FUZZY LOGICS AND NEURAL NETWORKS

TERM PAPER

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FUZZY LOGICS AND NEURAL NETWORKS TERM PAPER

PAPER(References) TITLE:

- Application of Fuzzy Numbers to Assessment of Human Skills
- Fuzzy control system for Aircraft Diesel Engines

PAPER AUTHOR:

- Michael Gr. Voskoglou (Author Paper 1)
- Luca Piancastelli, Leonardo Frizziero, E.Morganti and A. Canaparo (Author Paper 2)

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TERM-PAPER 1

Implementation of Fuzzy Numbers to tackle Daily life Problems

Outline - Fuzzy numbers play an important role in fuzzy mathematics analogous to the role played by the ordinary numbers in crisp mathematics. A fuzzy number is a special form of a fuzzy set on the set of real numbers. In the paper at hands two of the simpler forms of them, the triangular and the trapezoidal fuzzy numbers are used together with the centre of gravity defuzzification technique to develop two methods for assessing human skills

Introduction - The fuzzy sets theory was created in response of expressing mathematically real world situations in which definitions does not have clear boundaries. For example, “the high mountains of a country”, “the young people of a city”, “the good players of a team”, etc.

Approach:

The FL approach for a problem’s solution involves the following steps:

- Fuzzification of the problem’s data by representing them with properly defined Fuzzy Sets.
- Evaluation of the fuzzy data by applying principles and methods of Fuzzy Logic in order to express the problem’s solution in the form of a unique Fuzzy Sets.
- Defuzzification of the problem’s solution in order to “translate” it in our natural language for use with the original real-life problem.

TERM-PAPER 2

FUZZY CONTROL SYSTEM FOR AIRCRAFT DIESEL ENGINES

Problem statement

Aim of this paper it to define rules and fuzzy controllers to optimize the performance of a diesel engine in various operating conditions with particular attention to the power output.
When anomalies occur we reduce engine performance Then technical assistance is required to restore normal condition since this approach cannot be used in aeronautical, naval etcetera therefore fuzzy system is used.

Proposed work

A reference map is implemented in the FADEC (Full Authority Digital Electronic Control) to obtain the best emissions to performance .This map is optimized during laboratory and road tests and it is used throughout engine running with the exception of start up. For startup a “cranking” map is adopted. Reliability is a subtask where the engine should be controllable at all times while eliminating risk to driver and passengers. . When a minor failure occurs, a suitable “recovery” map is automatically loaded into the FADEC and engine performance is subsequently reduced. For example, if fuel temperature exceeds 110° C, maximum crankshaft angular velocity is

reduced to 3000 rpm, and pilot injection is performed only in the case of massive power output reduction.

First of all, power output needs to be optimized along with engine efficiency. Power output reduction should be decided by the pilot and it cannot be automatically controlled by the FADEC. In current systems exhaust gas temperature is monitored by an instrument in the cockpit. If maximum allowed temperature is exceeded, the pilot can only reduce power to preserve engine integrity. However, in some flight condition like take-off or steep climb it may be preferable to keep the current power output level while sacrificing the engine . In this case the pilot should hope the engine stay running long enough to get through the critical situation.

FADEC include sensors like:

1.Hall type for RPM of crankshaft

2.Hall type for phase of camshaft.

3. Fuel temperature

4.Coolant temperature.

5.Air flow Temperature.

6.Low Pressure Fuel

7.High Pressure Fuel

8.Throttle potentiometer.

FADEC actuators are:

1.Pressure regulator.

2.Air actuator.

3.Injectors.

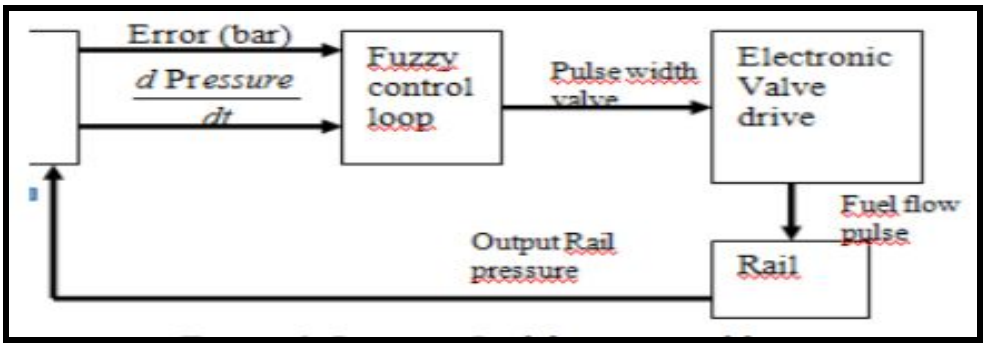
THE FUZZY CONTROLLER

The inputs are the time derivative of the pressure “dp/dt” and “error”. The fuzzy rules have the following form:

RULE i: **IF** *x* is A **AND** *y* is B **THEN** *z* is C with weight(i)

The product operation is used for the AND operator, so that the result of inference for the rule for the inputs x0 = error and y0 = dp/dt is:

$$\omega^i \equiv \mu_A(x_0)^i \times \mu_B(y_0)^i \times weight(i)$$



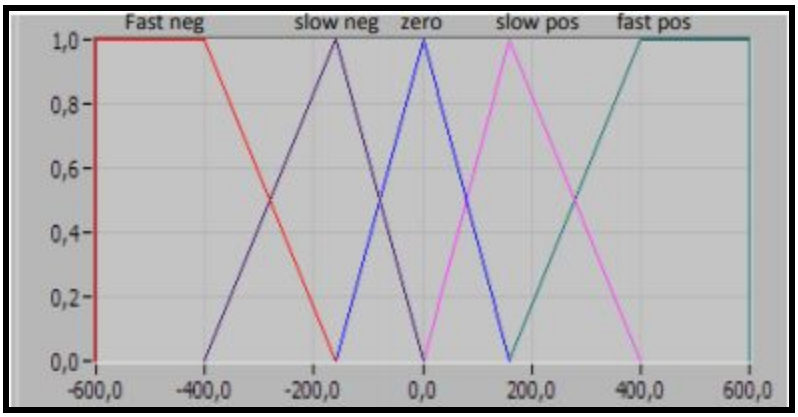
Where uA(x) and uB(y) are the input membership functions, the weight ranges from 0 to 100%. The “gravity center” defuzzification method was Adopted.

$$out \equiv \frac{\sum_{i=1}^{m} \omega_i \times \mu(\omega_i)}{\sum_{i=1}^{m} \mu(\omega_i)}$$

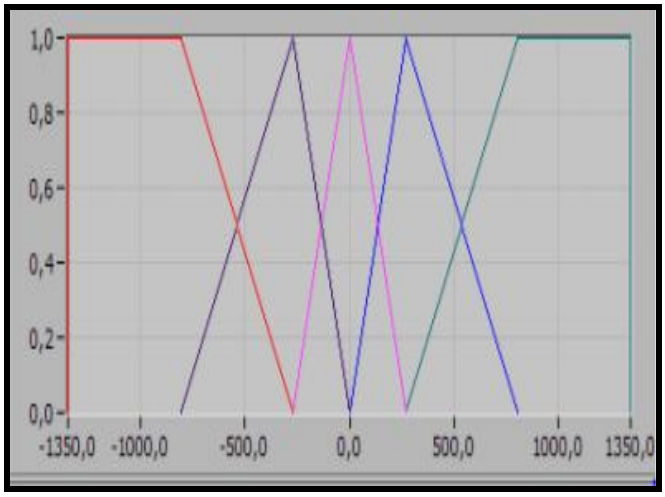
Results

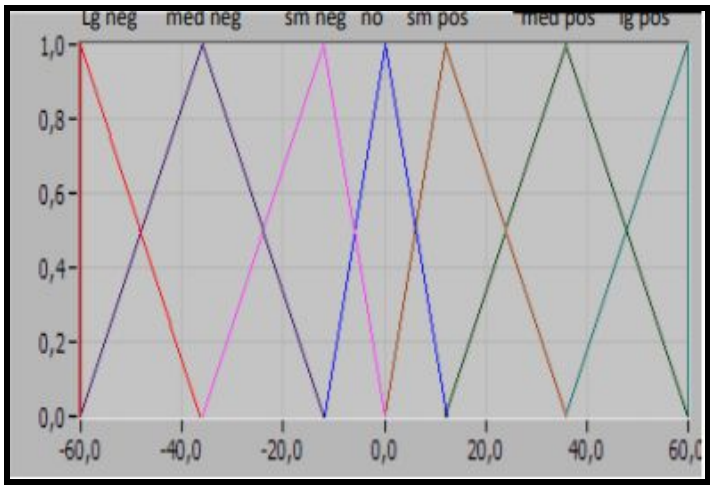
Rules and membership functions are described in following figures :

Fuzzy input set



Fuzzy output set





ADVANTAGES AND DISADVANTAGES

Advanatages :

The advantage of the prescriptive method is that it reduces the difficulties through the good protocol described providing the relevant variables can be identified. The protocol is then developed by a process of accumulation or integration of past experience. Present work is aimed at extension of this method to a multi-variable situation.

Disadvantages :

The different strategies introduced in this paper were tested only on an injection system test bench and should be controlled on the real engine and in flight.

Conclusion

Some tests were performed by software simulation and experimental simulation on the injection system test bench. The fuzzy controllers implemented were very simple to keep parameters under control.

The prescriptive approach described above is very much an ad hoc implementation. It illustrates what needs to be done to advance beyond a simply descriptive system. Such an approach should appear naturally within a suitably improved fuzzy logic theory itself.