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Developing Fuzzy Scheduling System for Jobs Prioritization & Route Selection of Jobs in FMS

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Abstract: ***In this study, we have done the scheduling of FMS using fuzzy logic approach. It has been applied by many researchers to various manufacturing problems. With the help of fuzzy logic, we can incorporate both numerical and linguistic variables. The advantage of fuzzy logic is that it has the ability to consider multiple criteria and can deal with uncertain or incomplete information. Scheduling of FMS is considered to be more arduous and complex than a conventional manufacturing system. Due to this, it is one of the arduous tasks to determine an optimal schedule and control a FMS environment. We have developed a fuzzy scheduling system using a fuzzy logic approach. This scheduling system will help in identifying job priorities and select the best alternative route with multi-criteria scheduling through fuzzy logic approach in Matlab. There are three inputs for both job priorities and route selection and this inputs are further divided into three ranges so total 27 rules will be used in fuzzy logic. With the help of these rules, the job selection and route selection both will be done.***

Keywords: Scheduling, Fuzzy logic, FMS, prioritization and route selection

1. Introduction

According to Mehdi Kaighobadi (1994), FMS (Flexible manufacturing system) is a group of machines and related equipment brought together to process a group or family of parts completely and includes Machine tools, a material-handling system and a supervisory computer control network as primary components and Numerical control (NC), Spindle tooling, work-holding fixtures and operations management as a secondary components of FMS (Venkatesh *et al.*, 1994). [4]

Quality of any type of scheduling depends on number and type of inputs to the fuzzy system. Based on the prevailing condition of the system, the type of input is selected. As the number of inputs increases, complexity level of scheduling system also increases (Nanvala, 2011). [6]

2. Classification of an FMS

Flexible Manufacturing Systems (FMSs) can be mainly classified into dedicated FMS, sequential FMS and manufacturing cells. Various kinds of manufacturing system and FMS are shown below in table I.

Table 1: Classification of Manufacturing Systems and FMS (Kaighobadi *et al.*, 1994)

Types of manufacturing system	Level of flexibility	No. of parts in product family	Average lot size
Transfer lines	Low	1-2	7,000 and up
Dedicated FMS	Medium	3-10	1,000-10,000
Sequential or random FMS	Medium	4-50	50-20,000
Manufacturing cell	Medium	30-500	20-500
Stand-alone NC Machine	High	200 and up	1-50

3. Scheduling Concepts

Scheduling is one of the most important functions in a manufacturing firm. It is the allocation of available production resources over time to meet some set of performance criteria. Typically the scheduling problem involves a set of jobs to be completed, where each job comprises a set of operations to be performed. Operations require machines and material resources and must be performed according to some feasible technological sequence. Schedules are influenced by such diverse factors as job priorities, due-date requirements, release dates, cost restrictions, production levels, lot-size restrictions, machine availabilities, machine capabilities, operation precedence's, resource requirements, and resource availabilities (Tan Hock Soon and Robert de Souza, 1997).[3]

4. Literature Review

Production is directly related with the schedule within companies. But other services like maintenance, purchasing, sales or workforce management should also have some effect on the schedule. A hierarchical relationship is present between these services which generates constraints. These constraints define the framework within which the other factors or criteria's have to satisfy their own objectives (T. Coudert *et al.*, 2002). [2]

P.R Venkateswaran *et al.* (2008) designed a supervisory controller using fuzzy logic for Flexible manufacturing systems. This makes it possible for the handling of the speed of the system in effective manner increasing productivity. [8]

Imtiaz Ahmed and Ineen Sultana (2013) developed a performance evaluation model using fuzzy approach for all types of organization where performance evaluation is significantly important for staff motivation, behavior development, attitude, communicating, aligning individual and organizational aims and developing positive relationships between staff and management. [1]

Hao-Cheng Liu and Yuehwern Yih (2013) focused on the liquid crystal injection (LCI) scheduling problem, which is divided into two sub-problems: automated guided vehicle

(AGV) dispatching and LCI machine scheduling. First sub-problem is solved using a fuzzy based method called self-adjusted fuzzy (SAF) method and second sub-problem is solved using a modified least slack time (MLST) method. [5]

5. Fuzzy Methodology

The concept of fuzzy logic was developed by the Lotfi Zadeh in 1965. Fuzzy logic is problem solving control system methodology that gives a simple way to come at a definite conclusion based on missing, uncertain, imprecise, ambiguous and noisy input information. Now days, fuzzy logic approach is used mostly in control problems. Structure of Fuzzy logic system consists of mainly four functional blocks i.e. rule base, fuzzifier, defuzzifier and inference. Structure of Fuzzy logic system is shown in figure 1.

