Radio analytic mean labeling of some graphs

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Abstract: A Radio Analytic mean Labeling of an associated diagram G is a balanced guide V from the vertex set v(G) to the arrangement of \( z^+ \) with the end goal that for any two distinct vertices x and y of G. \( d(x,y) + \left\lfloor \frac{|L(x) - L(y)|}{2} \right\rfloor \geq 1 + \text{diam} \ G \). The Radio Analytic mean number of n, \( \text{RAMN}(n) \) is the greatest number relegated to any vertex of G. The Radio Analytic mean number of G, is the least value of \( \text{RAMN}(n) \) taken over all Radio Analytic mean labeling n of G. In this paper we locate the radio Analytic mean number of splitting of Bistar graph, standing graph, wheel graph.

1. Introduction

First introduced the idea of Graph Theory by Euler. All the graphs are Limited, Basic, undirected and associated diagrams. Let V(G) and E(G) denote the vertex set and edge set of G. First defined the concept of Radio Labeling of Graph G. Motivated by problems we consider the Radio k Labeling of Cartesian product of two Graphs. In various Authors are discussed in Radio multilevel distance Labeling for path and cycles, Radio number of trees, Radio number of square of paths in. Radio Labeling of Graph is motivated by restrictions in assigning channel task for Radio Transmitters [8].

In Further R.Ponraj, S.Sathishnarayanan, R.Kala introduced the notion of Radio mean Labeling of a Graph [9]. A Radio mean Labeling of a connected Graph G is a one to one map \( f \) from vertex set V(G) to the set of natural N, two distinct vertices of u and v of G. The Radio mean condition defined in \( d(u,v) + \left\lfloor \frac{|f(u) - f(v)|}{2} \right\rfloor \geq 1 + \text{diam} \ G \). For every pair of distinct vertices in G is called Radio mean labeling. The highest number assigned to any vertex of G on \( f \) is called Radio mean number of \( f \) denoted by rmn(f). The Radio mean number of G is the minimum value of rmn(f) taken over all Radio mean labeling \( f \) of G.

D.S.T.Ramesh, A.Subramaniyan, K.Sunitha are introduced concept of Radio mean square Labeling of some Graph G [11]. A Radio Labeling of a Graph G is an injective function \( \text{f} : V(G) \rightarrow N \) Such that for every \( u,v \in V \), The Radio mean square condition defined in \( d(u,v) + \left\lfloor \frac{|f(u)^2 + f(v)^2|}{2} \right\rfloor \geq 1 + \text{diam} \ G \). In this paper we investigate Radio mean square Labeling of some Graphs such as In centric subdivision of spoke wheel Graph and Biwheel Graph.
T. Tharmaraj and P.B. Saraija are introduced the concept of Analytic Mean labeling in [12]. A graph \( G(V,E) \) is said to be an Analytic mean graph. If it is able to assign the vertices in \( V \) with distinct elements from \( 0, 1, 2, \ldots, p-1 \) in such a way that when each edge \( e = uv \) is labeled \( f(uv) = \frac{|f(u)-f(v)|}{2} \).

A detailed survey of Graph Labeling [6] we have found that different types of mean labeling such as Radio mean labeling, Radio odd mean labeling, Radio Geometric mean labeling. Motivated by the above results we have introduced a new type of labeling called as Radio Analytic mean labeling in \( G \). Radio Analytic mean condition as \( d(x,y) + 1 + \text{diam } G \). The Radio Analytic mean number of \( n, \text{RAMN}(n) \) is the greatest number relegated to any vertex of \( G \). The Radio Analytic mean number of \( G \), is the least value of \( \text{RAMN}(n) \) taken over all Radio Analytic mean labeling of \( G \). In this paper we locate the radio Analytic mean number of splitting of Bistar graph, standing graph, wheel graph.

