Emotional Intelligence in Robots Using Level 2 Fuzzy Sets

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ABSTRACT

In this paper the author has discussed about the mechanism of robots using level 2 fuzzy sets. Study of criminal psychology has revealed that there are some born criminals. To control their criminal activities, special jails are to be made with extra security .This needs extra human resource and extra finance. In order to lower the maintenance cost, robots can be designed in such a way that they can control these criminals.

I. INTRODUCTION

Robotics has been the interest of matter from last decade for all the researchers around the world. The attempt to humanize the machines was done by many engineers .Lotfi Zadeh was one of those .He developed the   fuzzy logic, a logic which is near to human logic [13]. Fuzzy logic can handle uncertainty in the data very efficiently. From last 50 years, fuzzy sets and fuzzy logic has been used in many areas of the technology [4,5]. Real world data contains uncertainty as well vagueness .In order to handle this type of uncertainty more efficiently, we have developed level 2 fuzzy logic system to manage the born criminals with help of robots.

In recent years the media have focused on violent crimes committed by young people, many of whom are very young. We have collected the data from the paper "*Crimes of the Young: Do the Theories Explain Them?*" to prepare emotional intelligence in robots using level 2 fuzzy logic system.

II. BORN CRIMINAL THEORY

Early scholars studied crime through a variety of approaches, some of which influenced modern sociological theory. Ecological theories, in particular, have been significant. *Ecology* is the study of the distribution of phenomena and their relationship to their environment. The **ecological school** attempts to explain crime as a function of social change that occurs along with environmental change. Born criminals have different chromosomes combination .They generally have XXY or XYY as their genetic combination. Their body structure is somewhat abnormal than normal person. Asymmetrical face, Large monkey-like ears, Large lips, Receding chin, Twisted nose, Long arms, Skin wrinkles are some of the common characteristics . Lombroso's theory motivated to search for characteristics that might cause individuals to commit crime. But based on this theory, one cannot catch the person only because they have above stated characteristics. Not only this, once these criminals commit some crime, it is hard to handle them or manage them. In this paper we have considered case study of following kinchens who have committed second degree offence in very teenage. Consider the following 4 cases: Lionel Tate, age 14, Nathaniel Brazill was also 14, Kip Kinkel, age 15, Luke Woodham, age 17. In this small age they have committed crime of murder in their play. If they are imprisoned in same jail then it is not an easy job to manage them. These super humans get panic after certain period of time.

Level 2 fuzzy logic system

The general structure of level 2 fuzzy logic system consists of following parts. It has extra one part and that is level reduction.
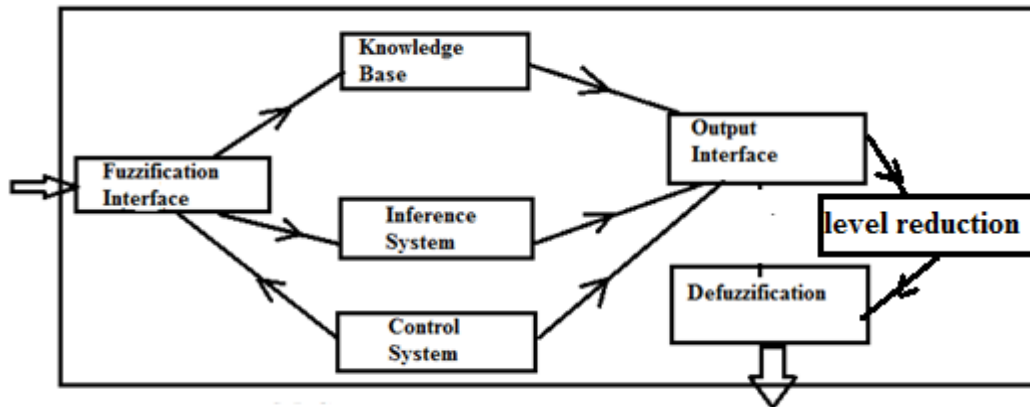
A s Mendal says,A fuzzy logic system can be viewed as the mapping from crisp inputs to crisp outputs.[9,10] Rules are the heart of fuzzy logic system. They may be provided by experts or extracted from the numerical data. . In either case, the rules can be expressed as collection of if-then statement containing connectors like 'and', 'or', 'nor'. The 'if part' of the rule as seen in chapter one is called antecedent and the 'then part' is called consequent. The only difference that in level 2 fuzzy logic system, instead of fuzzy sets, level 2 fuzzy sets are involved. In other words, the antecedent and consequent part is stated by the membership function which is either level one or level two fuzzy sets. The second one helps to quantify the uncertainty and vagueness at a time. A fuzzy logic system that is described completely in terms of type 1/level 1 fuzzy sets is called level one fuzzy logic system . On the other hand, the fuzzy logic system that is described by using at least one level 2 fuzzy set is called level 2 fuzzy logic systems.[4] We construct in the following example the level 2 fuzzy logic system based on single rule for finite L2FS with infinite domain.

