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Fuzzy Logic Controlled Automatic Vacuum Cleaner

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ABSTRACT
The main aim of this paper is to successfully develop an intelligent vacuum cleaner, which can control its suction power and vary it according to the size, quantity and type of the trash to be picked, with the help of fuzzy logic. Type, size, quantity of trash and type of surface are input quantities which are to be sensed by the system. Depending on those sensed information, system decides the percentage of suction power to be used; which is the output quantity of the system. In total, 112 rules are formed which produces adequate results. The total outcome will be the intelligent consumption of power which results in reductions in electric bills.

Key words:- Intelligent suction control, Rule based Fuzzy logic, Surface detection Vacuum cleaner

INTRODUCTION

s we advance in the age of modernization, the importance of time becomes greater and greater. Due to this, the ability of doing multitasking becomes very important. For this purpose, the involve[1]ment of intelligent machines in our daily life, i.e. Robots, becomes more. From joining parts of car in factories to setting the best possible environment in our homes, they are constantly making significant contributions to our life.

For the past years, many artificial intelligence techniques have been developed in order to teach computer about the human behaviors. Those systems are designed by studying human in different conditions, i.e. how humans perform control task, recognize things and make decisions etc. This is needed because there is a mismatch in reasoning between humans and computers. Humans think in uncertain and fuzzy manners while computers that run those techniques are based on binary reasoning. Fuzzy logic is the way to reduce that mismatch as much as possible by making machines

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to think in a way that is more similar to the humans thus making them more intelligent and efficient[1]. Fuzzy logic was proposed by Lotfi A.Zadeh in 1965[2-3].

Nowadays, more and more home appliances are being made intelligent in order to facilitate users. They not only help users by performing almost all the tasks automatically but they are energy efficient as well. Our washing machines, dish washers, air conditioners etc can perform their tasks by sensing given conditions which produces much better results in terms of energy efficiency as well as time consumption as compared to normal devices.

In this paper, Fuzzy logic has been used to modernize a very common house hold device, vacuum cleaner. An intelligent vacuum cleaner will not only make the lives of human beings very easy, by cleaning the room automatically, but it will also reduce the power consumed (hence a lesser electric bill), as compared to normal vacuum cleaner, by sensing the important factors that normal devices aren't able to differentiate.

Fuzzy logic has been used to modernize and automate the vacuum cleaner in order to make it make intelligent by varying its output power depending on the given conditions. Though many researches have been done in this particular field but most of them are concerned with the way vacuum cleaner moves about in the room while avoiding obstacles and selecting the best possible way to get to its target but it doesn't concern with how trash would be cleaned [4]. One other research just took the amount of dirt as the only input quantity depending on which vacuum cleaner varies its output motor's speed [5].

As compared to the other device that have been developed [6-7-8] the device presented in this paper can differentiate between the type of surface, trash plus the amount and size of the trash making it more efficient and sensitive, as compared to others, as different type of trash that are found on different type of surfaces requires different suction power in order to be cleaned.

The basic idea behind an automatic vacuum cleaner is an intelligent energy efficient device which can operate in the most possible human friendly manner. It will be able to differentiate not only between different kinds of trash but also their amount and sizes. It will also be able to sense its working surroundings, i.e. carpet, wooden floor etc. Based on those sensed factors, it will then decide how much suction force it should use to complete its job. All of that will result in the reduction in consumption of electricity, thus a low electric bill.

MATERIAL AND METHODS

In order to make a decision regarding how much suction power is sufficient to pick up the trash the type of surface plays a very important role. For example, if the surface type is going to be a carpeted one then there is a possibility that the pieces of trash might go deep into it thus requiring greater power in order to suck them in. Contrastingly, if the surface is ceramic or wooden then unwanted pieces can be easily reached thus requiring less power as compared to carpeted surface.

Similarly the type of trash is also very important while deciding the percentage of output power because something which is heavy, i.e. glass, needs greater power than something which is light, i.e. paper.

Also, the quantity and the size of the sensed piece of trash are also of important while making a decision on the amount of suction power required.

