Fuzzy Multi-Layer Relational Design for the explosive rule-based applications

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폭발적인크기의 룰-기반의 응용을 위한 멀티 레이어 퍼어지 관계 설계

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There are many realistic system necessities on the huge size of rule matrices with any Fuzzy Logical Inferences . This paper indicates the experimental design policy on the PCS design for the Platoon and AOS for the social application with some identical resemblances in between them so that we could use a design for two different usages feasibly.

Key words: Explosive rule matrix, Fuzzy Cognition, Platoons, Admissions officer, Situation awareness

1. Introduction

Recent development on the vehicle control authority migration from human to machine has been reached into the realization of a commercial PCS(Platoon control system) implementations. The key factors for this PCS are autonomous detection of relative distance between each vehicles and controlling the engine and braking system according to those detection results. There might be many different methodologies for the solution on this problem however, this paper shows the Fuzzy Cognitive Maps controlled hypothetical proposal concerning the decision making system of the Platoon system and other social application too.

Rashaad Jones[1] described an approach to provide an actionable model of SA (Situation Awareness) using fuzzy cognitive maps that has all three levels of situations (i,e. perception, comprehension, and projection) for its Army Infantry Platoon leaders system suggestion, however, this paper found out the fact that there exists an exact similarity and match up points in terms of GDTA(Goal Directed Task Analysis) hierarchy in between the result of Rashaad Jones et.al. and the PCS(Platoon control system) for the highway driving environmental concerns, in the section 4, 5 respectively, and also with the intelligent AOS (Admissions Office System) for some college entrance qualification evaluation situation in the section 3.

2. Leveled up Situation Awareness

Some of the recent prior approaches to modeling SA have been constructed only by using perception (Level 1) without concerning decision and projection as shown in CoJACK(Evertsz, et.al. 2009). However, in some critical and complex world, higher levels of SA are required for making reasonable decisions in those applications.

For those complex and critical domains, such as smart vehicle PCS(Platoon Control System) and a kind of social problem of the logical decision system for an intelligent Admissions Officer System of college education, the biggest problem should be insufficient data available with people/non-people behaviors involved objects realization (e.g. platoon vehicles, non- platoon vehicles, pedestrians, obstacles, road situations within the smart vehicles, and some individual characteristics of the applicants, like scholastic achievements and personal properties associated with their behavioral records in the admission office problems). Here, we found out the fact that there is big resemblance between the military platoon and the vehicles platoon applications in terms of modeling data and also with the admissions office of the college applications. The SA-FCM (Fuzzy Cognitive Mapping) model which is an advanced human cognitive modeling method incorporates higher levels of SA to reflect some real world conditions as in [1].

In this paper, the relationship between goals, decisions, and situation awareness requirements is described through the GDTA hierarchy and try to connect this relationship on the military Platoons application into the smart vehicle Platoons

implementation and a social application of college admissions office.

Here, the main issues of this paper concerns with the practical structural system resemblance in between many different applications in common GDTA hierarchy.

These hierarchical resemblances make the Fuzzy Logical Inference methodology powerful and outstanding way of many other different research areas in terms of intelligence.

3. Hierarchical/multi-level fuzzy logical decision systems

This paper suggests a multi-level fuzzy logical qualification decision system for an intelligent Admissions Office System of college education and compares it with the other fields of concerns such as in the Platoons algorithms in the military and smart vehicles both ways.

First of all, the current data model of college admissions offices shown below on the Fig. 1 indicates the total # of data as 17 with some possible explosive rule numbers increasing exponentially.

It could suffer from the rule explosion in high dimensions as in the case of a function F: $R^n \rightarrow R^i$, where it needs on the order of K^{n+i-1} rules to cover the graph when the k is the # of sets in each dimension.

evaluation	elements	evaluation index	data
schola-stic	subjects grades	·classified SAT performance	GPA
	annual grades	·incr./decr. rates	records
	research activities	·contents & periods of participations	records & essays
	awards	·# of titles ·levels of the titles	records
	non regular class	·goals & motives	records
non schola-stic	reading	·reading speeds & contents	essays
	certificates	·goals for, fields, planning	participants reports
	career plan	·path to quality of participation	essays
	student body	·activities, quality of participation	records
	volunteer services	·quality of service & periods	records & reports
person-ality	social group activities	·social activities	recommendations & reports
	leaderships	·self experiences	recommendations & essays
	study plan	·future goals	recommendations & essays
	extracurricular activities	·level of activities	recommendations & records
	attendance	·# of absence, reasons	recommendations & records
	teacher evaluation	·aptitudes	recommendations
	friendship	·relationships & contents	recommendations & essays

Fig.1 A Model of intelligent Admissions Office System for college entrance qualification evaluation

This example fuzzy system rule matrix has total # of 5^{17} expert sentences on the single-layered construction possibly which we could consider it as an explosive case, and there is a redesign necessity with the multi level construction to reduce the explosive rule capacity.

The possible multi level FCM for this AOS could be as follow.

