Middle-East Journal of Scientific Research 23 (Sensing, Signal Processing and Security): 243-248, 2015
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2015.23.ssps.103

Automation of Domestic Flour Mill Using Fuzzy Logic Control

K. Sudha

Bharatividyapeeth's College of Engineering, New Delhi, India

Abstract: Automation is one of the emerging technologies in the field of any industrial processes. This paper emphasis on the automation of a domestic flour mill using fuzzy logic. As fuzzy logic have various potential functions, this can be utilized in flour mill automation. In this paper an idea is proposed for the Range of grinding processas it helps to operate in optimal speed and saving electricity. Fuzzy Logic Controller (FLC) improves the performancecompared to a conventional PID controller as well.In this paper a comparison of PID and Fuzzy Logic Control was also performed andit is proved that FLC has better response and less overshoot. Also it is free from oscillations present in transient period. The simulation was carried over by using MATLAB/SIMULINK.

Key words: PID · Fuzzy logic · FUZZY PID · MATLAB/SIMULINK · Rotating roller blades

INTRODUCTION

Introduction of Flour Mill: A flour mill is a small scale machine which is used to grind different kinds of wheat and other starchy plant foods. Flour mills can be established at different levels like domestic, commercial, mini and roller flour mill. Milling machinery consist system components of feeding, grinding, separating husk and flour and power handling system. The flour mill processes the wheat to edible wheat flour. The four main stages of flour production are, a) conditioning of wheat feed using multiple hoppers. b) Cleaning of seed by separating the bran c) grinding of seeds using chilled cast iron roller blades and d) finally the flour is sieved and segregated. The segregated product goes for packing. The intermediate goes to purifier machine and rest goes to roller mill for further grinding and separating. The roller mill is generally vertically shaped so that it the material circulates through iron roller blades rather than spinning.Roller mill is placed on a base which consists of a motor for turning the roller blade and has control on its surface. The space between the rotating roller blades are adjusted to get the consistency as desired by the customer.To separate endosperm of the grain from bran and germ the roller mill which are highly powered are used. Then it is crushed and grinded to fine flour particles.

In recent years the domestic floor mill is operated manually. Operating the domestic floor mill is being carried out manually. In this paper a new method is proposed using fuzzy logic for automatic grinding which removes the manual operation.

PID and Fuzzy Logic Controller: The paramount need of any automation industry is speed control. There are various methods adopted for the speed control. One such speed control method is using conventional control methods like PID. In this paper speed control is performed using PD, PID and FLC.PD and PID has very simple structure but the response is less fast as compared with FLC. FLC is used to embroider the response and time domain parameters and the comparative analysis also proves the same.

Physical processes are largely based on human reasoning which is imprecise. Moreover they cannot solve a problem like milling machine components to the accuracy of micron meters. Fuzzy logic mimics how a person would make decisions. FLC is utilised in complex, ill-defined, nonlinear processes where human reasoning has the edge over mathematical models. An ordinary set (crisp set) has only two membership values 0 and 1 while fuzzy logic allows intermediate truth values between zero and one. An assertion can be more or less in fuzzy logic. To design any conventional classical or modern control system, it is necessary for an accurate mathematical model of the plant to be controlled. However in many cases this is not possible because of the complexity of the processes. Thus fuzzy logic is used in control system and design analysis as it incorporates simple, rule-based approach rather than a mathematical model. The first step

Corresponding Author: K. Sudha, Bharatividyapeeth's College of Engineering, New Delhi, India.

in implementing the fuzzylogic is to study the system behaviour by our knowledge and experience. Second step is to design the control algorithm using fuzzy rules in terms of relation between inputs and outputs. The final step is to simulate and debug the design.

Proposed Model: In general the working of FLC is divided into three main stages. The input stage, a processing stage and an output stage. The input stage called the fuzzifier stage formulates sensor and other inputs to the membership functions and degree of membership. The processing stage or fuzzy inference system brings about appropriate rules and generates results for each. The output stage called defuzzifier converts the results into a crisp control output value. So based on this the proposed model for flour mill with fuzzy logic control system was developed. Here we need to control the range of grinding process. For that two sensors are used. One is to detect the type of material and the other is used to measure the quantity of material. The outputs of the sensors are given to a signal conditioning unit which in turn is given as two inputs to the fuzzifiers of the FLC. The output stage called defuzzification gives the crisp output value called control range.

