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Approach to Road Traffic Control Using Fuzzy Logic Control

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ABSTRACT

Road traffic is greatest problem now a days in major cities of various countries. The most important utility of a road can derive from the traffic is that it can be free from wearing and tearing. It is to be noticed that different type of road has a different types of traffic which depends directly on the type of road, amount of the flow of vehicle etc. This paper author wants to be discussing the idea of controlling the road traffic using fuzzy logic control. The paper describes the procedure that can be used to get a suitable road map for different traffic. The process is based entirely on the principle of taking non-precise inputs from the sensors, subjecting them to fuzzy arithmetic and obtaining a crisp value of the road map.

KEYWORDS : Fuzzy sets, Fuzzy Logic, Controller, etc.

Introduction

The fact that mathematics as a whole is taken to be synonymous with precision has caused many scientists and philosophers to show considerable concern about its lack of application to real world problems. This concern arises because in logic as well as in science there is constantly a gap between theory and the interpretation of results from the inexact real world. Many eminent thinkers have contributed to the discussion on vagueness, occasionally holding human subjectivity as the culprit.

A Brief Review of Fuzzy Logic

The point of view adopted here is that the variables are associated with universes of discourse which are non-fuzzy sets. These variables take on specific linguistic values. These linguistic values are expressed as fuzzy Subsets of the universes. Given a subset A of X, A can be represented by a characteristic function: XA: X[0,1]. If the above mapping is from X to a closed interval [0,1] then we have a fuzzy subset. Thus if A were a fuzzy subset of X it could be represented by a membership function: X[0,1]

Problem to be discussed

When one wish to travel from one place to another place, the person generally select the length of road clearance time based on the road he/she wishes to travel through and the type and degree of traffics have. To automate this process, we use sensors to detect these parameters (i.e. length of the road, degree and type of traffic). The traffic clearance time is then determined from this data. Unfortunately, there is no easy way to formulate a precise mathematical relationship between length of the road and traffic and the traffic clearance time required. Consequently, this problem has remained unsolved until very recently. Conventionally, people simply set the road clearance time by hand and from personal trial and error experience. The sensor system provides external input signals onto the road from which decisions can be made. It is the controller's responsibility to make the decisions and to signal the outside world by some form of output. Because the input/output relationship is not clear, the design of a road controller has not in the past lent itself to traditional methods of control design. We address this design problem using fuzzy logic. Fuzzy logic has been used because a fuzzy logic controlled road traffic controller gives the correct road clearance time even though a precise model of the input/output relationship is not available.

The problem in this paper has been simplified by using only two variables. The two inputs are:

1. Degree of traffic
2. Type of traffic

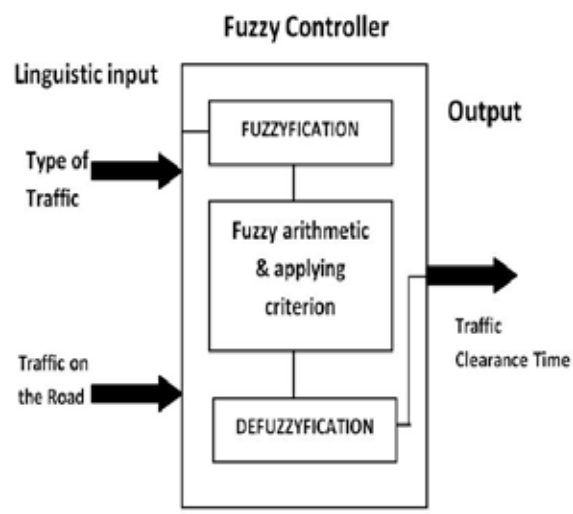

Figure 1 Shows Basic Blocks of Process

Figure 1 shows the basic approach to the problem. The fuzzy controller takes two inputs (as stated for simplification), processes the information and outputs a traffic control time. How to get these two inputs can be left to the sensors (optical, electrical or any type). The working of the sensors is not a matter of concern in this paper. We assume that we have these inputs at our hand. Anyway the two stated points need a bit of introduction which follows. The degree of traffic is determined by the clearance of the traffic on the road. The heavy traffic on the road, less clearance of the traffic on the road being analyzed by the sensors is. On the other hand, type of traffic is determined by the time of saturation, the time it takes to reach saturation. Saturation is a point, at which there is no more appreciable change in the public on the road. Degree of traffic determines how much heavy rush on the road is. Whereas Type of traffic determines the quality of traffic. Fully loaded trucks with goods, for example, take longer for covering the short distances in traffic. Thus a fairly straight forward sensor system can provide us the necessary input for our fuzzy controller.

Methodology:-

The fuzzy logic controller:-

Before the details of the fuzzy controller are dealt with, the range of possible values for the input and output variables are determined. These (in language of Fuzzy Set theory) are the membership functions used to map the real world measurement values to the fuzzy values, so that the operations can be applied on them. Fig.2 shows

the labels of input and output variables and their associated membership functions. Values of the input variables degree_of_traffic and type_of_traffic are normalized range 1 to 100 over the domain of optical sensor.

