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Few Results on Pseudo and Odd Mean Labeling

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It is widely accepted that the earliest article in the history of graph theory was the one authored by Leonhard Euler on the Seven Bridges of Königsberg and published in 1736. This essay continued the analytical framework Leibniz started, as did Vandermonde's thesis on the knight problem. Cauchy and L'Huillier researched and generalized Euler's formula, which relates the number of edges, vertices, and faces of a convex polyhedron. This work serves as the foundation for the field of mathematics known as topology.

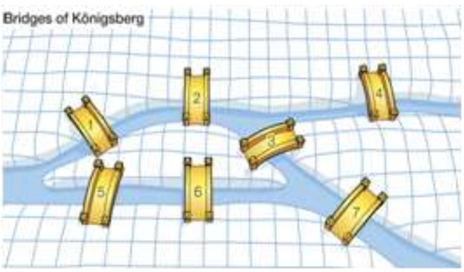


Chart. No: 1.1 Bridges of Konigs Berg

Cayley was inspired to examine a particular class of graphs, the trees, more than a century after Euler published his work on the bridges of Königsberg and about the same time that Listing introduced the idea of topology. This work had a wide range of effects on theoretical chemistry. He primarily employed methods for counting graphs with certain characteristics. The Cayley findings and the fundamental findings that were published between 1935 and 1937 led to the development of enumerative graph theory. De Bruijn generalized these in 1959.Cayley compared his findings on trees to recent research on chemical makeup. The concepts of mathematics and chemistry were combined to create what is now known as the standard vocabulary of graph theory. In particular, Sylvester coined the term "graph" in a piece that appeared in Nature in 1878. In it, he makes a comparison between the quantic invariants and co-variants of algebra and molecular diagrams.

Applications of Graphs

In physical, biological, social, and informational systems, graphs may be used to describe a wide variety of linkages and processes. Graphs may be used to illustrate a variety of real-world issues. The word "network" is often used to denote a graph in which characteristics (for example, names) are attached with the nodes or edges, emphasizing its relevance to real-world systems.

Chart.No:1.2 Network Connectivity Model

Graphs are commonly used in computer science to depict computation, data organization, communication networks, and other concepts. For instance, a directed graph, in which the vertices represent web pages and the directed edges indicate links from one page to another, may be used to depict the link structure of a website.

Problems in social media, travel, biology, computer chip design, and many other domains may be approached in a similar way. Therefore, computer science is very interested in developing methods to handle graphs. Graph rewriting systems are frequently used to describe and illustrate the transformation of graphs. Graph databases, designed for transaction-safe, persistent storage and querying of graph-structured data, are a complement to graph transformation systems that concentrate on rule-based in-memory manipulation of graphs.

In recent years, it has become increasingly obvious how closely related fields like Graph Theory and Computer Science are and how one may contribute considerably to the advancement of the other. Thus, graph theorists are discovering that using computational approaches can help them address many of their difficulties. One of them is the challenge of graph labeling.

The literature review has looked into a variety of labelings. Gallian [23] presents a summary of current findings, hypotheses, and outstanding difficulties in labeling graphs.

The majority of the results on graph labelings really focus on certain kinds of graphs, despite the fact that there are many articles on the subject. A wide range of applications, including coding theory, X-ray crystallography, radar, astronomy, circuit design, and communication networks, benefit from the usage of labeled graphs as models [49] and [50].

Literature Survey

Survey on Graph Labelings

Most graph labeling methods trace their origin to one introduced by Rosa in 1967, or one given by Graham and Sloane in 1980. Rosa called a functionf a $\beta -$ valuation of a graph G with q edges if f is an injection from the vertices of G to the set {0, 1, 2, · · · , q} such that, when each edge xy is assigned the label $| f(x) - f(y)|$, the resulting edge labels are distinct. Golomb subsequently called such labelings graceful.

Somasundaram and Ponraj have introduced the notion of mean labelings of graphs. A graph G with p vertices and q edges is called a mean graph if there is an injective function f from the vertex set of G to {0, 1, 2, · · · , q} such that when each edge uv is labeled with$\frac{f(u)+f(v)+1}{2}$ if $f(u)+f(v)$ is odd, then the resulting edge labels are distinct.