For each \( u, v \in G \). In this paper we find out the Radio Analytic mean number of some degree split bistar graph, stand graph, wheel graph. Let \( x \) be any real number. Then \( \lceil x \rceil \) stands for smallest integer greater than or equal to \( x \). Terms and definitions not characterized here are pursued from Harary and Gallian [6].

Definition 1.1: A Radio Analytic mean labeling of a connected graph \( G \) is a one to one map \( f \) from the vertex set \( V(G) \) to the set of \( \mathbb{Z} \). To such an extent that for any two distinct vertices \( x \) and \( y \) of \( G \).

\[
d(x, y) + \left\lceil \frac{|f(x) - f(y)|}{2} \right\rceil \geq 1 + \text{diam } G.
\]

Definition 1.2: Let \( G = \text{DS}(B_{m,n}) \) be the degree splitting graph of with vertex set \( V(G) \). The vertex set \( V(G) = V(B_{m,n}) \cup \{u, v, v_i, v_i, w \} \) \((1 \leq i \leq n)\) and edge set \( E(G) = \{wv_i, uw_i, uv, v_iw_i|1 \leq i \leq n\}\).

Definition 1.3: Let \( u, v \) be the apex vertex on the path. Let \( u_2, u_2, u_2, \ldots, u_n \) be the pendent vertices attached on vertex \( u \). Similarly \( v_1, v_2, v_2, \ldots, v_n \) attached on the vertex \( v \).

Definition 1.4: The wheel graph \( (w_n) \) for \( n \geq 0 \) is a graph on \( 2m + 1 \) vertices. Let \( v \) be the centre vertex. This Graph consisting \( u_1, u_2, u_2, \ldots, u_n \) be the pendent vertices attached on the boundary on the wheel. The edge set \( E = \{u_i, u_{i+1}, 1 \leq i \leq 2m\} \)

Definition 1.5: The diameter of a graph \( G \), \( \text{diam}(G) \) is the greatest separation in a graph \( G \).

Definition 1.6: The \( d(u, v) \) is the length of the shortest path between every pair of \( u \) and \( v \) in \( G \).

2. Main results

Theorem 2.1: The Radio Analytic mean number of Degree splitting Bistar graph is \( 3n+3 \)

Proof:

![Figure 1. The Radio Analytic mean number is 3n+3, n \geq 5](image-url)
we define \(|v(G)| = 2n+3\) and \(E(G)= 4n+1\).

We describe a bijection \(f: v(G) \rightarrow (1,2,3,\ldots, 3n+3)\)

\[
\begin{align*}
f(u) &= 2n+1, \\
f(u_i) &= 2i-1 \quad (1 \leq i \leq n), \\
f(v_i) &= 2i \quad (1 \leq i \leq n). \\
f(w) &= 3n-1 \\
f(v) &= 3n+3
\end{align*}
\]

We have to prove that \(\text{RAML} \geq 1+\text{diam } G\). for each pair of vertices the above graph satisfied the Radio Analytic mean condition.

**case(i)**: check the pair \((u, u_i)\) for \(1 \leq i \leq n\).

\[
d(u, u_i) + \left[\frac{|f(u) - f(u_i)|}{2}\right] \geq 1 + \text{diam } G.
\]

\[
\Rightarrow 1 + \left[\frac{|2n+1-2i|}{2}\right] \geq 1 + \text{diam } G.
\]

The vertices are \(d(u, u_i)\) adjacent. The diameter of this graph is 2. \(d(u, u_i)\) satisfied Radio Analytic mean condition.

