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Computational analysis of molecular dynamics results in a fuzzy scaled system

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Abstract. This study presents a computational analysis of molecular dynamics results within a fuzzy scaled system framework. Molecular dynamics simulations are widely used to investigate the behavior of materials at the atomic level, providing insights into their structural and dynamic properties. However, the inherent uncertainties and complexities in molecular interactions often challenge traditional analytical approaches. By applying fuzzy logic to the analysis of molecular dynamics results, we can effectively capture the variability in atomic interactions and enhance the interpretation of simulation outcomes. This approach enables the development of a more nuanced understanding of material behaviors under various conditions, accounting for factors such as temperature fluctuations and external stresses. The fuzzy scaled system allows for the integration of qualitative and quantitative data, facilitating a comprehensive assessment of molecular dynamics results. Through detailed computational experiments, we demonstrate the efficacy of the fuzzy scaled system in analyzing molecular dynamics data, highlighting its ability to improve prediction accuracy and provide meaningful insights into material properties. The findings underscore the potential of combining fuzzy logic with molecular dynamics simulations to advance the field of computational materials science. This research contributes to the development of more robust analytical tools for interpreting complex molecular behaviors, ultimately paving the way for innovations in material design and engineering applications.

Keywords: fuzzy grey GM(1,1) model; nanocomposite; nonlocal elasticity; size-dependent properties; stability

1. Introduction

Molecular dynamics (MD) simulations have become a cornerstone in the study of material properties at the atomic level, enabling researchers to explore the intricate behaviors of molecules and their interactions under various conditions. These simulations provide valuable insights into phenomena such as diffusion, phase transitions, and mechanical properties, which are critical for advancements in fields ranging from materials science to biophysics. However, despite their

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power, MD results often come with inherent uncertainties and complexities that can complicate the interpretation of data.

Traditional analytical methods may struggle to account for the variability and imprecision present in molecular dynamics simulations, particularly when dealing with large datasets or non-linear relationships. This limitation highlights the need for innovative approaches that can effectively manage uncertainty and enhance the robustness of analysis. One promising solution lies in the application of fuzzy logic, which offers a framework for handling ambiguity and imprecision in data interpretation.

This study introduces a fuzzy scaled system to analyze molecular dynamics results, integrating fuzzy logic principles with computational analysis. By employing this approach, we aim to capture the nuances of molecular interactions and provide a more comprehensive understanding of the underlying physical phenomena. The fuzzy scaled system allows for the incorporation of both qualitative and quantitative aspects of data, enabling researchers to better represent the inherent uncertainties in molecular dynamics outputs.

Through this investigation, we will explore the benefits of using a fuzzy scaled system in the context of molecular dynamics, demonstrating its potential to improve prediction accuracy and facilitate more informed decision-making in material design and analysis. By bridging the gap between fuzzy logic and molecular dynamics, this research seeks to enhance the analytical capabilities available to scientists and engineers, ultimately contributing to the development of advanced materials and innovative applications in various domains.

Therefore, the analysis of system latency is stable in research (Mori 1985, Trine Aldeen 1995, Tsai *et al*. 2012, 2015, Chen 2011, 2014) has been published and demonstrated. In recent years, there have been many interesting topics related to system administration. Numerous applications have been received successfully, some have been received. Of course, many fundamental issues still need to be resolved. And the main problem with control systems is designing systems that ensure stability. Several stability studies have recently been conducted (see Tanaka Sugeno 1992, Tim *et al*. 2021, Zhen *et al*. 2021, Chen *et al*. 2022, Hsiao *et al*. 2005, Wang *et al*. 1996, Feng *et al*. 1997 and references therein). For example, Chiang *et al*. (2001, 2002, 2004) provided a new criterion for the system, Cheng *et al*. (2002) provided IMT units for the system, Hsiao *et al*. (2003, 2005) Application of Artificial Intelligence Theory to Nonlinear Systems, Hsieh *et al*. (2006) Proposition of Stability Analysis for Artificial Intelligence, Lin *et al*. (2010). Implementation of control in the TLP system, Chen *et al*. (2006, 2007, 2009) have also demonstrated the efficiency of neural networks using LDI theory. Recently, Zhou *et al*. (2023) published studies but have not yet addressed the stability and instability problems of large systems with multiple delays. Furthermore, some promising methodologies would be better choices, On the other hand, atomic simulations show that the elastic modulus of 1-2nm diameter CNTs increases with increase in the diameter (Chang and Gao 2003). It is argued that the increase in elastic modulus in small diameter (<1.5 nm) is due to the excessive strain imposed on the graphene shells, and this effect is not prevalent in the experimental results that deal with 10-25 nm nanotubes. (Chang and Gao 2003) presented an analytical method based on molecular dynamics to calculate the elastic properties of carbon nanotubes as a function of their geometry parameters such as diameter and chirality. The results indicate that the Young modulus of SWCNT increases with increase in diameter and then converges to a constant value for large diameters. (Li and Chou 2003) calculated the young and shear modulus of single layer carbon nanotubes using a structural mechanics method. In their analysis, a C-C bond is modeled as a beam with specific Young, bending and shear moduli that were calculated by matching beam specifications with force field constants. Using this method,

they observed that the Young modulus of CNTs reduces with increase in diameter. The shear modulus also shows similar dependency on the diameter. In recent years, length dependent properties of SWCNT is investigated by (Naumov *et al*. 2013, Rao *et al*. 2015, Zhu and Li 2017, Taati *et al*. 2020) and (Ranjbartoreh and Wang 2010). Anandatheertha *et al*. (2010) used molecular dynamics based finite element method to evaluate Young modulus of SWCNT. In lengths smaller than 60 nm, the Young modulus exhibits an increase when increasing in length of the CNT, and for longer lengths, it converges to a constant value. Ranjbartoreh and Wang (2010) employed molecular dynamics simulation to predict behavior of SWCNT under various loading conditions. The results show that the Young modulus increases with increase in the length. There can be found several research works on the size dependent vibrational and buckling behavior of CNTs and CNT-reinforced nano-composites employing nonlocal and gradient theories of elasticity (Hosseini *et al*. 2017, 2018, Aydogdu *et al*. 2018, Boutaleb *et al*. 2019, Ebrahimi *et al*. 2019a, Soni *et al*. 2020). Nonlocal theory is also employed in obtaining size-dependent responses of properties other than mechanical ones. Coupled magnetic, thermal and elasticity responses in shape memory alloyed was investigated by Lata and Singh (2021, 2022)

In investigating the mechanical properties of CNTs, the classical continuum based modeling has also been adopted by many researchers (Liu *et al*. 2020a, Wang *et al*. 2020, Zhou *et al*. 2020, Dai *et al*. 2021a, Guo *et al*. 2021a, Shao *et al*. 2021, Wu and Habibi 2021, Kong *et al*. 2022). Employing classical theory of elasticity instead of atomic simulation, some complicated mechanical behavior such as vibrations and buckling of CNTs can be studied (Shariati *et al*. 2012, 2016a, b, Shariati *et al*. 2019, 2020d, e, f, g, h, i, j, 2021a, b, Fan *et al*. 2022, Luo *et al*. 2022b, Wang *et al*. 2022a, Xia *et al*. 2022). Another virtue of employing the classical theory of elasticity is that it has less computational costs than the atomic simulations. However, the classical continuum modeling cannot reflect the size dependency of properties in nano materials. In the constitutive equation of the classical continuum theory, the stress is assumed a function of the local strain, so nonlocal effects and size parameters are not observed in the equations of the classical elasticity theory. Nonlocal theory of elasticity (Eringen 1972) incorporating an internal length scale parameter into the constitutive equation, presents size-dependent mechanical properties in nano materials (Zenkour and Abouelregal 2015, Lata and Singh 2019, Pham *et al*. 2021). Pisano and Fuschi (2003) presented a nonlocal formulation for a bar under uniaxial tension and their results indicated a non-uniform strain distribution in the bar. Failla *et al*. (2010) used approximate methods in order to obtain strain, displacement and strain energy in a nonlocal bar under uniaxial tension. After (Peddieson *et al*. 2003), the size dependent nonlocal theory of elasticity has been widely used in predicting mechanical behavior of nanomaterials. They formulated the deflection equation of a nonlocal Bernoulli-Euler beam, and showed that based on the nonlocal elasticity theory, the nonlocal effect manifest itself in the nano-scale devices. Sudak (2003) investigated the buckling of a multiwall carbon nanotube (MWCNT) using nonlocal elasticity theory. In the analysis, each individual CNT is modeled as a column and the buckling of the MWCNT is investigated by considering the interaction between adjacent CNTs as van der Walls interaction. The results demonstrated that the critical load of buckling is highly dependent on the scale parameter. In these studies, the results of the nonlocal elasticity are more conservative than those of the classical elasticity. Wang *et al*. (2006) investigated buckling of CNTs using both nonlocal column and shell models. In the nonlocal shell model, the critical load is found to be function of diameter as well as length of the CNT, where the column model cannot reflect the dependency of critical load on the diameter. Zhang *et al*. (2005) investigated free vibrations of DWCNT using nonlocal elasticity theory. Each CNT was modeled as a nonlocal beam and the

interaction between two CNT is modeled as spring with a specific coefficient. They concluded that the classical theory of elasticity could overestimate the amount of the natural frequencies.

In nanocomposite materials, which are frequently reinforced with CNTs and other nano-structures, elasticity parameters are usually considered as constants (Bellal *et al*. 2020, Matouk *et al*. 2020, Rouabhia *et al*. 2020, Bouafia *et al*. 2021, Heidari *et al*. 2021, Kumar *et al*. 2021, Van Vinh and Tounsi 2021, Bendaida *et al*. 2022). However, a size dependent properties are more desirable in this context. Using embedded size-dependent theories in analyzing nanocomposite puts extra computational costs in calculation which could be easily avoided using approximate or exact closed-form relations (Al-Furjan *et al*. 2020h, i, 2021, Bendenia *et al*. 2020, Arshid *et al*. 2021, Huang *et al*. 2021d, Zerrouki *et al*. 2021). On the other hand, in chemical production of nanostructures, it is barely possible to control size of each nanostructure (Al-Furjan *et al*. 2020g, Bourada *et al*. 2020, Bousahla Abdelmoumen *et al*. 2020, Asgharnejad Lamraski *et al*. 2022, Moradi *et al*. 2022a, b, Vatanpour *et al*. 2022a, b). Moreover, novel methods of evaluating size and effects of nanostructures and nanoparticles are commonly relies on statistical approximations (Lingamdinne *et al*. 2023). Using numerical methods like finite element has its own drawbacks in terms of computational, accuracy and modeling time (Amelirad and Assempour 2019, 2021).

Thus, this study provides a stability formula based directly on Lyapunov's method, which provides asymptotic stability for large multi-delay systems. According to this explanation and limited control system, fuzzy control groups are involved in stabilizing large-scale systems in multi-delay systems with many interconnected systems. Furthermore, these subsystems are represented in the models by a simple Takagi-Sugen law model. Each of these layers is represented by a linear model of the system. Therefore, the linear control response can be used as a fixed response. Therefore, the coverage design type based on the fuzzy model is the Parallel Distributed Coverage (PDC) model. Lines in all linear spaces use the same assumptions. and we highlight the results that show the best performance of the proposed damage propagation theory for the structural analysis of composites in space.