Design of Flc for Automation of Domestic Flourmill: The controller design algorithm is used to design the input stage, processing stage and output stage for automation of domestic flour mill. The FLC design algorithm achieves the effective range of grinding with improved control strategy. The algorithm uses three membership functions divided over a scale range of 0 to 100. Here there are two input variables called "Quantity" and "Material Type" while the output of this proposed algorithm is "Range".The membership function for Range of grinding was chosen to be as: Slow 0-35, Intermediate 30-75, Fast 65-100.The membership function and Ranges are explained in the following table.

Table 1: Range of input variable "Quantity" (in gm's)

Membership Function	Range
SMALL	0-40
MEDIUM	30-75
LARGE	65-100

Table 2: Range of input variable "Material Type" (in %)

Membership Function	Range
SOFT	0-45
MEDIUM	40-75
HARD	60-100

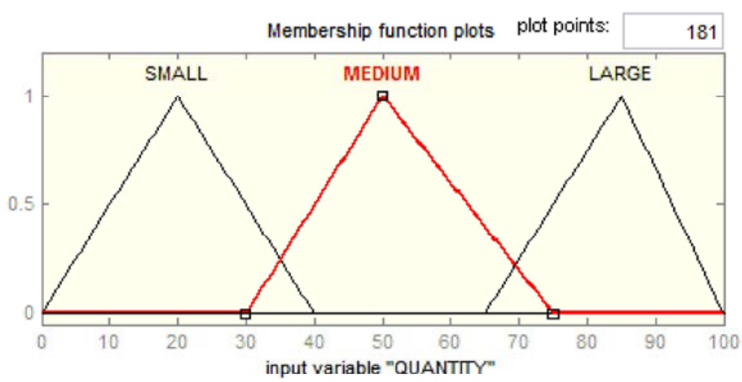

Fig. 1: Membership Function for input variable "Quantity"

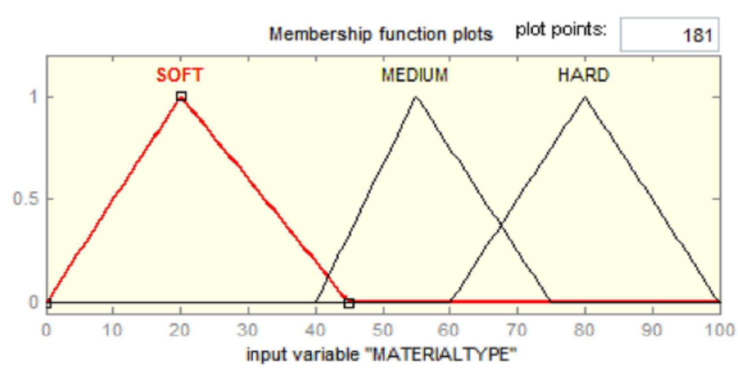

Fig. 2: Membership Function for input variable "Material Type"