They also prove the following graphs are mean graphs: Pn, Cn, K2, n, K2 + mK1, Kn + 2K2, Cm ∪ Pn, Pm × Pn, Pm × Cn, Cm s K1, Pm s K1, triangular snakes, quadrilateral snakes, Kn if and only if n < 3, K1, n if and only if n < 3, bistarsBm, n(m > n) if and only if m < n + 2, the subdivision graph of the star K1, n if and only if n < 4, the friendship graph $C_3^{(t)}$ if and only if t < 2, the one point union of two copies of fixed cycle, dragons (the one point union of Cm and Pn, where the chosen vertex of the path is an end vertex), the one point union of a cycle and K1,n for small values of n and the arbitrary super subdivision of a path, which is obtained by replacing each edge of a path by K2,m .

They also prove that Wn is not a mean graph for n > 3 and enumerate all mean graphs of order less than 5. Maheshwari and Ramesh, proved that the two star graph K1,m ∪ K1,n with an edge in common is a mean graph if and only if |m − n| ≤ 4 .

Manickam and Marudai defined a graph G with q edges to be an odd mean graph if there is an injective function f from the vertices of G to{1, 3, 5, · · · , 2q − 1} such that when each edge uv is labeled with $\frac{f(u)+f(v)}{2}$ if f (u)+ f (v) is even, and $\frac{f(u)+f(v)+1}{2}$ if f (u) + f (v) is odd, then the resulting edge labels are distinct. Such a function is called aodd mean labeling.

Vasuki and Nagarajan use Pb to denote the graph obtained by starting with vertices y1, y2, y3, · · · , ya and connecting yi to yi+1 with b internally disjoint paths of length i + 1for i = 1, 2, 3, · · · , a − 1 and j = 1, 2, · · · , b . For integers a ≥ 1 and b ≥ 2 they use Pb to (2a) denote a graph obtained by starting with vertices y1, y2, · · · , ya+1 and connecting yi to yi+1 with b internally disjoint paths of length 2i fori = 1, 2, · · · , a and j = 1, 2, · · · , b. They proved that the graphs P2r, m, P2r+1, 2m+1, and Pm(2r) are odd mean graphs for all values of r and m . For a Tp− tree T with m vertices T @Pn is the graph obtained from T and m copies of Pn by identifying one pendant vertex of ith copy of Pn with ith vertex of T. Selvi, Ramya and Jeyanthi [54] prove thatPm s K¯n(m ≥ 2; n ≥ 1)is an odd mean graph, Tp trees are odd mean graphs, and, for anyTptreeT, the graphsT @Pn, T @2Pn,T o˜K1,n; are odd mean graphs. Selvi, Ramya and Jeyanthi prove that for a Tp tree T the graphs T oˆCn (n > 3, n ≠ 6) are odd mean graphs.

Maheshwari and Balaji, has proved the following results in Relaxed Mean Labeling, any cycle is a relaxed mean graph; If n > 4, Kn is not a relaxed mean graph; K2,n is a relaxed mean graph for all n ; Any triangular snake is a relaxed mean graph; Any quadrilateral snake is a relaxed mean graph; The graph P2n is a relaxed mean graph; LetCn = u1u2 · · · unu1 be the cycle, let G be a graph with V(G) = V(Cn) ∪ wi : 1 ≤ i ≤ n and E(G) = E(Cn)∪uiwi, ui+1wi : 1 ≤ i ≤ n, then G is a relaxed mean graph.