The stability measurements are obtained and verified using the Lyapunov method to ensure the asymptotic stability of the multi-delay system, and we highlight the results that show the best performance of the proposed damage propagation theory for the analysis of complex land structures. Finally, descriptive results and conclusions for the numerical model are presented.

2. Nonlocal theory of elasticity

Nonlocal theory of elasticity is one the theories that take into account the effects of the size in the mechanical properties (Ma *et al*. 2022, Zhao *et al*. 2022, Hou *et al*. 2021, Huang *et al*. 2021b, c, Jiao *et al*. 2021, Liu *et al*. 2021c, Moradi *et al*. 2021, Xu *et al*. 2021, Dong *et al*. 2022, Fan *et al*. 2022, Luo *et al*. 2022a, b, Michael *et al*. 2022, Wang *et al*. 2022b, c, Yang *et al*. 2022a, b, Yu *et al*. 2022, Zheng *et al*. 2022, Zhu *et al*. 2022). The essence of incorporating size effects in the mechanical properties is that the stress at a point of the material is considered to be affected by not only the local strain but also the nonlocal strain field. The influence of the nonlocal strain is imposed on the stress by employing an attenuation function. In this way, strain at farther points (compared to internal characteristic length) has less influence on the stress than strain at the points near the reference point. The constitutive equation of a nonlocal linear homogenous elastic solid is given as follows:

$$F^0 = (F_1^0, F_2^0, \dots, F_n^0) \tag{1}$$

where σij are the nonlocal stress components, and εij are the strain components for infinitesimal displacement components, and they are defined by the following equation:

$$F^1 = (F_1^1, F_2^1, \dots, F_n^1), \tag{2}$$

where ui are the displacement vector components. The fourth order tensor $Cijkl$ is the elasticity tensor of the classical elasticity (Fan *et al*. 2022, Luo *et al*. 2022b, Wang *et al*. 2022a, Xia *et al*. 2022).

As mentioned above, the influence of the nonlocal strain on the stress at point $\boldsymbol{x}$ is incorporated by an attenuation function $\alpha(|\boldsymbol{x}-\boldsymbol{x}'|)$. The attenuation function $\alpha(|\boldsymbol{x}-\boldsymbol{x}'|)$ is apositive scalar function of the Euclidean distance between point $\boldsymbol{x}'$ and the reference point $\boldsymbol{x}$. When the Euclidean distance is very large compared to internal length $|\boldsymbol{x}-\boldsymbol{x}'|\to\infty$ theattenuation function vanishes $\alpha\to 0$. However, in practice, the influence of nonlocal strain after an specific distance, called influence distance, vanishes, so that the attenuation function after that distance become $\alpha(|\boldsymbol{x}-\boldsymbol{x}'|)\approx 0$ (Polizzotto 2001). For small distances, the value of theattenuation function $\alpha$is considerable whereas at large distances the nonlocality effects substantially decrease. The influence distance is characterized by the internal characteristic length, and it is in the same order of the internal characteristic length. It is expected when the influence distance vanishes so that only local strain takes into account, the constitutive Eq. (1) become the local form of:

$$\frac{dF^1}{dt} + aF^1 = b, \tag{3}$$

where a represents the expanded coefficient which needs to be a non-negative value to have a stable dynamic, b represents the control variable Gray, both unknown variables.

The first order of differential equations, $\mathrm{d}F^1/_{dt}$ is denoted by

$$\frac{dF^1}{dt} = \lim_{h\to 0}\frac{F_{t+h}^1 - F_t^1}{h}, \quad \forall t \geq 1. \tag{4}$$

Let be the unit sampling interval, then the difference of the generation series F $^{1\text{ can be described}}$ as a discrete time series $F_{t+1}^1,\ \forall t \geq 1$ which

$$\frac{dF^1}{dt} = \frac{F_{t+1}^1 - F_t^1}{1} = F_{t+1}^1 - F_t^1 = F_{t+1}^0,\ \ \forall t \geq 1. \tag{5}$$

Approximation in (5) and therein equations lie in the linear assumptions. The second part of the first-order gray model is the mean F_t^1e F_{t-1}^1. Then we can rewrite equation (3) as

$$F_{t+1}^0 = a\left[-\frac{1}{2}(F_{t+1}^1 + F_1^1)\right] + b, \quad \forall t \geq 1. \tag{6}$$

If $t = 1,2,\dots,n$, then equation (6) can be rewritten in matrix form as

$$\begin{bmatrix} F_2^0 \\ F_3^0 \\ \vdots \\ F_n^0 \end{bmatrix} = \begin{bmatrix} -\frac{1}{2}(F_2^1 + F_1^1) & 1 \\ -\frac{1}{2}(F_3^1 + F_2^1) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(F_n^1 + F_{n-1}^1) & 1 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix}. \tag{7}$$

Using the least squares method, the variables a and b in equation (7) can be solved as

$$\hat{a} = \begin{bmatrix} a \\ b \end{bmatrix} = (B^{\top}B)^{-1}B^{\top}F^{0} \tag{8}$$

where the states

$$F_0 = \begin{bmatrix} F_2^0 \\ F_3^0 \\ \vdots \\ F_n^0 \end{bmatrix}, \quad B = \begin{bmatrix} -\frac{1}{2}(F_2^1 + F_1^1) & 1 \\ -\frac{1}{2}(F_3^1 + F_2^1) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(F_n^1 + F_{n-1}^1) & 1 \end{bmatrix}.$$

By obtaining the solutions of the variables a and the matrix bi (8), we can solve the differential equation (3) to obtain the F_{t+1}^1 estimated cumulative value at

$$\hat{F}_{t+1}^1 = \left(F_1^0 - \frac{b}{a}\right)e^{-at} + \frac{b}{a}, \quad \forall t \geq 1. \tag{9}$$

Finally, it is possible to obtain a forecast value for period *t+1* which

$$\hat{F}_{t+1}^0 = \hat{F}_{t+1}^1 - \hat{F}_t^1, \quad \forall t \geq 1. \tag{10}$$

Suppose that the original series with fuzzy data F°* is defined as

$$\hat{F}_t^{0,R} = \hat{F}_t^{1,R} - \hat{F}_{t-1}^{1,R}, \forall t \geq 2 \tag{11}$$

You can get $\tilde{F}_1^{0*}, \tilde{F}_2^{0*}, \ldots, \tilde{F}_n^{0*}$ explained fuzzy values $\hat{\tilde{F}}_{n+1}^0, \hat{\tilde{F}}_{n+2}^0, \ldots, \hat{\tilde{F}}_{n+k}^0, \forall t \geq 1$ through the input data. Theorem 1 shows that a fuzzy number $\hat{\tilde{F}}_t^1, \forall t \geq 2$ is not a symmetric fuzzy number, so $\hat{\tilde{F}}_t^0$ it is also not a symmetric fuzzy number. Conversely, $\hat{\tilde{F}}_t^0$ to estimate the forecast error, the mean is defined as $\hat{F}_t^{0,Aver}$, given by

$$\hat{F}_t^{0,Aver} = \frac{F_t^{0,L} + F_t^{0,R}}{2}, \quad \forall t \geq 2.$$

Therefore, the gray time series model GM(1,1) is used.$F_2^0, \ldots, F_n^0$ is specified to extrapolate the values for $\hat{F}_{t+1}^0, \hat{F}_{t+2}^0, \ldots, \hat{F}_{t+k}^0, \forall k \geq 1$. The main features of the Takagi-Sugeno multilayer fuzzy model are the expression of each rule by a linear equation of state, and the model is as follows (Chen 2014, Chen *et al*. 2019, 2020):

r_j is the IF-THEN rule number for this $A_{ij}\, j$. *Subsystem*., $A_{i\overleftarrow{\tau}k\overleftarrow{\tau}j}$ and B_{ij} are paired system matrices, state $x_j(t)$, input $u_j(t)$, $\tau_{k\overleftarrow{\tau}j}$ delay fuzzy set M_{ipj} ($p = 1, 2, \cdots, g$) and assumption are used $x_{1j}(t) \sim x_{gj}(t)$ to derive the dynamic fuzzy model:

$$\dot{x}_j(t) = \frac{\sum_{i=1}^{r_j} w_{ij}(t)\left\{A_{ij}x_j(t) + \sum_{k=1}^{N_j} A_{i\overleftarrow{\tau}k\overleftarrow{\tau}j}x(t - \tau_{k\overleftarrow{\tau}j}) + B_{ij}u_j(t)\right\}}{\sum_{i=1}^{r_j} w_{ij}(t)}$$

$$= \sum_{i=1}^{r_j} h_{ij}(t)\left\{A_{ij}x_j(t) + \sum_{k=1}^{N_j} A_{i\overleftarrow{\tau}k\overleftarrow{\tau}j}x(t - \tau_{k\overleftarrow{\tau}j}) + B_{ij}u_j(t)\right\}$$

with

$$w_{ij}(t) = \prod_{p=1}^{g} M_{ipj}(x_{pj}(t)), \; h_{ij}(t) = \frac{w_{ij}(t)}{\sum_{i=1}^{r_j} w_{ij}(t)} \tag{12}$$

where $x_{pj}(t)\, w_{ij}(t) \geq 0, \;\; i = \;\; 1, 2, \cdots, r_j$ and $\sum_{i=1}^{r_j} w_{ij}(t) > 0 \;\; i = \;\; 1, 2, \cdots, r_j, \;\; \sum_{i=1}^{r_j} h_{ij}(t) = 1.$

3. Smart control for nonlocal elastic bar in tension

In this section, we consider an SWCNT with length L under uniaxial tension. For simplicity, the CNT is modeled as a one-dimensional nonlocal bar in tension under applied stress $\bar{\sigma}$, and one end of it is pinned at (x=0). From equilibrium of the bar, it is concluded that the internal stress of the CNT is uniform and equals the applied stress $\bar{\sigma}$. The one-dimensional form of Eqs. (9) and (2) is as Eqs. (11) and (12), respectively:

$$\varepsilon(x) = \frac{\bar{\sigma}}{\zeta_1 E} - \frac{\zeta_2}{\zeta_1}\int_0^L \bar{\alpha}(|x - x'|)\varepsilon(x')dx' \tag{13}$$

This equation is the Fredholm equation of the second kind and it is indicated that, despite the fact that the stress state in the CN'T is uniform, the strain is not uniform in the CNT. A solution for this equation with following form for attenuation finction $\bar{\alpha}$ is given by (Pisano and Fuschi 2003).

$$\bar{\alpha}(r) = A\exp\left(-\frac{r}{l}\right) \tag{14}$$

And, the solution for Eq. (13) is given by the following equation (Pisano and Fuschi 2003):

$$\varepsilon(x) = \frac{\bar{\sigma}}{E}\left\{1 + \frac{\zeta_2}{4\zeta_1}\left[e^{\frac{x}{l}(\frac{\zeta_2}{2\zeta_1}+1)} + e^{\frac{L-x}{l}(\frac{\zeta_2}{2\zeta_1}+1)}\right]\right\} \tag{15}$$

