objectives, assessment of the dynamic behaviour and determination of structural vibration responses are related to dynamic properties, which can be defined as mass, damping and stiffness matrices. This paper presents a new approach for estimation of dynamic parameters, including mass and stiffness matrices, by a model updating technique. These matrices are estimated based on the initial dynamic properties of the analytical model and utilizing modal data such as natural frequencies and mode shapes. Modal parameters are identified by numerical simulation of modal testing or based on signal processing and data acquisition in the experimental modal analysis. In the numerical simulation, these data are determined by the solution of generalized eigenvalue problems. Furthermore, in all parts of the formulation, the damping matrix is assumed as proportional. Therefore, the results of the simulation method are calculated as real data. The proposed approach is introduced based on the general objective function that is defined by the difference between analytical and experimental models. Once the objective function is evaluated, the dynamic parameters are estimated via expanding mass and stiffness orthogonality conditions. The dynamic properties are identified at two stages. In the first stage, the complete modal parameters are used. Then, in the second stage, the mass and stiffness matrices are determined by the first mode of vibration. Measured modal data are obtained by experimental modal analysis on a three story, simple, laboratory frame. It can be noted that the algorithm of identification of dynamic parameters is sensitized to accurate and pure modal data, which are originally extracted from experimental testing or simulation techniques. Investigation of the proposed formulation is verified by a numerical solution on a simulated four story shear frame building as an experimental model. Eventually, comparison of the natural frequency between estimated and experimental models can provide reliable results to accurately identify the dynamic parameters as mass and stiffness matrices.

Key Words: Estimation of mass and stiffness, modal parameters, model updating method.

and figures. In this analysis, both assumptions of small and large fields of deformation are used. The analytical modeling and solutions are supported by different simulations obtained using ABAQUS software. The results reveal how the change of loading direction can affect the orientation of the wrinkles. Moreover, the effects of load level and anisotropy on the depth of the wrinkles are studied.

Key Words: membrane, orthotropic, wrinkling, wrinkling pattern, Roddeman's method, ABAQUS.

EXPERIMENTAL INVESTIGATION INTO THE EFFECTS OF VARIABLE DEPTH AIR PADS ON AIR SPINDLE VIBRATIONS IN NANOMACHINING

M. Akhondzadeh(corresponding author)
m_akhondzadeh@iauahvaz.ac.ir
Dept. of Engineering
Islamic Azad University Ahvaz
M. Vahdati
vahdati@kntu.ac.ir
Dept. of Mechanical Engineering
K. N. Toosi University of Technology

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Abstract

The increasing demand for precision manufacturing of components for computers, electronics, nuclear energy and defence applications has caused the appearance of ultra precision machining, UPM, processes, as high speed rotation with small heat generation is possible for air spindles, due to the low viscosity of the air lubricant. It also gives rise to noise-free and smooth running, and does not add to the sound and vibration levels of the machine like high-speed ball bearings. UPMs are made in order to create very fine and accurate products. The main features of an UPM can be classified as: A machine tool structure with high loop stiffness, high thermal and mechanical stability, low vibrations, and high precision axis of motion. Air spindles and drive systems are important parts of ultra precision machines, because spindle motion error has a significant impact on the surface quality and accuracy of machined components. Spindles in ultra precision machines have high motion accuracy and rotational speed, and its vibrations directly affect the quality of the work surface. In order to achieve nanometer accuracies, the low vibration of air spindles is vital. Pressurized air is injected into the gap of the spindle in order to make it operative. Injected air may create a lack of stiffness for several reasons. Some of the parameters affecting air spindle vibrations are: Rotational speed, input hole diameter, parameters of air pads, air gap pressure, and etc. In this study, the air pad depth and rotational speed are experimentally investigated. The air pad depth is considered variable. 6 levels are selected for the air pads bottom mode: flat, conical, pyramid, spherical with 2 various radii, and constant depth. Also, for rotational speed, 3 levels are selected. Totally, 18 experiments have been undertaken. For accomplishing these experiments, air spindles are made using various production processes. The VibroTest 60 is used for studying air spindle vibrations. Then, experimental results are analyzed using the DOE method. The results show that the case of air spindles with air pads in a pyramid bottom, at low speed, has minimum vibrations.

