Identification and Elimination of Safety Risk using T-S Neuro Fuzzy System over Textile and Apparel

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ABSTRACT

There are several safety hazard problems faced in textile and apparel, which have been a major area of concern for governments, consumers and workers. Most of the recent studies on safety management of textile and apparel mainly focus on defects in products and quality control, the risk assessment was based on the simple tool called checklist to textile and apparel is still at the stage of investigation. So, we use T-S Neuro Fuzzy System to analyze the safety risk of textile and apparel. All the major risk elements that affect the safety state of textile and apparel are obtained. Using this system, we can identify risk level in a certain period of time. To eliminate these risks we use molecular modeling to generate input to the T-S Neuro Fuzzy System through which risks free attributes of textile and apparel can be obtained.

Index Terms – safety issues over textile and apparel; risk assessment; T-S Neuro Fuzzy System; assessment model; risk elimination

1. INTRODUCTION

The textile and apparel industry involves the process used to convert fibers into finished fabrics or garments. Several health risks are related to working within these industries and also the end users of the final product. Exposure to some textile processes can put workers at risk for developing diseases such as cancer or respiratory problems etc., There are several safety hazards of textile and apparel like Exposure to dust from processing of fibers, dyeing chemicals, printing chemicals, lubricants and anti-static agents etc., .we are finding the risk levels of some of the attributes like formaldehyde, color fastness to water, color fastness to acidic perspiration, color fastness to alkaline perspiration, color fastness to dry rubbing, color fastness to saliva, pH value, peculiar smell, detachable fragrant amine dyestuffs, product marking, fiber composition using T-S Neuro Fuzzy Approach. Using the values of the risk levels we can design the desired dyes, chemical auxiliaries, polymers and textile fibers via the same Neuro Fuzzy approach.

All countries, particularly developed countries have enacted a large number of technical regulations and standards directed to safety of textile and apparel. Although governments all have taken certain measures to strengthen the supervision of textile product safety, the security features of textile product such as complexity, concealment and uncertainty make current security situations of textile product unpleasant. Safety hazards of textile and apparel may cause trade disputes and waste of resources and harm consumers' safety of life and property. Hence, it's necessary to build a risk assessment model to find out prominent risk factors which affect safety state and evaluate safety state of textile and apparel [7].

An Artificial Neural Network (ANN), usually called neural network (NN), is a mathematical model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Modern neural networks are non-linear statistical data modeling tools. They are usually used to model complex relationships between inputs and outputs or to find patterns in data. Fuzzy logic is a form of many-valued logic or probabilistic logic; it deals with reasoning that is approximate rather than fixed and exact. In contrast with traditional logic theory, where binary sets have two-valued logic, true or false, fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false. Furthermore, when linguistic variables are used, these degrees may be managed by specific functions.

In the field of Artificial Intelligence, the recent developments are mainly based on the Fuzzy theory and neural network technology which are the two research hotspots. So, the fuzzy theory and the computational neural networks are integrated for the purpose of analyzing the risk level and designing of attributes. Advantage is being taken of the learning capability of the neural network to manipulate fuzzy entropies for classification and recognition processes. The neural network is being used to find patterns in terms of structural features and properties that correspond to a desired level of activity in various classes of molecules, such as nitrodyes. Neuro Fuzzy System (NFS) combines the advantages of vague and uncertainty information. Takagi-Sugeno (T-S) fuzzy both neural network in good learning abilities and fuzzy logic in processing model was proposed by Takagi and Sugeno in 1985[1], in which consequents of fuzzy rules can be presented as the linear combination of input variables. When T-S fuzzy system was applied into general fuzzy neural network, it brings to T-S Neuro Fuzzy System [2, 3], T-S Neuro Fuzzy System has been widely used by researchers for system modeling in different areas.