Let Cn = u1u2 · · · unu1 be the cycle, let G be a graph withV(G) = V(Cn) and E(G) = E(Cn) ∪u1u3, then G is a relaxed mean graph; Let Cn = u1u2 · · · unu1 be the cycle, let G be a graph withV(G) = V(Cn) andE(G) = E(Cn) ∪ u3u6, then G is a relaxed mean graph; LnK1 is a relaxed mean graph; L_nK_1 is a relaxed mean graph;K^c+ $2K_2$ is a relaxed mean graph for all n; W4 is a relaxed mean graph;K2 + mK1 is a relaxed mean graph for all n; If G1 and G2 are trees, then G = G1 ∪ G2 is a relaxed mean graph; The planar grid Pm × Pn is a relaxed mean graph for m> 2 and n > 2; The prism Pm × Cn is a relaxed mean graph for m> 2 and n > 3; Identification of two graphs is a relaxed mean graph; The caterpillar graph is a relaxed mean graph; The dragon graph and arbitrary super subdivision of path is a relaxed mean graph and the graphCnoˆK1,2is a relaxed mean graph. Balaji, Ramesh and Subramanian use the term ‘Skolem mean’ labeling for super mean labeling. They proved: Pn is Skolem mean graph, K1,m is not a skolem mean graph if m ≥ 4 ; K1,m ∪ K1, n is skolem mean graph if and only if |m − n| ≤ 4. The three star graph K1, ℓ ∪ K1, m ∪ K1, n is a skolem mean graph if |m − n| = 4 + ℓ forℓ = 1, 2, 3, · · · ;m = 1, 2, 3, · · · and ℓ ≤ m < n. The four star graph K1,ℓ ∪ K1, ℓ ∪ K1, m ∪ K1, n is a skolem mean graph if|m−n|=4 + 2 ℓ forℓ = 2, 3, · · · ; m = 2, 3, · · · and ℓ ≤ m < n . The five star graph K1, ℓ ∪ K1,ℓ ∪ K1, ℓ ∪ K1, m ∪ K1, n is a skolem mean graph if |m − n| = 4 + 3 ℓ forℓ = 2, 3, · · · ; m=2, 3,· · · and ℓ ≤ m < n . I. Gnanaselvi and et al. proved that the six star graph K1,ℓ ∪ K1,ℓ ∪ K1, ℓ ∪ K1, ℓ ∪ K1, m ∪K1, n is a skolem mean graph if |m − n| = 4 + 4 ℓ for ℓ = 2, 3,· · ; m = 2, 3, · · · andℓ ≤ m < n . The six star graph K1, ℓ ∪ K1, ℓ ∪ K1, ℓ ∪ K1, ℓ ∪ K1, m ∪ K1, n is not a skolem mean graphif |m − n| > 4 + 4 ℓ for ℓ = 2, 3, · · · ; m = 2, 3, · · · ; n ≥ 4 ℓ + m + 5 and ℓ ≤ m < n

Maheshwari, Balaji and Ramesh proved the three star graphK1, ℓ ∪ K1,m ∪ K1,n is a skolemmean graphif |m − n| < 4 + ℓ forℓ = 1, 2, 3, · · · ; m = 1, 2, 3, · · · ;ℓ + m − 3 ≤ n ≤ ℓ + m + 3 andℓ ≤ m < n. The four star graph K1, ℓ ∪ K1, ℓ ∪ K1,m ∪ K1,n is a skolem mean graph if |m − n| < 4 + 2 ℓ for ℓ = 2, 3, · · · ; m = 2, 3, · · · ;2ℓ + m − 3 ≤ n ≤ 2 ℓ + m+3 and ℓ ≤ m < n .

star graph $K1, \ell \cup K1, \ell \cup K1, \ell \cup K1,m \cup K1,n$ is a skolem mean graphif $|m - n| < 4 + 3\ell$ for $\ell = 2, 3, \cdots$; $m = 2, 3, \cdots$; $3\ell + m - 3 \leq n \leq 3\ell + m + 3$ and $\ell \leq m < n$. The six star graph $K1, \ell \cup K1, \ell \cup K1, \ell \cup K1, \ell \cup K1,m \cup K1,n$ is a skolem mean graph if $|m - n| < 4 + 4\ell$ for $\ell = 2, 3, \cdots$; $m = 2, 3, \cdots$; $4\ell + m - 3 \leq n \leq 4\ell + m + 3$ and $\ell \leq m < n$.