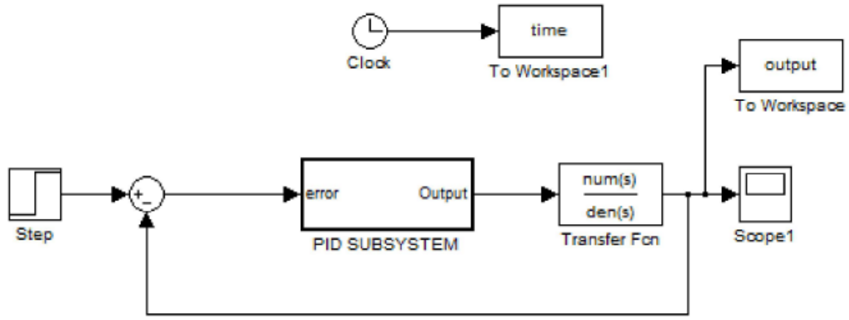

Fig. 3: Simulink model of PID controller

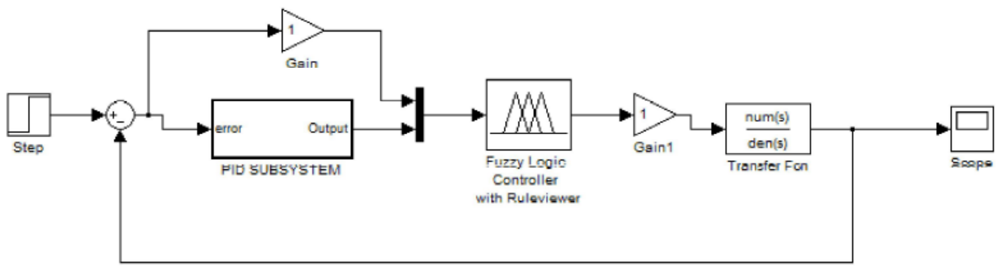

Fig. 4: Simulink model of Fuzzy Logic Controller

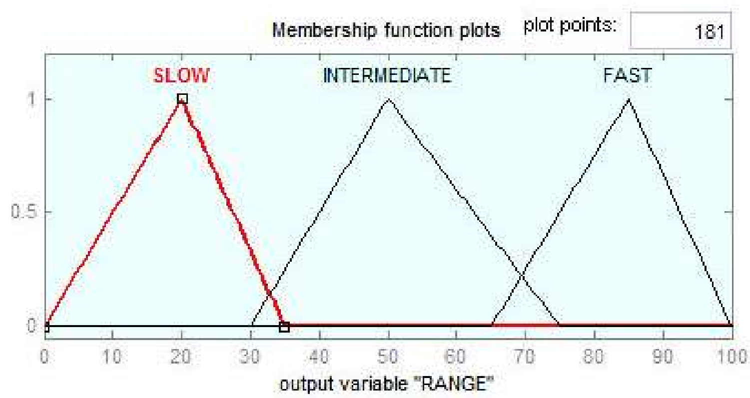

Fig. 5: Membership Function for output variable "Range"

Design of PID and FLC

PID Controller: PID controllers are most commonly used in process industries. PID controllers are mostly used for higher order system. Fig. 3. shows the Simulink model of a PID controller. Fig.3.Simulink model of PID controller

Fuzzy Logic Controller: Since the response of PID controller is not fast and reliable, the Fuzzy Logic Controller is used here which improves the system response with small overshoot and zero steady state error. Fig. 4. Shows the Simulink model of Fuzzy Logic Controller with unity feedback.

The membership function and range of the output variable "Range" is shown as below.

Table 3: Range of output variable "Range"

Membership Function	Range
SLOW	0-35
INTERMEDIATE	30-75
FAST	65-100

Table 4: Rule Base for proposed model

Quantity	Material Type	Range
SMALL	SOFT	SLOW
SMALL	MEDIUM	SLOW
SMALL	HARD	INTERMEDIATE
MEDIUM	SOFT	INTERMEDIATE
MEDIUM	MEDIUM	INTERMEDIATE
MEDIUM	HARD	FAST
LARGE	SOFT	INTERMEDIATE
LARGE	MEDIUM	FAST
LARGE	HARD	FAST

