Optimization Based On Evolutionary Algorithm in Vibration Control Process- A Review

P. D. Darade[1], Bimlesh Kumar[2]

[1]Asst. Professor, Sinhgad Institute of Technology and Science, Narhe, Pune, India,

[2] Principal, J.T. Mahajan College of Engineering, Jivramnagar, Faizpur, Dist:-Jalgaon India,

Abstract: - **The review of existing technique has provided the result of output like displacement and light intensity values in various model beams. The process of available technique has found vibration of seismic effect on buildings in different boundary models. So, in the modern research, investigators are making efforts to establish the vibration control processes in soft computing techniques. Due to vibration control on various structure models employing photostrictive actuators, we resort to the results of control in which corresponding outputs are obtained economically. Due to huge number of processes happening under this process, the time of process is high and also the cost of material. With a view to further improving the results in various time periods, with low cost and elapsed time, we are planning to utilize the fuzzy logic control (FLC) with evolutionary algorithm.**

I. INTRODUCTION

Nowadays, vibrating environments have gradually emerged as the order of the day, being commonplace and widespread in day-to-day-life. When a structure is experiencing a certain kind of vibration, many options and remedies unfold, which can be competently exploited to check this weird phenomenon. In this regard, passive control aims at certain forms of structural interventions, frequently necessitating the application of springs and dampers, resulting in decrease in vibration levels, whereas active control performs the task of bringing down the measured response by means of sensors, actuators and electronic control systems [1]. The amazing appearance of the concept of smart materials over the past few decades has become a shot in the arm for the elite in engineering fields, especially those in the aviation and aerospace industries [2]. Vibration hassles may haunt anytime during the course of the installation or functioning of a motor. At the time of its incidence, it is usually fraught with grave consequences and hence it is essential to initiate immediate steps to tackle the dilemma. The failure to respond to the issue in a quick way, it may lead to permanent destructions to the machine or sudden breakdown of the motor [8]. The shape memory alloys with the glittering specifications of shape memory and super elasticity have recently emerged as the cynosure of the investigating community. It must be pointed at this juncture that super elasticity specifications of these alloys have been a source of inspiration and delight to the researchers to delve deep into the dynamical behavior of shape memory alloys [3].

Vibration control systems are divided into two types: active control system and passive control system. The combination of both active and passive systems is called hybrid control system. Active control of vibrations relieves a designer from strengthening the structure from dynamic forces and the structure itself from additional weight and cost [9]. Passive control systems add damping to the structure, naturally, when a tremor occurred. These systems have been used extensively because of their simplicity and low-priced [10].

Shape memory alloy (SMA) elements have been considered for control of vibrations as well as for the enhancement of stability of composite and metallic plates by numerous investigators [4]. Shape memory alloys (SMA) undergo a reversible thermoelastic martensitic transformation (MT) between a high temperature phase β called austenite, and a low temperature phase, called martensite [5]. Most of the recent mechatronic systems necessitate numerous feasible devices namely, reaction or momentum wheels, revolving devices, and electric motors for its operation and performance. However, these devices can also be the sources of harmful vibrations that may greatly affect the mission performance, efficiency, and accuracy of operation. Hence, there is a need for vibration control [7].

High-temperature shape memory alloys (HTSMAs) have attracted much attention in high-temperature filed, such as aerospace, nuclear power, fire, oil and gas exploration, etc [6]. Metal alloys that are capable of reclaiming a certain shape when heated i.e. they can recover from large damages without permanent deformation is called a shape memory effect [11]. Shape-memory materials (SMMs) are one of the most important elements of intelligent/smart composites because of their different properties, such as the shape-memory effect (SME), pseudo elasticity or large recoverable stroke (strain), high damping capacity and adaptive properties which are due to the (reversible) phase transitions in the materials [12].

Endowed, they are, with the amazing virtues such as superior power density, solid state actuation, elevated damping capacity, robustness, and fatigue resistance, no wonder, SMAs have found versatile applications in a number of arenas When incorporated with civil structures, SMAs tend to be inactive, semi-active, or dynamic components to reduce the dent produced by ecological effects or underground outbreaks [13]. The lanthanum-adapted lead zircon ate titan ate material, otherwise known as PLZT, is a potential input to produce photostrictive actuator. This actuator turns out superior photostriction under the effect of non-varying illumination of peak-intensity light. The photostriction mechanism owes its origin to the superposition behavior of photovoltaic and converse piezoelectric effect.