Using Eq. (15) and integrating Eq. (12) the displacement for each point is obtained:

$$and$$

$$andu(x) = \frac{\bar{\sigma}L}{E}\left\{\frac{x}{L} - \frac{l}{L}\frac{\frac{\zeta_2}{2\zeta_1}}{2\left(\frac{\zeta_2}{2\zeta_1}+1\right)} \times \left[e^{\frac{x}{l}\left(\frac{\zeta_2}{2\zeta_1}+1\right)} - e^{\frac{L-x}{l}\left(\frac{\zeta_2}{2\zeta_1}+1\right)} + e^{\frac{L}{l}\left(\frac{\zeta_2}{2\zeta_1}+1\right)} - 1\right]\right\} \tag{16}$$

In order to calculate the Young modulus of the CNT, the applied stress is divided by the average strain inside the bar. The average strain of the CNT is obtained by following relation.

$$\begin{aligned} \varepsilon_{ave}and &= \frac{1}{L}\int_0^L \varepsilon(x)dx = \frac{u(L)}{L} \\ and &= \bar{\varepsilon}\left\{1 - \frac{l}{L}\frac{\frac{\zeta_2}{2\zeta_1}}{\left(\frac{\zeta_2}{2\zeta_1}+1\right)}[e^{-\frac{L}{l}\left(\frac{\zeta_2}{2\zeta_1}+1\right)} - 1]\right\} \end{aligned} \tag{17}$$

where the $\bar{\varepsilon}$ is the strain field produced with considering the classical constitutive equation that is $\bar{\varepsilon} = \bar{\sigma}/\mathrm{E}$. Finally, the Young modulus of the CNT can be obtained as follows:

$$\frac{E^{nl}}{E} = \left\{1 - \frac{l}{L}\frac{\frac{\zeta_2}{2\zeta_1}}{\left(\frac{\zeta_2}{2\zeta_1}+1\right)}\left[e^{-\frac{L}{l}\left(\frac{\zeta_2}{2\zeta_1}+1\right)} - 1\right]\right\}^{-1} \tag{18}$$

Theorem 1: The fuzzy large-scale system $\boldsymbol{F}$ is asymptotically stable, if the feedback gains (K_{ij}) are chosen to satisfy $\beta_j = \sum_{\substack{n=1 \\ n\neq j}}^{J}(\|C_{nj}^T P_j\| + \|C_{jn}^T P_n\|) > 0$, for $j = 1, 2, \cdots, J$ with

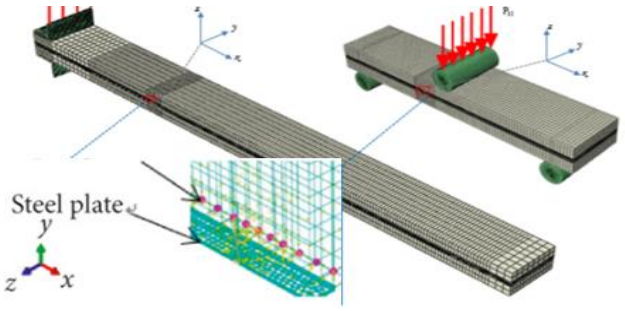

Fig. 1 Finite element model of an aluminum beam

$G_{ifj} = \dfrac{(A_{ij} - B_{ij}K_{fj}) + (A_{fj} - B_{fj}K_{ij})}{2}$, $P_j = P_j^T > 0$, and $\lambda_m(Q_{ij})$ as well as $\lambda_m(Q_{ifj})$ denote the minimum eigenvalues of Q_{ij} and Q_{ifj}, respectively.

4. Example

ANSYS finite element (FE) software has an electromechanical stress simulation function that can simulate aluminum beams with customized boundary conditions. In the finite element model the beam is in SOLID185 unit and the PZT sensor is in SOLID5 unit.

The final model of the aluminum beam is very similar to the data of Liu and Jiang (2009) (Fig. 1). Aluminum support sample size is 1000 x 20 x 2 mm, 50 × 10 × PZT detector is placed. 0.5 mm to the left of the 62.5 mm beam. Two cracks of length 3 mm and 6 mm of length 500 mm are visible from the left of the beam. The excitation voltage of the PZT sensor is 4 V. Numerical simulations were performed in three cases: an aluminum beam without cracks, 3 mm cracked aluminum beam and 6 mm cracked aluminum beam. Calculate the frequency range.

For all cases, the number of maximum frequencies in this study is the same as Liu and Jiang (2009), there is no crack. Two panels had 3 mm cracks and three panels had 6 mm cracks. However, there were two patterns in each of these three cases. The maximum resistance in this study deviates from the maximum value of Liu and Jiang (2009), and the deviation is less than 1% and can be ignored in the comparison (Table 3). This study demonstrates the high accuracy and reliability of barrier response simulation. Therefore, the numerical simulation results are used for the structural crack detection problem.

This chapter presents a detailed review of crack analysis in beams. The selection of frequency range is very important for impedance-based error analysis. Several studies have shown that the properties of resonance barriers are more sensitive to structural damage. Ryu *et al*. (2017) measured the impedance response in the frequency range 10–55 kHz. The highest frequency range is 24-26 kHz. Ai *et al*. (2018) measured the impedance response. Frequency range 10-55 kHz. The highest frequency range is 24-26 kHz. Ai *et al*. (2017). According to 0-300 kHz (2018). This reduces the sensitivity of the RMSD index. Damage in this study the response of uncracked, 3 mm cracked, and 6 mm cracked barriers was studied at the following frequency ranges:10 to 100 kHz (frequency step 0.1 kHz) Fig. 2 shows the simulated impedance response for the three case studies. It should be noted that there are several distinct amplitude impedance peaks in this frequency

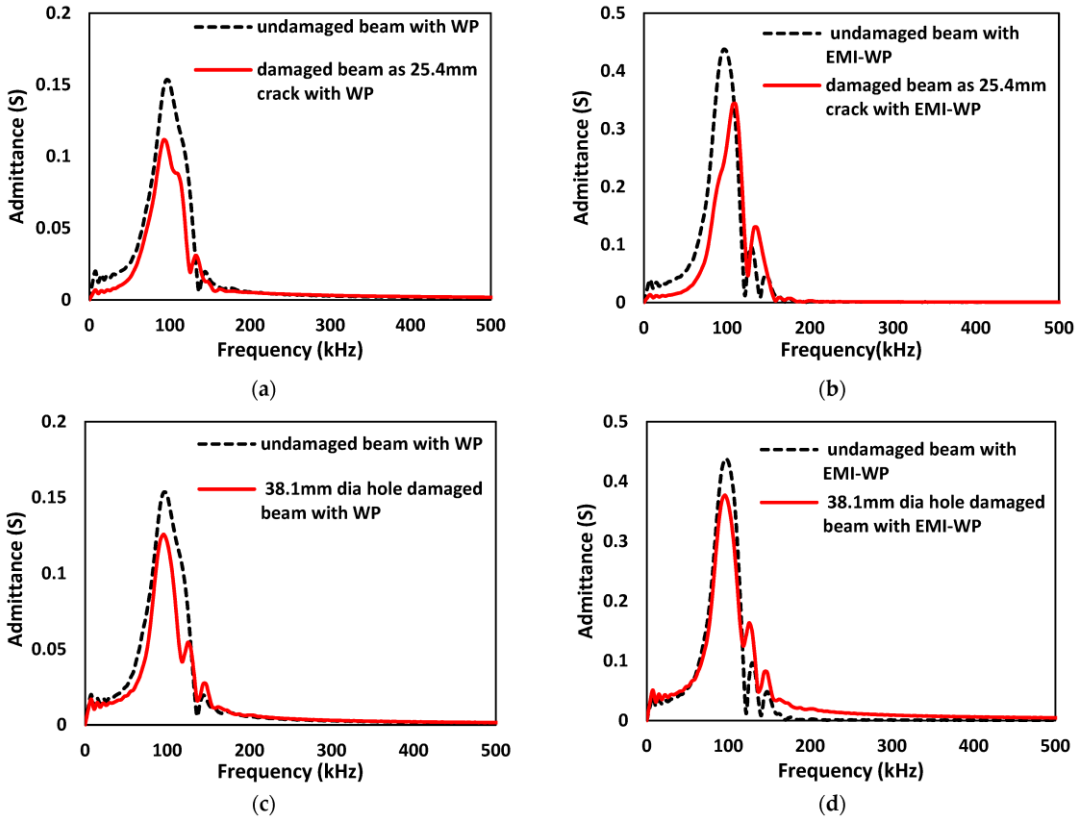

Fig. 2 EMI response of aluminum beam with different cracks

range. The impedance response is then divided into 18 subbands (eg 10-15 kHz, ..., 95-100 kHz) with a magnitude of 5 kHz. The RMSD index is calculated according to formula (1) (3) applied to 18 subbands, so the most sensitive subband is selected as input to the next step of MLP-DNN.

Different parts of the frequency range have different RMSD indices for the same damage condition. Furthermore, different damage conditions may result in different RMSD ratios. even if they are in the same sub-frequency range. There is no specific rule for changing the RMSD index. For example, in the 10–15 kHz sub-frequency range, the RMSD factor decreases with increasing crack. However, in the 15–20 kHz sub-frequency range, the RMSD factor decreases. with a growing crack. In the frequency range of 45–55 kHz, the RMSD coefficient reaches its maximum value and is higher than that of other frequency sub-ranges. This is also the frequency range where the resonant impedance peak in the response is highest. Therefore, the RMSD index can predict the cracks in the beam. However, the RMSD index cannot determine the crack size. Therefore, MLP DNN was used to determine the crack size of the beam.

Two additional crack conditions are proposed for the size of the crack: 2 mm crack and 5 mm crack, so the training arm will not crack or break.