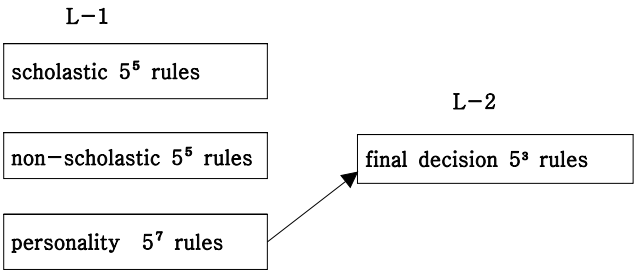


Fig. 2 Multi-level constructs of AOS

Here, the systems rule matrix capacity has become realistically feasible with the level up design. More over, the PCS design also has the same characteristics in terms of explosive situation property as shown below.

4. The resemblance between PCS & AOS design

Previous section shows the multi-layered AOS, however, this section reveals the fact that the whole structural shape of the PCS's FCM is almost identical in term of the fuzzy logical inference. Fig. 3 shows the construct of these resemblance in between them.

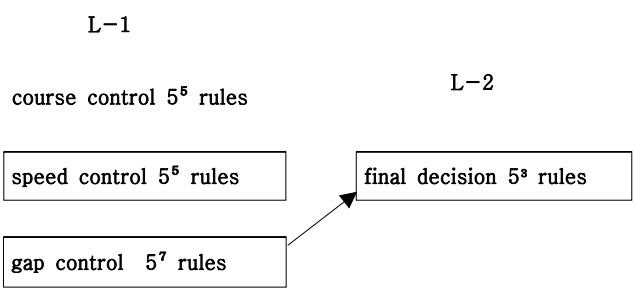


Fig 3 Multi-level constructs of PCS

These results of resemblance are not the only cases in the fields of Fuzzy Logical Inferences as

a matter of fact. As an illustration of this important fact, the PCS design of the following Fig. 4 indicates the model structure to show the powerful system re-usabilities and simplicity due to the same architectures with different control usages.

evaluation	elements	evaluatio index	data
course control	merge	merge in	my car or other car
	split	split out	my car or other car
	velocity change	platoon/ non- platoon	acceleration/ deceleration
	lane change	left/right turn	pedestrian exsistance
	road situations	regularity	speed limits
speed control	platoon speed	long dist/short dist	leader/ follower
	non platoon speed	obstacles/ pedestrians	leader/ follower
	pedestrian	dist from	speed limits
	road situations	regularity	speed limits
	vehicle conditions	regularity/ irregularity	speed limits
gap control	desired gap	long dist/short dist	leader/ follower
	velocity differences	long dist/short dist	leader/ follower
	gap distances	long dist/short dist	leader/ follower
	logical sw throttle or brakke	safety situations	danger/safe
	engine torque	regularity	speed limits
	transmission torque	regularity	speed limits
	road situations	regularity	speed limits,

Fig. 4 A model of Platoon Control System for smart vehicle autonomous driving

The two example systems resemblance on the construction of each, totally and definitely different application fields shows remarkable coincidence in terms of the structure. This fact might generate a huge influence to the application fields of intelligence control mechanism what so ever it would be.

That is because, if you had any type of fuzzy controller on your lab, you might be able to use it for any other kinds of application, complex or not, as long as the rule matrix capacity and the # of sets for each fuzzified variables are not totally beyond your desired designations.

On the next section, this paper suggestions of each variables fuzzification processes for the clarification and also verifications will be discussed in details.

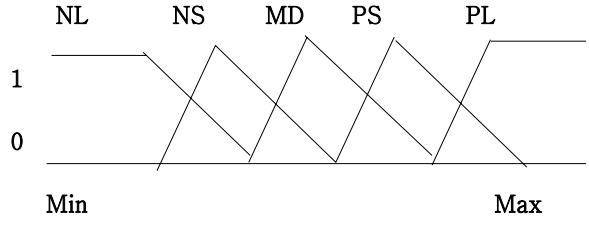
5. System design for the coincident shape of functions and rule matrices.

This paper verifies the compactness and re-usabilities with feasible design overheads by giving the system fuzzifications on each input variables and also output variables for PCS & AOS designs.

First of all, the scholastic subject grade data and non-scholastic reading skill data of the AOS will use the same fuzzified structures with the second example of PCS design's input data, velocity change, and road situations together.

Of course, with all other variables, we would use the same formats of fuzzification and same fuzzy rule matrices with some proper formats of de-fuzzification methods for sure without any drastic modifications and change of directions for any specific application problems.

For those of many explosive cases of rule-based system, which are common for almost of the currently realistic applications, we might only need some fuzzy prototype design for them without any big design overheads for each different cases of implementations.



Scholastic grades variables
Non-scholastic Reading skill variables
Velocity change variables
Road situation variables
etc.

Fig. 5. The coincident shape of each fuzzification variable examples

As a matter of fact, this In/Output variables fuzzifications on the general 5 subset linguistics concepts design for any control applications could be utilized in any kinds of inferences as long as they are all in the case of Fuzzy inferences and this fact makes the fuzzy controller's robustness of the feasibility in the industrial or social applications.

6. Conclusions

This paper suggests the multi-layered control of the system constructions what so ever the applications are with an explosive rule capacity necessities which are in common for all the contemporary decisional systems in the artificial intelligence fields. For the illustrations, we took a look at the experimental construction of the partial design of the two system, PCS and AOS , and conclude the fact that this kind of fuzzy logical inference technique would be the most feasible strategies for any kind of complex and explosive rule based applications for sure.

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