Manshath and Sekar et al.proved that the three star graph$K1, \ell \cup K1,m \cup K1,n$ is not a skolem mean graph if $|m - n| > 4 + \ell$ for $\ell = 1, 2, 3, \cdots$; $m = 1, 2, 3, \cdots$; $n \geq \ell+m+ 5$ and $\ell \leq m < n$. The four star graph $K1, \ell \cup K1, \ell \cup K1,m \cup K1,n$ is not a skolem mean graph if $|m - n| > 4+2\ell$ for $\ell = 2, 3, \cdots$; $m = 2, 3, \cdots$; $n \geq 2\ell +m+5$ and $\ell \leq m < n$. The five star graph $K1, \ell \cup K1, \ell \cup K1, \ell \cup K1,m \cup K1,n$ is not a skolem mean graph if $|m - n| > 4 + 3\ell$ for $\ell = 2, 3, \cdots$; $m = 2, 3, \cdots$; $n \geq 3\ell + m + 5$ and $\ell \leq m < n$.

Further results proved by Balaji and Ramesh et al. are, the four stargraph $K1,1 \cup K1,1 \cup K1,m \cup K1,n$ is a skolem mean graph if $|m - n| = 7$ for $m = 1, 2, 3, \cdots$ and $1 \leq m < n$. The four star graph $K1,1 \cup K1,1 \cup K1,m \cup K1,n$ is not a skolem mean graph if $|m - n| > 7$ for $m = 1, 2, 3, \cdots$; $n \geq m + 8$ and $1 \leq m < n$. The five star graph $K1,1 \cup K1,1 \cup K1,1 \cup K1,m \cup K1,n$ is a skolem mean graphif $|m - n| = 8$ for $m = 1, 2, 3, \cdots$ and $1 \leq m < n$. The five star graph$K1,1 \cup K1,1 \cup K1,1 \cup K1,m \cup K1,n$ is not a skolem mean graph if$|m - n| > 8$ for $m = 1, 2, 3, \cdots$; $n \geq m + 9$ and $1 \leq m < n$.

Cahit has introduced a variation of both graceful and harmonious labelings. Cahitproved the following: Every tree is cordial; Kn is cordial if and only if $n \leq 4$; The friendship graph C3(t) is cordial if and only if t. 2 ; All fans are cordial; The wheel Wnis cordial if and only if n.3(mod 4); Maximal outer planar graphs are cordial and an Eulerian graph is not cordial if its size is congruent to 2 (mod 4). Khan proved that a graph that consisting of a finite number of cycles of finite length joined at a common cut vertex is cordial if and only if the number of edges is not congruent to 2 (mod 4) .

Definitions and Notations of Graph

Definition: A graph G is an ordered triple (V(G), E(G), ψG) consisting of a nonempty set V(G) of vertices, a set E(G) , disjoint from V(G), of edges, and an incidence function ψG that associates with each edge of G an unordered pair of (not necessarily distinct) vertices of G. If e is an edge and u and v are vertices such that ψG(e) = uv, then e is said to join u and v; the vertices u and v are called the ends of e .

Definition: A bipartite graph is one whose vertex set can be partitioned into two subsets X and Y, so that each edge has one end in X and one end in Y; such a partition (X, Y) is called a bipartition of the graph. A complete bipartite graph is a simple bipartite graph with bipartition (X, Y) in which each vertex of X is joined to each vertex of Y ; if $|X| = m$ and $|Y| = n$, such a graph is denoted by Km,n . K1,m is called a star for $m \geq 1$.

Definition: The two star is the disjoint union of two star graphs K1,m and K1,n and is denoted as $K1,m \cup K1,n$. Similarly n star graph is also defined as the union of n star graphs.

Definition: Two vertices u and v of G are said to be connected if there is a (u, v) - path in G. Connection is an equivalence relation on the vertex set V. Thus there is a partition of V into nonempty subsets $V1, V2, \cdots, V\omega$ such that two vertices u and v are connected if and only if both u and v belong to the same set Vi. The subgraphsG[V1], G[V2], $\cdots$, G[Vω] are called the components of G. If G has exactly one component, G is connected; otherwise G is disconnected. We denote the number of components of G by ω(G) .

Definition: A Wedge is defined as an edge connecting two components of a graph, denoted as ∧, such that $\omega(G\wedge) < \omega(G)$.