In the existing system, the tool used for safety risk assessment is Checklist the major disadvantage in this model is that it could not cover and identify all the hazards and risks of textile and apparel and monitoring process was also seemed to be difficult. To overcome this we propose, a safety risk analysis of textile and apparel to identify the risk level which use fuzzy neural network based on T-S model and a same T-S model to eliminate the risk. It is capable of capturing all the risk, identifying the level of risk and after developing an appropriate set of input parameters, the neural network is trained with selected molecules, then a search is carried out for compounds that exhibit the desired level of activity. The elimination of risk is carried out with the same T-S Neuro Fuzzy System which make use of the molecular modeling [8]. In which, each molecule is described by a set of structural features, a set of physical properties and the strength of some activity under consideration are trained and tested to produce the risk free safety attributes.

2. HAZARDS AND RISKS IN TEXTILE AND APPAREL SECTOR

The major hazards in textile and apparel sector are from Asbestos, formaldehyde, dyes, fiber composition etc.,

A.Exposure to Chemicals

Textile workers who are engaged in activities such as dyeing, printing and finishing are exposed to chemicals that can cause major health issues. The exposure to formaldehyde causes leukemia, nasal, lung and brain cancer. In the long term, exposure to these chemicals can foster the development of respiratory difficulty and eczema.

1) Exposure to Formaldehyde: Health effects arising from release of formaldehyde are from domestic products such as blankets and clothing textiles are irritation of the eyes and nose, and allergic reactions on skin in contact with the clothes.

Breathing formaldehyde vapour can result in irritation of nerves in the eyes and nose, which may cause burning, stinging or itching sensations, a sore throat, teary eyes, blocked sinuses, runny nose, and sneezing. Skin contact with formaldehyde can cause skin rashes and allergic skin reactions. The levels of exposure which may cause these allergic reactions will vary between individuals, and will depend in part on the individual's previous allergy history. Instances of dermatitis arising from wearing clothing containing high levels of formaldehyde have been documented [14].

2) Exposure to Asbestos: Asbestos has been used extensively in the production of cloths, garments and other textiles for many centuries, as the mineral boasts superior resistance to heat, flame, acid and other corrosive elements. Asbestos is the only naturally-occurring mineral that can be spun and woven into fabric. Cloths and textiles containing asbestos could be found in almost every business, factory and residential home [15].

Textiles and cloth made from asbestos present a serious health hazard, both to the individuals who were directly involved with the manufacturing process and to those who used the finished asbestos cloth products. Asbestos was most commonly used in textiles. According to numerous medical studies over the years, exposure to chrysotile fibers and other types of asbestos used in the manufacturing of textiles is associated with an increased risk of lung cancer, asbestosis and mesothelioma. When tiny asbestos fibers are released into the air in textile mills where asbestos cloth is produced, the fibers can be inhaled and ingested and cause serious damage and possible malignancies with long-term exposure. The health risk associated with asbestos textiles is estimated to be even greater than the risk in other industries such as asbestos mining, as the asbestos fibers are released into the air in greater amounts during the textile manufacturing process [15].

Asbestos-containing cloth can also pose a health hazard if the material is torn, shredded, sanded, damaged or heavily worn, which can cause asbestos fibers to break away and become airborne. When exposed to very high temperatures, asbestos has a tendency to transform into a powder, which is especially dangerous if disturbed or inhaled [15].

3) Exposure to Dyes: Some dyes used in textile finishing can be harmful to health which causes many diseases like dermatitis, cancer, respiratory sensitization etc., [11].

B.Hazards of Polymers

A range of safety hazards is associated with polymer materials and the processes involved in their use. The hazards are common to all the materials and care should be taken at all times in dealing with them. The factors that lead to the health hazards of polymers are:

1) Uncured resins: Once fully cured or polymerised, polymeric materials present no health hazard, but care has be taken with all uncured resin systems. For example, for volume uses such as floor material, paints, or sealants, epoxy products are usually supplied in 'two-component' form, with separate resin and hardener which are mixed just before application. a) The epoxy resin base is an irritant and may give rise to allergies through contact. If product contains solvents which are also epoxy substances (so-called 'reactive solvents'), these may cause an allergic reaction through inhalation. b) The amine hardeners are most often corrosive, but products vary from irritant to poisonous. Many amines are sensitising by skin contact, and volatile amines may give off sensitising vapours [13].