**Subcase(i)**: we consider the pair \((u, u_i)\) for \(i=1\)

\[
d(u, u_1) + \left[\frac{|f(u) - f(u_1)|}{2}\right] \geq 1 + \text{diam } G.
\]

\[
\Rightarrow 1 + \left[\frac{|2n+1-(n-4)|}{2}\right] \geq 1 + n-3
\]

\[
\Rightarrow 1 + \left[\frac{|n+1-(n-2)|}{2}\right] \geq 1 + 2.
\]

\(d(u, u_1)\) satisfied Radio Analytic mean condition

**Subcase(ii)**: we consider the pair \((u, u_i)\) for \(i=4\)

\[
d(u, u_4) + \left[\frac{|2n+1-(n+2)|}{2}\right] \geq 1 + n-3.
\]

clearly \(d(u, u_i)\) is satisfied the Radio Analytic mean condition

**Case(ii)**: consider the pair \((u_i, u_{i+1})\) \(1 \leq i \leq n\),

\[
d(u_i, u_{i+1}) + \left[\frac{|f(u_i) - f(u_{i+1})|}{2}\right] \geq 1 + \text{diam } G.
\]

For example \(i=1\),

\[
d(u_1, u_2) + \left[\frac{|f(u_1) - f(u_2)|}{2}\right] \geq 1 + \text{diam } G.
\]

The distance of the pair \(d(u_1, u_2)\) is 2

\[
\Rightarrow 2 + \left[\frac{|n-4-(n-2)|}{2}\right] \geq n-2.
\]

Consequently the process \(i=2,3,4\) all the pairs satisfied the Radio Analytic mean condition.

**Case (iii)**: Examine the pair \((v_i, v_{i+1})\)

The vertices of \((v_i, v_{i+1})\) are non adjacent. The distance of \((v_i, v_{i+1})\) is 2
\[d(v_i, v_{i+1})^+ \geq 1 + \text{diam } G\]

Consider \(i=2\)
\[d(v_2, v_3)^+ \geq 1 + \text{diam } G \]
\[\Rightarrow 2^+ \geq \frac{n-2}{2} \geq n-2 \geq 3 \]

**Case(iv)**: Check the pair \((u,w)\)

The vertices are \(d(u,w)\) non adjacent vertices. The distance of \(d(u,w)\) is 2
\[d((u,w) + 1 + \text{diam } G.\]
\[\Rightarrow 2^+ \geq \frac{(n-1)-(n+1)}{2} \geq 1+n - 2 \geq 4 \]

**Case(v)**: verify the pair \((u,v)\)

The vertices are \(d(u,v)\) adjacent vertices. The distance of \(d(u,v)\) is 1.

The general diameter of this graph is 2
\[d((u,v) + 1 + \text{diam } G.\]
\[\Rightarrow 1^+ \geq \frac{(2n+1)-(2n+3)}{2} \geq 3 \]

**Case(vi)**: Check the pair \((u,vi)\) for \(i \leq n\)

The vertices are \(d(u, vi)\) non adjacent vertices. The distance of \(d(u, vi)\) is 2
\[d((u, vi) + 1 + \text{diam } G.\]
\[\Rightarrow 1^+ \geq \frac{(2n+1)-(2i+3)}{2} \geq 2 \]

The pair \((u, vi)\) is satisfied the Radio Analytic mean condition.

**Case(vii)**: consider the pair \((v,w)\)

The vertices are \((v,w)\) non adjacent vertices. The distance of \(d(v,w)\) is 2.

The constant diameter of this graph is 2.
\[d((v, w) + 1 + \text{diam } G.\]
\[\Rightarrow 2^+ \geq \frac{(2n+2)-(2n+1)}{2} \geq 3 \]

The pair \((v,w)\) satisfied the Radio Analytic mean condition.

**Case(viii)**: Examine the pair \((v,vi)\) for \(i \leq n\)
\[d((v,vi) + 1 + \text{diam } G.\]
\[\text{consider } i=1 \text{ above condition}\]
\[d((v, v_1) + 1 + \text{diam } G.\]
Consider $i=3$ above the condition

\[
d((v,v_3) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

\[
\Rightarrow 1 + \frac{1}{2}(2n+2)-(n-2) \geq n-2
\]

The pair $((v,v_3))$ satisfied the Radio Analytic mean condition. Continue the process Balanced pairs ($v,v_2$), ($v,v_3$) check the Radio Analytic mean condition.

