Roll Of Fuzzy Controllers in Avoiding Road Accidents

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ABSTACT-

Now a day we see that road accidents are taking place more lives than any other means of unnatural death. This is a matter of concern for all. In this paper, we discuss about the result of fuzzy logic controller for a vehicle on turning, which is most sensitive area for accidents. We studied all the possibilities of accident in all directions and it was observed that fuzzy controllers work as a basic tool to avoid road accidents. Fuzzy controllers are easy to build and work on human rules. This feature makes it more advantageous than traditional controllers. Fuzzy controllers are the part of everyday life. There are thousands of products in the market with fuzzy controllers. These includes autofocus cameras, motion control camcorders, washing machines that sense moisture, elevators that stop smoothly and automobile transmission and breaking system, and many more.

KEYWORDS- Linguistic variables, Fuzzification, Granulation, membership function, Zadeh hedges, Defuzzification.

Introduction-

In general fuzzy system is any system whose variables range over states that are fuzzy sets. For each variable, the fuzzy sets are defined some relevant universal set, which is often an interval of real numbers**.** **"**Fuzzy logic" has become a common buzzword in machine control. However, the term itself inspires certain skepticism, sounding equivalent to "half-baked logic" or "bogus logic". Some other nomenclature might have been preferable, but it's too late now, and fuzzy logic is actually very straight forward. Fuzzy logic is a way of interfacing inherently analog processes, which move through a continuous range of values, to a digital computer, that likes to see things as well-defined discrete numeric values. Fuzzy controllers are a class of knowledge based controllers using artificial intelligence techniques with origins in fuzzy logic. They can be found either as stand-alone control elements or as integral parts of a wide range of industrial process control systems and consumer products. Applications of fuzzy controllers are an established practice for Japanese manufacturers, and are spreading in Europe and America. Fuzzy control is not totally ad hoc, that there exist formal techniques for the analysis of a fuzzy controller, and that fuzzy control can be implemented even when no expert knowledge is available. For example the variable " distance" in this system can be divided into a range of "states", such as: "near", " little near", "very near", "far", " little far", and "very far" Defining the bounds of these states is a bit tricky. An arbitrary threshold might be set to divide "near" from "close", but this would result in a discontinuous change when the input value passed over that threshold. Traditional control systems are based on mathematical models in which the control system is described using one or more differential equations that define the system response to its inputs. Such systems are often implemented as "proportional-integral-derivative (PID)" controllers. They are the products of decades of development and theoretical analysis, and are highly effective. If PID and other traditional control systems are so well-developed, why bother with fuzzy control? It has some advantages. In many cases, the mathematical model of the control process may not exist, or may be too "expensive" in terms of computer processing power and memory, and a system based on empirical rules may be more effective.

Furthermore, fuzzy logic is well suited to low-cost implementations based on cheap sensors, low-resolution analog-to-digital converters, and 4-bit or 8-bit one-chip microcontroller chips. Such systems can be easily upgraded by adding new rules to improve performance or add new features. In many cases, fuzzy controller can be used to improve existing traditional controller systems by adding an extra layer of intelligence to the current control method.

2 Experiment -

Consider the problem of a vehicle at the turning. Discuss the approximate value for the safe curve to follow, after fuzzy controller alters the steering angle.

Consider the following situation Fig 1; a vehicle (v 1) of comparable length to the width of the road. Vehicle v 1 is seeking to turn to the right side of the road. Let y (-0.7) be the distance of the vehicle from the offset in the scale of -3 to 3.If we consider the diameter of offset to be 6 then y = -2.3. Let x (-105) be the (major) angle between the offset distance and the axis of object (vehicle). The two inputs to the fuzzy controller are x and y. Let z (5) is the steering angle which is the output variable.