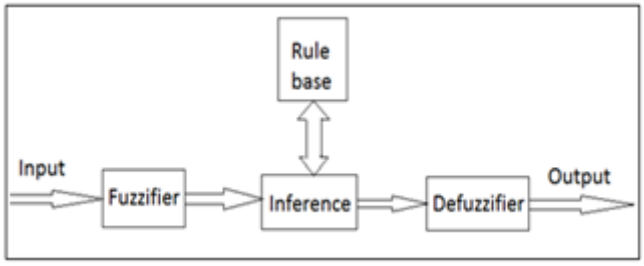

Figure 1: Structure of Fuzzy logic system

6. Problem Definition

Our Problem is to identify the priority of jobs and find best route of jobs using fuzzy logic system. Table II shows the processing time of jobs on different machines. Three variables that we used as an input in Fuzzy logic in Matlab to identify the job priority are:
(a) Processing time (0 to 30)
(b) Due date (0 to 65)
(c) Profit over cost (0 to 10000)

Table 2: Processing time of jobs on different machines

M/c	Job A	Job B	Job C	Job D	Job E	Job F
1	7	6	8	5	4	6
2	3	6	2	1	4	1
3	8	4	2	6	2	3
4	3	9	3	3	9	7
5	4	6	5	2	1	6
6	3	2	7	5	2	9

7. Fuzzy Rules For Job Prioritization

Since the input variables such as due date, profit over cost and processing time all have three states each. So total number of rules formed are 3×3×3=27 rules. An easy and convenient way to show all rules is a decision table, which is given below in table III.

Table 3: Fuzzy Rules for Job prioritization using three inputs and one output

Due Date	Profit Over Cost			Processing Time
	Small	Medium	High	
Small	HI	PHI	MAX	Small
Medium	PAV	HI	PHI	Medium
High	AV	PAV	HI	High
Small	AV	HI	PHI	Small
Medium	LO	NAV	NAV	Medium
High	NLO	NAV	PAV	High
Small	NAV	NAV	NHI	Small
Medium	NLO	NAV	AV	Medium
High	MIN	NLO	NAV	High

These 27 rules are entered in the Rule editor window of Fuzzy logic system. The output variable is priority variable (having triangular membership function also) divided into 9 parts: minimum (MIN), negative low (NLO), negative average (NAV), average (AV), positive average (PAV), high (HI), positive high (PHI) and maximum (MAX).

Three variables that we used as an input in Fuzzy logic in Matlab to identify the best route of jobs are:

(a) Work in queue (WIQ) (0 to 20)
(b) Processing time (0 to 40)
(c) Travel time (0 to 10)

8. Fuzzy Rules For Route Selection

Since the input variables such as work in queue, travel time and processing time all have three states each. So total number of rules formed are 3×3×3=27 rules. An easy and convenient way to show all rules is a decision table, which is given below in table IV.

Table 4: Fuzzy Rules for route selection of jobs using three inputs and one output

Travel Time	Work in queue			Processing Time
	Small	Medium	High	
Small	MAX	PAV	NAV	Small
Medium	MAX	PAV	LO	Medium
High	PHI	AV	LO	High
Small	PHI	AV	LO	Small
Medium	PHI	AV	NLO	Medium
High	HI	AV	NLO	High
Small	HI	AV	NLO	Small
Medium	HI	NAV	MIN	Medium
High	PAV	NAV	MIN	High

9. Results

The values of processing time, due date and profit over cost of different jobs all having equal contribution on outputs are put in fuzzy scheduling system of Matlab and priority using FLS is find out. Rule viewer in fuzzy logic system for Jobs prioritization is shown below in figure 2.

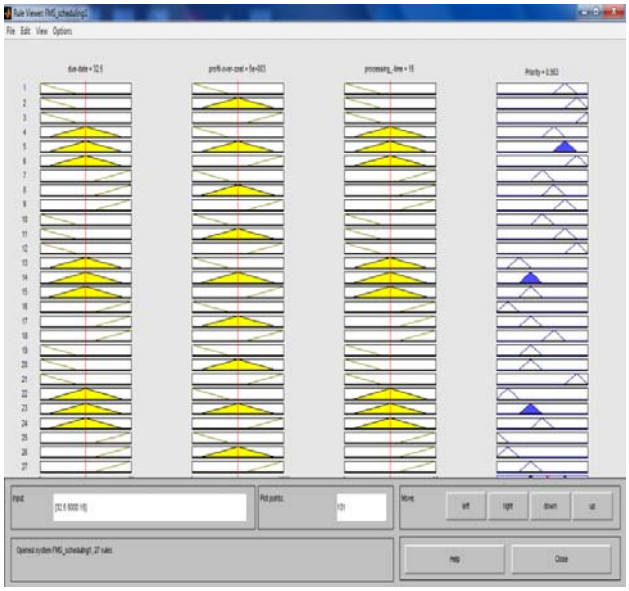

Figure 2: Snapshot of Rule Viewer window for Jobs Prioritization

Table 5: Jobs priority using fuzzy logic approach

Jobs	Priority using FLS
A	0.601
B	0.605
C	0.610
D	0.609
E	0.500
F	0.602

Using fuzzy logic system, we can find out the best route of jobs. Rule viewer in fuzzy logic system represents inputs on the left hand side and output on the right hand side. Rule viewer in fuzzy logic system for route selection is shown below in figure 3.

