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A Study on the Factors That Causes Manufacturing Defects In Composite Materials Using Combined Disjoint Block Fuzzy Cognitive Maps

Mohan Subbaraya*
**Department of Mechanical Engineering, SITAR, Bengaluru, India*

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ABSTRACT: The manufacturing of Composite materials is done by various number of techniques. These techniques combine the fiber and resin into a well-compiled product. The manufacturing technique which has been selected depends upon the size and quality or the composite required. During the manufacturing processes, defects can be introduced into the material. In this research paper we will find the most important defect that occurs during the manufacturing process of the composite materials using Combined Disjoint Block Fuzzy Cognitive Maps (CDBFCMs). Combined Disjoint Block Fuzzy Cognitive Map is an efficient method which analyses the data by directed graphs and connection matrices.

Keywords:: Fuzzy Cognitive Maps(FCMs), Combined Disjoint Block Fuzzy Cognitive Maps (CDBFCMs), Composite Materials, Manufacturing defects, Porosity, Directed Graphs.

I. INTRODUCTION

A Mathematical Model called Fuzzy Cognitive Maps was introduced by Lofti.A.Zadeh in 1965. Fuzzy Cognitive Maps are fuzzy structures that strongly resemble neural networks, and it is a powerful and far reaching consequences as a mathematical tool for modeling complex systems. Fuzzy cognitive maps (FCMs) are more applicable when the data in the first place is an unsupervised one (Vijayaraghavan, 2015). The FCMs work on the opinion of experts. FCMs model the world classes and causal relations between classes.FCMs are fuzzy signed directed graphs with feedback (Kumaresan & Vijayaraghavan, 2015). The directed edge eijfrom causal concept C_i to concept C_j measures how much Ci causes C_j. The time varying concept function $C_i(t)$ measures the non-negative occurrence of some fuzzy event, perhaps the strength of political sentiment , historical trend . The edges e_{ij} take values in the fuzzy causal interval [–1, 1]. $e_{ij}= 0$ indicates no causality, $e_{ji}> 0$ indicates causal increase, C_j increases as C_i increases (or $C_j$decreases as $C_i$decreases). $e_{ji}< 0$ indicates causal decrease or negative causality. C_j decreases as C_i increases (or C_j increases as C_i decreases) simple FCMs have edges values in {–1, 0, 1}.

Let $C_1, C_2,\ldots,C_n$ be the nodes of an FCM. $A = (a_1, a_2,\ldots,a_n)$ where $a_i \in \{0, 1\}$. A is called the instantaneous state vector and it denotes the on-off position of the node at an instant

$a_i = 0$ if a_i is off and

$a_i = 1$ if $a_i$is on for i = 1, 2, …, n.

Suppose $A = (a_1, \ldots , a_n)$ is a vector which is passed into a dynamical system E. Then $AE = (a'_1, \ldots ,a'_n)$ after thresholding and updating the vector suppose we get $(b_1, \ldots , b_n)$ we denote that by $(a'_1, a'_2, \ldots , a'_n) \rightarrow (b_1, b_2, \ldots , b_n)$. Thus the symbol '→' means the resultant vector has been thresholded and updated. Let $C_1, C_2, \ldots,C_n$ be n distinct attributes of a problem n very large and a non- prime. If we divide n into k equal classes i.e., k/n and if n/k=t which are disjoint and if we find the directed graph of each of three classes of attributes with t attributes each then their corresponding connection matrices are formed and these connection matrices are joined as blocks to form a n x n matrix. The n x n connection matrix forms the combined disjoint block FCM of equal classes If the classes are not divided to have equal attributes but if they are disjoint classes we have n x n connection matrix called the combined disjoint block FCM of unequal classes / size. Here we approach the problem through defects using Combined Disjoint Block Fuzzy Cognitive Maps (CDBFCMs) that are basically matrices which predict the feelings of all the attributes under certain conditions. Before we proceed to apply Combined Disjoint Block Fuzzy Cognitive Maps (CDBFCMs) to this problem, we define a set of 5 defects given by experts. We work with analyzing them using directed graph and its connection matrices.

