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Application of Graph Theory in Transportation Networks

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Abstract:-
When trying to estimate the maximum number of people who can fly from a city C_i to a city C_j through different routes and airports, one can use a networks N as a model. Let us assume the source s, as the origin C_i of the trip and the sink t, as the destination C_j, and the remaining internal nodes v_i are the intermediate airports. An arc $a = (v_i, v_j)$ of N represents a direct flight from the city v_i to the city v_j and c(a) denotes the maximum number of seats available on a direct flight from v_i to v_j.

Keyword:- Graph, Direct graph, Graph networks, Simple graphs .Multi graph.

Introduction:-

Graphs are used to model situation in which a commodity is transported from one location to another. A common example is the water supply, where the pipelines are edge, vertices represent water users, pipe joins and so on. Highway systems can be thought of as transporting cars. In many examples it is natural to interpret some or all edges as directed. A common feature of transportation system is the existence of a capacity associated with each edge……..the maximum number of cars that can use a road in an hour. The maximum amount of water that can pass through a pipe and so on.

1. Maritime Traffic :-

Let u_i, i = 1, 2………, m and v_j j = 1, 2…….., n are different seaports and some products are ready for shipment at u_i to v_j. let s_i be the quantity available at a_i and d_j the quantity demanded at v_j. How should the products be shipped?

Here also, network serves as a model. That is u_i, i = 1, 2………, m and v_j j = 1, 2…….., n are treated as nodes and shipping routes can be represented by arcs of the form (u_i, v_j) with a capacity equal to the shipping capacity between the two seaports. Two new nose s and t are introduced as a source and sink, respectively such that join s to each u_i by an arc with capacity $c(s, u_i) = s_i$ and join each node v_i to t by an arc with capacity $c(v_j, t) = d_j$. A maximum flow for this transportation network yields the quantity of products to ship along each route in order to satisfy all demands, if this is possible.

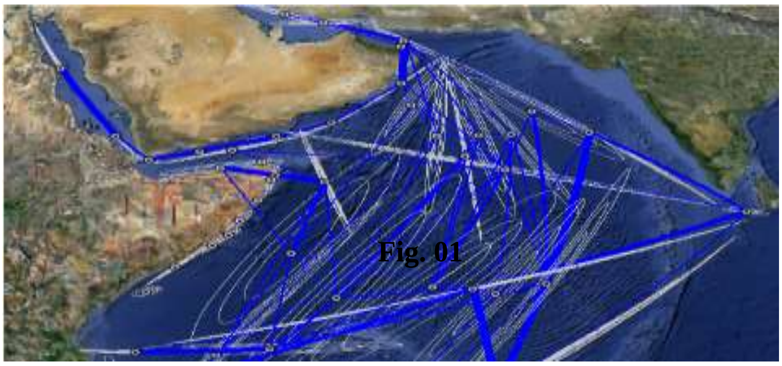

Fig. 01

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1.1 Graph Theory use Air Traffic Control Network :-

Air traffic control is an essential element of the communication structure which supports air transportation. Two basic for air traffic control (ATC) are safely and efficiency of air traffic movement. ATC organizes the air space to achieve the objective of a safe, expeditious and orderly flow of air traffic. The increasing range of aircraft technology means more attention to the allotment of air space. The problem is future compounded by the fact that busy airports sustain excessive lending and departure rates and airports themselves are invariably situated within busy terminal areas and in close proximity to other airports. Future more, these airports are often sited near the junction of air routers serving other destinations.

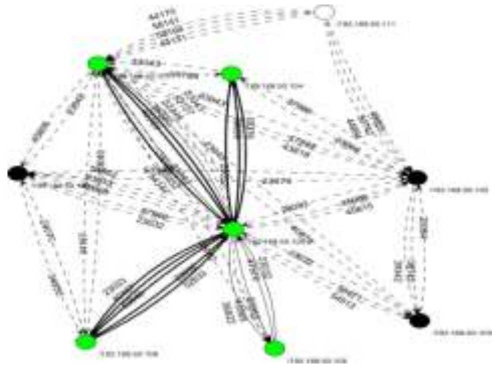

Fig. 02

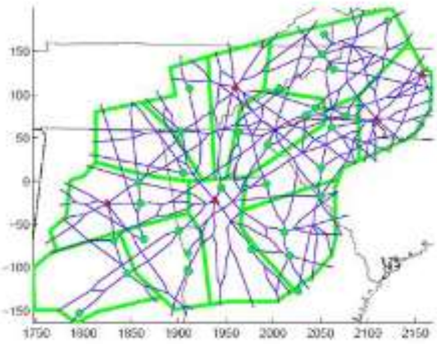

Fig. 03

The tern air traffic control is defined as service provided for the purpose of

- Preventing collision between aircraft on the air
- Assist in preventing collision between air craft moving on the apron or the maneuvering area.
- Expedite and maintain an orderly flow of air traffic and
- Providing information useful for safe and effective conduct of flights