Key Words: Ultra precision machining, air spindle, nanomachining, air pad, vibrations.

ESTIMATION OF MASS AND STIFFNESS MATRICES BY THE DIRECT MODEL UPDATING METHOD

H. Sarmadi(corresponding author)
hassan.sarmadi@stu-mail.um.ac.ir
A. Karamodin
akaramodin@yahoo.com
A. Entezamii
entezami@stu-mail.um.ac.ir
Dept. of Structural Engineering
Ferdowsi University of Mashhad

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Abstract

Identification of structural dynamic parameters has received much attention in regard to health monitoring and damage detection over recent years. Within these

WITH COOPERATIVE CONTROL FUNCTIONALITY

A. Mirzaie Saba
alisaba66@gamil.com
M. M. Moghaddam(corresponding author)
m.moghadam@modares.ac.ir
Dept. of Mechanical Engineering
Tarbiat Modares University

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Abstract

Gait rehabilitation using body weight support on a treadmill is a recommended rehabilitation technique for neurological injuries, such as spinal cord injuries. Over the last few years, the use of robots in gait rehabilitation has been considered. The robots can substitute physiotherapy training, and are particularly suitable when the exercise is very intensive. Moreover, robots can reduce therapist intensity and the exercise time can be increased.

This paper introduces a new robotic orthosis for the automation of treadmill training. The robot design basis is body weight supported treadmill training (BWSTT). In doing So, a part of the body weight is balanced using a supporting system. Then, the patient is placed on the treadmill and the walking algorithm is applied to the leg using an exoskeleton to perform the rehabilitation exercises.

In the design, many criteria such as the low inertia of robot components, backdrivability, high safety, and degrees of freedom, based on human walking, are considered. This robot is composed of a leg exoskeleton for leg control and a segment for pelvis control. In the exoskeleton, two degrees of freedom are considered for the hip joint and one degree of freedom for the knee joint and two degrees of freedom are considered for the pelvis. Different tests are designed to investigate the performance of the robot. Measuring the inertia of this robot reveals that it exhibits less resistive forces compared to other existing rehabilitation robots. Furthermore, different walking algorithms of a healthy human are applied to the robot with an artificial leg on a treadmill. Primitive tests, with artificial legs and healthy humans, indicate that the robot has enough capability of fulfilling the walking algorithms.

It can be concluded that the presented robot has the necessary design criteria, such as suitable degrees of freedom, low inertia and high safety, and so, is suitable for use in gait rehabilitation exercises.

Key Words: Rehabilitation, treadmill training, exoskeleton, inertia, backdrivability.

THE EFFECT OF STRETCH DIRECTION ON THE WRINKLING OF ORTHOTROPIC MEMBRANE

A. Daneshvar
armin.daneshvar@gmail.com
H. Ekhteraei Toussi(corresponding author)
ekhteraee@um.ac.ir
Dept. of Mechanical Engineering
Ferdowsi University of Mashhad

