IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676, p-ISSN: 2320-3331
PP 16-20
www.iosrjournals.org

Automation of Grinder - An Introduction of Fuzzy Logic

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ABSTRACT*: This research Paper describes an automation of grinder using fuzzy logic. The rules base receives two input values Quantity and Material Type, fires the rule, and gives the output in terms of Range as defuzzifiers. This research paper work will increases the capability of fuzzy logic control system in process of automation of Grinder with potential benefits. In this paper, we represented a new idea to control the Range (Speed) of grinding, so that it can operate on its optimal speed as well as save electricity. Simulation is carried out with the help of MATLAB.*
Keywords*: Blender, Fuzzy logic control, Grinder, MATLAB*

I. INTRODUCTION

A Grinder/Blender is a kitchen and laboratory appliance used to crush, puree, or emulsify food and other substances. A stationary blender consists of a blender jar with blade at the bottom, rotated by a motor in the base. The newer immersion blender configuration has a motor on top connected by a shaft to a blade at the bottom, which can be used with any container.

The blending container can be made of glass, plastic, stainless steel, or porcelain, and often has graduated markings for approximate measuring purposes. In cases where the blades are removable, the container should have an o-ring or gasket between the body of the container and the base to seal the container and prevent the contents from leaking. The blending container is generally shaped in a way that encourages material to circulate through the blades, rather than simply spinning around.

The container rests upon a base that contains a motor for turning the blade assembly and has controls on its surface. Most modern blenders offer a number of possible speeds. Low-powered blenders require the addition of some liquid to operate correctly. In these blenders, the liquid helps move the solids around the jar, bringing them in contact with the blades. The blades create a whirlpool effect which moves solids from top to bottom, ensuring even contact with the blade. This creates a homogenous mixture. High-powered blenders are capable of milling grains and crushing substances without such assistance.

The hand-held immersion blender has no container of its own, but instead has a mixing head with rotating blades that can be immersed in a container. Immersion blenders are convenient for homogenizing volumes that are too large to fit in the bowl of a stationary blender or, as in the case of soups, are too hot to be safely poured into the bowl.

Some of the functions of blenders have been taken over by food processors.

Following are the application:

Grinder are used both in home and commercial kitchens for various purposes, including to:
Mix and crush substances such as grains, etc.
Crush ice and other ingredients in non-alcoholic drinks
Emulsify mixtures
Make smooth purées of semi-solid ingredients, such as cooked vegetables and meat
Reduce small solids such as spices and seeds to powder or nut butters
Blend mixtures of powders, granules, and/or liquids thoroughly
Help dissolve solids into liquids
Blenders also have a variety of applications in food science. In addition to standard food-type blenders, there is a variety of other configurations of blender for laboratories.

1.1 Mechanical operation

A blender consists of housing, motor, blades, and food container. A fan-cooled electric motor is secured into the housing by way of vibration dampers, and a small output shaft penetrates the upper housing and meshes with the blade assembly. Usually, a small rubber washer provides a seal around the output shaft to prevent liquid from entering the motor. Most blenders today have multiple speeds. As a typical blender has no gearbox, the multiple speeds are often implemented using an universal motor with multiple stator windings and/or multitapped stator windings; in a blender with electromechanical controls, the button (or other electrical switching device or position) for each different speed connects a different stator winding/tap or combination thereof. Each different combination of energized windings produces a different torque from the motor, which yields a different equilibrium speed in balance against the drag (resistance to rotation) of the blade assembly in contact with the material inside the food container.[1]

Fuzzy logic allows for set membership values between and including 0 and 1, shades of gray as well as black and white, and in its linguistic form, imprecise concepts like "slightly", "quite" and "very". Specifically, it allows partial membership in a set. It is related to fuzzy sets and possibility theory. It was introduced in 1065 by Prof Lotfi Zadeh at the University of California, Berkley.[2]

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.

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].

Presently Grinder/Blender is operated manually. User has the command over it. It is his/her common sense or user manual to operate the Grinder. With new concept that is going to discuss in the paper, we are trying to make automatic control over Grinder and not to depend on the user's operation. The basic idea of the proposed model is described in Section 2. Section 3 gives the simplified design algorithm of fuzzy logic for Automation of Grinder/Blender. Conclusion and future work is given in Section 4.

II. BASIC STRUCTURE OF PROPOSED MODEL

The basic structure of the proposed model consists of Grinder with fuzzy logic control system. Two sensors are used. One is used to measure the Quantity of Material and second is used to detect Material type. The sensors with amplification are connected with the two fuzzifiers of the fuzzy logic control system. Outputs of defuzzifiers are to control the Range.

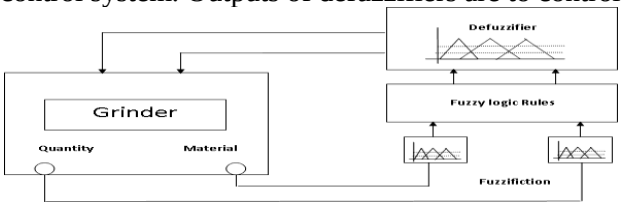


Fig 1: Showing the proposed model

III. SIMPLIFIED DESIGN ALGORITHM FOR AUTOMATION OF GRINDER/BLENDER

This simplified design algorithm is used to design the fuzzifier, rules, defuzzifier for Automation Grinder system according to the control strategy of the Grinder to achieve the better and effective Range (Speed) of Grinding.