$K1,m \cup K1,n$ is a two star and is a two component or a disconnected graph, whereas $K1,m \wedge K1,n$is a two star but a connected graph, which means adding a wedge to a disconnected graph with two components becomes a connected or a single component graph.

Definition: An acyclic graph is one that contains no cycles. A tree is a connected acyclic graph.

Definition: A unicyclic graph is a connected graph containing exactly one cycle.

Definition: The complete subdivision of a graph is the subdivision in which a new vertex is inserted in the interior of each edge. The ℓ th complete subdivision of a graph is the complete subdivision of the (ℓ − 1)th complete subdivision, denoted by S 4(G) .

Definition: A matching in a graph is a set of edges with the property that no vertex is incident with more than one edge in the set. A vertex which is incident with an edge in the set is said to be saturated.

Definition: A graph with p vertices and q edges is said to be a Mean graph ifthere exists a function f from the vertex set of G to{0, 1, 2, · · · , q} such that the induced map f ∗ from the edge set of G to {1, 2, · · · , q} defined by then the resulting edges get distinct labels{1, 2, · · · , q} .

Definition: A graph G = (V, E) with p vertices and q edges is said to be an Odd mean graph if there exists a function f from the vertex set of G to {0, 1, 2, · · · , 2q − 1} such that the induced map f from the edge set of G to {1, 3, 5, · · · , 2q − 1} defined by

$$f^*(e=uv)=\begin{cases}\frac{f(u)+f(v)}{2} & \text{if } f(u)+f(v) \text{is even}\\ \frac{f(u)+f(v)+1}{2} & \text{if } f(u)+f(v) \text{is odd}\end{cases}$$

then the resulting edges get distinct labels {1, 3, 5, · · · , 2q − 1} .

Definition: A graph with p vertices and q edges is said to be a Skolem mean graphif there exists a function f from the vertex set of G to {1, 2, · · · , p} such that the induced map f ∗ from the edge set of G to{2, 3, · · · , p} defined by

$$f^*(e=uv)=\begin{cases}\frac{f(u)+f(v)}{2} & \text{if } f(u)+f(v) \text{is even}\\ \frac{f(u)+f(v)+1}{2} & \text{if } f(u)+f(v) \text{is odd}\end{cases}$$

then the resulting edges get distinct labels {1, 2, · · · q} .

Definition: Let f be a function from the vertices of G to {0, 1} and for each edge xy assign the label | f (x) − f (y)|, call f a Cordial labeling of G if the number of vertices labeled 0 and the number vertices labeled 1 differs by at most 1 and the number of edges labeled 0 and the number of edges labeled 1 differs by at most 1.

Definition: Let, f be a function from V(G) to {0, 1, 2} for each edge uv of G, assign the label $\frac{f(u)+f(v)}{2}$ f is called a mean cordial labeling of G if Vf (i) − Vf (j) ≤ 1 and e f (i) − e f (j) ≤ 1, i, j ∈ {0, 1, 2}, where Vf (x) denotes the number of vertices and e f (x) denotes the number of edges labeled with x (x = 0, 1, 2) respectively. A graph with a Mean cordial labeling is called mean cordial graph.

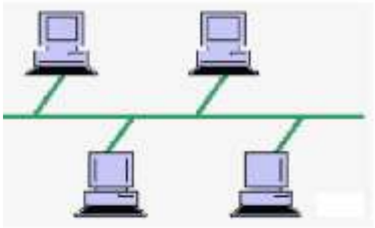
Application

Types of Network Topology

The physical communication protocols used by linked devices in a network are referred to as the topology of a computer network. The three primary types of computer network topology are:

Bus
Ring
Star
Mesh
Tree
Wireless

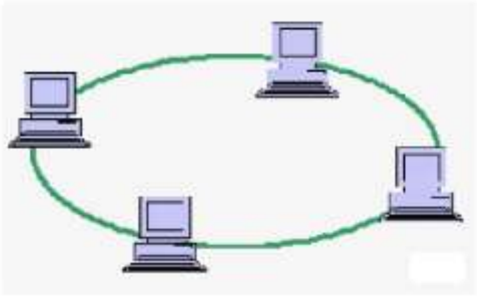
By combining two or more of these fundamental topologies, networks that are more complex can be created.