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Abstract

Every day, we use different objects in the shape of thin sheets or membranes. Papers, plastic bags, wrappings, and different kinds of textile, such as cloths, tents, and rugs, are among the best examples of membranes. Moreover, in most cases, the mechanical strength of these objects is their best characteristic. Safari or awning tents, parachutes and sports costumes are examples of membranes whose applications are somehow mechanically oriented. Yet, much more specifically, in many instances, the membranes are not isotropic. Good examples of these cases are polymeric synthetic cloths and thin rolled sheets of metal. One of the main aspects in the behavior of membranes is their wrinkling phenomenon. In fact, these objects cannot withstand different kinds of loadings, such as compressive and shear forces, as well as bending moments and, consequently, are very susceptible to a mode of failure known as wrinkling. There are different approaches to studying the mechanics of membranes. Many strategies used in these studies are based on the assumption of plane stress conditions. Obviously, these studies must assume that membranes cannot carry shear or compressive forces. One of the main approaches in this category is the Roddeman method. The method pointed out in the paper is used to analyze the wrinkling of an orthotropic membrane. Down to their structural composition under stretch forces, these types of membrane are more vulnerable than their isotropic relatives. The results obtained by using the theoretical approach of Roddeman are represented in the form of different tables, graphs this study, in order to improve the heat transfer performance of thermosyphon, two different passive and active techniques (applying electrical field and nanofluid injection) were used. Al_2O_3/water nanofluid with different concentration is prepared and injected to the evaporator section of the thermosyphon. Also, an electrical field with different voltage density was applied to the system, and the variations of thermal efficiency and resistance versus different parameters, such as nanofluid concentration, evaporator heat load and electrical voltage, were determined. During the present study, the defined Nusselt number for a two-phase closed thermosyphon, calculated for different conditions, and the ratio of Nu in the presence of an electrical field to Nu in the absence of an electrical field, in order to evaluate the effect of electrical field density on the heat transfer enhancement of a two-phase closed thermosyphon, were presented. The experimental results indicated that thermal efficiency and Nu were increased with nanofluid concentration and voltage increase, but the thermosyphon resistance decreased with these parameters. The variation of thermal properties through nanofluid injection was higher than through electrical field application. So, the maximum increment in Nusselt number ratio (Nusselt number in the presence of electrical field to Nusselt number in the absence of electrical field) and thermal efficiency at the maximum concentration of the present study, along with electrical field application, were 36% and 38%, respectively.

Key Words: Heat transfer enhancement, two- phase closed thermosyphon, electrical field, Al_2O_3/ water nanofluid.

THE ANALYTICAL SOLUTION OF PARTIAL CAVITATION OVER AN AXISYMMETRIC PROJECTILE AND OBTAINING OPTIMUM CAVITATOR PROPORTIONAL TO PROJECTILE VELOCITY

M. Rashidi
im.rashidi@gmail.com
M. Passandideh-Fard(corresponding author)
mpfard@um.ac.ir
M. Passandideh-Fard
fard_m@um.ac.ir
Dept. of Mechanical Engineering
Ferdowsi University of Mashhad

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Abstract

High speed submerged bodies, such as projectiles, are subjected to cavitation phenomena which often take place when velocity increases to an extent where pressure reduces to vapor pressure and, consequently, liquid changes into vapor. This phenomenon is often undesirable but sometimes it is useful because of the drag reduction, due to the lower viscosity of the vapor phase relative to that of the liquid. Thus, the formation of cavitation in submerged bodies is of interest as a drag reduction technique, and therefore, has attracted many researchers to study its characteristics. When the cavity covers the entire solid body, the phenomenon is called supercavitation. However, if the cavity length is smaller than that of the body, i.e., the cavity closes on the body, partial cavitation occurs. Partial cavitation may also occur during flight, when the maneuvering of a vehicle is necessary. In this paper, the partially cavitating flow over an axisymmetric projectile was studied in order to obtain the optimum cavitator. The procedure used for this purpose was based on the minimization of the total drag coefficient at a given cavitation number. The boundary element method (BEM), along with CFD simulations, was employed in obtaining the optimum cavitator. Using a parabolic relation with three geometric variables, a large number of cavitators for a certain projectile were created and the BEM method was used to solve the potential fluid flow. Next, the optimum cavitator was selected based on the goal function of the minimum total drag coefficient. To examine the optimization results, several cavitators with a total drag coefficient close to that of the optimum cavitator were simulated using a CFD program (Fluent V6.3). Finally, the optimum cavitator was selected, based on both BEM and CFD results. The simulations showed that for a given projectile at all cavitation numbers, the cavitator that generates a cavity covering the entire conical section of the body with a minimum drag coefficient is optimum. It was found that increasing the cavitation number causes the optimum cavitator to approach the disk cavitator.

Key Words: Partial cavitation, boundary element method, optimum, cavitator, projectile.

