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Study of fuzzy logic technique for power transistor problem

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Abstract *This paper is about a Study of Fuzzy Logic technique for Power Transistor problem. In our modern life today, we are using many complex equipments such as, mobile phones, i-pods, laptops and computers. The complexity of these instruments is difficult to understand. The Aim of fuzzy logic is to understand complexity more easily. Moreover, if we want precision in measurements then the cost increases. Fuzzy logic technique is useful in reducing the cost without loss of precision. In decision making, the probabilities of the outcome is unknown and decision is made under conditions of uncertainty. Fuzzy logic technique is more effective as compared to the conventional methods of decision making. In this research work the fuzzy logic technique has been explained with reference to the real world problems. The problem of power of power transistors for Fuzzy logic is solved using the MATLAB programming software. The Fuzzy Logic methods are used for solving the power transistor problems are Fuzzy Sets, Fuzzy Relation, membership function, Cartesian product, alpha cut, λ-cut etc. The three variables of interest in power transistor are the amount of current that can be switched, the voltage can be switched, and the cost. This paper is totally based on software implementation of MATLAB.*

Keywords: *Membership function, fuzzy set, power transistor, decision making, uncertainty.*

I. INTRODUCTION

1.1. FUZZY LOGIC

The real world is complex , complexity arises from uncertainty in the form of ambiguity.“ as the complexity of the system increases , our ability to make precise and yet significant statements about its behavior diminishes until a threshold is reached beyond which precision and significance (or relevance) become almost mutually exclusive characteristics.” These are the words of the LOTFI ZADEH who introduced fuzzy logic in 1965. “ The closer looks at a real world problem , the fuzzier becomes its solution”, observed Dr. Zadeh who published his seminal work “FUZZY SETS” in the journal or information and control.

When there is imprecision (more uncertainty) and inadequate data the fuzzy logic technique is useful. Secondly, the cost of information increases with precision. But the cost of fuzzy information is far less than the perfect or imperfect information. Thus, there are two – fold advantages of the fuzzy logic technique: Understanding of complex systems becomes easier and analysis makes the system costs effective. He used the linguistic variable and further suggested that set membership function is the key to decision making when there is uncertainty.

The attention currently being paid to fuzzy logic is most likely the result of present popular consumer products such as washing machine, cameras, elevators, air conditioners, rice cookers, automobile, dishwashers etc. The nature of uncertainty in a problem is a very important point that engineers should ponder prior to their.

FUZZIFICATION

Fuzzification is the process of making a crisp quantity fuzzy. We do this by simply recognizing that many of the quantities that we consider to be crisp and deterministic are actually not deterministic at all. They carry considerable uncertainty. If the form of uncertainty happens to arise because of imprecision, ambiguity or vagueness then the variable is probably fuzzy and can be represented by a membership function.

In the real world such as, digital voltmeter generates crisp data, but these data are subject to experimental error. The below fig 1.1 shows one possible range of errors for a typical voltage reading and associated membership function that might represent such imprecision.

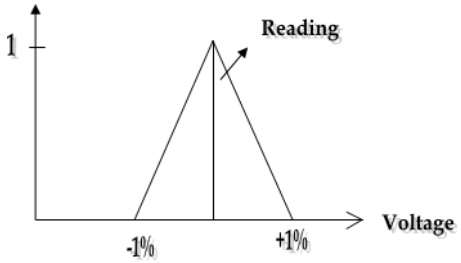

Fig 2.1. Membership function of crisp voltage reading

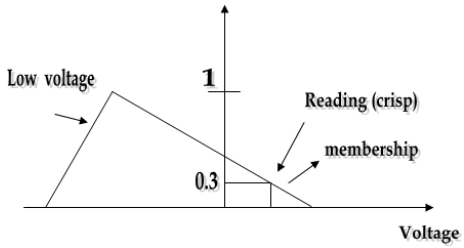

Fig.2.2 Fuzzy sets and crisp reading

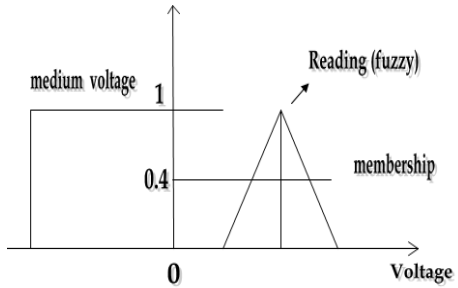

Fig 2.3 Fuzzy set and fuzzy reading

DEFUZZIFICATION

It is the conversion of fuzzy quantity to a precise quantity. The output of a fuzzy process can be the logical union of two or more fuzzy membership functions defined on the universe of discourse of the output variable.