This problem uses a frequency range of 45 to 55 kHz with a frequency step of 0.01 kHz. Fig. 3 shows the electronic response. MPedance or DNN MLP input data, the crack size analysis results are summarized in Fig. 4 for the training case. The accuracy of crack size analysis results is100% under specified operating conditions. Crack size results were 98.5% accurate for 2 mm

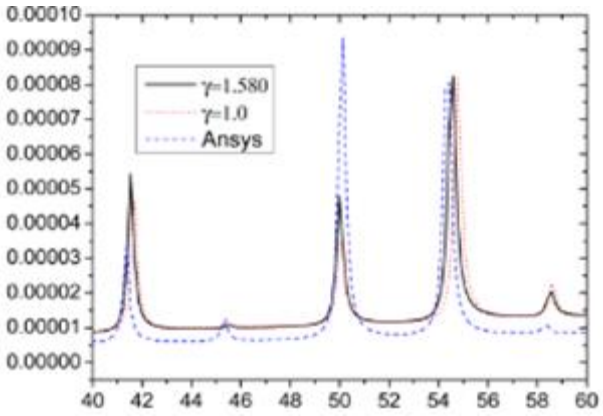

Fig. 3 EMI response during crack prediction

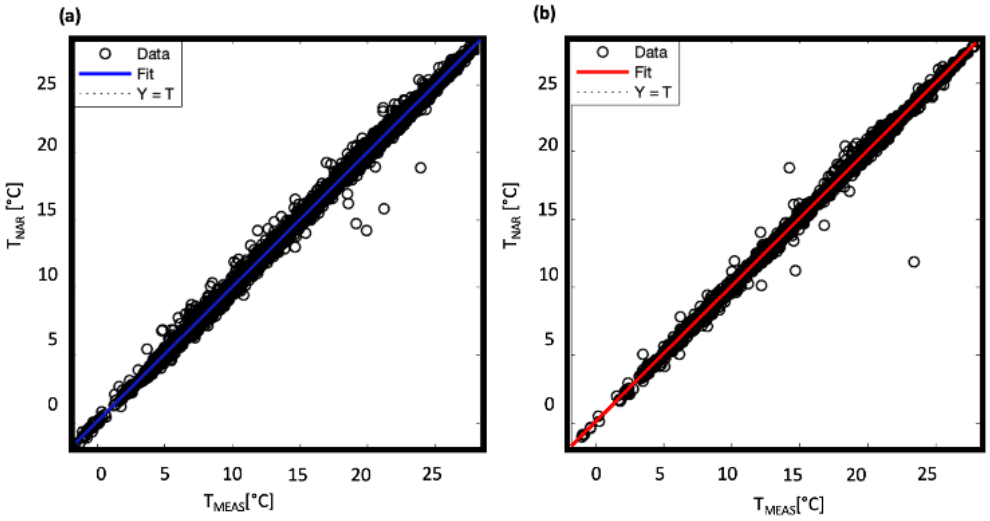

Fig. 4 Crack size prediction results of MLP ANN

Table 1 Performance comparison of different prediction models

	RMS error (training)		RMS error (experimental)		CPU time (training)	
Way	Average	Deviation	Average	Deviation	Average	Deviation
EA's suggestion	5.4	0.4	5. 6.	0.7	113.2	4.8
(Koza 1992) Details	28.3	3.5	30.2	4.2.2	143.5	6.5
(Vogel 1994) Author	19.5	1.5	20.1	4.3	257.2	8.5
(Rechenberg 1994) Author	14.7	1.7	1 6.2	2.1	216.3	9.2.2

cracks and 95.6% accurate for 5 mm cracks, allowing MLP to determine crack size with very high accuracy.

The quality values of the vibration control system of the offshore facility are R = 10 -5 and N = 210/ T. Networking between distributed devices and offshore networks differs from traditional

point control mechanisms. Due to the extreme conditions, delays and loss of packages are usually unavoidable.

The upper bounds on the delay are m sc =0.7/T=70 and m ca =0.7/T=70. M = 140, which is considered the maximum delay in ocean engineering. Based on the above variables, we obtained the following simulation results with different values of packet loss m1 and m2.

Table 1 shows these comparative performances of the genetic algorithm during the training and testing phases, including the mean and standard deviation of the RMS error and CPU time. As the table shows, the EA not only consumes less CPU time during the training and testing phases, but also produces less RMS error compared to other methods.

5. Conclusions

Based on earlier experiments and simulations the mechanical properties of nanomaterials such as carbon nanotubes are strongly dependent on length scales. The classical elasticity theory, because of its intrinsic nature, cannot present a size dependent result. In this paper, using nonlocal theory of elasticity, dependency of Young elasticity modulus of CNT on the length was investigated. The size exact size dependent of CNTs are often calculated from molecular dynamics simulation. According to the study, there is a fundamental relationship between the fuzzy method and the Gray method to solve the forecasting problem with powerful short-term forecasting models. We highlight results that demonstrate the high performance of the proposed theory applied to damage propagation for structural analysis of aircraft composites.

References

Canovas-Gonzalez, M. (2023), "Validity of the Nielsen-type hanger arrangement in spatial arch bridges with straight decks", *Steel Compos. Struct.*, **47**(1), 51. https://doi.org/10.12989/scs.2023.47.1.051.

Chandrasekaran, A. (2023), "Experimental investigations on resilient beam-column end-plate connection with structural fuse", *Steel Compos. Struct.*, **47**(3), 315. https://doi.org/10.12989/scs.2023.47.3.315.

Chen, C.H (2007a), "Interfacial wave motion in an impermeable rigid channel with stratified density fluid system", *Adv. Water Sci.*, **18**(4), 575-579.

Chen C.H. (2007b), "Interfacial wave motion in an impermeable rigid channel", *Adv. Water Sci.*, **18**(4), 570-574.

Chen, B. (2023), "Experimental study on vibration serviceability", *Steel Compos. Struct.*, **46**(4), 577. https://doi.org/10.12989/scs.2023.46.4.577.

Chen, C. (2006a), "Numerical model of internal solitary wave evolution on impermeable variable", *Chin Ocean Eng*, **20**(2), 303-313.

Chen, C. (2006b), "S-curve regression of fuzzy method and statistical application", *Proceedings of the 10th IASTED International Conference on Artificial Intelligence and Soft Computing*.

Chen, C. (2006c), "Energy dissipation and velocity distribution of internal soliton encountering submerged triangular obstacle", *J. Southwest Jiaotong Univ.*, China.

Chen, C.W. (2002a), "A novel fuzzy regression approach on managing target cash balance for construction firms", *Proceedings of the 17th IASTED International Conference on Modeling and Simulation*, Montreal, Canada.

Chen, C.W. (2002b), "A stability criterion of time-delay fuzzy systems", *J. Marine Sci. Technol.*, **10**(1), 5. https://doi.org/10.51400/2709-6998.2298.

Chen, C.W. (2002c), "Application of modeling and control", *Proc. Contr. Theory Appl.*, **149**, 1-10.

Chen, C.W. (2002d), "Model-based fuzzy control for nonlinear tuned mass damper", *Proceedings of the 2002 IEEE International Conference on Industrial Technology*, **1**, 60-65. https://doi.org/10.1109/ICIT.2002.1189862.
Chen, C.W. (2004), "Stability analysis of T–S fuzzy models for nonlinear multiple time-delay interconnected systems", *Math. Comput. Simul.*, **66**(6), 523-537. https://doi.org/10.1016/j.matcom.2004.04.001.
Chen, C.W. (2004a), "Fuzzy control of structural systems using Takagi-Sugeno fuzzy model", *Proceedings of the IEEE Conference on Mechatronics*, ICM'04, 340-345.
Chen, C.W. (2004b), "Fuzzy regression to construction management via TS fuzzy model", *Artificial Intelligence and Applications: IASTED Proceedings, 22nd IASTED Multi-Conference on Applied Informatics*.
Chen, C.W. (2006a), "Stability conditions of fuzzy systems and its application to structural and mechanical systems", *Adv. Eng. Softw.*, **37**(9), 624-629. https://doi.org/10.1016/j.advengsoft.2005.12.002.
Chen, C.W. (2006b), "Fuzzy Lyapunov method for stability conditions of nonlinear systems", *Int. J. Artif. Intel. Tool.*, **15**(2), 163-171. https://doi.org/10.1142/S0218213006002618.
Chen, C.W. (2007a), "A novel delay-dependent criterion for time-delay TS fuzzy systems using fuzzy Lyapunov method", *Int. J. Artif. Intel. Tool.*, **16**(3), 545-552. https://doi.org/10.1142/S0218213007003400.
Chen, C.W. (2007b), "Analysis of experimental data on internal waves with statistical method", *Eng. Comput.*, **24**(2), 116-150. https://doi.org/10.1108/02644400710729536.
Chen, C.W. (2007c), "Application of fuzzy stability control for buildings", *Artif. Intel. Appl.*, 592-597.
Chen, C.W. (2007d), "Modeling, H∞ control and stability analysis for structural systems using Takagi-Sugeno fuzzy model", *J. Vib. Control*, **13**(11), 1519-1534. https://doi.org/10.1177/1077546307073690.
Chen, C.W. (2007e), "An experimental study of stratified mixing caused by internal solitary waves in a two-layered fluid system over variable seabed topography", *Ocean Eng.*, **34**(14-15), 1995-2008. https://doi.org/10.1016/j.oceaneng.2007.02.014
Chen, C.W. (2008), "Stability analysis for time delay TLP systems", *Proceedings of the 2008 IEEE/ASME International Conference on Advanced Intelligent Mechatronics*, 1103-1107. https://doi.org/10.1109/AIM.2008.4601816.
Chen, C.W. (2009a), "Adaptive fuzzy sliding mode control for seismically excited bridges with lead rubber bearing isolation", *IJUFKS*, **17**(5), 705-727. https://doi.org/10.1142/S0218488509006224.
Chen, C.W. (2009b), "Managing target the cash balance in construction firms using a fuzzy regression approach", *IJUFKS.*, **17**(5), 667-684. https://doi.org/10.1142/S0218488509006200.
Chen, C.W. (2009c), "Modeling and control for nonlinear structural systems via a NN-based approach", *Exp. Syst. Appl.*, **36**(3), 4765-4772. https://doi.org/10.1016/j.eswa.2008.06.062.
Chen, C.W. (2009d), "The stability of an oceanic structure with T–S fuzzy models", *Math. Comput. Simul.*, **80**(2), 402-426. https://doi.org/10.1016/j.matcom.2009.08.001.
Chen, C.W. (2010), "Stability analysis of an oceanic structure using the Lyapunov method", *Eng. Comput.*, **27**(2), 186-204. https://doi.org/10.1108/02644401011022364.
Chen, C.W. (2010a), "Application of fuzzy-model-based control to nonlinear structural systems", *J. Vib. Control*, **16**(11), 1651-1672. https://doi.org/10.1177/1077546309104185.
Chen, C.W. (2010b), "GA-based adaptive neural network controllers for nonlinear systems", *Int. J. Innov. Comput. Inform. Control*, **6**(4), 1793-1803.
Chen, C.W. (2010c), "Modeling and fuzzy PDC control and its application to an oscillatory TLP structure", *Math. Prob. Eng.*, Article ID 120403. https://doi.org/10.1155/2010/120403.
Chen, C.W. (2011), "Conceptual framework and research method for personality traits and sales force automation usage", *Scientif. Res. Essay.*, **6**(17), 3784-3793. https://doi.org/10.5897/sre11.1022.
Chen, C.W. (2011a), "A critical review of nonlinear fuzzy multiple time-delay interconnected systems", *Scientif. Res. Essay.*, **6**(28), 5917-5932. https://doi.org/10.5897/SRE11.1347.
Chen, C.W. (2011b), "A critical review of parallel distributed computing", *Int. J. Phys. Sci.*, **6**(19), 4492-4501. https://doi.org/10.5897/IJPS11.908.
Chen, C.W. (2011c), "Internet services and interface design for marketing: A preliminary study of Cliven