To mange air traffic system there are three basic types of manned facilities, namely, air route traffic control centre, the airport traffic control tower and the flight service station.

- **Air route traffic control centers (ARTCC) -** The ARTCC is to control air traffic network within the assigned area . That is the area which is outside the confines of air spaces designated for the provision of air traffic services by approach control and aerodrome control. Each centre has control of a definite geographic area and is concerned primarily with the control of aircraft operating under IFR. For ease of operation of work on area control unit is divided into sectors. These sectors are usually longitudinal in dimension having specific boundary which are delineated by en route reporting points. In some cases sectors are also divided vertically. Permitting a separate sector responsibility for the air routes within the upper air space. The sectors are required to work in close liaison, one with another, their manning and method of operation of being primarily determined by the nature of technical equipment provided to carry out the tasks. Aircraft must not be permitted to penetrate the airspace of another sector or ARTCC unless prior coordination has taken place. It can be observed that an aircraft flight plan is transferred between sectors within an ARTCC and between ARTCC's when crossing the ARTCC boundary. At the boundary points marking the limits of ARTCC, the aircraft is released to and adjacent centre or to terminal control or an approach control facility.

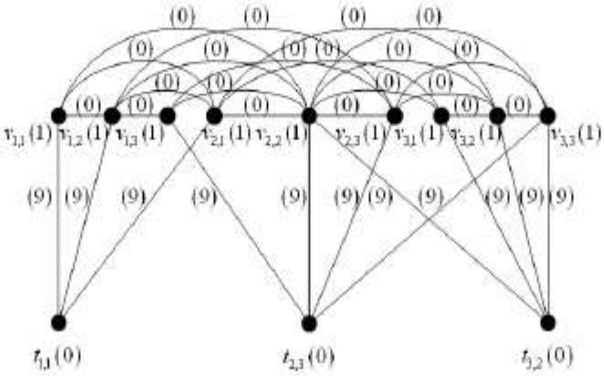

Fig. 04

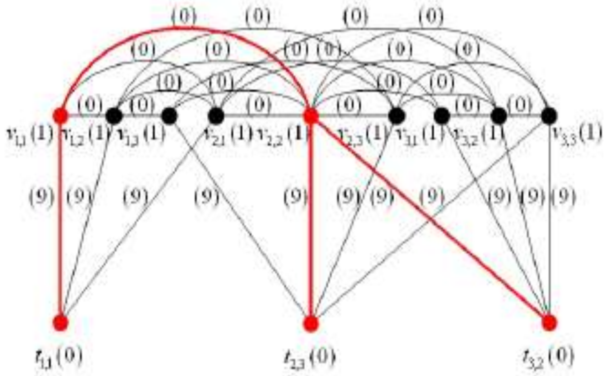

Fig. 05

❖ **Terminal Approach Control :** These purpose is to protect the flight path of aircraft leaving the airways system to land at the airport in the terminal or alternatively the flight path of aircraft departing the terminal for and en route airway. When these are several airports in and urban area. One facility may control traffic to all these airports. An approach control of busy airport can handle as many as fine stacks of arriving aircraft which have been transferred to it by ARTCC.