APPLICATION

The basic concept of the device presented in this paper is depicted in figure 1:

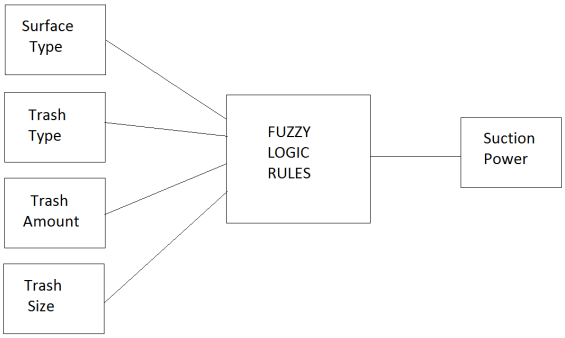

Figure 1: Automatic Vacuum Cleaner.

A. Inputs

There are 4 input parameters to be sensed by the device.First one is the detection of the type of floor on which the vacuum cleaner is going to be used (figure 2). The device can differentiate between carpeted, wooden and ceramic floor types.

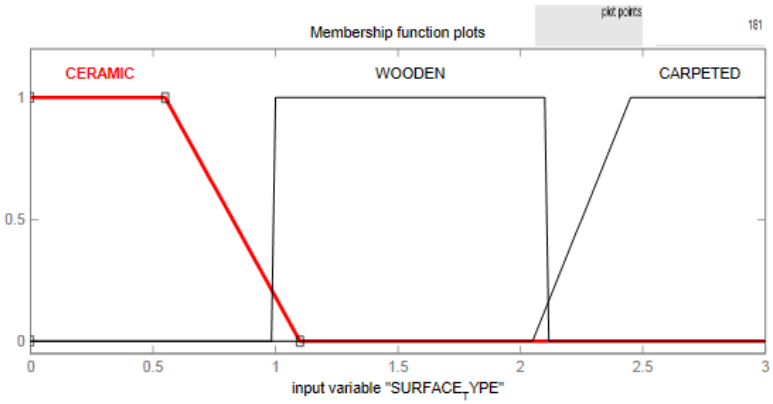

Figure 2: Input Surface Types

The second parameter is the type of trash to be cleaned (figure 3). The machine is able to detect sand, paper, plastic and glass.

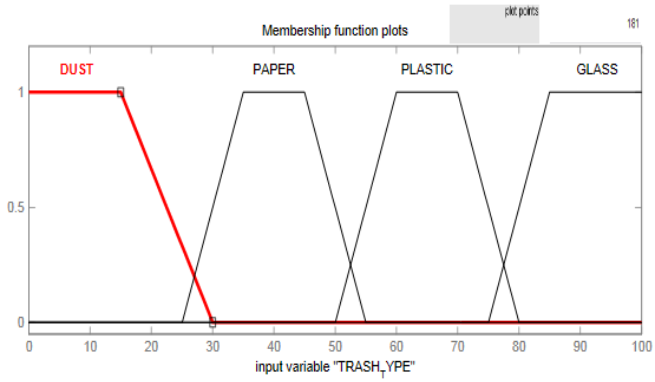

Figure 3: Input trash types.

Quantity of trash is the third information which is collected by the vacuum cleaner (figure 4). It will distinguish between less, normal and much depending on which it will adjust its output power.

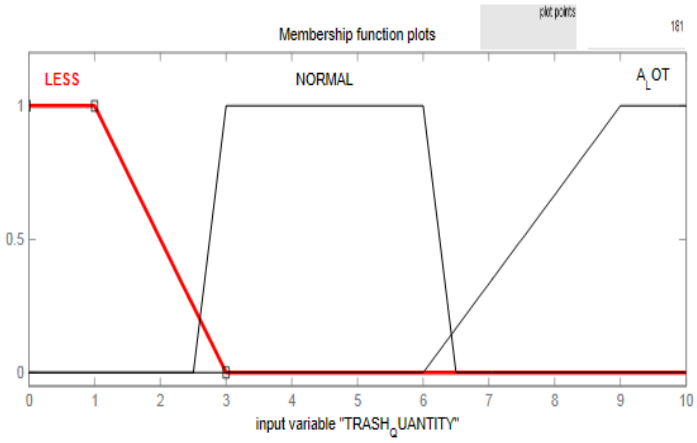

Figure 4: Input trash quantities.

It will also to be able to detect the size of the trash as small, normal or huge (figure 5).