The decision which the fuzzy controller makes is derived from the rules which are stored in the database. These are stored in a set of rules. Basically the rules are if-then statements that are intuitive and easy to understand, since they are nothing but common English statements. Rules used in this paper are derived from common sense, data taken from typical daily flow road, and experimentation in a controlled environment.

The fuzzy sets of rules used here to derive the output are:

1. If traffic on the road is Large and type_of_traffic is with fully loaded heavy vehicles then Road_clearance_time is Very Long;
2. If traffic on the road is Medium and type_of_traffic is with fully loaded heavy vehicles then Road_clearence_time is Long;
3. If traffic on the road is Small and type_of_traffic is with fully loaded heavy vehicles then Road_clearence_time is Long;
4. If traffic on the road is Large and type_of_traffic is with less fully loaded heavy vehicles then Road_clearence_time is Long;
5. If traffic on the road is Medium and type_of_traffic is with less fully loaded heavy vehicles then road_clearence_time is Medium;
6. If traffic on the road is Small and type_of_traffic is with less fully loaded heavy vehicles then road_clearence_time is Medium;
7. If traffic on the road is Large and type_of_traffic is without fully loaded heavy vehicles then road_clearence_time is Medium;
8. If traffic on the road is Medium and type_of_traffic is without fully loaded heavy vehicles then road_clearence_time is Short;
9. If traffic on the road is Small and type_of_traffic is without fully loaded heavy vehicles then road_clearence_time is Very Short

Membership function:-

Output:-

These rules have been shown as membership functions in figure 3.

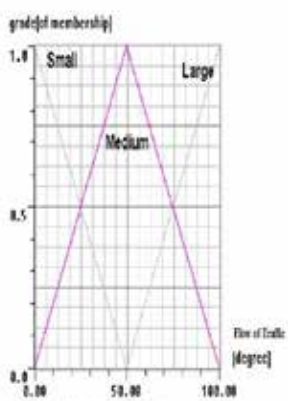

Figure 3a Membership function for type of traffic on road

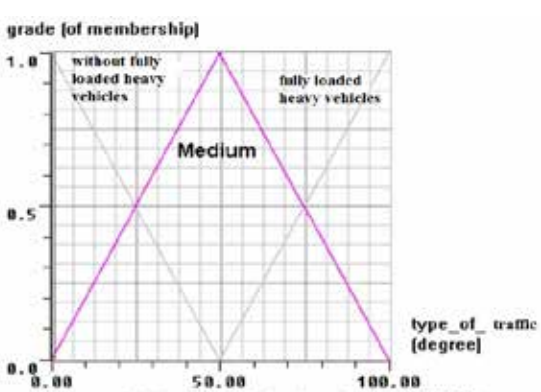

Figure 3b Membership Function of type_of_traffic

The rules too have been defined in imprecise sense and hence they too are not crisp but fuzzy values. The two input parameters after being read from the sensors are fuzzified as per the membership function of the respective variables. These in additions with the membership function curve are utilized to come to a solution (using some criteria). At last the crisp value of the traffic clearance time is obtained as an answer.

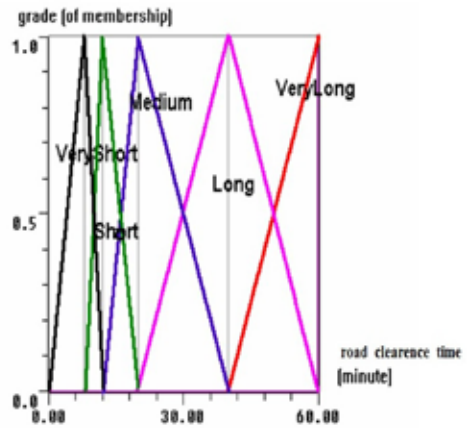

Figure 3 Labels and membership functions for output variable road_clearence_time

The sensors sense the input values and using the above model the inputs are fuzzyfied and then by using simple if -else rules and other simple fuzzy set operations the output fuzzy function is obtained and using the criteria the output value for road clearance time is obtained. Figure 4 shows the response surface of the input -output relations as determined by FIU. FIU stands for Fuzzy Interface Unit. This is the fundamental unit in which the application interface FIDE encodes controller information.

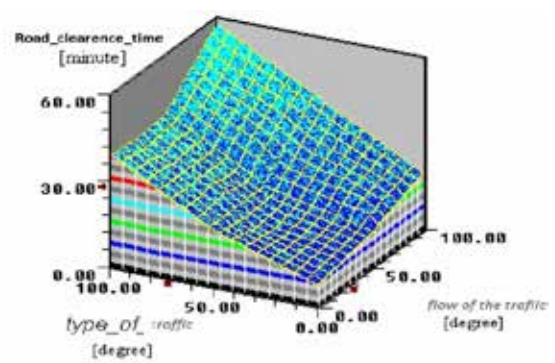

Figure 4 Input/Output response surfaces

Result:-

The results (the above plot) shows the way the road sesors will response in different conditions. For example, if we take type_of_traffic and flow of traffic value both to be 100, the road learance_time which the model output is equivalent to 60 mins. This is quite convincing and appropriate.

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