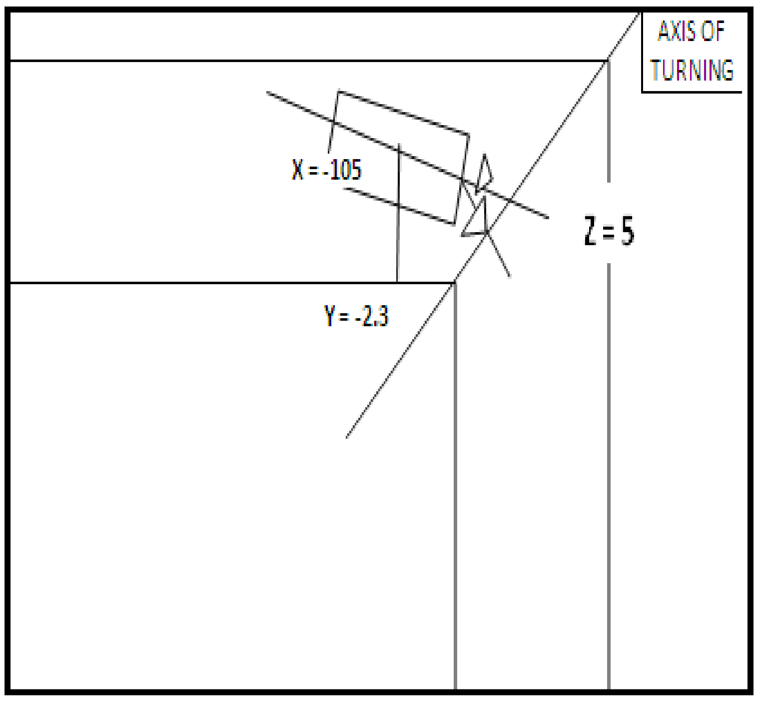


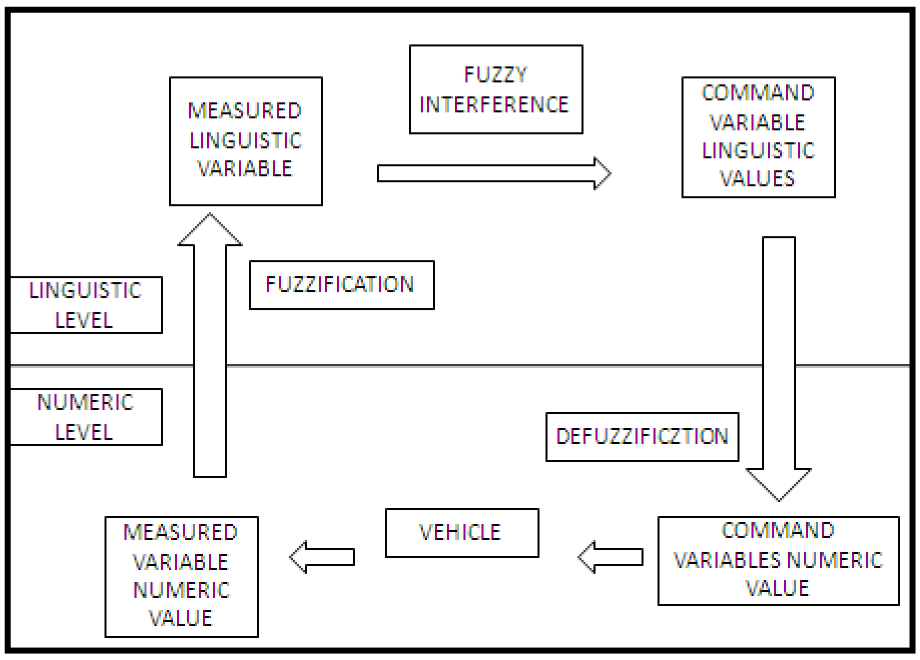
Fig (1)

	VEHICLE	RANGE
OFFSET DISTANCE (y)	y = -0.7	[-3, 3]
ANGLE (WITH OBJECT AXIS) (x)	X = -105	[-135, 75]
STEERING ANGLE (z)	Z = 5	[-35, 35]

Table (1.1)

For working of fuzzy controller, we can refer to the block diagram of fuzzy controller as shown in fig (2). A connection between cause and effect, or a condition and a consequence is made by reasoning. Reasoning can be expressed by a logical inference or by the evaluation of inputs (measured linguistic variables) in order to draw a conclusion (Command variable linguistic value). We usually follow rules of inference which have the form: IF cause1 = A and cause2 = B THEN effect = C. Where A, B and C are linguistic variables. For example, IF "distance" is *Medium* THEN "set angle little big" *Medium* is a function defining degrees of offset distance, while *big* is a function defining degrees of angle. The intelligence lies in associating those two terms by means of an inference expressed in heuristic IF…THEN terms. In order to convert a linguistic term into a computational framework one needs to use the fundamentals of set theory.