2) Solvents: Many polymers contain solvent additives to vary the viscosity and prevent premature curing. Solvents evaporate during dispensing as well as during the curing process. Solvents are generally classed as irritants and care should be taken not to touch the materials with bare skin and to provide sufficient ventilation (or preferably extraction) to remove the fumes. The solvent remains an irritant in vapour form and can affect people who suffer from asthma [13].

C.Exposure to Textile Fibers

The physical properties of the fibers have the potential to cause diseases of the lungs and respiratory system and in particular the likelihood of fatal diseases (mortalities) such as lung cancers and fibrosis. There are a number of hazards / health effects from exposures to fibers. These can be broadly divided into: 1) Mechanical irritant effects of the eyes, nose and skin. 2) Dermatitis (atopic eczema) 3) Endotoxin induced effects 4) Obstructive lung disease (e.g. asthma, bronchitis) 5)Other chronic effect (cough, loss of lung function) 6)Interstitial lung diseases (e.g. follicular bronchiolitis) 7)Fibrosis of the lung (e.g. asbestosis) 8)Cancers of the lung (e.g. lung cancer and mesothelioma) [12].

3. ARCHITECTURE OF NEURO FUZZY SYSTEM

A.Takagi- Sugeno model

The fuzzy model proposed by Takagi and Sugeno [1] is described by fuzzy a IF-THEN rule which represents local input-output relations of a nonlinear system. The main feature of a Takagi-Sugeno fuzzy model is to express the local dynamics of each fuzzy implication (rule) by a linear system model. The overall fuzzy model of the system is achieved by fuzzy "blending" of the linear system models. Almost all nonlinear dynamical systems can be represented by Takagi-Sugeno fuzzy models to high degree of precision. In fact, it is proved that Takagi-Sugeno fuzzy models are universal approximators of any smooth nonlinear system [5,6].

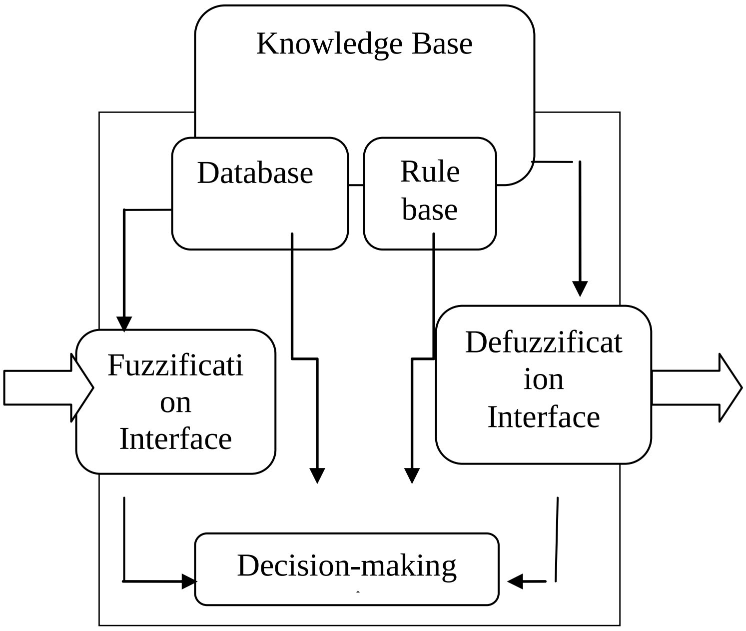

Fig. 1 Architecture of Neuro Fuzzy system

B.Architecture of T-S Neuro Fuzzy System

The architecture of T-S Neuro Fuzzy System also known as fuzzy rule-based systems or fuzzy models is given with reference to literature[10] .They are composed of 5 conventional block: a rule-base containing a number of fuzzy if-then rules, a database which denotes the membership functions of the fuzzy sets used in the fuzzy rules, a decision-making unit which performs the inference operations on the rules, a fuzzification interface which transform the crisp inputs into degrees of match with linguistic values, a defuzzification interface which transform the fuzzy results of the inference into a crisp output. To design a T-S fuzzy controller, we need a T-S fuzzy model for a nonlinear system. Therefore the construction of a fuzzy model represents an important and basic procedure in this approach. In general there are two approaches for constructing fuzzy models: 1.Identification (fuzzy modeling) using input-output data and 2. Derivation from given nonlinear system equations [10].