products", *Int. J. Phys. Sci.*, **6**(15), 3585-3596. https://doi.org/10.5897/IJPS11.606.
Chen, C.W. (2011d), "Modeling, control, and stability analysis for time-delay TLP systems", *Neur. Comput. Appl.*, **20**, 527-534. https://doi.org/10.1007/s00521-011-0576-8.
Chen, C.W. (2011e), "Stability analysis and robustness design of nonlinear systems: An NN-based approach", *Appl. Soft Comput.*, **11**(2), 2735-2742. https://doi.org/10.1016/j.asoc.2010.11.004.
Chen, C.W. (2012), "Default risk-based probabilistic decision model for risk management and control", *Nat. Hazard.*, **63**, 659-671. https://doi.org/10.1007/s11069-012-0183-8.
Chen, C.W. (2012a), "A novel strategy to determine the insurance and risk control plan for natural disaster risk management", *Nat. Hazard.*, **64**, 1391-1403. https://doi.org/10.1007/s11069-012-0305-3.
Chen, C.W. (2012b), "Hazard management and risk design by optimal statistical analysis", *Nat. Hazard.*, **64**, 1707-1716. https://doi.org/10.1007/s11069-012-0329-8.
Chen, C.W. (2012c), "knowledge-sharing intention among taiwanese enterprises: A model of hypotheses", *Human Fact. Ergonom. Manuf. Serv. Ind.*, **22**(4), 362-371. https://doi.org/10.1002/hfm.20286.
Chen, C.W. (2013), "A study of PDC fuzzy control of structural systems using LMI approach", *Proceedings of the IASTED International Conference*, Applied Informatics.
Chen, C.W. (2013a), "A new viewpoint of hazard assessment and management for Taiwan's insurance issues", *Nat. Hazard.*, **65**, 303-314. https://doi.org/10.1007/s11069-012-0363-6.
Chen, C.W. (2013b), "Application of GIS for the determination of hazard hotspots", *Nat. Hazard.*, **66**, 191-228. https://doi.org/10.1007/s11069-012-0402-3.
Chen, C.W. (2013c), "factor evaluation of knowledge sharing intention in Taiwanese enterprises", *Human Fact. Ergonom. Manuf. Serv. Ind.*, **23**(2), 95-106. https://doi.org/10.1002/hfm.20300.
Chen, C.W. (2013d), "personality traits and sales force automation usage: A Review of Methodology", *Human Fact. Ergonom. Manuf. Serv. Ind.*, **23**(4), 294-305. https://doi.org/10.1002/hfm.20311.
Chen, C.W. (2013e), "The integration of nautical hazard assessment and harbor GIS models to the Taichung Port area in Taiwan", *Nat. Hazard.*, **67**, 275-294. https://doi.org/10.1007/s11069-013-0559-4.
Chen, C.W. (2013f), sales force automation usage: A preliminary study", *Human Fact. Ergonom. Manuf. Serv. Ind.*, **23**(3), 243-253. https://doi.org/10.1002/hfm.20313.
Chen, C.W. (2014a), "A criterion of robustness intelligent nonlinear control", *Nonlin. Dyn.*, **76**, 23-31. https://doi.org/10.1007/s11071-013-0869-9.
Chen, C.W. (2014b), "Interconnected TS fuzzy technique for nonlinear time-delay structural systems", *Nonlin. Dyn.*, **76**, 13-22. https://doi.org/10.1007/s11071-013-0841-8.
Chen, C.W. (2015a), "Smart monitoring system with multi-criteria decision", *Smart Struct. Syst.*, **15**(6), 1583-1600. https://doi.org/10.12989/sss.2015.15.6.1583.
Chen, C.W. (2015b), "Structural system simulation and control via NN based fuzzy model", *Struct. Eng. Mech.*, **56**(3), 385-407. https://doi.org/10.12989/sem.2015.56.3.385.
Chen, C.W. (2011), "Stabilization of adaptive neural network controllers", *J. Vib. Control*, **17**(8), 1241-1252. https://doi.org/10.1177/1077546309352827.
Chen, C.Y. (2002), "On the permeability inside the granular media", *J. Marine Sci. Technol.*, **10**(2), 9. https://doi.org/10.51400/2709-6998.2312.
Chen, C.Y. (2005), "Fuzzy logic derivation of neural network models", *Int. J. Artif. Intel. Tool.*, **14**(6), 967-974. https://doi.org/10.1142/S021821300500248X.
Chen, C.Y. (2006), "Profile evolution and energy dissipation for internal soliton transmitting over different submarine ridges", *China Ocean Eng.*, **20**(4), 585-594.
Chen, C.Y. (2007), "Generation of internal solitary wave by gravity collapse", *J. Marine Sci. Technol.*, **15**(1), 1. https://doi.org/10.51400/2709-6998.2026.
Chen, C.Y. (2007a), "Laboratory observations on internal solitary wave evolution", *Ocean Eng.*, **34**(1), 157-170. https://doi.org/10.1016/j.oceaneng.2005.11.019.
Chen, C.Y. (2007b), "Localized mixing due to an interfacial solitary wave breaking on seabed topography", *J. Offshore Mech. Arct. Eng.*, **129**(3), 245-250. https://doi.org/10.1115/1.2426991.
Chen, C.Y. (2007c), "Stability analysis for floating structures using TS fuzzy control", *Proceedings of the Advanced Intelligent Computing Theories and Applications. ICIC 2007*, Qingdao, China.

https://doi.org/10.1007/978-3-540-74205-0_79.
Chen, C.Y. (2007d), "Wave propagation at the interface of a two-layer fluid system in the laboratory", *J. Marine Sci. Technol.*, **15**(1), 8-16. https://doi.org/10.51400/2709-6998.2027.
Chen, C.Y. (2007d), "An investigation on internal solitary waves in a two-layer fluid: Propagation and reflection from steep slopes", *Ocean Eng.*, **34**(1), 171-184. https://doi.org/10.1016/j.oceaneng.2005.11.020
Chen, C.Y. (2008a), "Diagnosing and revising logistic regression models: effect on internal solitary wave propagation", *Eng. Comput.*, **25**(2), 121-139. https://doi.org/10.1108/02644400810855940.
Chen, C.Y. (2008b), "Experiments on mixing and dissipation in internal solitary waves", *Environ. Fluid Mech.*, **8**, 199-214. https://doi.org/10.1007/s10652-008-9055-x.
Chen, C.Y. (2009a), "A stability criterion for time-delay tension leg platform systems subjected to external force", *China Ocean Eng.*, **23**(1), 49-57.
Chen, C.Y. (2009b), "A case study of reinforced concrete short column under earthquake using experimental and theoretical investigations", *Struct. Eng. Mech.*, **36**(2), 197-206. https://doi.org/10.12989/sem.2009.36.2.197.
Chen, C.Y. (2010a), "Applying half-circle fuzzy numbers to control system", *Int. J. Marine Environ. Sci.*, **4**(12), 1980-1984.
Chen, C.Y. (2010b), "Fuzzy control for an oceanic structure: a case study in time-delay TLP system", *J. Vib. Control*, **16**(1), 147-160. https://doi.org/10.1177/1077546309339424.
Chen, C.Y. (2010c), "Linking the balanced scorecard (BSC) to business management performance", *Int. J. Phys. Sci.*, **5**(8), 1296-1305.
Chen, C.Y. (2010d), "The study of a forecasting sales model for fresh food", *Exp. Syst. Appl.*, **37**(12), 7696-7702. https://doi.org/10.1016/j.eswa.2010.04.072.
Chen, C.Y. (2010e), "Association rule mining for evaluation of regional environments: Case study of Dapeng bay, Taiwan", *Int. J. Innov. Comput. Inform. Control.*, **6**(8), 3425-3436.
Chen, C.Y. (2010f), "Using discriminant analysis to determine the breaking criterion for an ISW propagating over a ridge", *Environ. Fluid Mech.*, **10**(5), 577-586. https://doi.org/10.1007/s10652-010-9172-1
Chen, C.Y. (2011a), "A critical review and improvement method on biped robot", *Int. J. Innov. Comput. Inform. Control.*, **7**(9), 5245-5254.
Chen, C.Y. (2011b), "The exploration of internet marketing strategy by search engine optimization: A critical review and comparison", *African J. Business Manage.*, **5**(12), 4644-4649. https://doi.org/10.5897/AJBM10.1417.
Chen, C.Y. (2011c), "Statistical and dynamical analyses of propagation mechanisms of solitary internal waves in a two-layer stratification", *J. Marine Sci. Technol.*, **16**(1), 100-114. https://doi.org/10.1007/s00773-010-0112-z.
Chen, C.Y. (2012a), "Assessment of the major hazard potential of interfacial solitary waves moving over a trapezoidal obstacle on a horizontal plateau", *Natural Hazards*, **62**(3), 841-852. https://doi.org/10.1007/s11069-012-0107-7
Chen, C.Y. (2012b), "Disaster prevention and reduction for exploring teachers' technology acceptance using a virtual reality system and partial least squares techniques", *Natural Hazards*, **62**(3), 1217-1231. https://doi.org/10.1007/s11069-012-0146-0
Chen, P.C. (2008), "GA-based fuzzy sliding mode controller for nonlinear systems", *Math. Prob. Eng.*, 2008, Article ID 325859. https://doi.org/10.1155/2008/325859.
Chen, P.C. (2009), "Application to GA-based fuzzy control for nonlinear systems with uncertainty", *Proceedings of the 2009 Conference on Intelligent Information*, 249-252. https://doi.org/10.1109/ACIIDS.2009.86.
Chen, P.C. (2009a), "GA-based modified adaptive fuzzy sliding mode controller", *Exp. Syst. Appl.*, **36**(3), 5872-5879. https://doi.org/10.1016/j.eswa.2008.07.003.
Chen, P.C. (2009b), "Stability analysis of fuzzy control for nonlinear systems", *Proceedings of the 2009 Conference on Intelligent Information*, 238-242. https://doi.org/10.1109/ACIIDS.2009.83.

