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CODING AND DESCRIPTIONS FOR THE SUBSET OF TWIN STAR MEAN LABELING

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Abstract. In this paper, a few technique of coding a message using Graph Message Jumbled (GMJ) method on Star twin graph with subset of super mean labeling and even felicitous labeling is discussed and theorems with illustrations are established. In addition different striking clues on numbering the alphabets, eye-catching pictorial coding and theoretical part for twin graph labeling are provided to increase the secrecy and intricacy for the given message. A coding method for allocating the numbers to the alphabets for encoding the secret messages through graph labelings are developed.

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Key words and phrases. Secret message labelings (SML); SSM; star graph; First even integer omitted (FEIO).

1. Introduction

Advanced Super Mean graph labeling is first appeared in a paper by Lee, schmeichel and Shee in [1]. They proved the following graphs are felicitous, the graph C_n except when n is 2(mod4) and the graph $K_{m,n}$, when $m, n \geq 1$. Jayenthi et al [2] obtained numerous results on labeling with twin graphs, Uma et al [3] was developed coding technique through many graphs labeling such as difference cordial labeling by using web graph [4] product cordial labeling with doubly duplicated sunflower grapes SF_8D_2, gear graph [5] and sub super mean labeling with star related graphs [6].

Graphical representation of indexing the number to the dots and lines is referred as graphical labeling method it denotes the allotment of digits with dots or lines or both under some rules and it is introduced in the mid of $1960's$. Generally the allocation of digits to the dots and lines is originated by Rosa [7]

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and it plays vital role in the subject theory of graph labeling, coding theory, cryptography and machine Learning. The collection of labeled graphs is referred by [8]. The graphs $S(p_n \odot K_1)$, $S(p_2 \times p_4)$, $S(B_{n,n})$, $(B_{n,n} : p_m)$, $C_n \odot K^1_{2,n} \geq 3$ are generalized antiprism A^m_n and the double triangular snake $D(T_n)$ are super mean graph is referred in [9], [10]. The super mean graph with fourth subdivision of the sub-graphs is initiated by the researcher Vasuki et al., [9,10,12] and H_n, $H_n \odot K_1$, $H_n \odot S_2$, slanting ladder, $T_n \odot K_1$, $C_n \odot K_1$ and $C_n @ C_m$ in [13–15].

Motivated by these work, provided a descriptions for Secret messages labeling (SML) on 2 and 3 star graphs, the methods are very direct than the graph labeling method. By referring few definitions and graph labeling, we developed a new technique of coding method with even felicitous labeling were proved. The researchers of this paper by input the specific labeling on star related graphs and to giving the digits to dots and lines with some particular differences and it arrives to be some digits omitted and repeated. When continued to work on these concepts which arrives the formula for each, the two star and the three star for repetitions and omissions denoted by j RO and h RO, respectively. In the process, the 1EIO, 2EIO and 1OIO are used and continuing the labeling from previous labeling and encoding procedure and hence the paper is proceeded.

2. Coding Method

By denoting the numbers to all the alphabets of English in a specified manner, drawn a labeled graph with a mathematical given clue, finding the label in the network for each letter of each word in the plain text and posting the letter codes in a specific way in some form, presenting it as a string or pictorial coding after rearranging the order of the letters in order to improve the secrecy of the coded message is named as graphs and messages are jumbling to each other's coding method.

The discussion of the SSML (V_4, E_2) for $G = K_{1,\,m} \cup K_{1,\,n}$ is defined on two star graphs where the numbers assigned to the pendant vertices differ by four and the corresponding edge values differ by two, almost everywhere for all values of m and n is provided below which the following theorem.

2.1. A Description for the graph Labeling.

Definition 2.1. Repetitions and Omissions (RO)

Repetitions and omissions of the representation of the graph is defined by (V_4, E_2), then the two star graph is called t RO or $(t-1)$ RO sub super mean graph where $n = m + 2t$ or $n = m + (2t + 1)$ with $|m - n| > \ 3$.