Bus networks connect all devices via a centralized connection. Small networks typically employ this network design since it is straightforward to comprehend. The same connection connects every computer and network device, so if the cable breaks, the entire network goes down. However, installing a network is not expensive.

It is economical to use this kind of network. The network is slower than a ring network due to the short length of the connecting connection.

Ring Network Topology



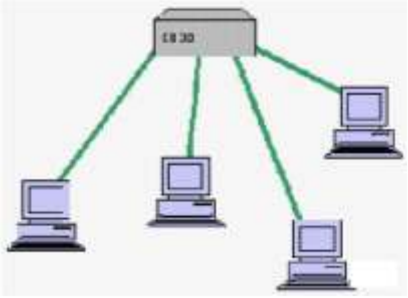
Each device in a ring network is attached to two other devices, and the last device connects to the first to form a circular network. Each message travels through the ring in one direction – clockwise or counter clockwise – through the shared link. Ring topology that involves a large number of connected devices requires repeaters. If the connection cable or one device fails in a ring network fails.

Although ring network are faster than bus network they are more difficult to troubleshoot.

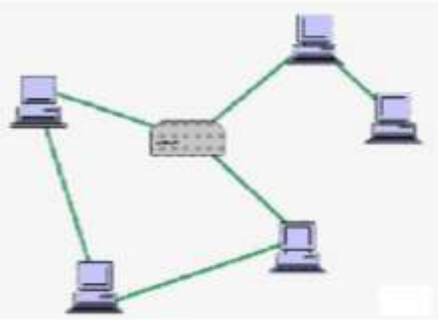
Star Network Topology

Home networks frequently employ a star topology, which generally makes use of a network hub or switch. Each gadget has a unique connection to the hub. The hub determines how well a star network performs. All linked devices lose access to the network if the hub malfunctions. Because there are often fewer devices linked in a star topology than in other types of networks, the associated devices typically function well.

Star networks are simple to install and troubleshoot. Although the setup fee is higher than for bus and ring network topologies, the failure of one attached device has no impact on the other connected devices.



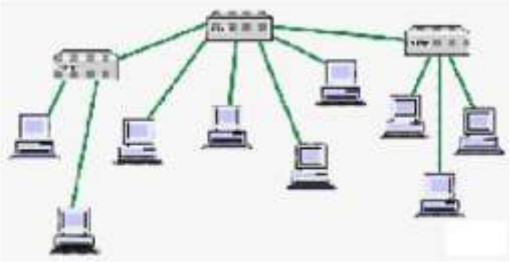
Mesh Network Topology



A partial or complete mesh's redundant communication channels between some or all of its components are provided by the mesh network topology. Each device in complete mesh topology. In a partial mesh topology, some of the devices are connected to every other device, while others are only connected to a small number of other devices.

Mesh topology is reliable, and problems can usually be resolved quickly. However, compared to the star, ring, and bus topologies, installation and setup are more challenging.

Tree Network Topology



To increase network scalability, the tree topology combines the star and bus topologies in a hybrid design. In most cases, the network is built up as a hierarchy with three layers or more. One of the devices on the level above it was connected to all of the devices on the lowest level. All hardware eventually connects to the central hub that manages the network.

This kind of network functions effectively in businesses with a variety of grouped workstations. Both system management and troubleshooting are simple. However, setting it up is rather expensive. If the network's main hub malfunctions, it also malfunctions.

Wireless Network Topology

The newest kid on the block is wireless networking. Although wireless networks are often slower than wired networks, this is rapidly improving. The demand for networks that can support wireless remote access has significantly increased as a result of the widespread use of laptops and other mobile devices.

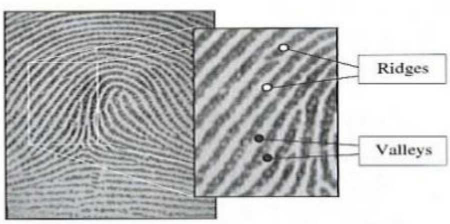
A hardware access point that is accessible to all wireless devices requiring network connectivity is becoming a typical feature of wired networks. This increase in capability raises significant security concerns that need to be addressed.