Case (ix) : verify the pair $(v,u_i)$ for $1 \leq i \leq n$

\[
d((v,u_i) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

consider $i=4$, above condition

\[
d((v,u_4) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

The distance of pair $(v,u_4)$ is 2

\[
\Rightarrow 1 + \frac{1}{2}(2n+2)-(n+2) \geq n-2
\]

Case (x) : Examine the pair $(w,u_i)$ for $1 \leq i \leq n$

\[
d((w,u_i) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

substitute $i=5$ above condition

\[
\Rightarrow d((w,u_5) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

\[
\Rightarrow 1 + \frac{1}{2}(2n-1)-(n+4) \geq 1 + \frac{1}{2}diam(G) \geq 4
\]

Case (xi) : verify the pair $(w,v_i)$ for $1 \leq i \leq n$

\[
d((w,v_i) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

substitute $i=3$ above condition

\[
\Rightarrow d((w,v_3) + \frac{1}{2}diam(G)) \geq 1 + \frac{1}{2}diam(G)
\]

\[
\Rightarrow 1 + \frac{1}{2}(2n-1)-(n+3) \geq 1 + \frac{1}{2}diam(G)
\]

\[
\Rightarrow \geq 5
\]

Therefore Radio Analytic mean number of a DS($B_{n,n}$) is $3n+5$

Theorem 2.2: The Radio Analytic mean number of stand graph (SG) is $(n + \frac{n^2}{2})$

**Proof:** Let $u,v$ be the two apex vertex of the Graph. The vertices adjacent to $u$ and consequently labeled by $(u_1,u_2,u_3 \ldots \ldots u_n)$

The vertices are adjacent to $v$ consequently labeled $v_1,v_2,v_3 \ldots \ldots v_n$. We define bijection

\[
f : v(G) \rightarrow (3,4,9,\ldots (n+\frac{n^2}{2})
\]

We define the vertices
\[ f(u)=2n+2, \]
\[ f(u_i)=4^j, \quad 1 \leq i \leq n, \quad 1 \leq j \leq n \]
\[ f(v)=4n^+, \]
\[ f(v_i)=3^j, \quad 1 \leq i \leq n, \quad 1 \leq j \leq n. \]

Since the diameter of the standgraph (SG) is 3.

We check the Radio Analytic labeling condition:
\[ d(u, v) + \left| \frac{f(u) - f(v)}{2} \right| \geq 1 + \text{diam } G \]

Each pair of vertices with \( u \neq v \)

**Case (i):** Check the pair \( d(u, v) \).

Let \( u, v \) be two vertices of SG. Then \( u, v \) are adjacent. The distance of \( d(u, v) = 1 \)

The condition is:
\[ d(u, v) + \left| \frac{f(u) - f(v)}{2} \right| \geq 1 + \text{diam } G \]

\[ => d(u, v) + \left| \frac{2n^2 - 4n + 4}{2} \right| \geq 1 + \text{diam } G \]

The pair \( d(u, v) \) satisfied the Radio Analytic mean condition.

**Case (ii):** Check the pair \( d(u, v_i) \).

Then \( d(u, v_i) \) be any two non-adjacent vertices of G.

Let \( i \leq n \), \( j \leq n \)

\[ d(u, v_i) + \left| \frac{f(u) - f(v_i)}{2} \right| \geq 1 + \text{diam } G \]

\[ => 2 + \left| \frac{2n^2 - 4n + 4}{2} \right| \geq n \]

The pair \( d(u, v_i) \) satisfied RAMC.

**Case (iii):** Check the pair \( d(u_i, v_i) \).

Let \( d(u_i, v_i) \) be any two vertices of G. and \( ((u_i, v_i) \) are any two adjacent vertices of G.

\[ d(u_i, v_i) + \left| \frac{f(u_i) - f(v_i)}{2} \right| \geq 1 + \text{diam } G \]

\[ => 1 + \left| \frac{2n^2 - 4n + 4}{2} \right| \geq n \]

So the pair \( d(u_i, v_i) \) satisfied the Radio Analytic mean condition.

