	T	S	R	Q	P	O	N	Z	Y	X
P	L	M	A	B	C	D	E	F	G	H	I	J	K
Q	M	A	B	C	D	E	F	G	H	I	J	K	L
R	V	U	T	S	R	Q	P	O	N	Z	Y	X	W
S	U	T	S	R	Q	P	O	N	Z	Y	X	W	V
T	T	S	R	Q	P	O	N	Z	Y	X	W	V	U
U	S	R	Q	P	O	N	Z	Y	X	W	V	U	T
V	R	Q	P	O	N	Z	Y	X	W	V	U	T	S
W	Q	P	O	N	Z	Y	X	W	V	U	T	S	R
X	P	O	N	Z	Y	X	W	V	U	T	S	R	Q
Y	O	N	Z	Y	X	W	V	U	T	S	R	Q	P
Z	N	Z	Y	X	W	V	U	T	S	R	Q	P	O

Algorithm for $U(S_n)$ polyalphabetic cipher

Steps for encryption process

Start

1. Show plaintext
2. Divide the plaintext into $n + 1$ equal block
3. Show the $U(S_n)$ olyalphabetic cipher table
4. Match each letter in the plaintext with the corresponding matching alphabets in the column in the $U(S_n)$ polyalphabetic cipher table.
5. Change each letter in the plaintext into ciphertext according to the block sequence in the $U(S_n)$ polyalphabetic cipher table.
6. Show Ciphertext.

7. Finish.

For description start the algorithm by showing the ciphertext instead of plaintext and reverse the process.

Conclusion

Based on the above discussion, it can be concluded that odd hexagonal graceful labeling of U-star graph can be used to generate a table of $U(S_n)$ polyalphabetic cipher. The table is then used as a key for encryption and decryption of the message or information.

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