4. SAFETY RISK ANALYSIS

A.Identifying hazards and those at risk

Looking for those things at work that have the potential to cause harm, and identifying workers who may be exposed to the hazards. Using workers' knowledge helps to ensure hazards are spotted and workable solutions implemented. Consultation encourages workers to commit themselves to health and safety procedures and improvements [9]. A risk assessment should cover all workers regardless of whether they are employed on long- or short-term contracts. Where there are persons employed by another organization on site, there is a duty on the two employers to cooperate and safeguard the health and safety of workers [9]. Risk assessment should take account of differences in workers, such as by gender, age, or disability. For example, older employees may learn differently than a younger worker, and also have different concepts of risk due to a lack of experience. Different prevention measures may be required for these worker groups. Work, its organization and the equipment used should be adapted to the worker, not the other way around. This principle is enshrined in EU legislation [9]. Workers with disabilities should be considered specifically in the risk assessment process. For example, people with disabilities may be subjected to bullying, which can lead to work-related stress. Consultation with workers with disabilities is vital to ensure a risk assessment is appropriate [9]. The major safety hazards which affect the safety of workers and end users are classified as follows: 1.Many different groups of chemical substances are used in the textiles sector, including dyes, solvents, optical brighteners, crease-resistance agents, flame retardants, heavy metals, pesticides, and antimicrobic agents. They are used in dyeing, printing, finishing, bleaching, washing, dry cleaning, weaving slashing/sizing, and spinning. 2. Respiratory and skin sensitizers can be found in the textiles industry, for example textiles fibers, reactive dyes, synthetic fibers, and formaldehyde. The textile industry has been evaluated as a sector with an increased carcinogenic risk. Several studies have showed an increased risk of nasal, laryngeal and bladder cancer in women [9]. Other major elements are: asbestos, formaldehyde, dyeing agent, cotton dust, color fasteners etc.,

B. Evaluating and prioritizing risks

Evaluate how likely it is that the hazard will lead to harm or injury, and how severe that injury is likely to be. Consider what control measures are in place and whether they are sufficient. It is essential that the work to be done to eliminate or prevent risks is prioritised. The focus for cost-effective and sustainable risk management should be on collective protection and preventative measures [9].

C. Monitoring and Reviewing

The assessment should be reviewed at regular intervals to ensure it remains up to date. It has to be revised whenever significant changes occur in the organisation or as a result of the findings of an accident or "near miss" investigation [9].

D. Applying T-S Neuro Fuzzy System for Risk analysis

The basic attributes that affect the workers and end users of apparel and textile are taken for analyzing the safety risk. They are: formaldehyde, color fastness to water, color fastness to acidic perspiration, color fastness to alkaline perspiration, color fastness to dry rubbing, color fastness to saliva, pH value, peculiar smell, detachable fragrant amine dyestuffs, product marking, fiber composition. These attributes are of two categories: quantifiable and qualifiable. The quantifiable attributes are formaldehyde, color fasteners and pH value. The qualifiable attributes are peculiar smell, detachable fragrant amine dyestuffs, product marking and fiber composition. With the help of this classification values and related literature [5] the following TABLE I is obtained. The assessment attributes are the input for the Neuro Fuzzy System.

1)Training the Neuro Fuzzy System with samples :

Equally spaced interpolation in a uniform distribution way in risk estimation regulation to expand training samples is adopted since large quantity of data are needed for the training of T-S Neuro Fuzzy System system(NFSs). The specific methods are that T-S NFSs is trained by the relative membership matrix of standard index and the relative membership matrix of classes to construct training sample of standard index membership.

***2) Testing the Neuro Fuzzy System with samples*: ** We are taking last amount of data for training and testing, of which maximum amount of data is utilized for training the NFS and a limited amount of data is taken for testing. The trained data are stored in the database using the method said above. Testing is performed by searching the appropriate value to identify the risk level. There are five levels of risks. They are free of risk, low risk, moderate risk, high risk and extreme high risk, accordingly the risk levels are assigned to the attributes depending on the output of NFS. For example, level value less than 1, 1-1.5, 1.5-2.5, 2.5-3.5, 3.5-4.5, and more than 4.5 are defined as free of risk, low risk, moderate risk, high risk and extreme high risk respectively.

