CHAPTER 9

9. CONCLUSION

M.Sc. project on operational research was carried out in department of Mathematics, university of Moratuwa, and it involved simulation of dispatching strategies for more than one AGV in a bi-directional block layout involving 21 control points. Here I focus attention on coding and support for efficient execution the speed, concede minimum computer resources, while a higher degree is flexibility is inherited.

One of the most important point found from this simulation is that a great impact of simulation time horizon for the performance of the system is possible. But a significant role of dispatching policy could not be noticed either on total job completion time or average idle AGV time. In addition to the above, maximum velocity of an AGV has a dominant effect on the performance of system.

One of the key features of this simulation is not assuming any probability distribution or generating pseudo random numbers. User could enter realistic values to the system or real random numbers.

The following points will be interesting topics for future study in this area:

1. One of the interesting points for future research is to evaluate the performance of an AGV given that a scheduling system is in place, that schedules the jobs to machines according to some criteria. One method of doing that is to build a model that incorporates this scheduling system and then inserting the AGV into the system dispatching them according to accepted rules. .
2. If there are more than one control point between any two-work centers and if the paths of the AGVs cross each other, then the AGVs also have to be set in such a way such that there is no collision between them. This is another key point identified for future research.
3. Incorporating dead lock resolution algorithms to this programme and make it pit fall free is yet another requirement.

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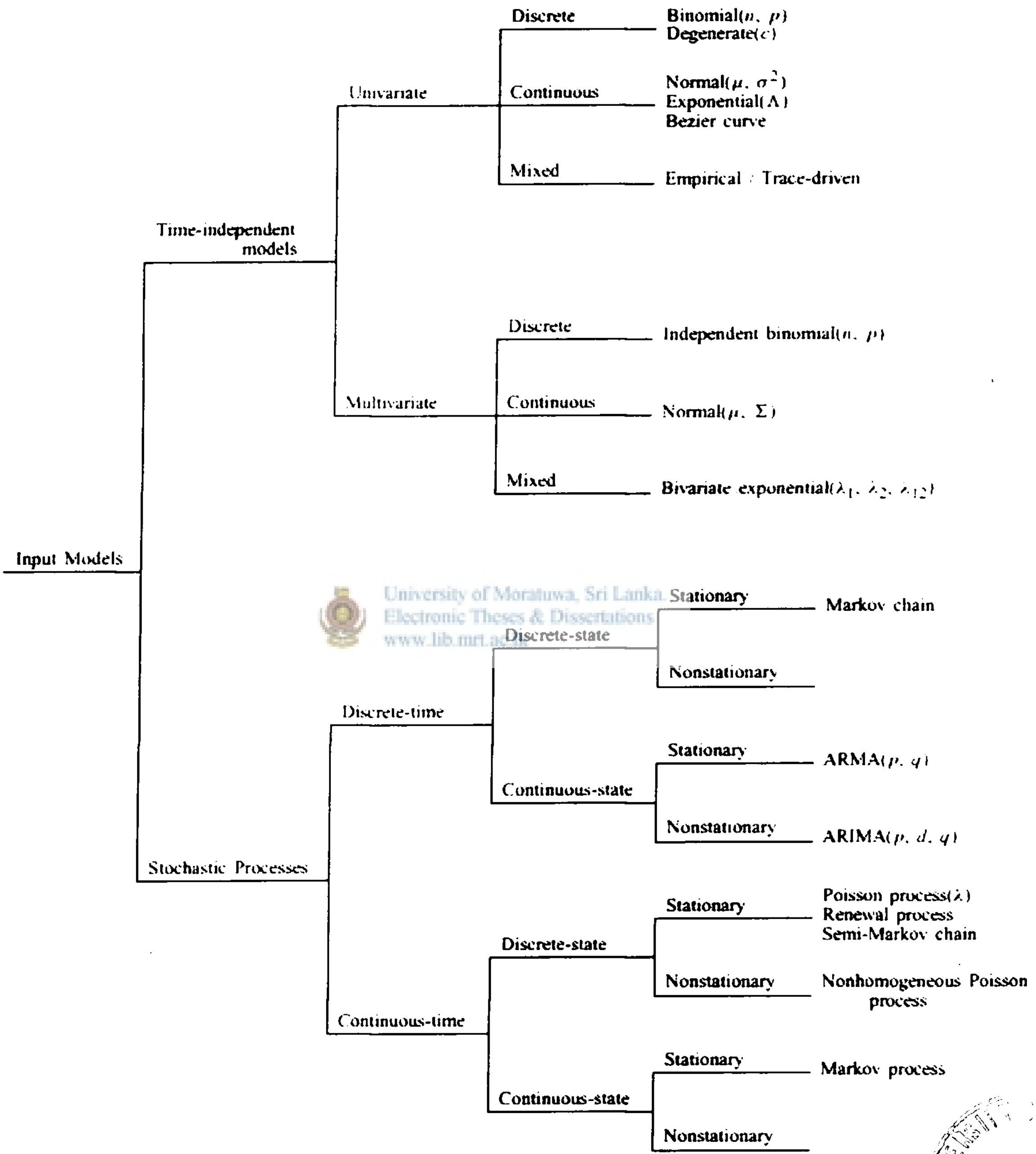
Taxonomy for Input Models