The general structure of level 2 fuzzy logic system is given as follows

Suppose $\breve{A}$, $\breve{B}$ and $\breve{C}$ are level 2 fuzzy sets are level 2 fuzzy sets on X,Y, and Z

A level 2 fuzzy set is defined as the fuzzy set whose elements are fuzzy set in themselves. Mathematically, if F(X) denotes fuzzy power set of X, then level 2 fuzzy set is defined as

$$\breve{A} = \{(T, \mu_{\breve{A}}(T))/\mu_{\breve{A}} : F(X) \rightarrow [0,1]\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..(2.1)$$

Equation 2.1 can be rewritten as

$$\breve{A} = \int_{T \in F(X)} \mu_{\breve{A}}(T)/T \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(2.2)$$

where T is the fuzzy set.

Suppose the rules are of the form

R_i: *If* x is $\breve{A}_i$ and y is $\breve{B}_i$ then z is $\breve{C}_i$

for some linguistic variables x,y and z respectively. Then firing of R_i is done at x=x' and y=y' as follows.

We consider the line passing through x' of the form x=x' on XY plane

Consider the plane A parallel to YZ plane passing through x=x'.

The curve of intersection of plane A and level 2 fuzzy set $\breve{A}_i$ is considered as C'.

Similarly C'' is the curve of intersection of plane passing through y=y' parallel to YZ plane and level 2 fuzzy set $\breve{B}_i$

We consider minimum C of C' and C'' where C is considered as point wise minimum.

These two curves lie in different parallel planes .Hence to define the minimum we project them on

single plane. Say YZ=0. Once the curve C is obtained, we fire it on our level 2 fuzzy set $\breve{C}$

The solid obtained by curve and level 2 fuzzy set is the required level 2 fuzzy set.

For applying this level 2 fuzzy logic system, it is required that the output must be in crisp form hence the output level 2 fuzzy set must be converted into crisp number by using level 2 reduction followed by defuzzification.

Here level 2 reductions is defined as follows

Let $\breve{A}$ be level 2 fuzzy set as given in equation as above. Then S-defuzzification of $\breve{A}$ is given by

$$\breve{A}_S = \int\limits_{T \in S} \mu_{\bar{A}}(T) / x_T$$

Where x_T is defuzzified value of fuzzy set T.

Case study

Consider the case that four above stated children are imprisoned in same jail and a robot is to be constructed which will keep eye on these four criminals. Let A denotes Lionel Tate, B denotes Nathaniel Brazill ,C denotes Kip Kinkel, D denotes Luke Woodham .Suppose there time schedule of getting violent with its intensity is as follows.

Time in hours(24 hour format)	Normal I	More or less panic II	Panic III	Very panic IV
0.00	A	D	C	B
1.00	A	D	C	B
2.00	A	D	C	B
3.00	D	A	B,C	--
4.00	D	A,C	B	--
5.00	D	A,C	B	--
6.00	D	A,C	B	--
7.00	--	C,D	A,B	--
8.00	C	B,D	A	--
9.00	C	B,D	A	--
10.00	C	B	A,D	--
11.00	C	B	D	A
12.00	B	--	D	A,C
13.00	B	--	D	A,C
14.00	B	--	--	A,C,D
15.00	B	A	--	C,D
16.00	B	A	C	D
17.00	--	A	B,C	D
18.00	--	A	B,C,D	--
19.00	--	A	B,C,D	--
20.00	A	C,D	B	--
21.00	A	C	D	B
22.00	A	C	D	B
23.00	A	C	D	B

In the above data there is uncertainty of 2 kinds one is the criminal is getting 'panic' 'very panic' these all are fuzzy terms .While level 2 fuzzy term is of the kind 'more or less panic' .More over between 16.00 to 17.00, B becomes normal to panic. This period of transition of his state of mind is uncertain and unpredictable. Hence mechanism of robots must be made in such a way that they can handle these uncertainties.

Here we define fuzzy sets for 'normal','panic' , 'very panic 'on the percentage scale by using Gaussian fuzzy sets and 'more or less panic' by using finite level 2 fuzzy set of infinite domain that is level 2 fuzzy set in which elements inner level membership is infinite while outer layer membership is finite.

> Normal: Trap(x:0,0,30,45)
> Panic:TFN(x:30,50,70)
> Very panic:Trap(x:50,70.100.100)
> More or less panic: 0.7/panic+0.8/very panic+0.7/normal.

As stated above, since more or less panic is level 2 fuzzy set we cannot make use of Matlab programming. Rules can be constructed   as follows

"At 0.00, if A   is normal, D is more or less panic ,C is panic and B is very panic, then robot must pay little attention to A, more or less attention towards D, attentive towards C and very attentive towards B "

Here on output interface we use level 2 fuzzy set ' more or less attention' and fuzzy sets 'little attention', 'attention', 'very attention' which are defined on 10 point scale. Here 10 points means total attention and 0 points means no attention. That is 0 denotes total black while 10 denotes total white. Using level 2 fuzzy inference rules, and calculating manually we get the result which on combination creates the set of instructions to be given to robot so that emotional intelligence can be cultivated in it.

III.   FUTURE SCOPE

In this paper live data cannot be collected. Hence a dummy model is considered above. Paying attention may include many aspects like offering him food or involving the criminal in hobby so on and so forth. Fitting a model using level 2 fuzzy set is not the exact solution but definitely more accurate than that obtained by using fuzzy sets. Further one can also use level 2 type 2 fuzzy sets to get more accurate results. Precisely sky is the limit to get the accuracy.

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