II. LITERATURE REVIEW

In 2013, Wei Zhan *et al.* [14] have valiantly propounded an innovative optimization method for Multiple Active Tuned Mass Dampers (MATMDs) system under seismic and wind-induced building vibration. A replica of an n-storey edifice with MATMD system was constructed and a dual optimization technique was employed to acquire an optimal state- feedback controller advantage and the constraints of the MATMD system. A diverse $H_2/H_1/GH_2$ control was used to assuage the seismic and wind-induced vibration of the building with the parameters of the actuating forces and strokes of the masses. Genetic algorithm (GA) was used to investigate the optimal parameters and achieve the parallel controller advantage. In the preliminary assessment, the GA-based method was able to garner a superior set of constraints, snatching amazing array of achievement outcomes in the avenues of control efficiency. When analyzed with an Active Tuned Mass Damper (ATMD), the MATMD system showed superior qualities yielding identical control effects with minimal acting forces.

In 2013, S. Pourzeynali *et al.* [15] have proficiently brought to light an innovative multi-objective optimization blueprint of the device employing Genetic Algorithms (GAs) to put in check the structural vibrations against earthquakes. With an eye on scaling up the efficiency of the TMD system, related constraints encompassing mass, stiffness, and damping ratio, had been optimally planned employing multi-objective genetic algorithms. This was done by using three non-commensurable objective functions, such as utmost displacement, greatest velocity, and utmost acceleration of each floor, which were to be reduced concurrently. For this, a fast and elitist Non-dominated Sorting Genetic Algorithm (NSGA-II) method was adopted to look for a set of Pareto optimal solutions. In addition, to tackle the ambiguities prevalent in the system, a robust design optimization process was executed by means of the Hamersley sequence sampling method. In their investigation, the exemplar building was modeled as a 3-D frame, and its reactions were assessed by means of coupled multi-mode scrutiny. The cheering outcomes of the investigations glisten with the revelation that the ambitious TMD system has come out with flying colors in bringing to books a whopping diminution to the tune of 28% on utmost displacement of the edifice.

In 2013, N. Fallah *et al.* [16] have elegantly experimented on the efficient performance of piezoelectric actuators for active control of the seismic responses of mega edifices. Three-dimensional modeling of the building was envisaged in which three levels of freedom including displacements in two perpendicular horizontal directions and rotation about the vertical axis were related to each and every floor. Linear quadratic regulator (LQR), supervisory fuzzy controller (SFC) and fuzzy logic controller (FLC) were made functional on the control designs. With a view to statistical scrutinizes, an actual 10- story edifices subjected to an assembly of 20 universal records was taken in to account. As there were numerous potential locations for positioning of piezoelectric actuators in the test building, genetic algorithm was employed for assessing the optimal arrangement of actuators so as to realize utmost diminution in building reactions. The assessment of the restricted and free reactions of the investigated edifices has revealed without any iota of doubt that the piezoelectric actuators could bring about significant declines in the seismic reactions of the edifices. When the efficiency of the three controllers was assessed, it was found that the fuzzy controller scaled higher up in the ladder of efficiency, relegating the other two to inferior positions.

In 2013, Zheng Shijie *et al.* [17] have brilliantly given vent to an innovative genetic algorithm based controlling algorithm for multi-modal vibration control of beam structures by means of photostrictive actuators. Two couples of photostrictive actuators were laminated with the beams and the fluctuation of light irradiation was in relation to the shifting of the relative modal velocity direction. The modal force indexes for beams with diverse boundary stipulations were evolved and a binary-coded GA is employed to optimize the positions and dimensions of photostrictive actuators to enhance to the utmost the modal force index and ensure the entire modal force index enthused by two couples of photostrictive actuators was positive. The control effect of multiple vibration modes of beams under irradiation of set/variable light intensity was assessed. Statistical outcomes underline the sterling vigor and efficiency of the system, and pinpoint the fact that the application of strategically located actuator patches can efficiently check the first two bending modes that overwhelm the structural vibration.