DESIGN AND MANUFACTURING OF A GAIT REHABILITATION ROBOT

Dept. of Mechanical Engineering
Azad University, Kashan
M. T. Masouleh(corresponding author)
m.t.masouleh@ut.ac.ir
A. M. Niary
samir_mir57@yahoo.com
Faculty of New Science and Technology
University of Tehran
M. Wadizade
m_wadizade@yahoo.com
Dept. of Aerospace Engineering
Imam Hossein University

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Abstract

Over the past decade, developing an Unmanned Aerial Vehicles (UAV) design has stimulated the interest of many mechanical, aerospace, and electrical engineering researchers in an industrial context, and, due to their combined efforts with academia, there has been huge progress made in developing such a device. Due to several feature of UAVs, such as compact size, special flying capabilities and light maneuverability, they have widespread functional applications in civil and military applications.

Construction of the promising design of a Mini Unmanned Helicopter requires investigation in an interdisciplinary context of aerospace and mechatronics, and a blend of necessary knowledge from both; a synergy hard to achieve, which is the central subject of this paper.

Although a large number of helicopters have been made over the decades, despite their unique features including savings in cost and time, they still require more scientific research to fill general theoretical gaps. Considering the complex mechanical mechanisms in a Mini Unmanned Helicopter, besides a considerable increase in cost, a great deal of time is required to make it functional and effective.

In this article, the design and construction of a mini unmanned helicopter is detailed. Building an efficient, inexpensive flying machine can be applicable to a wide range of applications, including, among others, freight purposes. In the proposed mini unmanned helicopter, some attempts were made to reduce the number of mechanical parts and simplify the involved mechanisms; in particular, the command transfer mechanism, known as the swashplate, which is of special significance and complexity. One of the main topics of this article is analysis of the swashplate as a mechanism. The so-called swashplate is made equivalent to a parallel mechanism, and kinematic properties are investigated accordingly. Reaching high altitude lift-off is another achievement of this device, which enabled the project to test its flying performance in a city at almost 8900 feet above sea level. This mini unmanned helicopter is capable of carrying a weight of 4 kg, at sea level altitude, which is of great significance with respect to helicopter weight. The anti-torque system and power transfer of this device is built with the aid of some available and simple mechanical tools, such as gears and steel shafts with a diameter of 2 mm.

Key Words: Mini unmanned helicopter, swashplate mechanism, parallel mechanism, power transmission, anti-torque mechanism.

EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER PERFORMANCE OF TWO-PHASE CLOSED THERMOSYPHON UNDER ELECTRICAL FIELD EFFECT AND AL_2O_3/WATER NANOFLUID

F. Mohammadpour
f.mohamadpur@yahoo.com
S. Zeinali Heris(corresponding author)
zeinali@um.ac.ir
S.M. Nowee
nowee@um.ac.ir
Dept. of Chemical Engineering
Ferdowsi University of Mashhad

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Abstract

A two-phase closed thermosyphon (TPCT) was used as the main experimental system. Thermosyphon consists of three sections: Condenser, adiabatic and evaporator. 40% volume of evaporator is filled with nanofluid with different concentrations. Water is used as coolant fluid around the condenser. The flow rate of the coolant water was 200 ml/min. The condenser and evaporator are the electrodes of the electrical field. These two electrodes are attached to an AC electrical source. In each investigation, four parameters were measured after the stable state: Inlet and outlet temperature, flow rate of cooling water, evaporator and condenser temperatures. In

angular velocity was measured in order to find its relation with the governing parameters of this phenomenon. The results indicate that the angular velocity depends on Reynolds and Weber numbers. The angular velocity of an unstable hydraulic jump can increase or decrease in its durability region by changing the flow rate, downstream height and jet radius. According to the experimental observations, the unstable hydraulic jump has a flow structure similar to *type IIb* hydraulic jumps that have already been revealed. Afterwards, the jump dimensions are studied by available pictures. The inscribed and circumscribed circular radii of each polygon were measured exactly in order to compare the variable polygons. The observations clearly indicated that the inscribed and circumscribed circles of several polygonal jumps having the same parameter regime have constant radii. Also, the mean jump radius is compared to the modified Watson's theoretical prediction for the circular hydraulic jump radius. Finally, laboratory studies illustrate that a quick unstable wave appears on the circular jump before the formation of a polygonal form, which may be related to Rayleigh-Plateau instability.

