Saving Printer Toner, Ink Cartridges - An Introduction of Fuzzy Logic to Help the Environment and Your Wallet

R. K. Karambe
Deptt. of Computer Science
N. H. College, Bramhapuri
Dist – Chandrapur 441 206

D. H. Gahane
Deptt. of Electronics
N. H. College, Bramhapuri
Dist – Chandrapur 441 206

P. B. Dhumane
Deptt. of Computer Science
S. P. College, Chandrapur
Dist – Chandrapur 441 402

ABSTRACT
This research Paper describes the design idea and implementation of Saving Toner / Cartridge of a printer using fuzzy logic. The rules base receives two input values Toner/Cartridge available; and importance of documents, fires the rule, and gives the output in terms of quality of Printing as defuzzifiers. This research paper work will increases the capability of fuzzy logic control system in process of automation of printer with potential benefits. In this paper, we represented a new idea to save toner / cartridge of Printer depends on the Toner / Cartridge / Ink available and Importance of paper that will help for better environment and person's wallet. It is only theoretical study; no practical work is done in this regard.

Soft/Bio-computing

Keywords
Cartridge, Fuzzy logic control, Ink, Printer, Toner

1. INTRODUCTION
Modern printing technology is heavily dependent on automatic control systems. The control automation has become essential for machines and processes to run successfully for the achievement of consistent operation, better quality, reduced operating costs, and greater safety.

The image output on a monitor is often referred to as soft copy. Information output on paper is called hard copy. Two popular kinds of printer used with microcomputers are ink jet and laser.[1]

An ink cartridge is a replaceable component of an ink jet printer that contains the ink (and sometimes the print-head itself) that is spread on paper during printing. Each ink cartridge contains one or more partitioned ink reservoirs; certain manufacturers also add electronic contacts and a chip that communicates with the printer. By 1990 this method was accepted by all printer and ink printer cartridge manufacturers. This is the printer technology of choice for the vast majority of consumers today. This printing method is available for black and white and color documents as well as photo printing. [2]

Laser printers are more economical than inkjet in the long run, even though inkjets are less expensive in the initial purchase price.

Professional digital printing (using toner) primarily uses an electrical charge to transfer toner or liquid ink to the substrate onto which it is printed. Digital print quality has steadily improved from early color and black and white copiers to sophisticated colour digital presses such as the Xerox iGen3, the Kodak Nexpress, the HP Indigo Digital Press series, and the InfoPrint 5000. The iGen3 and Nexpress use toner particles and the Indigo uses liquid ink. The InfoPrint 5000 is a full-color, continuous forms inkjet drop-on-demand printing system. All handle variable data, and rival offset in quality. Digital offset presses are also called direct imaging presses, although these presses can receive computer files and automatically turn them into print-ready plates, they cannot insert variable data.[3]

Computational Intelligence (CI) is a field of intelligent information processing related with different branches of computer sciences and engineering. The fuzzy systems are one paradigm of CI. The contemporary technologies in the area of control and autonomous processing are benefited using fuzzy sets[4].

The user based processing capability is an important aspect of fuzzy systems taken into account in any design consideration of human centric computing systems. The human centricity plays a vital role in the areas of intelligent data analysis and system modeling [5]. The elements of fuzzy sets belong to varying degrees of membership or belongingness. Fuzzy sets offer an important and unique feature of information granules. A membership function quantifies different degrees of membership. The higher the degree of membership A (x), the stronger is the level of belongingness of this element to A. Fuzzy sets provide an ultimate mechanism of communication between humans and computing environment [6].

The fuzzy logic and fuzzy set theory deal with nonprobabilistic uncertainties issues. The fuzzy control system is based on the theory of fuzzy sets and fuzzy logic [7]. Previously a large number of fuzzy inference systems and defuzzification techniques were reported. These systems/techniques with less computational overhead are useful to obtain crisp output. The crisp output values are based on linguistic rules applied in inference engine and defuzzification techniques [8],[9].

This proposed design idea work of Toner saving System is the application of fuzzy logic control system consisting of two input variables: Available ink and importance of documents, and one output variable: Quality of printing. The importance of document is calculated in terms of points given to the documents by the user. The basic idea of the proposed model is described in Section 2. Section 3 gives the simplified design algorithm of fuzzy logic for Toner saving printing system. Conclusion and future work is given in Section 4.

2. BASIC STRUCTURE OF PROPOSED MODEL

The basic structure of the proposed model for Saving toner / cartridge consists of Printer with fuzzy logic control system. Two sensors are used. One is used to measure the Availability of toner / ink in the printer cartridge and second is used to check the importance of document. The sensors with amplification are connected with the two fuzzifiers of the fuzzy logic control system. Outputs of defuzzifiers are to control the quality of printing.
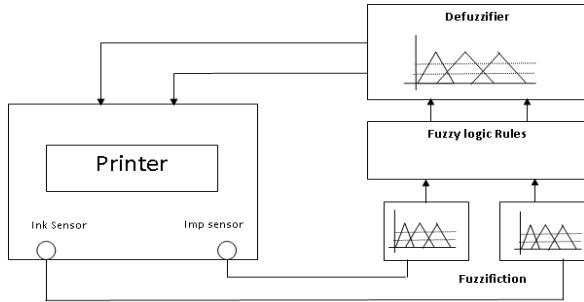

Fig 1: Showing the proposed model

3. SIMPLIFIED DESIGN ALGORITHM OF FUZZY LOGIC FOR TONER / INK SAVING PRINTER

This simplified design algorithm is used to design the fuzzifier, rules, defuzzifier for the Toner / Ink saving printer system according to the control strategy of the Printer to achieve the better and effective Quality of printing.