Now we introduce linguistic variables for the offset distance y are up -UP, centre - CE and down - DN. For angle x, EU –Extreme up, MU- Moderate up, CE- Centre, MD-Moderate down and ED – Extreme down. For steering angle z are NM – Negative medium, NS – Negative small, ZE – Zero position, PS – Positive small and PM – Positive medium. The ranges for them are tabulated in table (1.1). The variables are further granulated to fulfill the first step of fuzzification as shown in table (1.2) given below.



BLOCK DIAGRAM Fig (2)

Offset distance (y)				**Angle(x)**				**Steering angle (z)**			
				EU	**[-135**	**-110**	**-85]**	**NM**	**[-35**	**-22.5**	**-10]**
				MU	**[-90**	**-70**	**- 50]**	**NS**	**[-20**	**-10**	**0]**
UP	**[3**	**2**	**1]**	**CE**	**[-60**	**-15**	**30]**	**ZE**	**[-10**	**0**	**10]**
CE	**[2**	**0**	**-2]**	**MD**	**[10**	**30**	**50]**	**PS**	**[0**	**10**	**20]**
RC	**[-1**	**-2**	**-3]**	**ED**	**[45**	**70**	**95]**	**PM**	**[10**	**22.5**	**35]**

Table (1.2)

The heart of any fuzzy controller is the rule pad which is based on the exponential membership for the two inputs x and y. Here r is origin. (y-r) or (x-r) are the respective deviation from the initial position. Where p= 0.5 and q = .001.

OFFSET DISTANCE (y)	$\mu(y) = \dfrac{1}{1+p(y-r)^2} \quad for \quad -3 < y < 3$ $\mu(y) = 0 \quad for\, y = -3 \; and\, 3$
ANGLE (WITH OBJECT AXIS) (x)	$\mu(x) = \dfrac{1}{1+q(x-r)^2} \quad for \quad -135 < x < 75$ $\mu(x) = 0 \quad for\, x \leq -135 \; and \geq 75$

Here we define membership for offset distance (y) and angle(x) according to above given relations. Details are given in following table (1.3) followed by the corresponding graph. All the rules that apply are invoked, using the membership functions and truth values obtained from the inputs, to determine the result of the rule. This result in turn will be mapped into a membership function and truth value controlling the output variable. These results are combined to give a specific ("crisp") answer, the actual "steering angle" a procedure known as "defuzzification". This combination of fuzzy operations and rule-based "inference" describes a "fuzzy expert system".

MEMBERSHIP FUNCTION FOR OFFSET (y)	MEMBERSHIP FUNCTION FOR ANGLE(x)
μ(-2) = μ(2) = 0.3 μ(-1) = μ(1) = 0.6 μ(0) = 1	μ(-30) = μ(30) = 0.52 μ(-20) = μ(20) = 0.7 μ(-10) = μ(10) = 0.9 μ(0) = 1

