AIRCRAFT LANDING PROBLEM (ALP)

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Introduction:-

The air traffic (AT) flow planning and control systems are designed to ensure safe, ordered and accelerated AT, including in airport and airline hubs, reduce the costs of airlines and passengers, and reduce the negative environmental impact, taking into account the uncertainty of AT forecasting. The complexity of planning and regulating AT flows in the vicinity of an aerodrome and the workload of dispatchers increases with increasing AT intensity. At the same time, management efficiency drops, aircraft delays and fuel consumption increases. To prevent such situations, special tools are developed to support the work of the dispatcher in the planning and regulation of AT flows, which perform part of the dispatcher's functions and allow more efficient use of the capacity of the runway and airspace. In Europe, such tools are called Arrival Manager (AMAN) and Departure Manager (DMAN).

The capacity of a runway system represents a bottleneck at many international airports. The current practice at airports is to land approaching aircraft on a first-come, first-served basis. An active rescheduling of aircraft landing times increases runway capacity or reduces delays. The problem of finding an optimal schedule for aircraft landings is referred to as the "aircraft landing problem". The objective is to minimize the total delay of aircraft landings or the respective cost. The necessary separation time between two operations must be met. Due to the complexity of this scheduling problem, recent research has been focused on developing heuristic solution approaches.

NEEDS:-

The aircraft landing problem (ALP) is on the agenda several decades, but still didn’t lose the relevance. The first publications devoted to a problem of ALP appeared in the 1970s. However, the complexity of the problem, new requirements for the organization of AT, new methods of solving optimization problems make the task relevant at present, as evidenced by numerous new publications on this topic. Due to the complexity and importance of ALP, it is still one of the main problems in the study of AT flow control problems.

GOALS:-

This project of the scheduling ofaircraft landings involves developing and evaluating algorithms for the static (or off-line) problem where information about all aircraft to be scheduled is known in advance. The solution of the static problem provides a building block for the dynamic (or on-line) problem where aircraft join the system over time.

Scheduling Aircraft Landings in a Static Environment:-

In the first part of the analysis of scheduling aircraft landings, the aircraft landing problem is modelled based on the assumption that a given set of aircraft is known to the scheduler/air traffic controller and this set does not change. For these aircraft, complete information is assumed to be available and known. Following the model development, a collection of possible algorithms is then developed, and a computational evaluation of these algorithms is performed.

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Most previous studies focus only on maximizing runway usage. In addition to this performance measure, the model also incorporates a

delay term into the objective function, together with an environmental effect term which is computed from an estimate of the extra fuel used by aircraft performing manoeuvres in order to achieve the desired landing schedule. Second, a variety of different solution approaches are explored. Algorithms that have run times of at most one or two seconds are required for practical use.

Strategy and Equation:

In this section we give the mathematical formulation of the static aircraft landing problem

based on [3]. We also define some new parameters which are later used in the presented

algorithm in the next sections.

Let,

N = the number of aircraft,

E_i = the earliest landing time for aircraft i, $i = 1, 2, \ldots, N$,

L_i = the latest landing time for aircraft i, $i = 1, 2, \ldots, N$,

T_i = the target landing time for aircraft i, $i = 1, 2, \ldots, N$,

ST_i = the scheduled landing time for aircraft i,

$S_{i,j}$ = the required separation time between planes i and j, where plane i lands before

plane j on the same runway, $i \neq j$,

$s_{i,j}$ = the required separation time between planes i and j, where plane i lands before plane

j on different runways, $i \neq j$,

g_i = the penalty cost per time unit associated with plane i for landing before T_i,

h_i = the penalty cost per time unit associated with plane i for landing after T_i,

α_i = earliness (time) of plane i from T_i,

$\alpha_i = \max\{0, T_i - ST_i\}, i = 1, 2, \ldots, N,$

β_i = tardiness (time) of plane i from T_i,

$\beta_i = \max\{0, ST_i - T_i\}, i = 1, 2, \ldots, N$.

The total penalty corresponding to any aircraft i is then expressed as $\alpha_i g_i + \beta_i h_i$. If aircraft i lands at its target landing time then both α_i and β_i are equal to zero and the cost incurred by its landing is equal to zero. However, if aircraft i does not land at T_i, either α_i or β_i is non-zero and there is a strictly positive cost incurred. The objective function of the problem can now be defined as :

$$\min \sum_{i=1}^{N} (\alpha_i g_i + \beta_i h_i) .$$

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