THE SOURCE CODE OF PROGRAME

Please refer the supplementary booklet for source code of the programme

Pseudo Codes for algorithms

a) Least distance between all node pair

Floyd – Warshall All Pair Shortest Path (APSP) algorithm

$$A[i,j] = \begin{cases} w(i,j) & \text{if } (i,j) \in E \\ 0 & \text{if } i = j \\ d & \text{if } i \neq j \text{ and } (i,j) \notin E \end{cases}$$

where➢ $D^{(0)} = A$

$w(i,j)$ – distance from node i to node j

$d > dmax$

E – Edge set

- ➢ $D^{(n)}$ is the matrix to be calculated
- ➢ $D^{(k)}[i,j] = d_{ij}(k) = \min\{d_{ij}(k-1), d_{ik}(k-1) + d_{kj}(k-1)\}$

b) Accessibility between all node pair

•Define edge set matrix is formed as follows

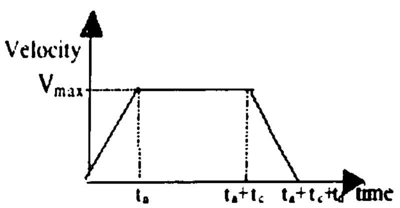
$$E[i,j] = e_{ij} = \begin{cases} 1 & \text{if } a_{ij}/d_{max} \leq 1 \\ 0 & \text{else} \end{cases}$$

•Apply Floyd – Warshall All Pair Shortest Path (APSP) algorithm using logic “OR” function instead of simple summation

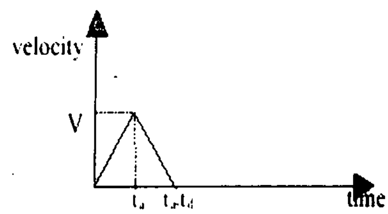
$$e_{ij}(k) = \max\{ e_{ij}(k-1), [e_{ik}(k-1)] OR [e_{kj}(k-1)]\}$$

c) Minimum time considering the velocity profile

Minimum time motion could be realized under maximum acceleration and velocity constraints with following velocity profiles



realizes maximum velocity



maximum velocity is not achieved

•***For saturation of velocity***

$t_a = t_d = V_{max}/f_{max}$ $t_c = \{(d/v_{max})-(v_{max}/f_{max})\}$

Total time $T = \{(d/v_{max})+(v_{max}/f_{max})\}$

•***When unable to achieve maximum velocity***

$t_a = t_d = v/f_{max}$

$v = Ö(d*f_{max})$

Total time $T = 2 Ö(d/f_{max})$

d) Least distance route

•Backtracking of shortest distance from shortest distance matrix
•Load start node to variable i and end note to variable j
•Find a node k and record such that

sdm[i,j]=sdm[i,k]+sdm[k,j] and sdm[i,k]=dm[i,k]
where sdm – shortest distance matrix
dm - distance matrix

•Assign the value of k to variable i and reiterated until it is not possible to find out node k satisfying the above condition

e) Assignment of AGVs according to the selected dispatching policy

•Work center initiated rules
(when single work station and multiple AGVs)
–Longest Idle Vehicle
–Nearest Vehicle

•AGV initiated rules
(when single work station and multiple AGVs)
–First come first served (FCFS)
–Priority

f) Avoidance of multiple AGVs at initial positions

•Check of each AGV pair for the same initial location
•Mathematically speaking

for AGV = 1 to (number of AGVs – 1)
for otheragv = AGV to (number of AGVs)
check other AGV and AGV be at the same location

g) Coding of pick up and drop off node pair

•Demand information composed of three data
–Pickup node
–Drop off node
–Amount of material (can look up from demand matrix)

•This demand information duplicates in demand queue cum priority queue, and subjected to dynamically change
•To better utilization of memory resource and enhance the operating speed, coding is needed
•Coded value = (pick up node)*(number of nodes)+(drop off node)

h) Dynamic routing of AGVs