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Methodology with Result and Discussion

Let us take the manufacturing defects as nodes
C1: Porosity
C2:Bonding defects.
C3 :Delaminations.
C4 :Fiber defects.
C5 : Foreign bodies.
We take three experts opinion on the three disjoint classes so that each class has three attributes. Let the disjoint classes be classes be E1, E2, E3 be divided by the following
E1= { C1 , C3 , C4 }
E2= { C2, C3, C5} and
E3 = { C1 , C2 , C4 }
The directed graph given by the first expert C1 , C3 , C4 which forms the class B1

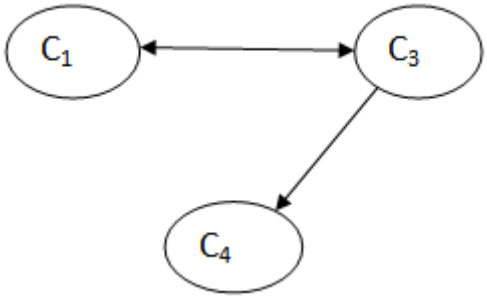

Figure 1

The related connection given by first expert opinion on C2 , C3 , C5 which forms the class B1

E1 =

	C1	C2	C3	C4	C5
C1	0	0	1	0	0
C2	0	0	0	0	0
C3	1	0	0	1	0
C4	0	0	0	0	0
C5	0	0	0	0	0

The directed graph given by the expert C2, C5, C3 which forms the class B2.

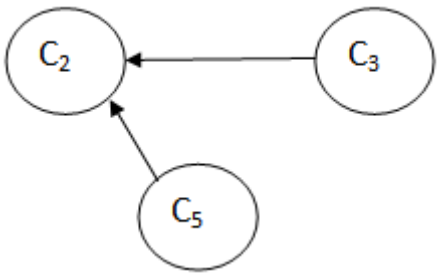

Figure 2

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The related connection given by second expert opinion on C2, C4, C3which forms the class B2.

E2 =

	C1	C2	C3	C4	C5
C_1	0	0	0	0	0
C_2	0	0	0	0	0
C_3	0	1	0	0	0
C_4	0	0	0	0	0
C_5	0	1	0	0	0

The directed graph given by the third expert C1 , C4 , C2 which forms the class B3

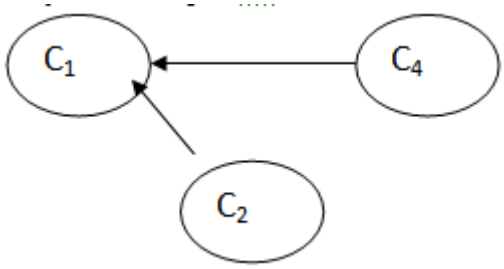

Figure 3

The related connection given by third expert opinion on C1 , C4 , C5 which forms the class B3.

E3 =

	C1	C2	C3	C4	C5
C_1	0	0	0	0	0
C_2	0	0	0	0	0
C_3	0	0	0	0	0
C_4	1	0	0	0	0
C_5	1	0	0	0	0

Combined Disjoint Block Fuzzy Cognitive Map From Figure 1,2 & 3 , we get

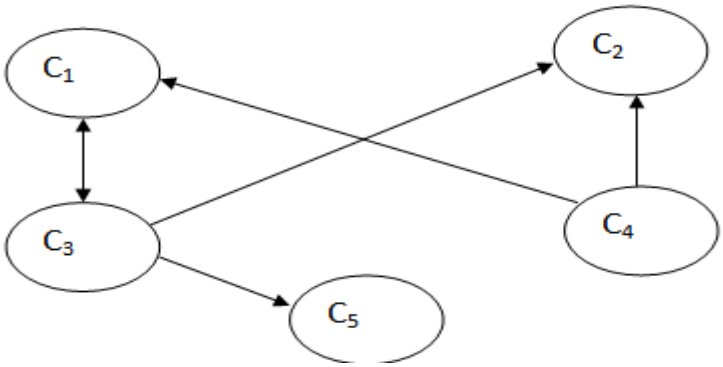

Figure 4

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The combined FCM adjacency matrix is

$$E = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \end{array} \begin{array}{c} \begin{array}{ccccc} C1 & C2 & C3 & C4 & C5 \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

Now using the matrix A of the combined overlap block FCM, we determine the hidden pattern. Suppose the concept C1 is in the ON state and all other nodes are in the OFF state. Let the initial input vector be X = (1 0 0 0 0), where porosity is taken as the ON state and all other nodes are in the OFF state.

The effect of X on the dynamical system E is given by:

$XE = (0\ 0\ 1\ 0\ 0) \rightarrow (1\ 0\ 1\ 0\ 0) = X_1$

$X_1E = (1\ 1\ 1\ 1\ 0) \rightarrow (1\ 1\ 1\ 1\ 0) = X_2$

$X_2E = (1\ 1\ 1\ 1\ 0) \rightarrow (1\ 1\ 1\ 1\ 0) = X_3 = X_2.$

X2 is the hidden pattern, which is the fixed pattern.

II. CONCLUSION

From our study we conclude that while analyzing FCM, when the concept C1, "Porosity", is in the on state, the other concepts C2, C3, C4, are also in the on state. Therefore we conclude that the most important manufacturing defect that is likely to occur in practice is "porosity"—the presence of voids.

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