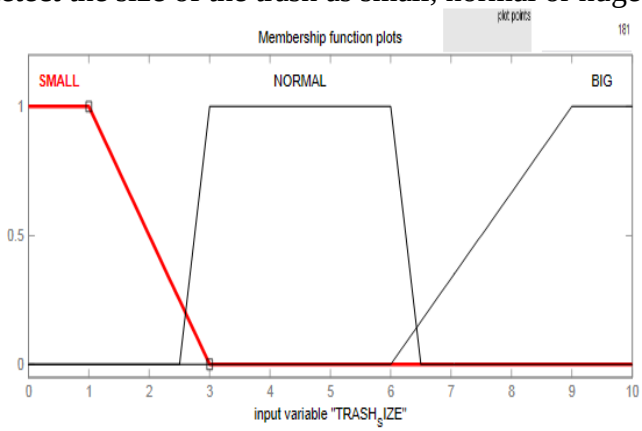

Figure 5: Input trash size.

B. Rules

Formation of rules is based on the level of difficulty that a normal vacuum cleaner faces. For example, it is harder for a vacuum cleaner to suck trash from a carpeted surface as compared to the wooden one because of the depth of it. Similarly a glass piece requires more suction power than a piece paper. The sizes and quantities of the things to be picked are also kept in observation while deriving those rules.In total 112 rules are made. Some of the rules are shown in the table 1.

Surface Type	Trash Type	Trash Quantity	Trash Size	Suction Power
C	1	L	S	LOW
C	3	A	B	HEAVY
W	2	N	N	NORMAL
W	4	A	S	NORMAL
W	4	A	B	HEAVY
W	1	N	N	LIGHT
C	3	A	S	NORMAL
C	2	N	B	STRONG
Cm	4	A	B	HEAVY
Cm	3	S	S	LOW
Cm	2	N	B	STRONG
Cm	1	A	S	NORMAL

Table 1: C=Carpet, W=Wooden floor, Cm=Ceramic, 1=Dust, 2=Paper, 3=Plastic, 4=Glass, L=less, N=Normal, A= A lot, S=Small, B=Big.

C. Output

Depending on those aforementioned factors, vacuum cleaner will vary its output power, i.e. suction power; between very light, light, normal, strong and very strong (figure 6).

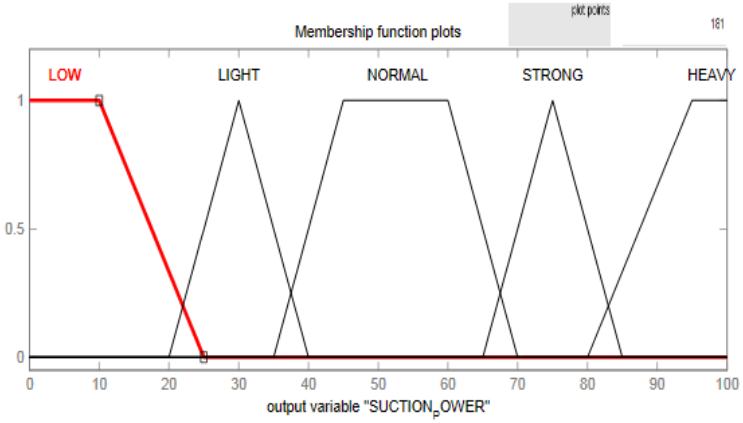

Figure 6: Output suction powers.

The output power (in %) that the vacuum cleaner would be using for some different type of conditions is shown in Table 2.

Surface Type	Trash Type	Trash Quantity	Trash Size	Suction Power (%)
C	1	L	S	9.02
C	3	A	B	93.3
W	2	N	N	52.5
W	4	A	S	52.5
W	4	A	B	93.3
W	1	N	N	30
C	3	A	S	30
C	2	N	B	75
Cm	4	A	B	44.4
Cm	3	S	S	9.02
Cm	2	N	B	32.6
Cm	1	A	S	35

Table 2: C=Carpet, W=Wooden floor, Cm=Ceramic, 1=Dust, 2=Paper, 3=Plastic, 4=Glass, L=less, N=Normal, A= A lot, S=Small, B=Big.

D. Output Graphs

Following graphs are generated, by matlab, which describes the rule surface presented in this paper very thoroughly versus the output suction power (Figure 7, 8, 9).