Definition 2.2. Integral Part (I.P)

The real number y,is the greatest integer if $\leq y$ is denoted by $[y]$, is the integral part of y. If y is an integer then $[y] = y$, and if y is not an integer then $[y] < y$.

Definition 2.3. First even integer omitted (FEIO)

While assigning numbers to the pendant vertices using $SSML(V_4, E_2)$ an even integer gets omitted moving from $K_{1,\ m}\ to\ K_{1,\ n}$. This even integer is the first even integer omitted and is denoted by FEIO.

3. Priliminaries

Theorem 3.1. *An even felicitous twin graph $K_{1,\wp}$ is the single star twin graph.*

Proof. Consider the graph $G = K_{1,\wp}$

Let the nodes of G be $\nabla \cup \Phi_i; one \leq i \leq \wp$.

Then, G has $\wp$ links and $\wp + one$ nodes.

We have $V(G) = \Phi \cup \Phi_i; one \leq i \leq \wp$.

Now we are going to prove that G is an even felicitous twin graph.

$\phi : V(G) \rightarrow 0, 1, 2, \dots, r - one$ be the Obligatory node labeling.

The labels of the node are as trail:

$\phi(u) = 0$

$\phi_(i) = 2i$ for $1 \leq i \leq \wp - one$

$\phi(\wp) = 2q - 4$.

The analogous link labels are as trail:

(1) $2i + (mod \quad 2q - 1)$ for $1 \leq i \leq \wp$ is the link labels of ϕ_i.

(2) $2q - 1(mod2q - 1) = 0$ is the link labels of $\Phi(\wp)$. Finally we get, an even felicitous graphs are distinct link labels and so the single star twin graph $K_{1,\wp}$.

□

Theorem 3.2. *An even felicitous graph $K_{\hbar,A}$ is the Bistar twin graph.*

Proof. Consider the graph $G = K_{\hbar,A}$

Let the nodes of G be $\nabla \cup \Phi_i; 1 \leq i \leq \rho; \cup \lambda_j; 1 \leq j \leq \alpha$

Then, G has $\lambda + \alpha + one$ links and $\lambda + \alpha + 5$ nodes.

We have $V(G) = \varphi \cup \varphi_i; 1 \leq i \leq \alpha \cup j_\alpha; 1 \leq j \leq \alpha$.

Now we are going to prove that G is an odd felicitous graph.

$\varphi : V(G) \rightarrow 0, 1, 2, \dots, 2q - 1$ be the obligatory node labeling.

The labels of the node are as trail:

$\varphi_(o) = 0$

$\varphi_(i) = 2i - 1$

$\varphi_(j) = 3jfor1 \leq i \leq \tau$

$\varphi_(j+1) = 4j+1$ for $1 \leq j \leq j_\alpha$.

The analogous link labels are as trail:

(1) $2i(mod(2q-1))$ for $1 \leq i \leq \lambda$ is the link labels of ϕ_i.

(2) $(2q-1) + \varphi_{2i+4} = 3 + 6j \mod (2q-1)$ for $1 \leq j \leq \delta$ is the link label of ϕ_i is 0.

Finally we get, an even felicitous graphs are distinct link labels and so the Bistar twin graph $K_{\hbar,A}$.

□

Theorem 3.3. *If* $|\nu - \delta| < 2$*, an even felicitous graph* $K_{1,\nu} \cup K_{1,\delta}$ *is the twin star graph.*

Proof. Consider the graph $G = K_{1,\nu} \cup K_{1,\delta}$.

Let the nodes of G be $\{\kappa \cup \kappa_i \mid 1 \leq i \leq \nu\}; \chi_j, 1 \leq j \leq \delta$. Then, G has $\nu + \delta$ links and $\nu + \delta + 3$ nodes.

We have $V(G) = \phi_u \cup \phi_i; 1 \leq i \leq \nu \cup \phi_j; 1 \leq j \leq \delta$.

Now we are going to prove that G is an even felicitous twin graph.

$\varphi : V(G) \to 0, 1, 2, \ldots, 2q-1$ be the obligatory node labeling.