Chen, P.C. (2011a), "GA-based decoupled adaptive FSMC for nonlinear systems by a singular perturbation scheme", *Neur. Comput. Appl.*, **20**, 517-526. https://doi.org/10.1007/s00521-011-0540-7.
Chen, P.C. (2011b), "Linear matrix inequality conditions of nonlinear systems", *J. Vib. Control*, **17**(2), 163-173. https://doi.org/10.1177/1077546309352826.
Chen, T.H. (2010), "Application of data mining to the spatial heterogeneity of foreclosed mortgages", *Exp. Syst. Appl.*, **37**(2), 993-997. https://doi.org/10.1016/j.eswa.2009.05.076.
Chen, T.H., (2008), "A mathematical tool for inference in logistic regression with small-sized data sets", *Math. Prob. Eng.*, Article ID 186372. https://doi.org/10.1155/2008/186372.
Chen, T.H. (2009), "Application of logistic regression model: propagation effect on internal soliton", *J. Chung Cheng Inst. Technol.*, **37**, 1-10.
Chen, Y.Y. (2023), "Experimental study on fatigue behavior of innovative hollow composite bridge slabs", *Steel Compos. Struct.*, **46**(6), 745. https://doi.org/10.12989/scs.2023.46.6.745.
Chen, Z.Y. (2002), "Fuzzy control for nonlinear systems modeled via neural-network", *Proceedings of the 2002 IEEE Conference on Industrial Technology*, **1**, 66-71. https://doi.org/10.1109/ICIT.2002.1189863.
Cheng, M.H. (2009), "Modelling the propagation of an internal solitary wave across double ridges and a shelf-slope", *Environ. Fluid Mech.*, **9**, 321-340. https://doi.org/10.1007/s10652-008-9104-5.
Cheng, X. (2023), "On wave propagation of football ball in the free kick and the factors affecting it", *Steel Compos. Struct.*, **46**(5), 669. https://doi.org/10.12989/scs.2023.46.5.669.
Chiang, W.L. (2001), "Application and robust H?? control of PDC fuzzy controller for nonlinear systems with external disturbance", *J. Marine Sci. Technol.*, **9**(2), 3. https://doi.org/10.51400/2709-6998.2438.
Chiang, W.L. (2010a), "A neural-network approach to modeling and analysis", *Proceedings of the International Conference on Tools with Artificial Intelligence*.
Chiang, W.L. (2010b), "Detecting the sensitivity of structural damage based on the Hilbert-Huang transform approach", *Eng. Comput.*, **27**(7), 799-818. https://doi.org/10.1108/02644401011073665.
Chiou, D.J. (2011), "Applications of Hilbert-Huang transform to structural damage detection", *Struct. Eng. Mech.*, **39**(1), 1-20. https://doi.org/10.12989/sem.2011.39.1.001.
Dong, F. (2023), "Finite element computer simulation of twinning caused by plastic deformation of sheet metal", *Steel Compos. Struct.*, **47**(5), 601. https://doi.org/10.12989/scs.2023.47.5.601.
Doostdar, P. (2022), "NN model-based evolved control by DGM model for practical nonlinear systems", *Exp. Syst. Appl.*, **193**. https://doi.org/10.1016/j.eswa.2021.115873.
Doostdar, P. (2020), "INS/GNSS integration using recurrent fuzzy wavelet neural networks", *GPS Solut*, **24**, 29. https://doi.org/10.1007/s10291-019-0942-z
Fan, X., Li, J. and Hao, H. (2021), "Review of piezoelectric impedance based structural health monitoring", *Adv. Struct. Eng.*, **24**(16), 3609-3626. https://doi.org/10.1177/13694332211038444.
Fard, K.M (2023), "Energy absorption optimization on a sandwich panel with lattice core under the low-velocity impact", *Steel Compos. Struct.*, **46**(4), 525-538. https://doi.org/10.12989/scs.2023.46.4.525.
Farrar, C.R. (2001), "Historical overview of structural health monitoring", Lecture Notes on Structural Health Monitoring Using Statistical Pattern Recognition, Los Alamos Dynamics, Los Alamos, NM, USA.
Hossein, N. (2018), "Fuzzy adaptive integration scheme for low-cost SINS/GPS navigation system", *Mech. Syst. Signal Pr.*, **99**, 434-449. https://doi.org/10.1016/j.ymssp.2017.06.030.
Hsiao, F.H. (2003), "Robustness design of fuzzy controllers for nonlinear interconnected systems", *Proceedings of the SICE Annual Conference Program and Abstracts SICE Annual Conference 2003*, 34-34.
Hsiao, F.H. (2004), "Decentralized fuzzy control for nonlinear multiple time-delay large-scale systems", *Proceedings of the SICE 2004 Annual Conference*, **3**, 2806-2810.
Hsiao, F.H. (2005a), "Application and robustness design of fuzzy controller for resonant and chaotic systems with external disturbance", *IJUFKS*, **13**(3), 281-295. https://doi.org/10.1142/S0218488505003461.
Hsiao, F.H. (2005b), "Fuzzy controllers for nonlinear interconnected TMD systems with external force", *J. Chin. Inst. Eng.*, **28**(1), 175-181. https://doi.org/10.1080/02533839.2005.9670984.
Hsiao, F.H. (2005c), "Robust stabilization of nonlinear multiple time-delay large-scale systems via

decentralized fuzzy control", *IEEE Trans. Fuzzy Syst.*, **13**(1), 152-163. https://doi.org/10.1109/TFUZZ.2004.836067.
Hsiao, F.H. (2005d), "TS fuzzy controllers for nonlinear interconnected systems with multiple time delays", *IEEE Trans. Circuit. Syst. I: Regular Papers*, **52**(9), 1883-1893. https://doi.org/10.1109/TCSI.2005.852492.
Hsiao, F.H. (2005e). Fuzzy control for nonlinear systems via neural-network-based approach", *Int. J. Comput. Meth. Eng. Sci. Mech.*, **6**(3), 145-152. https://doi.org/10.1080/15502280590923612.
Hsieh, T.Y. (2004), "A case study of S-curve regression method to project control of construction management via TS fuzzy model", *J. Marine Sci. Technol.*, **12**(3), 10. https://doi.org/10.51400/2709-6998.2241.
Hsieh, T.Y. (2006), "A new viewpoint of s-curve regression model and its application to construction management", *Int. J. Artif. Intel. Tool.*, **15**(2), 131-142. https://doi.org/10.1142/S021821300600259X.
Hsu, M.H. (2013), "Routing protocol performance evaluation in wireless Ad hoc network", *Inform. Technol. J.*, **12**(22), 6595.
Hsu, W.K. (2011), "An integrated flood risk assessment model for property insurance industry in Taiwan", *Nat. Hazard.*, **58**, 1295-1309. https://doi.org/10.1007/s11069-011-9732-9.
Hsu, W.K. (2012), "Risk and uncertainty analysis in the planning stages of a risk decision-making process", *Nat. Hazard.*, **6**1, 1355-1365. https://doi.org/10.1007/s11069-011-0032-1.
Hsu, W.K. (2013a), "A probabilistic approach for earthquake risk assessment based on an engineering insurance portfolio", *Nat. Hazard.*, **65**, 1559-1571. https://doi.org/10.1007/s11069-012-0425-9.
Hsu, W.K. (2013b), "Earthquake risk assessment and optimal risk management strategies for hi-tech fabs in Taiwan", *Nat. Hazard.*, **65**, 2063-2076. https://doi.org/10.1007/s11069-012-0462-4.
Hsu, W.K. (2014), "A case study of damage detection in four-bays steel structures using the HHT approach", *Smart Struct. Syst.*, **14**(4), 595-615. https://doi.org/10.12989/sss.2014.14.4.595.
Hsu, W.K., Huang, P.C., Chang, C.C., Chiang, W.L., Chiou, D.J. and Chen, C.W. (2023), "Generation of artificial rainfall events for flood risk assessment in Taiwan", *Natural Hazards*, 1-16. https://doi.org/10.1007/s11069-014-1233-1
Huang, C.F. (2007), "Managing target cash balance in construction firms using novel fuzzy regression approach", *Proceedings of the ICIC 2007*, Qingdao, China, August. https://doi.org/10.1007/978-3-540-74205-0_74.
Im, C.R. (2023), "Cyclic loading test for concrete-filled hollow PC column produced using various inner molds", *Steel Compos. Struct.*, **46**(6), 793. https://doi.org/10.12989/scs.2023.46.6.793.
Jafari, N. (2023), "Nonlinear free vibration analysis of moderately thick viscoelastic plates", *Steel Compos. Struct.*, **48**(3), 293-303. https://doi.org/10.12989/scs.2023.48.3.293.
Jansukpum, K. (2015), "Applying innovation resistance theory to understand consumer resistance", *Proceedings of the 2015 14th International Symposium*. https://doi.org/10.4156/AISS.vol4.issue22.7.
Karalar, M. (2023), "Experimental and numerical investigation on flexural response", *Steel Compos. Struct.*, **48**(1), 43-57. https://doi.org/10.12989/scs.2023.48.1.043.
Ke, X. (2023), "Seismic performance and damage evaluation of concrete-encased CFST composite columns", *Steel Compos. Struct.*, **47**(1), 121. https://doi.org/10.12989/scs.2023.47.1.121.
Khosravikhor, A. (2023), "Effect of Ni-Ti shape memory alloy on ductility and response modification factor of SPSW systems", *Steel Compos. Struct.*, **48**(3), 353. https://doi.org/10.12989/scs.2023.48.3.353.
Kontoni, D.P.N. (2023), "Experimental and numerical study of a steel plate-based damper", *Steel Compos. Struct.*, 47(2), 185-201. https://doi.org/10.12989/scs.2023.47.2.185.
Kuan, F.Y. (2012), "The Consumers' heuristics effects of E-commerce's price promotion on perceived value", *Adv. Inform. Sci. Serv. Sci.*, **4**(20).
Kuan, F.Y. (2012), "The impact of mood state of information service on purchase intention: A perspective of heuristics", *Adv. Inform. Sci. Serv. Sci.*, **4**(17).
Kuan, F.Y. (2013), "Using RPC Block Adjustment models for the accuracy of environmental research", *Stochast. Environ. Res. Risk Assess.*, **27**, 1315-1331. https://doi.org/10.1007/s00477-012-0668-8.
Kuo, H.M. (2009), "A study of information and aiding interface design in B2C web sites", *Proceedings of*