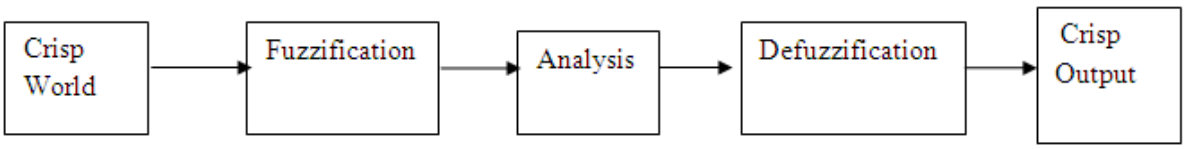

Fig 3.1. Block diagram of Fuzzy to Crisp Conversion

II. METHODOLOGY

For solving the power transistor problem using fuzzy logic technique number of methods are available like Fuzzy Sets, Fuzzy relation, Cartesian product, alpha- cut etc. Among this method we have selected the Cartesian product method for solving the power transistor problem.

2.1. Cartesian product method

Fuzzy relations also map elements of one universe, say x, to those of another universe, say 'Y', through the Cartesian product of the two universes. Let A be a fuzzy set on universe 'X' and B be a fuzzy set on universe 'Y'; then the Cartesian product between fuzzy sets A and will results in a fuzzy relation R is given by,

A x B =R C X x Y Where, the fuzzy relation R has membership functions

$\mu_R(x,y) = \mu_{AxB}(x,y) = \min(\mu_A(x), \mu_B(y))$

2.2. Λ– cuts for fuzzy relations method

Let fuzzy set A, then define a lambda cut set, A_λ , where $0 \le \lambda \le 1$. The set A_λ Is a crisp set called the (λ) – cut (or alpha- cut) set of the fuzzy set A, where

$A_\lambda = \{x/\mu_A(x) \ge \lambda\}$

It is a crisp set derived from its parent fuzzy set, A. Any particular fuzzy set A can be transformed into an infinite number of λ – cut sets, because there are an infinite number of λ on the interval [0,1]. Any element $x \in A_\lambda$ belong to A with a grade of membership that is greater than or equal to the value λ.

III. EXPERIMENTAL WORK

Here we describe the operations used to find the power of the power transistor and this problem is solved using MATLAB software.

Three variables of interest in power transistor are the amount of current that can be switched, the voltage can be switched, and the cost.

Average current (in amps) **I** = {0.4/0.8 + 0.7/0.9 + 1/1 + 0.8/1.1 + 0.6/1.2}

Average voltage (in volts) **V** = {0.2/30 + 0.8/45 + 1/60 + 0.9/75 + 0.7/90}

Now how the membership values in each set taper off faster towards the lower voltage and currents. There two fuzzy sets are related to the "power" of the transistor power in electronics is defined by an algebraic equation, P = VI but let us deal a general Cartesian relationship between voltage and current, that is simply with P = V x I. Keep in mind that Cartesian product is different from the arithmetic product. The Cartesian product expresses the relationship between Vi and Ij, where Vi and Ij are individual elements in the fuzzy sets V and I.

Taking the α – cuts after solving the problem i.e Defuzzification will be required which converts the fuzzy quantity to a crisp quantity.

The fuzzy Cartesian product P = V x I

Now let us define a fuzzy set for the cost C, in dollars of a transistor for example.

C = {0.4/0.5 + 1/0.6 + 0.5/0.7}

P =

	0.8	**0.9**	**1**	**1.1**	**1.2**
30	0.2	0.2	0.2	0.2	0.2
45	0.4	0.7	0.8	0.8	0.6
60	0.4	0.7	1	0.8	0.6
75	0.4	0.7	0.9	0.8	0.6
90	0.4	0.7	0.7	0.7	0.6

Using a fuzzy Cartesian product

T = I x C is

T =

	0.5	**0.6**	**0.7**
0.8	0.4	0.4	0.4
0.9	0.4	0.7	0.5
1	0.4	1	0.5
1.1	0.4	0.8	0.5
1.2	0.4	0.6	0.5