**Case (iv):** Verify the pair \( (v, v_i) \).

Let \( (v, v_i) \) be two adjacent vertices of G. The distance of the pair \( d(v, v_i) \) is 1

\[ d(v, v_i) + \left| \frac{f(v) - f(v_i)}{2} \right| \geq 1 + \text{diam } G \]

\[ => 1 + \left| \frac{4n^2 + 4 - 5}{2} \right| \geq n \]

**Subcase (i):** Now check the pair \( d(v_i, u_{i+1}) \) let \( 1 \leq i \leq n \)

The pair \( (v_i, u_{i+1}) \) are adjacent vertices.

The distance of \( d(v_i, u_{i+1}) \) is 2.
Subcase(i): Now check the pair $d(v_i, v_{i+1})$ let $1 \leq i \leq n$. The pair $(v_i, v_{i+1})$ are adjacent vertices. The distance of pair $d(v_i, v_{i+1})$ is $2$.

$$
d(v_i, v_{i+1}) = \left| \frac{(f(v_i) - f(v_{i+1}))}{2} \right| \geq 1 + \text{diam } G
$$

$$
\geq 2 \left( \left| \frac{(|G| - |G|)}{2} \right| \right)
\geq 5
$$

Example:

![Diagram of a wheel graph](image)

**Figure 2.** The RAMN of stand graph (SG) is $(m+n^2)$

**Theorem 2.3:** The Radio Analytic mean number of wheel graph ($W_n$) is $7m$, $m > 0$.

**Proof:** Let $v$ be the central vertex. Let $u_1, u_2, u_3, \ldots, u_n$ be the consecutive vertices on the wheel graph. $E = \{u_i, u_{i+1} | 1 \leq i \leq n \}$ $\cup$ $u_iu_i | i = 1, 2, 3, \ldots$ is the edge set. We define the labeling $f : v(G)$ as follows.

Let $v(G) = 2m+1$, $E(G) = 4m+1$, $f(v) = 2m-4$.
$f(u_i) = \begin{cases} 
\frac{1}{2m+6i} & \text{if } i = 1 \\
\frac{2}{m+2i} & \text{if } i = 0 \text{ mode 2} \\
\frac{2}{m+2i} & \text{if } i = 1 \text{ mode 2}
\end{cases}$

Since diameter of this graph is 2. We prove that any pair of two vertices wheel graph satisfied the Radio Analytic mean condition $d(u, v) + \left\lfloor \frac{|f(v) - f(u)|}{2} \right\rfloor \geq 1 + \text{diam G}$ for every pair $u$ and $v$ for $u \neq v$.

**Case (i):** Check the pair $v, u_i$, for $1 \leq i \leq n$

Let $v, u_i$ be the two adjacent vertices of the wheel graph.

$d(v, u_i) + \left\lfloor \frac{|f(v) - f(u_i)|}{2} \right\rfloor \geq 1 + \text{diam G}$

Consider $i = 1$

$d(v, u_1) + \left\lfloor \frac{|f(v) - f(u_1)|}{2} \right\rfloor \geq 1 + \text{diam G}$

$\geq 1 + \lfloor \frac{\text{diam G}}{2} \rfloor \geq 11$

**Case (ii):** Verify the pair $(u_i, u_{i+1})$, $1 \leq i \leq n$

Consider $i = 1$

$d(u_1, u_2) + \left\lfloor \frac{|f(u_2) - f(u_1)|}{2} \right\rfloor \geq 1 + \text{diam G}$