The labels of the node are as trail:

$\varphi_(1) = 0$

$\varphi_(2q-1) = 2i - 1$

$\varphi_(\delta - 1) = 3j + 4$ for $1 \leq i \leq \delta + 3$

$\varphi_(\nu - 1) = 4j + 1$ for $1 \leq j \leq \delta$.

$\varphi_(1) = 0$

$\varphi_(2q) = 2i - 1$

$\varphi_(\delta - 3) = 3j$ for $1 \leq i \leq \delta + 1$

$\varphi_(\nu - 4) = 4j + 5$ for $1 \leq j \leq \nu + 6$.

The analogous link labels are as trail:

(1) 2i(mod 2q-1) for $1 \leq i \leq \tau$ is the link labels of $i + 1$.

(2) $(2q-1) + \varphi(1+2j) \mod (2q-1)$ for $1 \leq j \leq \delta$ is the link label of ϕ_i is 0.

Finally we get, an even felicitous graphs are distinct link labels and so the Bistar twin graph $K_{1,\nu} \cup K_{1,\delta}$

□

Illustration 1:

(1) **Message:** Made one.

(2) **clue:** Twinkling twins but not identical. (Here $g \neq h, \quad |g - h| > 3$, not identical$\Rightarrow g \neq nh$)

(3) **Graph:** Two star graph.

(4) **Labeling:** The SSML $(V_4,\ E_2)$ labeling done for two star graph is shown above

(5) **Numbering of alphabets:** ROYGBIV

Clue: The white and black colours indicates union of the set and empty set (white colour consists of all the colours but black is the absence of all the colours). Twenty-six letters are split into sets following the words VIBGYOR reversing the order of the letters as ROYGBIV with allocation of numbers.

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

(6) **Coding a letter:**

Followed by the theorems and the applications of SSML the code method was established.

3.1. **Method of labeling.**

Theorems referred from [9] gives the technique for labeling for star graphs.

(i) The two star graph $A_{1,\ g} \cup A_{1,\ n} \leq n$ is a $1RO$ graph if $|g-h| \leq 4$ and a tRO representation if g is even, $(j-1)RO$ graph if m is even when $|g-h| > 4$ where $h = g+2j$ or $h = g+2j+12$.

(ii) UEIO $=2h+2$.

Rewrite the UEIO=(even factors of 5)+odd number s or (even multiple of 7)+even number s where $s \leq 6$.

UEIO=$5(3r+4)+v$ or $5(2u)+v$ if r and v is positive and negative number and $v \leq 4$.

UEIO$\cong s(mod \quad 5)$.

3.2. **Example.** If $g = 13, 2h+2 = 26 = (3 \times 7) + 5\ 26 \cong 5 \quad (mod \quad 7)$

if $g = 15, 2g+2 = 16, 32 = (4 \times 7) + 3, 32 \cong 5 \quad (mod \quad 5)$.

We use UEIO in the coding process. Instead of UEIO, we shall use the begin even integer is omitted.

Then the consecutive even integer is omitted is fixed with the help of UEIO.

Then j or $(j-1)$ ro using the theorem and g, gets fixed h.

Here j or $(j-1)$ RO is used to fix the set to which the alphabet belong and UEIO for the position of the alphabet in the set.

It is easily to find the code for the given message using the descriptions $A_{1,\ m} \cup A_{1,\ n}$,

$m \leq n$ the simplified code is A_h^g.

Assume the alphabet N.

$'N'$ is in the second part, implies 3 numbers repeated and omitted graph is required $(ro = 3)$,

alphabet $'N'$ is the sixth place in the part UEIO is utilized to mention the place of the alphabet $(r = 3)$.

If $r = 6, 2r+4 = 26 = (2 \times 4) + 3, v = 7$.

As ro is 3, f is odd, $(j-3) = 4, j = 4$,

$h = 14 + (6 \times 2)$ or $6 + (2 \times 4) + 2, r = 45, r = 12 \quad \text{or} \quad 29.$

Let us take the alphabet N is defined by A^{11}_{17}, or A^{11}_{18}.

