A Study on Positive and Negative impacts of Wearable Technology using Neutrosophic Cognitive Map Approach

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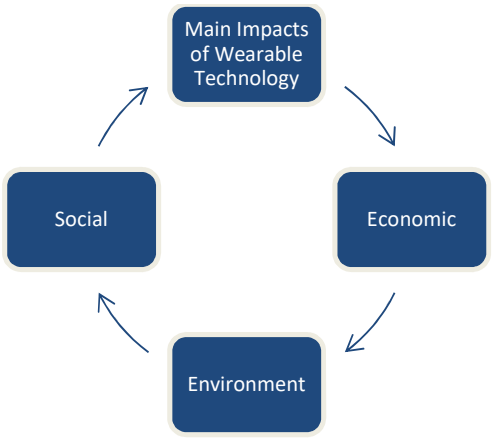
Abstract: A word technology becomes Smaller, Smarter and integrated into everything. The term Wearable Technology is a category of technological devices that can be used by consumers and also track the information's associated with privacy, health and fitness issues. Some other type of wearable gadgets is a small notion of sensors to capture photos and synchronize with phones. Wearable Technology has been beneficial in various fields such as medicine, media, business, artificial Intelligence and rehabilitation etc., but there is always a drawback behind every development because a coin has two sides. The generalized concept of Fuzzy Cognitive Map which is Neutrosophic Cognitive Map (NCM) technique is to deal the concept of indeterminacy instead of merely positive and negative influences which was introduced by Florentin Samarandache and W.B. Vasantha Kandasamy. In this research work NCM has been discussed to study the Boon and Bane of Wearable Technology.

Keywords: Wearable Technology, Fuzzy Cognitive Map (FCM), Neutrosophic Cognitive Map (NCM)

Introduction

Technology is one of the keys to develop the quality of Everyone's life from new born to senior citizens [8]. In recent years, wearable technology is a new idea of interaction between the rapid growth of communication and information technology. While moving, users can easily access the online information conveniently and comfortably communicate with each other's [5]. The term "wearable" indicates that the concept of portable compact computing devices which is different from laptops or desktop computers. In the early days, technology has looked massive and heavy. But nowadays, wearable devices are flexible and lightweight. Because the wearer concentrates the wearable's size, shape, outlook, everyday movements and tasks, etc., and also esthetics quality of wearability is very important to the wearer [2].

Today, Wearable Technology is facing a demanding challenge. Now, there is a clash with the positive aspects of wearable technology. Wearable technology was founded for a better advancement in the field of medicine and fitness trackers, but now it is mainly focused on the money based business. For example, the collected information from the fitness trackers and mentally retarded peoples are connected with the smartphones, may be the measured data is not reliable to the original data means the risky factors arises. It is one of the claim of wearable technology [5].



In this paper, particular consideration with recent case studies, and discussed the positive and negative effects related to the quality of human life.

Background of the study

Applications of current wearable technology from the sustainable wearables and definition of sustainable wearables is discussed to improve the quality of an individual's life, social impact [5].The societal perceptions of a user interacting with the e-textile interface at different on body locations is discussed [9]. This study investigates the key psychological effects of smart watch adoption develops and extended the technology acceptance model [4]. This paper investigates the predictors of an individual's privacy in health care wearable devices and considered the importance of privacy in health care wearable devices [6]. This paper analyzed the context of wearable technology within the aspect of evaluated and understanding the concept of wearable technology in social context [2]. The educators who understanding the consequences of wearable technology and conducted the surveys about the educational benefits and difficulties at sake [1].

Brief Review of Fuzzy Cognitive Map

In this section, the concepts of Fuzzy Cognitive Maps are discussed elaborately to support the readers of the paper for their essential background. Robert Axelrod (1976) proposed Cognitive Maps (CMs) for the unstructured Situations. It is a signed digraph used to explain the causal relationship of a person with respect to a certain concept. ie) Decision making problems, society and political problems etc.,

The relation between variables can be either positive or negative. If the relationship is positive, there may be an increase or decrease in the concept in the same direction. If the relationship is negative there may be an increase in one concept leads to decrease in another concept. In the developing field, Cognitive Maps are used in problem formulation, decision analysis especially in unstructured problems.

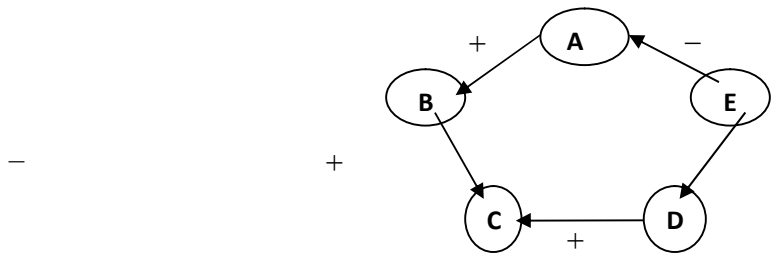


Figure. 1

Fig. 1 is a graphical representation of a cognitive map, where the variables (A, B, C, etc.) are represented as nodes, and causal relationships as directed arrows between variables, thus constructing a signed digraph.