In 2012, H.K. Cho *et al.* [18] have had the vision to bring to light a novel non-linear finite element scrutiny method to the process of modeling hybrid laminate composite shells with embedded shape memory alloy (SMA) wire treated with united structural and thermal loading. Statistical estimates of SMA wire reinforced composite laminates were performed by invigorating the non-linear laminate shell element with Brison's model of the SMA constitutive law. To authenticate the process, the current illustrative applications make use of rectangular laminated panels clamped along one side. Estimate outcomes analyzed in relation to identical outcomes from the previous investigation. Numerous experimental cases depending on the volume fraction of SMA, temperature, and ply angles were offered to exhibit the extremely disheveled thermo mechanical conduct of shape memory alloy hybrid composites (SMAHCs). The outcome of the statistical estimates shows the aptitude of the proposed process to assess the thermo-mechanical nature of a SMAHC in relation tithe SMA's internal phase modifications enthused by stress and temperature variation and exhibits highly superior harmony with test outcomes.

In 2012, I. Lopez-Ferre˜no *et al.* [19] have invested time and energy to conduct investigation on martensitic modification tendency of Cu–Al–Be solitary crystalline shape memory alloys with three diverse concentrations. The effect of the four specific thermal management of quenching and aging on the conversion temperatures had been investigated by means of differential scanning calorimetry and was contrasted with identical researches by mechanical spectroscopy. The scrutiny of the effect of thermal treatments on the martensitic conversion tendency facilitates optimization of a treatment advantageous for the entire the alloys changing between 200 K and 400 K, keeping aloof from both stabilization and precipitation. Moreover, an abnormal erratic tendency has come light as regards the alloy with minimal conversion temperatures, which was elaborated in detail according to the potential systems.

III. MOTIVATION FOR THE RESEARCH

In majority of the cases, vibrations tend to affect the human body in several ways. The retort to a vibration exposure is mainly reliant on the frequency, amplitude, and interval of exposure. Additional factors may comprise the direction of vibration input, location and mass of diverse body segments, level of exhaustion, and the presence of external support. The human response to vibration can be both mechanical and psychological in nature. Mechanical harms to human tissue can transpire due to the resonance within different organ systems. Psychological stress reactions also happen on account of vibrations. The upper extremities of the human being can be considered as unique body segments. Skeletal muscle is a specialized tissue that changes its complete functional capacity in response to chronic exercise with high loads. In order to eradicate faults of this nature, proper vibration controlling techniques have to be applied to minimize the vibration and safeguard humans. There are a lot of further techniques for vibration control, each endowed with its own uniqueness. Photostrictive actuator also controls the vibration. It has an added advantage of being immune to electric/magnetic disturbances and applicable to remote-control devices. There are three different boundary conditions such as simply supported–clamped beam, simply supported beam and Clamped–clamped beam to the photostrictive actuator. Now, we have found the final solution. In the boundary model, we have considered the size of actuators, the location and the modal index values. Based on the above-mentioned parameter values, we get the value of displacement in each boundary model. But these values are not accurate for displacement and the time of process is very prohibitive. So, in order to find the accurate displacement value for each boundary model and reduce the time bound, we are planning to utilize the fuzzy logic controller with evolutionary algorithm in the proposed method.

IV. PROPOSED METHODOLOGY

Existing technique has provided the result of output like displacement and light intensity values in various model beams. The process of available technique has found vibration of seismic effect on buildings in different boundary models. So, in the modern research, investigators are making efforts to establish the vibration control processes in soft computing techniques. Due to vibration control on various structure models employing photostrictive actuators, we resort to the results of control in which corresponding outputs are obtained economically. Due to huge number of processes happening under this process, the time of process is high and also the cost of material. With a view to further improving the results in various time periods, with low cost and elapsed time, we are planning to utilize the fuzzy logic control (FLC) with evolutionary algorithm.

Input parameters of the process are area of the building model of beams, actuator location and distance, output of the process displacement and light intensity values in various periods of time.

Input parameter values are generated under FLC and evolutionary algorithm to optimize the displacement value under various beam models. By using the behavior and characteristics of the parameters in building with various boundary models, we can attain the values for each boundary model.

Afterwards, we can get the output while boundary model values are applied to FLC and evolutionary algorithms. On detection of error values, we can subtract them from the existing solutions in appropriate time period.

The performance of the proposed system will be analyzed and compared against the existing methods to prove its performance. Entire process of proposed technique is carried out through Matlab.

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