The design uses three membership functions equally divided over a scale range of 0 to 100% for the Ink available and 0 to 100 pts for Importance of documents. The three membership function for Ink available are termed as: Low 0-40%, Med 30-75%, High 65-100% and membership function are termed for Importance as: GE 0-45pts, IM 50-75pts, VI 60-100pts. The output of this proposed system is Quality of Printing. The membership function for Quality of Printing as: AVG 0-35, GOOD 30-75, EXE 65-100

3.1 Fuzzifier

The fuzzifier uses the data of two input variable, "INK" and "IMPORTANCE". The membership function and range are given in the table.

Table 1: Membership function and range of input variable INK (in %)

Membership function	Range
LOW	0-40
MEDIUM	30-75
HIGH	65-100

Table 2: Membership function and range of input variable IMPORTANCE (in pts)

Membership function	Range
GE	0 - 45
IM	50 - 75
VI	60 - 100

For each input variable, four membership functions are used as shown in Fig. 2 and Fig. 3

Fig. 2 Plot of membership function for input variable "INK Available"
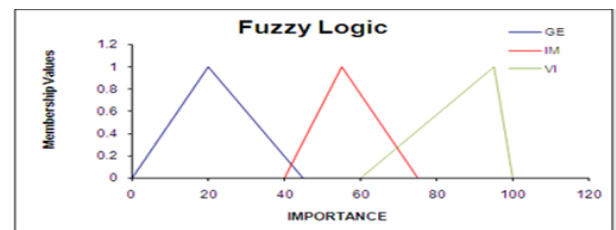

Fig. 3 Plot of membership function for input variable "IMPORTANCE"

3.2 Rules and its selection

Table 3: Rules applicable for Toner / Ink saving printer system

INPUTS		OUTPUT
INK	IMP	QUALITY
LOW	GE	AVG
LOW	IM	GOOD
LOW	VI	GOOD
MEDIUM	GE	AVG
MEDIUM	IM	GOOD
MEDIUM	VI	EXE
HIGH	GE	GOOD
HIGH	IM	EXE
HIGH	VI	EXE

The rule selector receives two crisp values of INK and IMP, distributed the universe of discourse into regions with each containing two fuzzy variable, fires the rules, and gives the outputs values corresponding to each variable.

3.3 Defuzzifier

In this system, two defuzzifier control the Quality of Printing. The membership function of the output variable is shown below:

Table 4: Membership function and range of output variable QUALITY

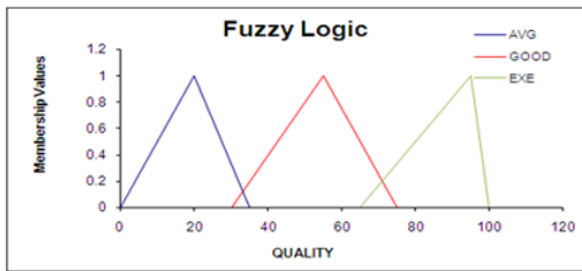| Membership function	Range
AVG	0 - 35
GOOD	30 - 75
EXE	65 - 100

Fig. 4 Plot of membership function for input variable "QUALITY"

4. RESULT AND CONCLUSION

The value for Quality of Printer is calculated using Centroid of Gravity method [8]: If INK available is 60% and Importance of documents available is 50pts, then membership value for INK input is 0.74 (approximately) and for IMPORTANCE input is 0.62(approximately). Using Conjunction ($\wedge$) operator : min(0.74 , 0.62) = 0.62.
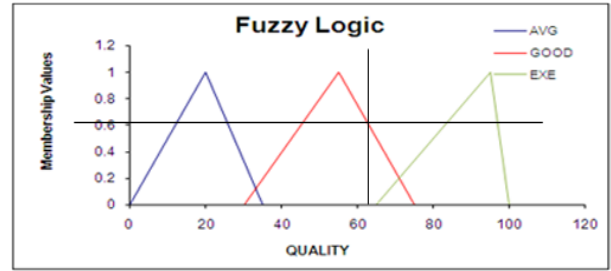

Fig 5: Output of membership function for input variable "QUALITY"

From figure, it was found in Good range. By using Center of Gravity method:

= (50.2*6)/6 = 50.2 Good (approximately)

The utility of the proposed system is to help save toner / ink and avoided wastage of toner /ink, so one can use toner for long duration without refilling early. As the printing quality is improved automatically with importance of documents and available ink, it will control wallet and environment robbery. In future it will help to design the advanced control system for printers taking other parameters as input like thickness of paper, etc and other various printing devices generally used in industrial applications at large scale.

5. REFERENCES

[1] Dr Madhulika Jain, Information Technology Concept, BPB,2006, ISBN – 81-7656-276-9

[2] www.phoenixdirectuk.co.uk.

[3] Kipphan, Helmut (2001), Handbook of print media: technologies and production methods (Illustrated ed.). Springer. pp. 130–144. ISBN 3-540-67326-1.

[4] M. Perkowitz and O. Etzioni, Adaptive web sites, Commun ACM 43: 8 (2000) 152-158

[5] M. Spott and D. Nauck, Towards the automation of intelligentdata analysis, Appl. Soft Comput. 6(2006) 348- 356

[6] S. Gottwald, Mathematical fuzzy logic as a tool for the treatment of vague information, Inf. Sci. 172:1-2 (2005) 41-71

[7] H. J. Zimmermann, Fuzzy Set and Its Applications, 3rd ed., Kluwer Academic Publishers, Norwell, MA. (1996)

[8] Y.Y. Chen and T.C. Tsao, A Description of the Dynamic Behaviour of Fuzzy Systems, IEEE Trans. 19 (1989)745-755

[9] M. Sugeno Tanaka, Successive Identification of a Fuzzy Modeand its Application to Prediction of a Complex System, Fuzzy Sets Syst. 42 (1991)315-334