the 2009 IEEE on Industrial Engineering and Engineering Management, 852-855. https://doi.org/10.1109/IEEM.2009.5372897.
Kuo, H.M. (2010), "A behavioral model of the elderly Internet consumer: a case study", *Int. J. Innov. Comput., Inform. Control*, **6**(8), 3507-3518.
Kuo, H.M. (2010a), "A study of consumer behavior model on auction websites", *ICIC Expr. Lett.*, **4**(1), 65-70.
Kuo, H.M. (2010b), "An observation of online auction difficulties for customers", *Int. J. Res. Surveys*, **4**(3).
Kuo, H.M. (2011a), "A study of merchandise information and interface", *J. Marine Sci. Technol.*, **19**(1), 3. https://doi.org/10.51400/2709-6998.2133.
Kuo, H.M. (2011b), "Application of quality function deployment to improve the quality of Internet shopping website interface design", *Int. J. Innov. Comput., Inform. Control*, **7**(1), 253-268.
Kuo, H.M. (2012a), "A novel viewpoint on information and interface design for auction web sites", *Human Fact. Ergonom. Manuf. Serv. Indus.*, **22**(4), 287-295. https://doi.org/10.1002/hfm.20274.
Kuo, H.M. (2012b), "Retracted: A study of a B2C supporting interface design system for the elderly", *Human Fact. Ergonom. Manuf. Serv. Indus.*, **22**(6), 528-540. https://doi.org/10.1002/hfm.20297.
Lee, J.J., Yun, C.B., Lee, J.W. and Jung, H.Y. (2005), "Neutral network-based damage detection for bridges considering errors in baseline finite element model", *J. Sound Vib.*, **280**, 555-578. https://doi.org/10.1016/j.jsv.2004.01.003
Lee, W.I. (2010), "Relationship between quality of medical treatment and customer satisfaction-a case study in dental clinic association", *Int. J. Innov. Comput., Inform. Control*, **6**(4), 1805-1822.
Lee, W.I. (2012a), "A comparative study on the forecast of fresh food sales using logistic regression, moving average and BPNN methods", *J. Marine Sci. Technol.*, **20**(2), 4. https://doi.org/10.51400/2709-6998.1832.
Lee, W.I. (2012b), "Self-service technologies: A review of extant knowledge", *Adv. Inform. Sci. Serv. Sci.*, **4**(20).
Li, G. (2023), "Lateral impact behaviour of concrete-filled steel tubes with localised pitting corrosion", *Steel Compos. Struct.*, **47**(5), 615. https://doi.org/10.12989/scs.2023.47.5.615.
Li, H.N., Yi, T.H., Ren, L., Li, D.S. and Huo, L.S. (2014), "Reviews on innovations and applications in structural health monitoring for infrastructures", *Struct. Monitor. Maint., Int. J.*, **1**(1), 1-45. http://doi.org/10.12989/smm.2014.1.1.001
Li, Y.P. (2023), "Nonlinear thermal post-buckling analysis of graphene platelets reinforced metal foams plates", *Steel Compos. Struct.*, **46**(5), 649. https://doi.org/10.12989/scs.2023.46.5.649.
Lin, C.L. (2009), "Improving the generalization performance of RBF neural networks", *Exp. Syst. Appl.*, 36(10), 12049-12053. https://doi.org/10.1016/j.eswa.2009.03.012.
Lin, C.W. (2013a), "Application of a feature-based approach to debris flow detection by numerical simulation", *Nat. Hazard.*, **67**, 783-796. https://doi.org/10.1007/s11069-013-0605-2.
Lin, C.W. (2013b), "The construction of a high-resolution visual monitoring for hazard analysis", *Nat. Hazard.*, **65**, 1285-1292. https://doi.org/10.1007/s11069-012-0409-9.
Lin, C.W. (2015), "Large-area, multilayered, and high-resolution visual monitoring using a dual-camera system", *ACM Trans. Multimed. Comput., Commun. Appl.*, **11**(2), 1-23. https://doi.org/10.1145/2645862.
Lin, J.W. (2012a), "Fuzzy statistical refinement for the forecasting of tenders for roadway construction", *J. Marine Sci. Technol.*, **20**(4), 9. https://doi.org/10.6119/JMST-011-0318-1.
Lin, J.W. (2012b), "Kalman filter decision systems for debris flow hazard assessment", *Nat. Hazard.*, **60**, 1255-1266. https://doi.org/10.1007/s11069-011-9907-4.
Lin, J.W. (2012c), "Modeling and assessment of bridge structure for seismic hazard prevention", *Nat. Hazard.*, **61**, 1115-1126. https://doi.org/10.1007/s11069-011-9969-3.
Lin, J.W. (2012d), "Potential hazard analysis and risk assessment of debris flow by fuzzy modeling", *Nat. Hazard.*, **64**, 273-282. https://doi.org/10.1007/s11069-012-0236-z.
Lin, J.W. (2013), "A novel regression prediction model for structural engineering applications", *Struct. Eng. Mech.*, **45**(5), 693-702. https://doi.org/10.12989/sem.2013.45.5.693.
Lin, M.L. (2010), "Application of fuzzy models for the monitoring of ecologically sensitive ecosystems",

Eng. Comput., **27**(1), 5-19. https://doi.org/10.1108/02644401011008504.
Lin, M.L., (2008a), "A gis-based local spatial autocorrelation for drought risk assessment", *Proceedings of the IGARSS 2008 IEEE Geoscience and Remote Sensing Symposium*, **4**, IV-830. https://doi.org/10.1109/IGARSS.2008.4779851.
Lin, M.L. (2008b), "Monitoring drought dynamics in the ejin oasis using drought indices from modis data", *Proceedings of the IGARSS 2008-2008 IEEE International Geoscience and Remote Sensing Symposium*, **4**, IV-834.
Lin, M.L. (2009a), "Fuzzy model-based assessment and monitoring of desertification using MODIS satellite imagery", *Eng. Comput.*, **26**(7), 745-760. https://doi.org/10.1108/02644400910985152.
Lin, M.L. (2009b), "Using MODIS-based vegetation and moisture indices", *Proceedings of the 2009 IEEE Geoscience and Remote Sensing Symposium*, **4**, IV-338. https://doi.org/10.1109/IGARSS.2009.5417382.
Lin, M.L. (2011a), "Using GIS-based spatial geocomputation from remotely sensed data for drought risk-sensitive assessment", *Int. J. Innov. Comput., Inform. Control*, **7**(2), 657-668.
Lin, M.L. (2011b), "Spatial filtering analysis for quick drought assessment using MODIS images", *Proceedings of the 2011 IEEE Geoscience and Remote Sensing Symposium*, 767-770. https://doi.org/10.1109/IGARSS.2011.6049243.
Lin, S.G. (2006), "Modelling ionospheric effects with multiple reference stations for gps satellite surveying", *Proceedings of the 17th IASTED on Modelling and Simulation*, ACTA PRESS ANAHEIM, Anaheim, 68-73.
Liu, C.C. (2013), "Application of multi-scale remote sensing imagery to detection and hazard analysis", *Nat. Hazard.*, **65**, 2241-2252. https://doi.org/10.1007/s11069-012-0472-2.
Liu, C.C., Kuo, Y.C. and Chen, C.W. (2013), "Emergency responses to natural disasters using Formosat-2 high-spatiotemporal-resolution", *Nat. Hazard.*, **66**, 1037-1057. https://doi.org/10.1007/s11069-012-0535-4.
Liu, J. and Qiu, C. (2023), "Cyclic behavior of self-centering braces utilizing energy absorbing steel plate clusters", *Steel Compos. Struct.*, **47**(4), 523-537. https://doi.org/10.12989/scs.2023.47.4.523.
Liu, K.F.R. (2009), "A qualitative decision support for environmental impact assessment using fuzzy logic", *J. Environ. Inform.*, **13**(2). https://doi.org/10.3808/jei.200900144.
Liu, K.F.R. (2010), "Combining fuzzy logic and data mining to predict the result of an EIA review", *Int. J. Environ. Ecolog. Eng.*, **4**(12), 628-632.
Liu, K.F.R. (2011a), "Health risk assessment for sewer workers using Bayesian belief networks", *Int. J. Med. Hlth. Sci.*, **5**(9), 383-387.
Liu, K.F.R. (2011b), "Hierarchical analytic network process and its application in environmental impact evaluation", *Civil Eng. Environ. Syst.*, 28(1), 1-18. https://doi.org/10.1080/10286600903215078.
Liu, K.F.R. (2012a), "Applying Bayesian belief networks to health risk assessment", *Stochast. Environ. Res. Risk Assess.*, **26**, 451-465. https://doi.org/10.1007/s00477-011-0470-z.
Liu, K.F.R. (2012b), "Combining risk assessment, life cycle assessment, to estimate environmental aspects", *Int. J. Life Cycle Assess.*, **17**, 845-862. https://doi.org/10.1007/s11367-012-0407-x.
Liu, K.F.R. (2012c), "Combining scientific facts and significance criteria to predict the result of an environmental impact assessment review", *J. Environ. Inform.*, **19**(2). https://doi.org/10.3808/jei.201200212.
Liu, K.F.R. (2013a), "Incorporating the LCIA concept into fuzzy risk assessment as a tool for environmental impact assessment", *Stochast. Environ. Res. Risk Assess.*, **27**, 849- 866. https://doi.org/10.1007/s00477-012-0621-x.
Liu, K.F.R. (2013b), "Using Bayesian belief networks to support health risk assessment for sewer workers", *Int. J. Environ. Sci. Technol.*, **10**, 385-394. https://doi.org/10.1007/s13762-012-0136-5.
Liu, K.F.R. (2015), "Using fuzzy logic to generate conditional probabilities in Bayesian belief network", *Int. J. Environ. Sci. Technol.*, **12**, 871-884. https://doi.org/10.1007/s13762-013-0459-x.
Liu, M. (2023a), "Nonlinear vibration of FG-CNTRC curved pipes with temperature-dependent properties", *Steel Compos. Struct.*, **46**(4), 553. https://doi.org/10.12989/scs.2023.46.4.553.
Liu, S. (2023b), "Reinforced concrete structures with damped seismic using multi-objective evolutionary

niching ChOA", *Steel Compos. Struct.*, **47**(2), 147. https://doi.org/10.12989/scs.2023.47.2.147.
Lu, L.T. (2003), "Active control for a benchmark building under wind excitations", *J. Wind Eng. Indus. Aerodyn.*, **91**(4), 469-493. https://doi.org/10.1016/S0167-6105(02)00431-2.
Lv, H. (2023), "Influence of loading and unloading of hydraulic support on the caving property of top coal", *Steel Compos. Struct.*, **48**(1), 103-111. https://doi.org/10.12989/scs.2023.48.1.103.
Lyu, J. (2023), "Study on the fire resistance of castellated composite beams with ortho hexagonal holes and different beam-end constraints", *Steel Compos. Struct.*, **46**(4), 539. https://doi.org/10.12989/scs.2023.46.4.539.
Lyu, Y.F. (2023a), "Lateral stiffness of corner-supported steel modular frame with splice connection", *Steel Compos. Struct.*, **48**(3), 321. https://doi.org/10.12989/scs.2023.48.3.321.
Lyu, Y.F. (2023b), "Lateral stiffness of corner-supported steel modular frame with splice connection", *Steel Compos. Struct.*, **48**(3), 321. https://doi.org/10.12989/scs.2023.48.3.321.
Mahmoud, S.R. (2023), "Stability investigation plates via a novel hyperbolic RPT br", *Steel Compos. Struct.*, **46**(4), 471-483. https://doi.org/10.12989/scs.2023.46.4.471.
Min, J.A. and Park, S. (2012), "Impedance-based structural health monitoring incorporating neural network technique", *Eng. Struct.*, **39**, 210-220. https://doi.org/10.1016/j.engstruct.2012.01.012
Mohamed, N. (2023), "Nonlinear stability of bio-inspired composite", *Steel Compos. Struct.*, **46**(6), 759. https://doi.org/10.12989/scs.2023.46.6.759.
Rafatnia, S.H. (2018), "In-move aligned SINS/GNSS system using recurrent wavelet neural network (RWNN)-based integration scheme", *Mechatronics*, **54**, 155-165. https://doi.org/10.1016/j.mechatronics.2018.08.001.
Rafatnia, S. (2019), "Fuzzy-adaptive constrained data fusion algorithm for indirect centralized integrated SINS/GNSS navigation system", *GPS Solut.*, **23**, 62. https://doi.org/10.1007/s10291-019-0845-z
Ryu, J.Y. (2017), "Experimental investigation of magnetic-mount PZT-interface", *Struct. Monitor. Maint., Int. J.*, **4**(3), 237-253. https://doi.org/10.12989/smm.2017.4.3.237
Setiawan, G.H. and Suryawan, I.K.D. (2020), "Analisis Kinerja Akurasi", *Seminar Nasional Teknologi Komputer and Sains* (SAINTEKS), **1**(1), 579-583. https://doi.org/10.4156/aiss.vol3.issue6.6.
Shen, C.W. (2011), "A fuzzy AHP-based fault diagnosis for semiconductor lithography process", *Int. J. Innov. Comput., Inform. Control*, **7**(2), 805-816.
Shih, B.Y. (2010), "A preliminary study on design and development of template-based for license plate recognition system", *Proceedings of the 2010 IEEE International Conference on Industrial Engineering and Engineering Management*, 80-83. https://doi.org/10.1109/IEEM.2010.5674430.
Shih, B.Y. (2012a), "A robust license plate recognition methodology by applying hybrid artificial techniques", *Int. J. Innov. Comput., Inform. Control*, **8**(10A), 6777-6785.
Shih, B.Y. (2012b), "Merged search algorithms for radio frequency identification anticollision", *Math. Prob. Eng.*, Article ID 609035. https://doi.org/10.1155/2012/609035.
Shih, B.Y. (2012c), "NXT information and control on test dimensionality", *Proceedings of the 2012 Information Technologies in Medicine and Education*, **1**, 194-198. https://doi.org/10.1109/ITiME.2012.6291279.
Song, C. (2023), "Application of computer methods on the frequency of the concrete beams experimentally and numerically", *Steel Compos. Struct.*, **48**(1), 19-25. https://doi.org/10.12989/scs.2023.48.1.019.
Su, D.T. (2013), "The integration of nautical charts to reconstruct 3D harbor area models and apply assisted navigation", *Nat. Hazard.*, **66**, 1135-1151. https://doi.org/10.1007/s11069-012-0516-7.
Su, R. (2023), "Axial behavior of square CFST encased seawater sea-sand concrete filled PVC/GFRP tube columns", *Steel Compos. Struct.*, **47**(6), 781. https://doi.org/10.12989/scs.2023.47.6.781.
Su, T.J. (2011), "Applications of cellular neural networks to noise cancelation in gray images", *Circuit., Syst. Signal Pr.*, **30**, 1131-1148. https://doi.org/10.1007/s00034-011-9269-x.
Sui, L. (2023), "Seismic performance evaluation of steel moment frames with self-centering energy-dissipating coupled wall panels", *Steel Compos. Struct.*, **47**(5), 663-677. https://doi.org/10.12989/scs.2023.47.5.663.
Tagrara, S.H. (2023), "Mechanical and thermal stability investigation of functionally graded plates resting