Finger Print Recognition Using Graph Representation

The three characteristics of FINGER PRINTS are:

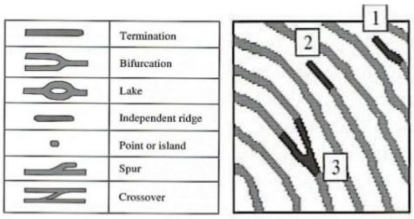
1. There are no similar fingerprints in the world.
2. Fingerprints are unchangeable.
3. Fingerprints are one of the unique features for identification systems.

Finger Print Types



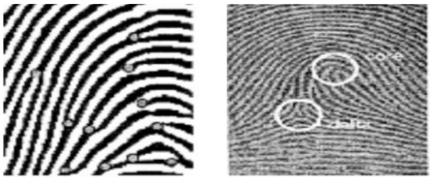
The lines that flow in various patterns across fingerprints are called *Ridges* and the space between ridges are *valleys*.

Content



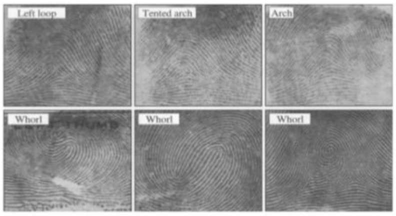
Types of patterns in fingerprint.1 and 2 are terminations 3 is bifurcation.

Minute, Core and Delta

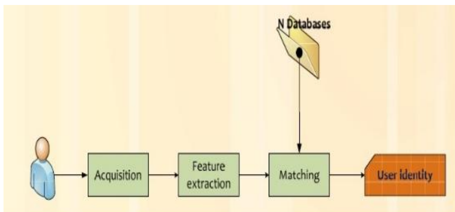


Minute - The places at which the Core - The places where the ridges form a half Ridges intersects or ends. Circle. Delta-The places where the ridges form a triangle.