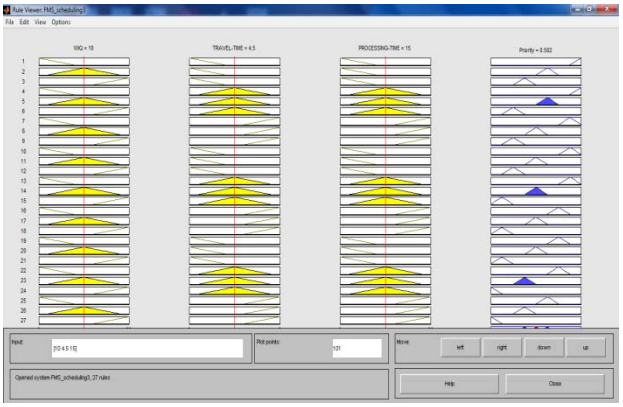

Figure 3: Snapshot of Rule viewer window for Route Selection of Jobs

Third input in the surface viewer is taken as reference input with constant average value. It can vary according to the customer requirements and different surface can be generated. Snapshot of surface viewer for route selection of jobs are shown below in figure 4.

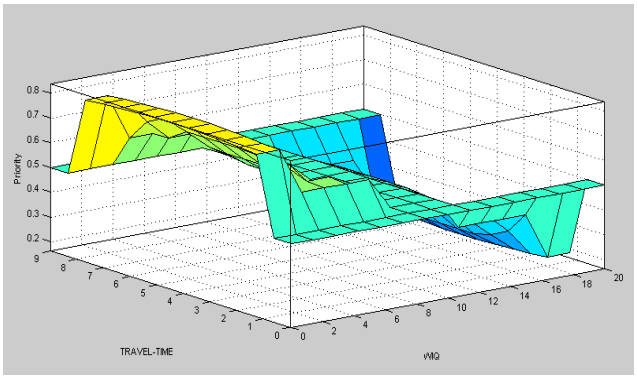

Figure 4: Impact of WIQ and Travel time on Route selection of Jobs

10. Conclusion

This study shows the application of fuzzy logic approach as a decision aid in the short-term control of flexible manufacturing systems. A fuzzy scheduling system was developed in Matlab for job prioritization and route selection. This scheduling system uses fuzzy rules as well as fuzzy multiple attribute decision-making techniques. The study was done to increase performance by using fuzzy techniques and also in giving a systematic design procedure that takes into account multiple objectives and needs no interface with linguistic directions from human experts.

References

[1] Ahmed, Imtiaz and Sultana, Ineen, "Employee performance evaluation: a fuzzy approach", *International Journal of Productivity and Performance Management*, Vol. 62 No. 7, pp. 718-734, 2013.

[2] Coudert, T., Grabot, B. and Archimède, B. (2002), "Production/maintenance cooperative scheduling using multi-agents and fuzzy logic", *International Journal of Production Research*, Vol. 40 No. 18, pp. 4611-4632, 2002.

[3] Hock Soon, Tan and de Souza, Robert, "Intelligent simulation-based scheduling of work cells: an approach", *Integrated Manufacturing Systems*, Vol.8 No.1, pp.6–23, 1997.

[4] Kaighobadi, Mehdi and Venkatesh, Kurapati, "Flexible Manufacturing Systems: An Overview", *International Journal of Operations & Production Management*, Vol. 14 No. 4, pp. 26-49, 1994.

[5] Liu, Hao-Cheng and Yih, Yuehwern , "A fuzzy-based approach to the liquid crystal injection scheduling problem in a TFT-LCD fab", *International Journal of Production Research*, Vol. 51 No. 20, pp. 6163–6181, 2013

[6] Nanvala, Hamesh babu, "Use of Fuzzy Logic Approaches in Scheduling of FMS: A Review", *International Journal on Computer Science and Engineering*, Vol. 3 No. 4, pp. 1734-1739, 2011.

[7] Oke, S.A. and Charles-Owaba, O.E., "Application of fuzzy logic control model to Gantt charting preventive maintenance scheduling", *International Journal of Quality & Reliability Management*, Vol. 23 No. 4, pp. 441-459, 2006.

[8] Restrepo I.M, Balakrishnan S., "Fuzzy-based methodology for multi-objective scheduling in a robot-centered flexible manufacturing cell", *Journal of Intelligent Manufacturing*, Vol. 19 No. 4, pp. 421-432, 2008.
[9] Venkateswaran P., "Applying Fuzzy Modelling to Flexible Manufacturing Systems", *ICGST-AIML Journal*, Vol. 8 No. 1, pp.1-4, 2008.
[10] Wen, H.J., "Formation and dynamic routing of part families among flexible manufacturing cell", *International Journal of Production Research*, Vol. 8 No. 34, pp. 2229-2245, 1996.