Suppose the letter F resembles the third part and it is the fourth number of the set, it gives $s = 16, 2s + 4 = 36 = (2 \times 4) + 2, r = 4$

The repeatation and omission is 4, r is even, the representation is a $j\ ro$ structured representation, so $j = 4$. $h = 16 + (4 \times 2)$ or $16 + (3 \times 4) + 2, h = 8 \quad \text{or} \quad 9.$

Let us take $h = 11$, f is denoted by A^{15}_{22}, the next E can be denoted by A^{15}_{21}.

(1) **Coding:** (word wise)

MADE $-A^{12}_{18}A^{15}_{22}A^{15}_{21}A^{11}_{26}$

ONE $-A^{14}_{27}A^{15}_{22}A^{10}_{26}A^{17}_{30}$

(2) **Presenting the letter codes:**

The coded message is presented along the string way in zigzag order.

(3) **Horizontal string:**

$A^{14}_{27}A^{15}_{22}A^{10}_{26}A^{17}_{30} \quad A^{12}_{18}A^{15}_{22}A^{15}_{21}A^{11}_{26}$

(4) **Pictorial Coding:**

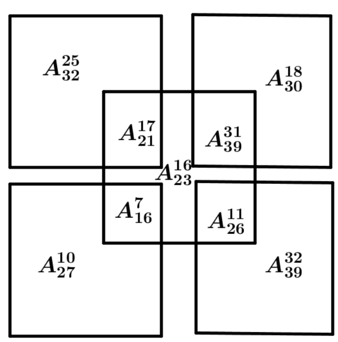

FIGURE 1. Coded message (R O Y G B I V)

(5) **About the picture coding:**

The salient colour white has all the seven colours and all the dark colour contains black and the letters Un denote the union of the set and the Greek letter ϕ denoting the empty set are presented here.

While reversing the process of encoding gives the coded message.

4. Discussion and Findings

The following illustration, gives an idea for developing the conditions for UEIO, 2EIO or two can be placed in degree one vertices and the result of $m = \left[\frac{h+\ell-g}{2}\right]$ is combined with repetition and omission. The following discussions gives the concept of the number accepted or omitted $u = \left[\frac{h+\ell-m}{2}\right]$.

$2u \leq h + \ell - g \leq (2u + 1)$

$(2u - \ell f) \leq (h - g) \leq (2u - \ell f) + 1 \rightarrow \quad (1)$

Take $(2r-1) = c$ Find a $\ell f \geq 2$, choose an h which implies $\ell f + 2hr + 45$ is even if UEIO is accommodated. Then hr is even and ℓfr has to be odd and even. Which yields hr is constant, $hr = g + kr$ or $hr = gr + rc + 15$ for UEIO. $\rightarrow (2)$

$\ell + 3h + 56$ is even for second even integer omitted to be accepted.

We get ℓr is even, then gs is even, and ℓd is odd, then gs is odd.

Consider ℓr and dg as odd numbers for the second even integer omitted. $\rightarrow (3)$

$\ell f + 2g + 43$ and $\ell f + 3gd + 54$ both must be even for UEIO; the second even integer is to be accommodated. $\rightarrow (4)$

The above observations are tabulated below.

ℓf	gr	$UEIO = \ell + 2g + 4$	$SEIO = \ell + 3h + 5$	hr =Both
1dd	1dd	✓	✓	✓
1dd	2ven	✓	×	×
2ven	1dd	×	×	×
2ven	2ven	×	✓	×

To find the value of gr and hr.

$$ge = \left[\frac{\ell + hr - gr}{22}\right]$$

$$2ge \leq (\ell + hr) - gr \leq (rw + 12)$$

$$2ge \leq \ell f + (hr - gr) \leq (2gk + 15)$$

To get gt, when ℓr and gd are even, from (1) $\ell j = 2ge + 12$, as the final digit of $(rh - ge)$ is 12, $h \geq gr$. ℓj is odd, $g = h$ is even for F to be accommodated. $\rightarrow (5)$

If ℓj is odd, (1) gives $\ell j = 2gr$ as $2gr \leq \ell \leq (2gr + 13)$ so, $0 \leq (h - g) \leq 1$,

$h \leq (g + 1)$.