Bart Kosko (1986) introduced the concept of Fuzzy Cognitive Map to rectify the uncertainty of Cognitive Map. An FCM is weighted directed graph. After the Kosko's contribution to the field of fuzzy logic, advanced and creative applications have been developed in many areas such as expert systems and decision making etc.,

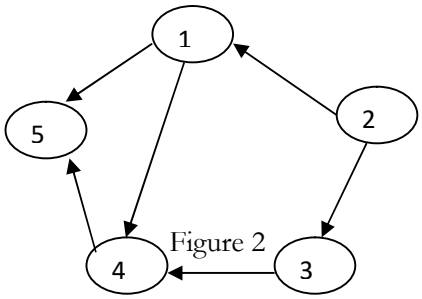


Figure 2

Fuzzy set is the mathematical way of modelling to represent uncertainty and vagueness. It was characterized by the membership function and grade of membership function [7].

Research Method

In this paper, the advancement of FCM considers the impacts of wearable technology. The relationship among the factors are discussed based on the expert's choice.

In step one, the factors have been identified by analyzing the research articles and literature of wearable technology.

In step two, Used the panel of experts to determine the relation between factors.

In step three, the obtained Cognitive Map has been extended to a Neutrosophic Cognitive map by establishing the concept of Positive, Negative and Indeterminacy. To identify the relationship between the factors, the fuzzy questionnaire has been formulated and collect the opinion for the panel of experts.

Introduction to Neutrosophic Logic

The generalization /combination of Fuzzy Logic is named as Neutrosophic Logic in which indeterminacy is included. The logic of neutrosophy plays a major role in various real world problems like medicine, business, society, environment, etc., The concept of fuzzy logic measures the degree of membership and non-membership function in the repeating way. Fuzzy theory has failed to measure the concept indeterminacy. In Fact, the concept of indeterminacy with the concepts will form the neutrosphic logic [3].

Definitions

A Neutrosophic digraph with concepts like policies, events etc., as nodes and indeterminants or causalities as edges.In represents the causal relation between variables.

Consider $C_1,C_2,....,C_n$ be the n nodes. Further assume each node is a neutrosophic vector. So the node Ci will be represented by $(X_1, X_2,....,X_n)$ where X_i's are zero or one or I (Indeterminate) and x_k = 1means that the node C_k is in the on state and x_k=0 means the node is in the off state and x_k = I means the node state is an indeterminate at the situation.

Let C_i and C_j be two nodes of the NCM.The directed edge from C_i to C_j denote the causality of C_i and C_j called connections. Every edge in the NCM is weighted with a number in the set {-1,0,1,I} .Let e_{ij} be the weight of the directed edge $C_i C_j$, $e_{ij} \in \{-1,0,1,I\}$. $e_{ij} = 0$ if C_i does not have any effect on C_j, $e_{ij} = 1$ if increase (or decrease) in C_i causes increase (or decrease) in Cj, $e_{ij} = -1$ if increase (or decrease) in C_i causes decrease (or increase) in Cj. If e_{ij} = I means that the relation between the concept in indeterminate [10].

Adaptation of Neutrosophic Cognitive Maps

Based on the peer reviewed journals, research articles the following relevant factors are framed.

Positively Impactful factors

A_1 Interact with new ways
A_2 Easily contactable/Conveyable
A_3 Detection of health problems
A_4 Improves personal safety
A5 Health and fitness tracking
A_6 Development of Industrial Sectors

Negatively Impactful factors

E_1 Decrease in self confidence
E_2 Radiation affects the health
E_3 Reduced interaction with people face to face
E_4 Lack of Privacy
E_5 Wearable worries
E_6 Increases the hacking technology
E_7 The frustration of the quality and accuracy provided by the devices
E_8 Measure data inaccurately in some occasions (false information lead to overexertion and health issues).

According to the open-ended questions, interviews from the expert's (Creative professionals) the relative adjacency matrices are found

$$M_1 = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} \begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & 4 & 5 & 6 \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & \\ - & 1 & 0 & \mathbf{I} & 1 & \\ 1 & - & 0 & \mathbf{I} & 1 & \\ 0 & 0 & - & 1 & 1 & \\ \mathbf{I} & \mathbf{I} & 0 & - & 1 & \\ 1 & 1 & 1 & 1 & - & 6\times 6 \end{pmatrix} \end{array}$$

$M_2 =$

		1	2	3	4	5	6	7	8
1	-	1	1	**I**	1	1	1	1	
2	1	-	1	0	1	1	1	1	
3	1	1	-	**I**	1	1	1	1	
4	**I**	0	**I**	-	**I**	1	1	1	
5	1	1	1	**I**	-	1	1	1	
6	1	1	1	1	1	-	0	0	
7	1	1	1	1	1	0	-	1	
8	1	1	1	1	1	0	1	-	8×8

For the Positive Impactful factors

i) Consider the state vector A_1 which is in ON position.