3. Flow chart

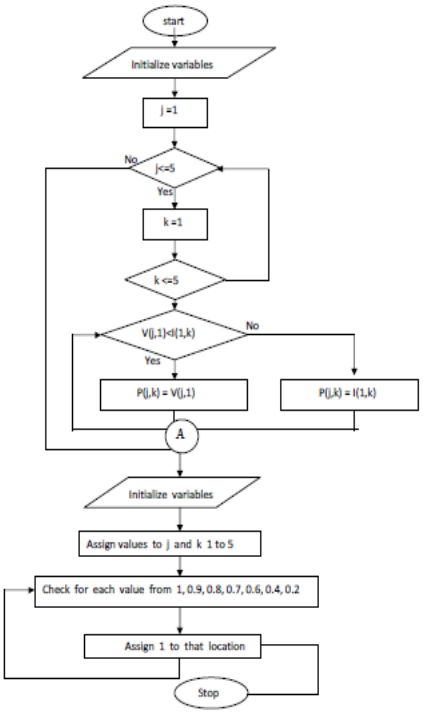

Fig. 3 P = V .I

1. Programming in MATLab

```
V=[0.2;0.8;1;0.9;0.7]
I=[0.4 0.7 1 0.8 0.6]
      for j=1:5
          for k=1:5
              if V(j,1)<I(1,k)
                    P(j,k)=V(j,1)
                    else
                    P(j,k)=I(1,k)
                    end
                end
          end
  P= [0.2 0.2 0.2 0.2 0.2;0.4 0.7 0.8 0.8 0.6;0.4 0.7 1 0.8 0.6;0.4 0.7 0.9 0.8 0.6;0.4 0.7 0.7
      0.7 0.6]
     % labda cuts of 1,0.9,0.8,0.7,0.6,0.4,0.2
     R=zeros(5,5)
            for j=1:5
               for k=1:5
                  if P(j,k)==1
                  R(j,k)=1
                  elseif P(j,k)==0.9
                     R(j,k)=1
                  elseif P(j,k)==0.8
                     R(j,k)=1
                  elseif P(j,k)==0.7
                     R(j,k)=1
                  elseif P(j,k)==0.6
                     R(j,k)=1
                  elseif P(j,k)==0.4
                     R(j,k)=1
                  elseif P(j,k)==0.2
                     R(j,k)=1
                  end
```

```
        end
    end
```

2. Program in I and C

```
I=[0.4;0.7;1;0.8;0.6]
C=[0.4 1 0.5]
T=zeros(5,3)
for i=1:5
  for j=1:3
    if I(i,1)<C(1,j)
      T(i,j)=I(i,1)
    else
      T(i,j)=C(1,j)
    end
  end
end
T=[0.4 0.4 0.4;0.4 0.7 0.5;0.4 1 0.5;0.4 0.8 0.5;0.4 0.6 0.5]
% lambda cuts of fuzzy relation R at values of =1,0.8,0.7,0.6,0.5,0.4
R=zeros(5,3)
  for i=1:5
  for j=1:3
    if T(i,j)==1
     R(i,j)=1
    elseif T(i,j)==0.8
      R(i,j)=1
    elseif T(i,j)==0.7
      R(i,j)=1
    elseif T(i,j)==0.6
      R(i,j)=1
    elseif T(i,j)==0.5
      R(i,j)=1
    elseif T(i,j)==0.4
      R(i,j)=1
    end
  end
  end
```

IV. RESULT AND DISCUSSION

The power transistor problem has three variables voltage V, current I, Cost C in dollars, each of them is a fuzzy set. The Cartesian product P=VI (is the power of the transistor) and defuzzification (means crisp reading) is calculated and another Cartesian product is T=CI. This all problems solved using MATLAB programming and the result is displayed given below in matrix form.

Output :-

```
V =    0.2000
       0.8000
       1.0000
       0.9000
       0.7000

I =  0.4000   0.7000   1.0000   0.8000   0.6000

P =  0.2000   0.2000   0.2000   0.2000   0.2000
     0.4000   0.7000   0.8000   0.8000   0.6000
     0.4000   0.7000   1.0000   0.8000   0.6000
     0.4000   0.7000   0.9000   0.8000   0.6000
     0.4000   0.7000   0.7000   0.7000   0.6000
```

R = 1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1
1 1 1 1 1

I = 0.4000
0.7000
1.0000
0.8000
0.6000

C = 0.4000 1.0000 0.5000

T = 0.4000 0.4000 0.4000
0.4000 0.7000 0.5000
0.4000 1.0000 0.5000
0.4000 0.8000 0.5000
0.4000 0.6000 0.5000

R = 1 1 1
1 1 1
1 1 1
1 1 1
1 1 1

IV. Discussion

One area in which fuzzy set theory has a great potential that in psychology; in particular the psycho logistics which is essential for studying the connection between human communication and decision machines. Today, close to four decades after the artificial intelligence (AI) was born. It can finally be said that intelligent systems are becoming a reality. The soft computing has direct bearing on machine intelligence. Neuro fuzzy soft computing has a special role in the design of modern intelligent systems.

V. APPLICATIONS OF FUZZY LOGIC

- Control systems
- Pattern recognition
- Robotics
- Consumer electronics
- Automobiles
- Intelligent systems

VI. FUZZY LOGIC IN CONSUMER GOODS

Cameras , Washing machine , Air conditioners , Luxury cars , Elevators , Rice cookers , Automobile , Dishwashers , Refrigerator , Camcorders , Vac. Cleaner etc.

VII. SCOPE OF WORK

The scope of further research work is to develop and design some electronic circuits such as speed control motor, automatic control system and some decision making problem like weather forecast. This has been recently used for user-oriented verification of probability forecasts, but there is applied to aid forecast users in optimizing their decision making from probability forecasts.

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