on visco-Pasternak foundation", *Steel Compos. Struct.*, **46**(6), 839. https://doi.org/10.12989/scs.2023.46.6.839.
Taheri-Behrooz, F. and Torabia, M. (2023), "Low-velocity impact performance of the carbon/epoxy plates exposed to the cyclic temperature", *Steel Compos. Struct.*, **48**(3), 305. https://doi.org/10.12989/scs.2023.48.3.305.
Tan, Z. (2023), "A novel design method for improving collapse resistances of multi-story steel frames with unequal spans using steel braces", *Steel Compos. Struct.*, **47**(2), 253. https://doi.org/10.12989/scs.2023.47.2.253.
Tharwan, M.Y. (2023), "Refined quasi-3D shear deformation theory on Winkler/Pasternak/Kerr foundation", *Mech. Bas. Des. Struct.*, 1-24. https://doi.org/10.12989/scs.2023.47.5.633.
Tim, C. (2021), "Smart structural stability and NN based intelligent control for nonlinear systems", *Smart Struct. Syst.*, **27**(6), 917-926. doi.org/10.12989/sss.2021.27.6.917.
Tsai, C.H. and Chen, C.W. (2010), "An earthquake disaster management mechanism based on risk assessment", *Tour. Manage.*, **31**(4), 470-481. https://doi.org/10.1016/j.tourman.2009.05.008.
Tsai, C.H. and Chen, C.W. (2011a), "Development of a mechanism–A case study of the Hualien area", *Scandinav. J. Hospital. Tourism*, **11**(3), 324-341. https://doi.org/10.1080/15022250.2011.601929.
Tsai, C.H. and Chen, C.W. (2011b), "The establishment of a rapid natural disaster risk assessment model for the tourism industry", *Tour. Manage.*, **32**(1), 158-171. https://doi.org/10.1016/j.tourman.2010.05.015.
Tsai, C.H. (2008), "Application of geographic information system to the allocation of disaster shelters via fuzzy models", *Eng. Comput.*, **25**(1), 86-100. https://doi.org/10.1108/02644400810841431.
Tsai, C.H. (2010), "Sonar-based obstacle avoidance using a path correction method for autonomous control of a biped robot", *Proceedings of the 2010 IEEE Conference*, 532-536. https://doi.org/10.1109/IEEM.2010.5674501.
Tsai, P.W. and Chen, C.W. (2014), "A novel criterion for nonlinear time-delay systems using LMI fuzzy Lyapunov method", *Appl. Soft Comput.*, **25**, 461-472. https://doi.org/10.1016/j.asoc.2014.08.045.
Tsai, P.W. (2016), "A novel control algorithm for interaction between surface waves and a permeable floating structure", *China Ocean Eng.*, **30**, 161-176. https://doi.org/10.1007/s13344-016-0009-7.
Tseng, C.P. and Chen, C.W. (2012), "Natural disaster management mechanisms for probabilistic earthquake loss", *Nat. Hazard.*, **60**, 1055-1063. https://doi.org/10.1007/s11069-011-9889-2.
Tseng, C.P. (2006a), "Default risk-based probabilistic decision model on natural disasters risk control", *Proceedings of the 17th IASTED International Conference on Modelling and Simulation*, 219-223.
Tseng, C.P. (2006b), "Optimum arrangement between natural disasters insurance and risk control", *Proceedings of the 17th IASTED International Conference on Modelling and Simulation*, 184-187.
Tseng, C.P. (2007), "Intelligent financial decision model of natural disasters risk control", *Proceedings of the Advanced Intelligent Computing Theories and Applications*, *ICIC 2007*. https://doi.org/10.1007/978-3-540-74171-8_6.
Tseng, C.P. (2012), "Retracted: Human factors of knowledge sharing intention: A preliminary study", *Human Factor. Ergonom. Manuf. Serv. Indus.*, **22**(4), 328-339. https://doi.org/10.1002/hfm.20507.
Tseng, C.P., Chen, C.W. and Tu, Y.P. (2011), "A new viewpoint on risk control decision models for natural disasters", *Nat. Hazard.*, **59**, 1715-1733. https://doi.org/10.1007/s11069-011-9861-1.
Wang, B.B. (2024), "Intelligent optimal grey evolutionary algorithm", *Smart Structure Syst.*, **33**(5) 365-374. https://doi.org/10.12989/sss.2024.33.5.365
Wei, J. (2023), "Axial compressed UHPC plate-concrete filled steel tubular composite short columns, Part I: Bearing capacity", *Steel Compos. Struct.*, **47**(3), 405. https://doi.org/10.12989/scs.2023.47.3.405.
Wen, C. and Yang, G. (2023), "Stud connection in composite structures: Development with concrete age", S*teel Compos. Struct.*, **47**(6), 729-741. https://doi.org/10.12989/scs.2023.47.6.729.
Wu, J. (2023), "Predicting drying shrinkage of steel reinforced concrete", *Steel Compos. Struct.*, **47**(4), 539. https://doi.org/10.12989/scs.2023.47.4.539.
Wu, P. (2023), "Experimental study on bearing capacity of PFCC column-RC", *Steel Compos. Struct.*, **47**(1), 19. https://doi.org/10.12989/scs.2023.47.1.019.
Wu, Y.L. and Chen, C.W. (2013), "Examining the learning experiences of science training among

Taiwanese Aboriginal adolescents", *J. Baltic Sci. Edu.*, **12**(3), 312.
Wu, Y.L. and Chen, C.W. (2013), "Examining the micropolitical literacy of science intern teachers in Taiwan", *J. Baltic Sci. Edu.*, **12**(4), 440.
Wu, Y.L., Tsai, Y.L. and Chen, C.W. (2014), "Examining the experiences of career guidance, vocational self-concept", *J. Baltic Sci. Edu.*, **13**(2), 182.
Xiamuxi, A. (2023), "Study of the longitudinal reinforcement in reinforced concrete-filled steel", *Steel Compos. Struct.*, **47**(6), 709. https://doi.org/10.12989/scs.2023.47.6.709.
Xu, J.Q. (2023), "Nonlinear resonances of nonlocal strain gradient nanoplates", *Steel Compos. Struct.*, 47(6), 795. https://doi.org/10.12989/scs.2023.47.6.795.
Yang, H.C. and Chen, C.W. (2012), "Potential hazard analysis from the viewpoint of flow measurement in large open-channel junctions", *Nat. Hazard.*, **61**, 803-813. https://doi.org/10.1007/s11069-011-0067-3.
Yang, H.C.P. (2008a), "Accuracy evaluation of a diagnostic test by detecting outliers and influential observations, COE 421 - 429.
Yang, H.C.P. (2008b), "Estimation on internal wave reflection in a two-layer fluid system by cumulative logistic regression model", *J. Marine Sci. Technol.*, **16**(1), 6. https://doi.org/10.51400/2709-6998.1996.
Yang, H.C.P., Alex, K.H.C. and Chen, T.H. (2008), "Evaluation of inference adequacy in cumulative logistic regression model", *China Ocean Eng.*, **1**, 5.
Yeh, K. and Chen, C.W. (2010), "Stability analysis of interconnected fuzzy systems using the fuzzy Lyapunov method", *Math. Prob. Eng.*, Article ID 734340. https://doi.org/10.1155/2010/734340.
Yeh, K. (2007), "Fuzzy control for seismically excited bridges with sliding bearing isolation", *Proceedings of the Advanced Intelligent Computing Theories and Applications, ICIC*. https://doi.org/10.1007/978-3-540-74171-8_47.
Yeh, K. (2008), "NN robustness design of nonlinear structure systems", *Proceedings of the 2008 SICE Annual Conference*, 733-736. https://doi.org/10.1109/SICE.2008.4654752.
Yeh, K. (2009), "Stability analysis of time-delay fuzzy systems using fuzzy Lyapunov method", *Intell. Inform. Database Syst.*, 243-248. https://doi.org/10.1109/ACIIDS.2009.85.
Yeh, K. (2013), "Fuzzy control for a permeable floating structure", *Proceedings of the 2013 Third International Conference on Intelligent System Design and Engineering Applications*, 796-799. https://doi.org/10.1109/ISDEA.2012.189.
Yeh, K., Chen, C.Y. and Chen, C.W. (2008), "Robustness design of time-delay fuzzy systems using fuzzy Lyapunov method", *Appl. Math. Comput.*, **205**(2), 568-577. https://doi.org/10.1016/j.amc.2008.05.104.
Zhou, H., Cao, S., Zhang, S., Li, F., and Ma, N. (2023), "Design of a fuel explosion-based chameleon-like soft robot aided by the comprehensive dynamic model", *Cyborg Bionic Syst.*, **4**. https://doi.org/10.34133/cbsystems.0010
Zhu, T., Ding, H., Wang, C., Liu, Y., Xiao, S., Yang, G. and Yang, B. (2023), "Modified analytical AI evolution of composite structures with algorithmic optimization of performance thresholds", *Steel Compos. Struct.*, **53**(1), 103-114 https://doi.org/10.12989/scs.2024.53.1.103

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