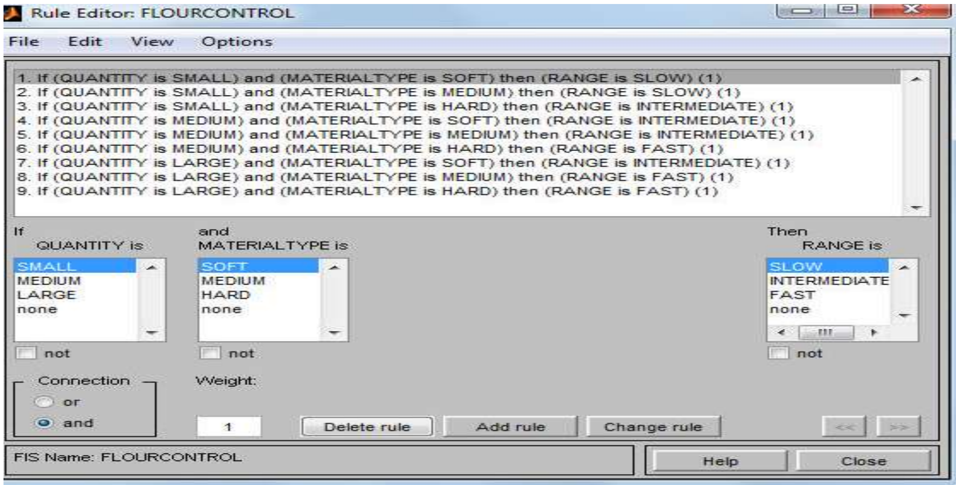

Fig. 6: Rule Editor for Proposed Model

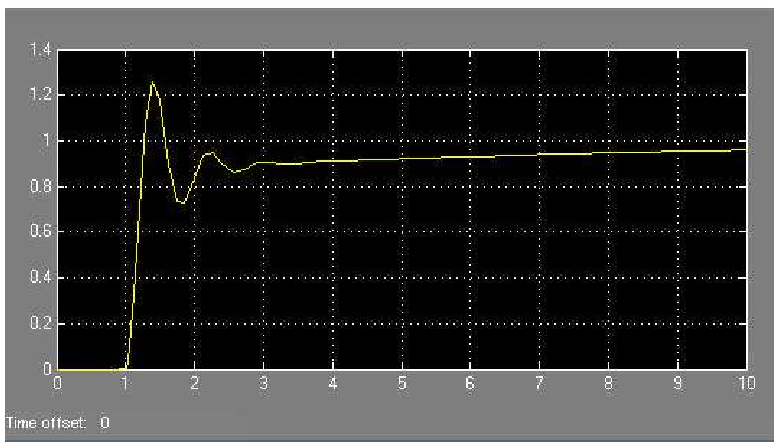

Fig. 7: Step response of PID Controller

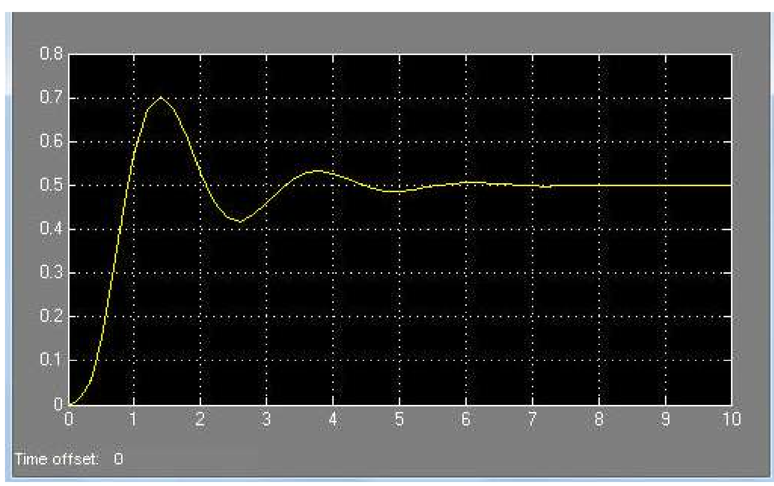

Fig. 8: Step response of Fuzzy Logic Controller

Proposed Rule Forautomation of Flourmill

Simulation Results: The Fig. 7and 8 shows the step responses of the PID controller and Fuzzy Logic Controller. The simulation results infer that FLC has smaller overshoot and fast response compared to PID Controller.