Let the initial input vector be $X_1 = (1\ 0\ 0\ 0\ 0\ 0)$

$X_1 \times M_1 = (I\ \ 1\ \ 0\ \ 0\ \ I\ \ 1)$

$\rightarrow (I\ \ 1\ 1\ \ 0\ \ I\ \ 1) = A_1$

$A_1 \times M_1 = (I+1\ \ 2+I^2\ 2+I\ \ I+1\ \ I^2+1\ \ I^2+2)$

$\rightarrow$ **(1 1 1 1 1 1)** $= A_2$

$A_2 \times M_1 = (I+1\ \ 2+I\ \ 2+I\ \ 2\ \ I^2+2\ \ 5)$

$\rightarrow$ **(1 1 1 1 1 1)** $= A_3$

$A_2 = A_3$

The state vector $X_1 = (1\ \ 0\ \ 0\ \ 0\ \ 0\ \ 0)$ gives the fixed point $(1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1)$

ii) Consider the state vectors A_3 which is in ON position.

Let the initial input vector be $X_3 = (0\ 0\ 1\ 0\ 0\ 0)$

$X_3 \times M_1 = (0\ \ 0\ \ 0\ \ 0\ \ 0\ \ 1)$

$\rightarrow (1\ \ 0\ \ 0\ \ 0\ \ 0\ \ 1) = B_1$

$B_1 \times M_1 = (1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1)$

$\rightarrow$ **(1 1 1 1 1 1)** $= B_2$

$B_2 \times M_1 = (1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1)$

$\rightarrow$ **(1 1 1 1 1 1)** $= B_3$

$B_2 = B_3$

The State vector $X_3 = (0\ \ 0\ \ 1\ \ 0\ \ 0\ \ 0)$ gives the fixes point $(1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1)$

For the Negative Impactful factors

i) Consider the state vector E_1 which is in ON position.

Let the initial input vector be $Y_1 = (1\ 0\ 0\ 0\ 0\ 0\ 0\ 0)$

$Y_1 \times M_2 = (0\ 1\ 1\ I\ 1\ 1\ 1\ 1)$

$\rightarrow (1\ 1\ 1\ I\ 1\ 1\ 1\ 1) = C_1$

$C_1 \times M_2 = (6+I^2\ 6\ 6+I^2\ 3I+3\ 6+I\ 4+I\ 5+I\ 5+I)$

$\rightarrow$ **(1 1 1 1 1 1 1 1)** $= C_2$

$C_2 \times M_2 = (6+I\ 6\ 6+I\ 3I+3\ 6+I\ 5\ 6\ 6)$

$\rightarrow$ **(1 1 1 1 1 1 1 1)** $= C_3$

$C_2 = C_3$

The State vector $Y_1 = (1\ 0\ 0\ 0\ 0\ 0\ 0\ 0)$ gives the fixed point (1 1 1 1 1 1 1 1)

i) Consider the state vector E4, which is in ON position.

Let the initial input vector be $Y_4 = (0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)$

$Y_4 \times M_2 = (I\ 0\ I\ 0\ I\ 1\ 1\ 1)$

$\rightarrow (I\ 0\ I\ 1\ I\ 1\ 1\ 1) = D_1$

$D_1 \times M_2 = (3I+3\ 3+3I\ 3I+3\ 3I^2+3\ 3I+3\ 3I+1\ 3I+2\ 3I+2)$

$\rightarrow$ **(1 1 1 1 1 1 1 1)** $= D_2$

$D_1 \times M_2 = (6+I\ 6\ 6+I\ 3I+3\ 6+I\ 5\ 6\ 6)$

$\rightarrow$ **(1 1 1 1 1 1 1 1)** $= D_3$

$D_2 = D_3$

The State vector $Y_4 = (0\ 0\ 0\ 1\ 0\ 0\ 0\ 0)$ gives the fixed point (1 1 1 1 1 1 1 1)

According to the calculation the following are the effects of wearable technology. The positive impactful factors are concerned. The factors "Interact with new ways and Detection of health problems" is in ON position A_3 and B_3 is the fixed point of the dynamical system. That is, the above two factors influencing easily contactable/Conveyable, Improves personal safety, Health and fitness tracking, Development of Industrial Sectors

In the similar manner, the negative impactful factors are concerned. Decrease in self confidence and Lack of Privacy is in ON position C_3 and D_3 is the hidden pattern.ie. The above two factors influencing the remaining negative impactful factors for the particular study. Likewise, it is possible to assess the effect of each factor on the other factors.

Conclusion

The Neutrosophic Cognitive Map is the useful tool to handle the complex data analysis. The research discussed the effects of wearable technology and found the influencing factors causing issues to human beings. The NCM Model predicates more accurate results when compared with FCM Model. The reason is, the concept of indeterminacy is considered to found the best vector for the unsupervised situations.

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