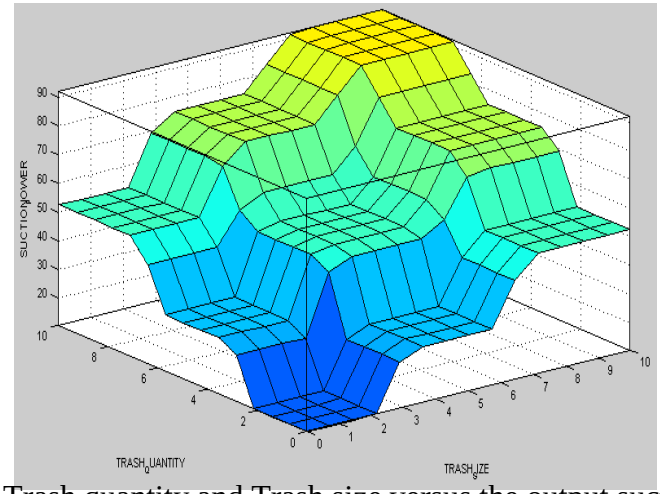

Figure 7: Trash quantity and Trash size versus the output suction power

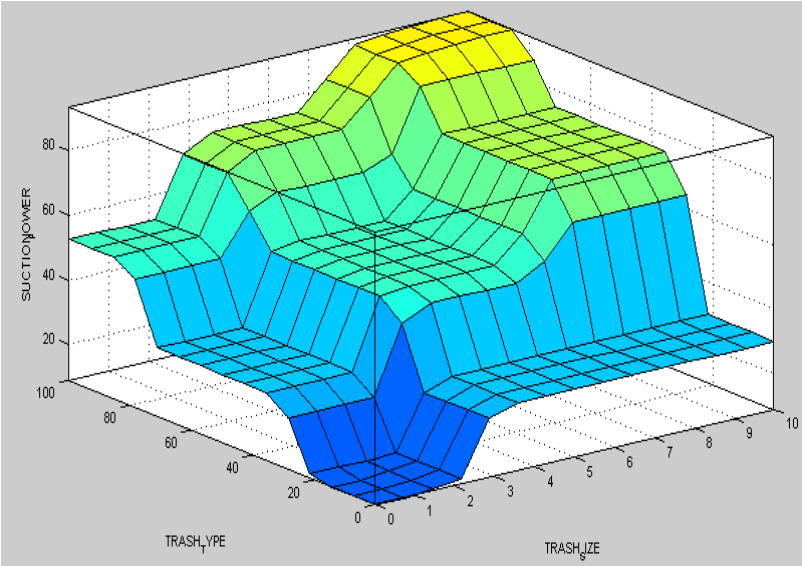

Figure 8: Trash quantity and Trash type versus the output suction power.

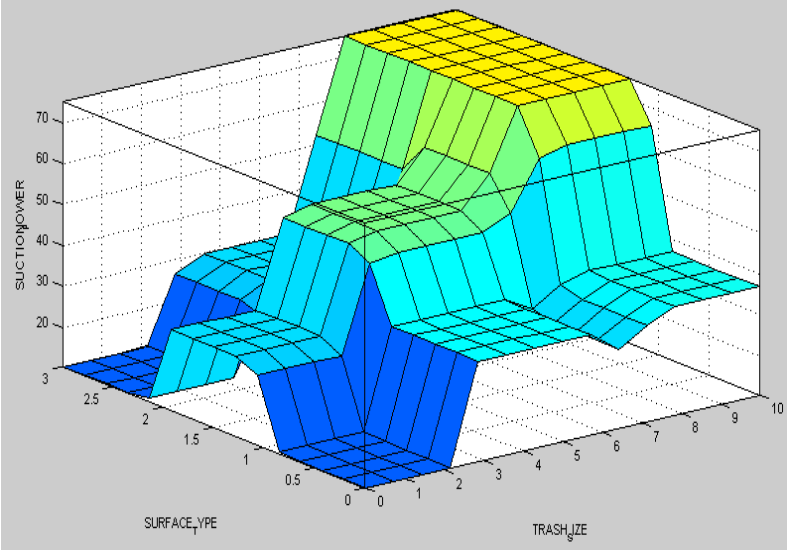

Figure 9: Trash quantity and Surface type versus the output suction power.