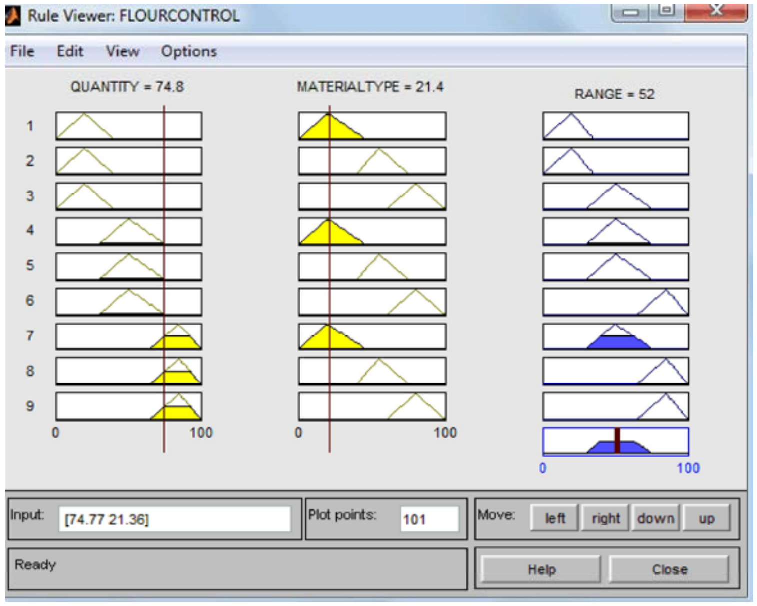

Fig. 9: Rule Viewer for the proposed model

RESULTS AND CONCLUSION

With the proposed model the automation of flourmill becomes an easier task and the mill operates at safer speed. A person without the knowledge of technical concepts can also use the flourmill. By using Centroid of gravity methodthe value for "Range" is calculated and from the results shown by the rule viewer it can be verified as well.To illustrate, if the Quantity is 74.8 (MEDIUM) and Material Type is 21.4(SMALL) and the Range of grinding is 52(INTERMEDIATE).

With the proposed model the efficiency of the flourmill can be increased as it is operated on its optimal speed. Further the same can be utilised for various other grinding devices for industrial applications as well.

REFERENCES

1. Campbell, G.M., C. Fang, P.J. Bunn, A.A. Gibson, F. Thompson and A. Haigh, 2001. Wheat Flour milling: A case study in processing of particulate foods, in: W. Hoyle, (Ed.), Powders and Solids-Developments in Handling and Processing Technologies, Royal Society of Chemistry, Cambridge, UK.
2. Philip, A. Adewuyi, 2013. "DC Motor Speed Control: A Case between PIDController and Fuzzy Logic Controller," international journal of multidisciplinary sciences and engineering, 4(4), may 2013.
3. Aravind, P., M. Valluvan and S. Ranganathan, 2013. "Modelling and Simulation of Nonlinear Tank", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 2, Issue 2, February 2013.
4. Gaurav and Amrit Kaur, 2012. "Conventional PID controller and Fuzzy logic controller for Liquid flow control: Performance Analysis Using MATLAB/Simulink," International Journal of Engineering Research and Technology (IJERT), 1(3), May-2012.
5. Santos, M. and S. Dormido, 2009. "Fuzzy-PID controllers vs. Fuzzy-PI controllers," in IEEE Transactions Systems, Man and Cybernetics, 20(2): 404-418.
6. Manoj Manjunath, R. and S. Janaki Raman, 2011. "Fuzzy Adaptive PID for Flow Control System based on OPC," IJCA Special Issue on "Computational Science-New Dimensions and Perspectives NCCSE".
7. Spott, M. and D. Nauck, 2006. Towards the automation of intelligentdata analysis, Appl. Soft Comput, pp: 6.
8. Awang, N.I. Wardana, 2005. "PID-Fuzzy Controller for Grate Cooler in Cement Plant," IEEE transaction of fuzzy system, 7(32).
9. Nagaraj, B., S. Subha and B. Rampriya, 2008. "Tuning Algorithms for PID Controller Using Soft Computing Techniques," IJCSNS International Journal of Computer Science and Network Security, 8(4), April 2008.

10. ChuenChien Lee, 1990. "Fuzzy logic in control systems i.e. fuzzy logic controller,"IEEE Transactions on Systems, man and cybernetics, 20(2), March/April 1990.

11. Wayne Bequette, B., 2003. Process Control: Modelling, Design and Simulation, Prentice Hall of India.