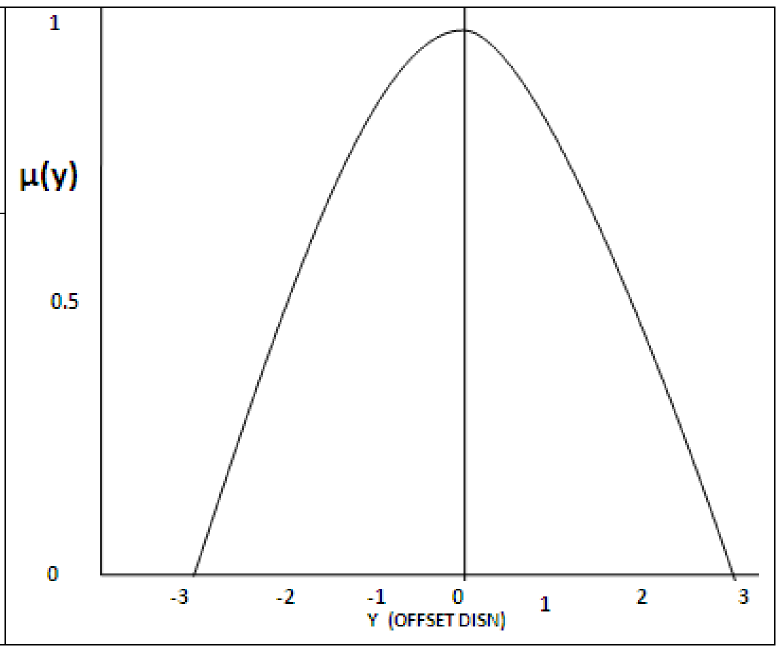


Table (1.3)

After computing individual membership we proceed towards, the relationship of input variables(x, y) and output variable z. Cartesian product of x and y is z = x* y. The fuzzy controller designed will need to have decision for any possible pairings of x, y. This above data is next fetched to interference engine to evaluate the control rules stored in fuzzy rule base. As three and five partition implies we have fifteen rules in the rule base for each order pair of vehicle. The rule pad for the steering angle in terms of linguistic variable is shown below Table (1.4).

Z =X* Y	EU	MU	CE	MD	ED
UP	NM	NS	NS	PS	PS
CE	NS	NS	ZE	PS	PM
DN	NS	PS	PS	PM	PM

Table (1.4)

μ(Z)	-2	-1.5	-1	-.5	0	.5	1	1.5	2
-135	.15	.23	.3	.4	.5	.4	.3	.23	.15
-125	.21	.32	.42	.56	.7	.56	.42	.32	.21
-115	.27	.42	.54	.72	.9	.72	.54	.42	.27
-105	.3	.47	.6	.8	1	.8	.6	.47	.3
95	.27	.42	.54	.72	.9	.72	.54	.42	.27
85	.21	.32	.42	.56	.7	.56	.42	.32	.21
75	.15	.23	.3	.4	.5	.4	.3	.23	.15

Table (1.5)

In some cases, the membership functions can be modified by "hedges" that are equivalent to adjectives. Common hedges include "about", "near", "close to", "approximately", "very", "slightly", "too", "extremely", and "somewhat". These operations may have precise definitions, though the definitions can vary considerably between different implementations. "Very", for one example, squares membership functions; since the membership values are always less than 1, this narrows the membership function. "Extremely" cubes the values to give greater narrowing, while "somewhat" broadens the function by taking the square root.

For avoiding accident we use specification of all possibilities. The concept of safe or nearly safe on turning we use the Zadeh hedges that is concentration. For steering angle (z) μ (z) = μ (x) μ (y) that is μ (-135,-2) = μ (75, 2) = 0.15, μ (-105, 0) = 1. Using membership grading given in above equation we computed the different nodes and their corresponding membership in the numeric value displayed in table (1.5). For the initial position we have μ (-105,-2.3) = (1, 0.8) = 0.8.Here 0.8 is the command variable linguistic value

3 Defuzzification –

The last step of the fuzzy controller is to produce a single real number to use as the control value or command variables numeric value. The desired output will be the change in steering angle (z). That is the number of degrees which should alter from its present position. This is exactly the reverse process of fuzzification in this will get a crisp value to fetch v 1. See fig 2. To start with 0.8, the fuzzy set NS is in support of it. Considering the fact that vehicle v1 has to turn right. As proposed by Mamdani, the method of MOM that is mean of maxima method. We use the z value with the resultant membership valued interval. Clearly it has been achieved in the interval [-20, -10, 0]. So by triangular membership function we compute the following.

Now NS (0.8) = Z1 = - 12 and NS (0.8) = Z 2 = - 8.The average of these two values is z = - 10.

4 Result/Conclusions

From above observations we conclude that the vehicle has to move with -10 steering angle for the safe turning.

Thus fuzzy controllers are useful in the safety measure on the road.

If fuzzy controllers are combined with sensor and indicators then driver could be alerted before hand and road accident could be avoided at turning points.

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