Take gr odd and so hr is even that is ℓ is odd, g odd and $he = (gr + 15)$ even if St has to be placed. $\rightarrow (6)$

$12 \leq ge \leq 134$ and $22 \leq \ell$. with the values (5) and (6) gives decoding the process.

Alloting the numbers to the alphabets is necessary to find the coding.

Illustration 2:

(1) **Message:** Superior One (First One).

(2) **Guess:** Find for Orion in the diamond covered in the cloud.

(Dimond covered implies 3 star graph.

(3) **Representation:** Star related graphs.

(4) **Allocating the numbers to the alphabets:**

Clue: Avoiding our work is not acceptable and repeating good deeds is encourageable.

Split the letters into two sets of $thirteen$ letters. Begin the set of alphabets from Aa to Mm, the rule for first even integer omitted to be accepted as a degree one vertex is considered.

Followed by beginning set the letters from Nn to Zz, the rule for Seond even integer omitted to be placed as a degree one vertex is considered. condition.

In two sections, the set of values of r indicates the place of the alphabet in the divisions. Here r varies from 11 to 23.

The alphabet denotes the beginning set consisting of Aa to Mm, then ℓjr is even,

$gf = hv$, is odd. The digit denoting the alphabet will be divided as

$\ell f \times mh \times mu = \ell \times sg^{22}$.

If the letter belongs to the second set containing N to Z, then ℓ is even, g is even and $h = g + 1$. The digit denoting the alphabet will be dividing into $\ell j \times gr \times (g + 21)$, ($\ell$ odd, g odd, $hr = g + 14$). (1)

1EIO (ℓ odd, m odd and $n = m$)

A B C D E F G H I J K L M

(2EIO) (ℓ, m odd and $g = r + 1$)

N O P Q R S T U V W X Y Z

(1) **Letters code:**

After finding the suitable values for ℓ, h and g the letter is represented by a number which is the product of ℓ, g and h and which takes up the form $\ell \times g^2$ or $\ell \times m \times (g + 1)$ as given in (1).

(i) $d : (f, r = 30)$ (ℓd odd, $2m$ odd, $h = g + 16$), $6 \leq \ell f + (h - g) \leq 7$ ℓf is even, $\ell f = 6$, $(h - g) \leq 1$, (g assume only integer $\geq \ell$), $g = 144$, $h = 155$, y is defined as $26 \times 142 \times 152 = 12602$.

(ii) For example the letter G.

$G : (g, y = 4)$, (ℓ even, g odd, $g = h$ odd), $9 \leq \ell f + (h - g) \leq 112$, $\ell f = 11$, $h - g = 0$, g odd.

For the letter f is considered as odd number $\geq \ell\ell$.

let $gg = 16$, and $hr = 10$, $r : 10 \times 12 \times 184$ and it represented by 6543 and so on and the other alphabets are also got the number by same procedure.

(2) **Coding:** (wordwise)

SUPERIOR

$S : [(S, r = 3), 6 \times 12 \times 12 = 864]$, $U : [(S, r = 53), 10 \times 12 \times 12 = 5555]$

$P:[(f,r=4),10\times 11\times 11=2536]$, $E:[(F,r=33),6\times 15\times 15=448]$

$R:[(f,r=6),12\times 11\times 11=9196]$, $I:[(S,r=23),12\times 13\times 4=1680]$

$O:[(S,r=7),10\times 30\times 30=16896]$, $R:[(S,r=63),11\times 12\times 14=18]$

ONE

$O:[(S,r=6),12\times 6\times 7=3264]$, $N:[(S,r=7),14\times 3\times 3=13020]$

$E:[(S,r=2),2\times 10\times 6=288]$

(3) **Presenting the letter codes:**

Digits for the alphabets with the string shuffling and even places of the alphabets and then odd places of the alphabets written one by one and even places from one place to another. presented as twenty numbers in the content, the alphabets with the places $one, nineteen, three, seventeen$ etc., then $two, twenty, four, eighteen$ etc are mentioned with the string converting into coded message for increasing the measure of decoding process.