PRACTICAL IMPLEMENTATION

Though the device hasn't been implemented practically, matlab was used to evaluate the performance; this section provides the practical information that will be needed in order to implement this device.

Basically there are 4 main quantities which are to be sensed. The first one is type of surface and the others are amount, type and size of trash.

For the detection of surface and the type of trash, image processing can be used as there is a detectable amount of difference between carpeted, wooden and ceramic floorings. For the other remaining factors, optical sensors can be the answer. For example, to detect the amount of trash, a dust sensor which includes a photo transistor mounted opposite to an infrared light emitting diode can be used. LED will emit infrared rays in a beam. Some of them will get diverted while passing through the dust thus decreasing the amount of rays that will be received by the sensor. The collected output can be amplified and can be used to evaluate the amount and also the size of the trash. Thewhole process is shown in the block diagram below in figure 10[9].

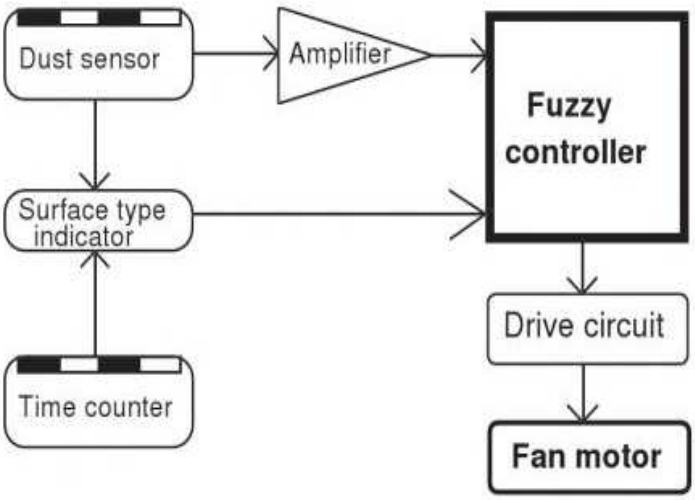

Figure 10: Block diagram describing sensing process.

CONCLUSION

A fully automatic vacuum cleaner, which is practically functional in real-time environment, by utilizing fuzzy rule based logic, has been developed in this paper. Fuzzy rules for the output power depending on the type of surface and trash plus the amount and size of trash are derived based on the human experience in real world conditions.

This paper optimizes the current available vacuum cleaners by making them more efficient depending on their environments. We can make vacuum cleaners more energy efficient by adding artificial intelligence them. This result in less consumption of electricity by vacuum cleaner which makes the consumer electric bills lesser than before.

Overall results of this research were fair as depicted by the matlab graphs. Though In all the conditions, vacuum cleaner presented in this paper was able to variate its output power still some improvements can be made specially by practically implementing it.

REFERENCES

[1] M.G.Simoes, “Introduction to Fuzzy Control”http://inside.mines.edu/~msimoes/documents/Intro_Fuzzy_Logic.pdf accessed on February **2014**.

[2] "Fuzzy Logic". Stanford Encyclopedia of Philosophy.Stanford University.http://plato.stanford.edu/entries/logic-fuzzy/ accessed on February **2014**.

[3] Zadeh, L.A. (1965). "Fuzzy sets", Information and Control 8 (3): 338–353.

[4] N. Agarwal, MIT International Journal of Mechanical Engineering Vol. 1, No. 1, Jan **2011**, pp 56-61,ISSN No. 2230 – 7699.

[5]Norfadzilah, Mohamad (**2008**) “Automatic Fuzzy Logic Controlled Motor For Vacuum Cleaner”, Project Report. UTeM, Melaka, Malaysia.

[6] M. KCiliz, “Rule base reduction for knowledge-based fuzzy controllers with application to a vacuum cleaner”, Expert Systems with Applications 28 (**2005**) 175–184.

[7] T. Matsuyo, M. Moro, S. Yamaguchi, “Vacuum Cleaner with Fuzzy Logic”, US5251358 A, October **1993**.
[8] S. Abe, Y. Hara, S. Kondoh, H. Terai, S. Yamaguchi, “Vacuum Cleaner with Fuzzy Logic", US5233682 A, August **1993**.
[9] L.Reznik,“Fuzzy controllers handbook: How to design them, how they work”, Page 77.