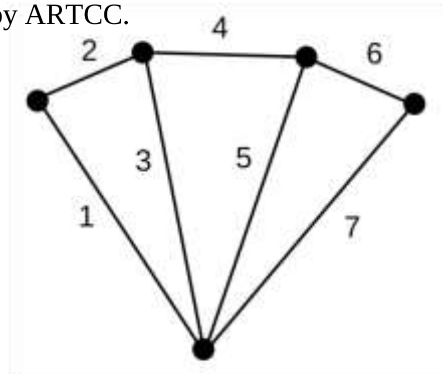

Fig. 06

❖ **Air Traffic Control Tower :** The modern airport, control room sits on the top of a concrete stalk or on top of a brick building placed at permissible height within the clearance angles of the airport runways. Seeing by eye, what is actually happening within the immediate environment of the airport and on its surface is what this part of the ATC service is all about. Usually at busy airports these would be two controllers. The air controllers and the ground controller. Air controller is responsible for aircraft which are flying in the vicinity of airport traffic zone and for aircraft taking off and landing. Ground movement on the airport surface. It is essential for him to see, as much as possible of the airport surface including its taxi ways and exit point form the runway in use.

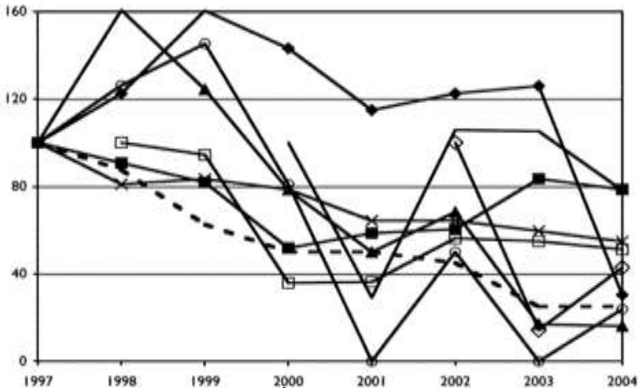

Fig. 07

1.2 Weighted Graphs and Travelling Salesmen :-

A weighted is a graph to which we assign each edge a weight. Which is a positive real number. The weight of an edge is typically of as the cost of using this edge. We draw this graphically by drawing our graph as usual, and

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then writing the weights on or next to each edge. Much of what we have done so far can be done in the content of weighted graphs.

First we can still represent graphs with matrixes. If the vertex set is v = { 1, 2, 3,…………n}, put with the weighted adjacency matrix A = (w_{ij} $)_{ij}$

San Francisco and Los Angeles draw the weighted graph. Some approximate road distances among four city New York, Oklahoma city.

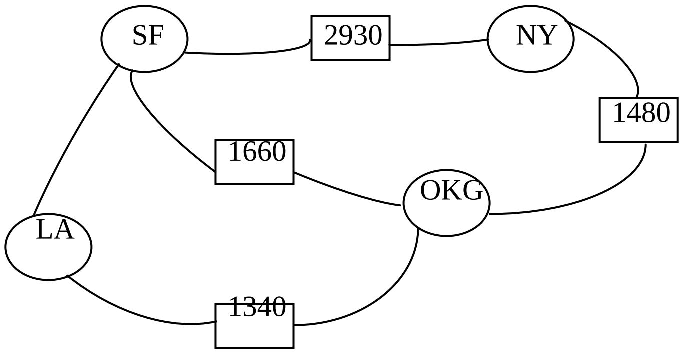

Fig. 08

The weighted between two cities is and approximates road distance. We did not include an edge between LA and NY because going through OKG is approximately the shortest way to get from LA to NY. The weighted adjacency matrix with respect to the vertex ordering { NY, OKG, SF, LA} is

$$A = \begin{pmatrix} 0 & 1480 & 2930 & 0 \\ 1480 & 0 & 1660 & 1340 \\ 2930 & 1660 & 0 & 390 \\ 0 & 1340 & 390 & 0 \end{pmatrix}$$

Path are define the same way for weighted graph as for unweighted graphs, expect now one might define the length of the path to be sum of the weighted of the edges. To avoid confusion of terminology, we won't use the word length for weighted paths. Bu we'll use the word cost. That is γ a path is G represented by a sequence of edges (e_1, e_2,e_3………..e_k), then the cost of γ is $\sum_{i=1}^{k}$ w (e_i) for instance in our example above the cost or path from LA to NY given by (LA, OKL, NY) is 1340 + 1480 = 2820. If G = (V, E, w) is a weighted graph where we assign each edge weight. The cost is the same as our definition of length for the unweighted graph (V, E), indeed, we can view the theory of graphs as a special case of the theory of weighted graphs where all edges have weight degree.

Conclusions:-

The main aim of this paper is to present the importance of Graph theory theoretical idea in transportation problem.

Researcher may set some information related to Graph theory and transportation problem and can get some ideas related to their field of research.

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