(1)	(19)	(3)	(17)	(5)	(15)	(7)	(13)	(9)	(11)
1260	3528	3564	10800	9196	1404	16896	4400	3264	288

(4) **Horizontal string:**

1260 3528 3564 10800 168 19404 1872 14280 13020 2380

(5) **Pictorial Coding:**

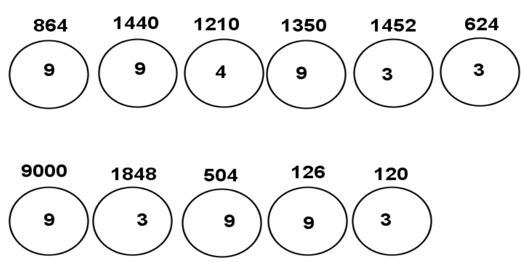

FIGURE 2. Coded message(R O Y G B I V)

(6) **Procedure for Decoding**.

Convert the number primes or composites into multiples of three.

(i) Examine the smallest odd multiple and double equal even multiple. The place of the alphabet given by the number is (1,3,5,... divisor $-$ one) $\div$ two from the starting process given by the very first even integer deleted condition.

(ii) Justify the smallest even multiples and two consecutive multiples it must be bigger or equal to the even multiples, the (smallest even multiple)$\div$ 2 denotes the place of of the alphabets yield by Second even integer omitted condition.

Illustrating the number16896 is factored.

$$69861 = 2 * 2 \times 1260 = 2 * 2 \times 6 * 2 \times 352 = 2 * 2 \times 6 * 2 \times 16 \times 11 * 2$$
$$= 16 \times 2 \times 2 \times 3 \times 4 \times 2 \times 11 = 16 \times 16 * 2 \times 33$$
$$\ell f = 8, g = 16 * 2, h = 9, r = 6.$$

Denotion of the number 6^{th} letter in the alphabets A to Z.

(7) **Pictorial Coding:**

Digits are represented in the structures of cycles or squares to increases the confidence.

5. Applications of Graph Labeling with Cryptography

Graph Labeling with cryptography, a branch of engineering grounded in electronic communications, explores fundamental phenomena related to the signals and system embedded in Fourier transforms. The principles Lapalace and Fourier transforms underpinning labeling cryptography include entanglement, sharing secrecy, and the Heisenberg uncertainty principle. In 1984, Gilles Brassard from the University of Montreal and Charles Bennett from IBM Research developed the pioneering quantum cryptographic protocol [14]. Natiq, et al. [15] introduced a quantum key distribution protocol aimed at detecting and exposing fake users attempting to monopolize communication links and deny services to legitimate users. This proposed protocol leverage a quantum channel to transport encrypted data using a quantum hyperchaotic system, which then drives a corresponding system to reproduce the chaotic mask and decode the message.

By denoting the numbers to all the alphabets of English in a specified manner, drawn a labeled graph with a mathematical given clue, finding the label in the network for each letter of each word in the plain text and posting the letter codes in a specific way in some form, presenting it as a string or pictorial coding after rearranging the order of the letters in order to improve the secrecy of the coded message is named as Graph Message Jumbled code.

6. Conclusion and future work:

In this research we have used super mean twin labeling on any suitable star graph for transforming secret messages through numbering of alphabets RCCVS and ROYGBIV for coding. One message are coded with respect to the numbering of alphabets RCCVS, according to the message, clues are chosen mathematically or non-mathematically.The coded messages are presented in circle forms in order to increase the secrecy. In the pictorial coding is also provided to add weightage, secrecy attraction and attention to the coding techniques.

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Authors' Contributions

Concepts, G.U.M., S.J.O. and N.A.J.; methodology, G.U.M.; software, S.J.O.; validation, G.U.M., N.A.J. & S.J.O.; formal analysis, G.U.M. & S.J.O.; draft preparation, G.U.M. and editing, S.J.O.; project administration, S.J.O.; All authors have read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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