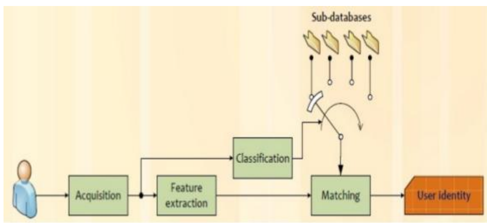
Different Classification



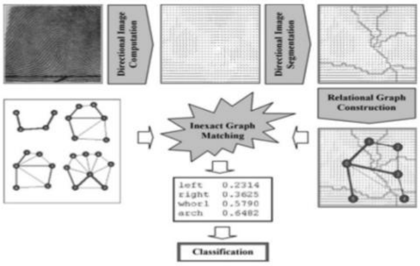
Old Method



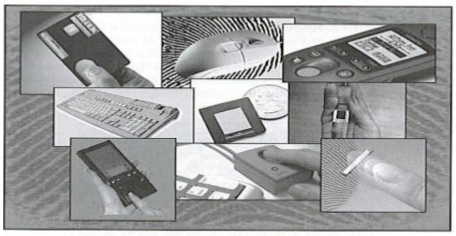
New Method



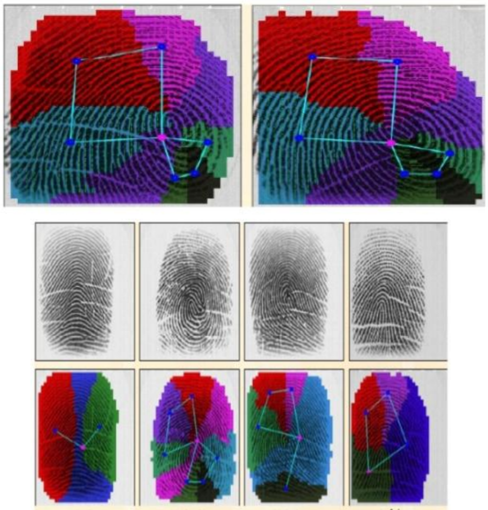
Process Flow



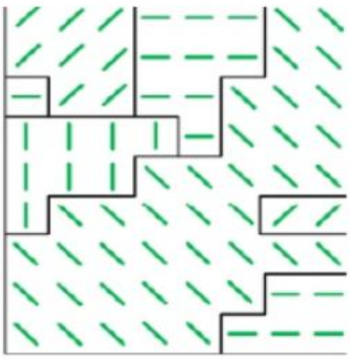
Fingerprint Capture Devices



Segmentation of Directional Image



Segmentation



Construction of Related Weight Graph

Graph can be shown by G index including four parameters of $G = (V, E, \mu, U)$

Where

V is number of nodes.

E is number of edges.

μ is weight of nodes.

U is weight of edges.

Some information can be used in construction the graph related to a finger print like.

- Centre of gravity of regions.
- The direction related to the elements of the various regions.
- The area of all the regions.
- The distance between centers of gravity.
- The perimeter of regions.

Weightage to Nodes and Edges

W_n = Area (R_j)

Where,

$\rightarrow i = 1,2,3,....n$

$\rightarrow W_n$ is the weight of nodes.

$\rightarrow R_j$ is the specified region in block directional image.

$W_n = (\text{Adj - p}) \times (\text{Node - p}) \times (\text{Diff - v})$

Where

→ Adj-p is the boundary of two adjacent regions linking with an edge.

→ Noded is the distance difference between nodes that links by an edge

→Diffv is the phase difference or direction difference between two regions ofblock directional image.

The nodes are placed in the center of gravity of each region. The nodes size varies according to the weight. The edges are shown by the lines and the thickness is proportional to the weight.

Construction Super Graph

We combine the properties of the graph and model of the Super Graph to form,

- A node for region with similar directions.
- Its co-ordinates are the center of gravity related to those regions of the graph.

Weightage to Snodes and Sedges

$$W_{sn} = \sum_{i=1}^{n} Area\ (R_j)$$

Where,

Area R_i is the area of all regions with similar directions.

R_i includes regions with similar directions.

$$W_{se} = \text{dis(sn)} + \sum_{i=1}^{n} Adj - p\ (R_{i,\ R_J}\ )$$

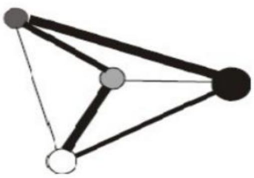
Where

W_{se} is the weight of edges in super graph.

dis(sn) is the distance between nodes of a super graph.

Adj-p is the sum of the adjacent perimeter between two regions.

Super Graph



- The obtained block directional image have four directions, so we have four nodes.
- All the nodes are connected with the other three edges.
- If the number of nodes are high, its take much time to find a match.

Retrieving the Fingerprints

- Fingerprints are classified according to their structure.
- A sample from each structure is taken for comparison.

Cost function = $(\sum_i (W_{i.node}$-"$W_{i.node}))(\sum_j (W_{j.edge}$-"$W_{j.edge}))$

where

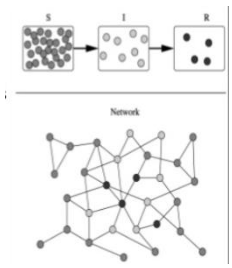
$W_{i.node}$ and $W_{j.edge}$ are the node weight and edge weight of the Super graph.

"$W_{i.node}$ and "$W_{j.edge}$are the node weight and edge weight of the model Super graph.

- Different classification give different cost value. Among that the lowest cost value function is taken and the comparison of the fingerprint proceeds in that class.
- By this method high accuracy is achieved in short comparison time.
- Previously FBI used 3 major classifications for matching the fingerprints and they had many sub-classifications.
- But now they use around 10 major classifications and many sub-classifications which gives them a fast result.

Epidemology

- Networks model used to represent the spread of infectious diseases and design prevention and response strategies.
- Vertices represent individuals, and edges their possible contacts. It is useful to calculate how a particular individual is connected to others.



- Knowing the shortest path lengths to other individuals can be relevant indicator of the potential of a particular individual to infect others.

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