The design uses three membership functions equally divided over a scale range of 0 to 100 for the Quantity, Material Type. The output of this proposed system is Range. The membership function for Range (Speed) of Grinding as: Speed I 0-35, Speed II 30-75, Speed III 65-100

3.1 Fuzzifier

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

Table 1: Membership function and range of input variable QUANTITY (in gm)

Membership function	Range
SMALL	0-40
MODERATE	30-75
LARGE	65-100

Table 2: Membership function and range of input variable MATERIAL TYPE (in %)

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

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

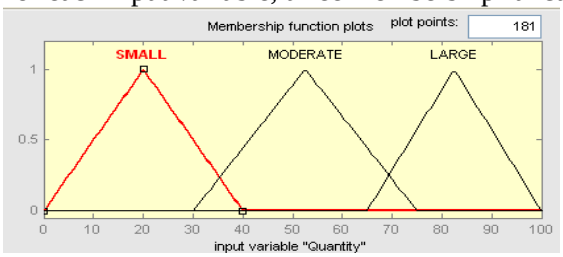


Fig. 2 Plot of membership function for input variable "QUANTITY"

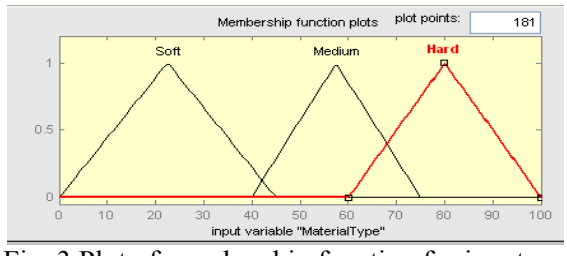


Fig. 3 Plot of membership function for input variable "MATERIAL TYPE"

IV. RULES AND ITS SELECTION

Table 3: Rules applicable for Automation of Grinder

INPUTS	OUTPUT

Quantity	Material Type	Range
SMALL	SOFT	I
SMALL	MEDIUM	I
SMALL	HARD	II
MODERATE	SOFT	II
MODERATE	MEDIUM	II
MODERATE	HARD	III
LARGE	SOFT	II
LARGE	MEDIUM	III
LARGE	HARD	III

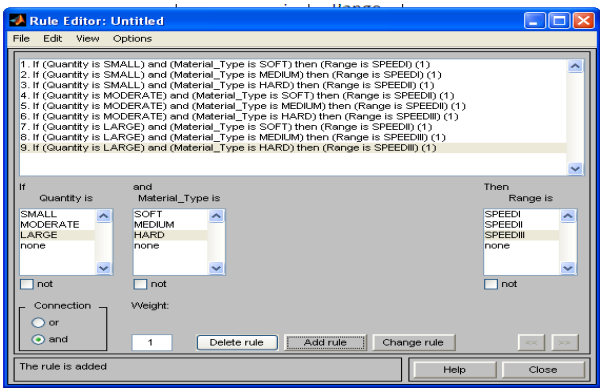


Fig. 4 Rules Editor from MATLAB

The rule selector receives three crisp values of QUANTITY
and MATERIAL TYPE, distributed the universe of discourse into regions, fires the rules, and gives the outputs values corresponding to each variable.

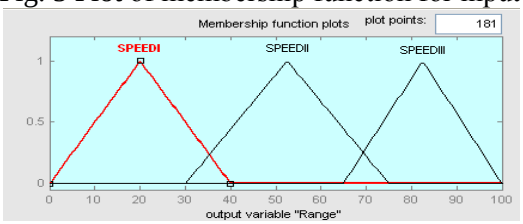
Defuzzifier

In this system, defuzzifier controls the Range of Grinding. The membership function of the output variable is shown below:

Table 4: Membership function and range of output variable RANGE.

Membership function	Range
SPEED I	0 - 40
SPEED II	30 - 75
SPEED III	65 - 100

Fig. 5 Plot of membership function for input variable “RANGE”



V. RESULT AND CONCLUSION

The value for Range of Grinding is calculated using Centroid of Gravity method [8]: If Quantity is 49gm and Material Type is Hard (73), then Range of Grinding is SPEEDIII and is about 75.6. Below fig. shows the result by Rule Viewer of MATLAB.

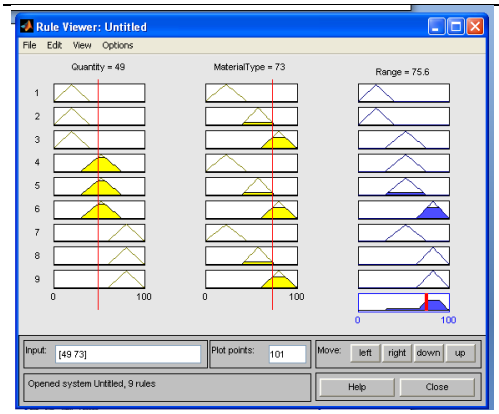


Fig 5: Rule viewer of MATLAB for Output (Rang)

The utility of the proposed system is help to operate the Grinder at safer speed, so one can use Grinder without having knowledge of internal construction and technical knowledge of grinder. With this, we can increase the life of Grinder and save electricity as it operated on its optimal speed. In future it will help to design the advanced control system for Mixture, Flour Mills taking other parameters, etc and other various Grinding devices generally used in industrial applications at large scale.

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