5. ELIMINATION OF RISK

In the first phase we determined the level of risk of certain safety attributes using the T-S NFS. So we are proposing a system for designing the dyes, chemical auxiliaries, polymers and textile fibers using the evaluated risk values, to prevent the safety risks and to help the workers and end users of textiles and apparels from the health hazards. To implement this, we use the same T-S NFS. Using molecular modeling [8] we can establish databases of various molecular properties required as input for the T-S NFS to eliminate risk. After developing an appropriate set of input parameters, the neural network is trained with selected molecules, and then a search is carried out for compounds that exhibit the desired level of activity [8]. High level molecular orbital and density functional techniques are being employed to establish databases of various molecular properties required by the neural network approach.

TABLE I

ESTIMATION SCALE REGULATION FOR TEXTILE AND APPAREL

Assessment attributes	Values of Risk Level				
	Free of risk	Low risk	Moderate risk	High risk	Extreme high risk
formaldehyde	20	21	24	27	30
Color fastness to water	3.5	3	2.5	2	1.5
Color fastness to acidic perspiration	3.5	3	2.5	2	1.5
Color fastness to alkaline perspiration	3.5	3	2.5	2	1.5
Color fastness to dry rubbing	4	3.5	3	2.5	2
Color fastness to saliva	4	3.5	3	2.5	2
pH value	4.0-7.5	≥3,≤9.125	≥2,≤10.75	≥1,≤12.375	≥0,≤14
Peculiar smell	0	5%	20%	35%	50%
Detachable fragrant amine dyestuff	0	5%	20%	35%	50%
Product marking	0	5%	20%	35%	50%
Fiber composition	0	5%	20%	35%	50%

6. CONCLUSION

In this paper we have used T-S Neuro Fuzzy System to identify and eliminate the risks of certain safety attributes of textile and apparel. The first phase is identifying the risk, where we have used T-S NFS to train and test the samples. The evaluation gives the risk level of the safety attributes. The second phase is eliminating the risk; here we use the same T-S NFS to eliminate the identified risk with the help of molecular modeling. The samples are trained and tested with the help of this model to eliminate the risk. Thus, protecting the workers and the end users from the health hazards of textiles and apparels.

REFERENCES

[1] T. Takagi, M. Sugeno, “Fuzzy identification of systems and its applications to modeling and control, ”IEEE Transactions on System, Man, and Cybernatics. vol. 15, pp. 116–132, 1985.

[2] R.J.Wai, Z.W. Yang, “Adaptive fuzzy neural network control design via T-S fuzzy model for a robot manipulator including actuator dynamics,”IEEE Transactions on Systems, Man, and Cybernatics, pp. 1326–1346, 2008.

[3] F. Wang, Y.R. Xu , L. Wan, Y. Li, Modified learning of T-S fuzzy neural network control for autonomous underwater vehicles, in:ITCS(International Conference on Information Technology and Computer Science), vol. 1, pp. 361–365.Shi-tong Wang, Fuzzy system, fuzzy neural network and its Application design: Shanghai Science and Technology Publishing House, 1998.

[4] C. Fantuzzi and R. Rovatti, “On the approximation capabilities of the homogeneous Takagi-Sugenomodel," in Fuzzy Systems, 1996. Proceedings of the Fifth IEEE Inter-national Conference on, vol. 2, 1996.

[5] J. Buckley, “Universal fuzzy controllers," Automatica (Journal of IFAC), vol. 28, no. 6, pp. 1245{1248, 1992. Shuhui Pang, Yuan Zhou, Xuemei Ding, Xiongying Wu “Application of T-S Fuzzy Neural Network in Safety Risk Assessment of Textile and Apparel” 2011 Eighth International Conference on Fuzzy Systems and Knowledge Discovery(FSKD).

[6] Les M. Sztandera, Charles Bock, and Mendel Trachtman “Use of Artificial Intelligence in Designing Dyes, Chemical Auxiliaries, Polymers and Textile Fibers”.