$\geq 1 + \left\lfloor \frac{|\text{diam G}|}{2} \right\rfloor \geq 9$

**Case (iii):** Verify the pair $(u_i, u_{2i+1})$, $1 \leq i \leq n$

Consider $i = 5$

$d(u_5, u_{11}) + \left\lfloor \frac{|f(u_{11}) - f(u_5)|}{2} \right\rfloor \geq 1 + \text{diam G}$

$\geq 2 + \left\lfloor \frac{|\text{diam G}|}{2} \right\rfloor \geq 5$

**Case (iv):** Verify the pair $(u_i, u_{2i+1})$, $1 \leq i \leq n$

Consider $i = 6$

$d(u_6, u_{13}) + \left\lfloor \frac{|f(u_{13}) - f(u_6)|}{2} \right\rfloor \geq 1 + \text{diam G}$

$\geq 2 + \left\lfloor \frac{|\text{diam G}|}{2} \right\rfloor \geq 5$

**Case (v):** Verify the pair $(u_{2i}, u_{2i+1})$, $1 \leq i \leq n$

Consider $i = 7$

$d(u_7, u_{20}) + \left\lfloor \frac{|f(u_{20}) - f(u_7)|}{2} \right\rfloor \geq 1 + \text{diam G}$

$\geq 2 + \left\lfloor \frac{|\text{diam G}|}{2} \right\rfloor \geq 11$

**Case (vi):** Verify the pair $(u_{2i+1}, u_{2i+2})$, $1 \leq i \leq n$

Consider $i = 5$

$d(u_5, u_{12}) + \left\lfloor \frac{|f(u_{12}) - f(u_5)|}{2} \right\rfloor \geq 1 + \text{diam G}$

$\geq 2 + \left\lfloor \frac{|\text{diam G}|}{2} \right\rfloor \geq 6$

**Case (vii):** Verify the pair $(u_i, u_{2i})$, $1 \leq i \leq n$

Consider $i = 8$
Case(viii): verify the pair \((u_1, u_{2i+1})\) \(1 \leq i \leq n\)
Consider \(i=7\)
\[
d(u_7, u_{15}) + \left| \frac{f(u_7) - f(u_{15})}{2} \right| \geq 1 + \text{diam } G
\]
\[
\geq 2 + \left[ \frac{|(2m) - (7m)|}{2} \right]
\]
\[
\geq 26
\]

Case(ix): verify the pair \((u_{6i+4}, u_{2i+5})\) \(1 \leq i \leq n\)
Consider \(i=9\)
\[
d(u_{12}, u_{22}) + \left| \frac{f(u_{12}) - f(u_{22})}{2} \right| \geq 1 + \text{diam } G
\]
\[
\geq 2 + \left[ \frac{|(m+7) - (2m+5)|}{2} \right]
\]
\[
\geq 6
\]

Case(x): verify the pair \((u_{6i-6}, u_{2i-2})\) \(1 \leq i \leq n\)
Consider \(i=10\)
\[
d(u_{4}, u_{18}) + \left| \frac{f(u_4) - f(u_{18})}{2} \right| \geq 1 + \text{diam } G
\]
\[
\geq 2 + \left[ \frac{|(2m) - (3m+6)|}{2} \right]
\]
\[
\geq 23
\]

Case(xi): verify the pair \((v, u_{2i-2})\) \(1 \leq i \leq n\)
Consider \(i=1\)
\[
d(u_4, u_{18}) + \left| \frac{f(u_4) - f(u_{18})}{2} \right| \geq 1 + \text{diam } G
\]
\[
\geq 2 + \left[ \frac{|(2m) - (3m+6)|}{2} \right]
\]
\[
\geq 23
\]

Clearly above all the pairs satisfied Radio Analytic mean condition.

Example: The RAMN of wheel graph is \(7m (m \geq 0)\)
3. Conclusions

In this paper, we have discussed the construction of various graphs such as degree splitting graph, stand graph, wheel graph such that they are Radio Analytic mean graphs. In future we are going to elaborate this construction on other type of graphs such as sunlet graph, flower graph, star graph.

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