Key Words: polygonal hydraulic jump; stable jump; unstable jump, Rayleigh-Plateau instability.

MODELING AND MOVING OBJECT TRACKING CONTROL OF A THREE LINK ROBOTIC FISH

H. Alemansour(corresponding author)
hamed.alemansour@gmail.com
G. R. Vossoughi
vossough@sharif.edu
Dept. of Mechanical. Engineering
Sharif University of Technology

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Abstract
Robotic fish have attracted the attention of many researchers over the last decade due to their diverse applications. The dynamic modeling and control of fish robots is an important and challenging problem. The modeling of robo-fish is useful in the design, manufacturing, efficiency estimation and control of fish robots. Presently, no exact analytical models are available that can predict the propulsive forces of a three-link robotic fish. In the present study, analytical dynamic modeling of a three-link robotic fish and its control to track moving objects is presented. Perhaps the best known theory for swimming is Lighthill's Elongated Body Theory (EBT), which has been used to study anguilliform and carangiform propulsion. In this paper, Lighthill's large amplitude Elongated Body Theory has been used to obtain the thrust forces for a three link robotic fish. Due to the complexity of the resulting dynamic model, utilization of nonlinear and robust controllers becomes impractical. In order to track moving objects, a fuzzy controller and a Brain Emotional Learning Based Intelligent Controller (BELBIC) have been proposed. Two different types of controller are designed using BELBIC and fuzzy control methods. Two controllers, one for the direction of motion and the other for tail swinging frequency, are designed in each case. The directional controller directs the fish robot towards the target, while the frequency controller adjusts the distance between the target and the robot. Finally, the dynamic equations of the robotic fish have been simulated and the performance of the proposed controllers is investigated. The simulation results show that the dynamic equations are able to simulate unsteady effects, and the robot is able to track a moving object properly using the proposed controllers. The results also reveal that the designed controllers provide good robustness to parametric uncertainties. Finally, the BELBIC controller is shown to have better performance compared to the fuzzy controller.

Key Words: Robotic fish, Lighthill theory, fuzzy controller, emotional learning, BELBIC.

CONCEPTUAL DESIGN AND CONSTRUCTION OF AN UNMANNED HELICOPTER

M. H. F. Kaloorazi
mhfarzane@ut.ac.ir
B. M. Gholamali
b.mashhadi@ut.ac.ir
Faculty of New Science and Technology
University of Tehran
A. Akhoundzadeh
sahpa_rph@yahoo.com
Dept. of Civil Aviation Technology
College A&P
M. Y. Dizgarani
myari.1986@yahoo.com

Key Words: Phase Change Materials (PCM), thermal comfort, energy consumption, desert climate, EnergyPlus.

NUMERICAL SIMULATION OF VANE-RECESSED CASING TREATMENT FOR STALL MARGIN IMPROVEMENT IN AN AXIAL FLOW COMPRESSOR

M. Akhlaghi(corresponding author)
mohammad.akhlaghi@iust.ac.ir
M. Jani
mojtaba.jani@gmail.com
School of Mechanical Engineering
Iran University of Science & Technology

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Abstract

In this paper the numerical simulation of a vane-recessed casing treatment was performed. The vane-recessed casing treatment largely optimizes the stability of an axial flow compressor. The main purpose of the current investigation was to compare the stall margin improvement as well as the stable and extended operation achieved from the experimental work and those resulted from the simulations.
The stability of a compressor is highly affected by the unsteady aerodynamic characteristics, namely, rotating stall and surge. These instabilities reduce the life duration and performance of the compressor.
When the mass flow rate is reduced to an amount lower than the design value then the stable flow may become unstable. This phenomenon would appear as rotating stall which in severe condition may lead to surge. Occurrence of rotating stall is usually accompanied with the significant reduction of the efficiency and pressure rise coefficient, which would provide a lower performance. The incidence of surge may lead to cessation of the mass flow rate which may lead to the complete breakdown of the compressor operation.
The current numerical study utilized a steady state simulation of a vane-recessed casing treatment, while different rotor blade axial cord exposures were tested. These different configurations of rotor blade exposures were 23.23%, 33.33%, 43.43%, 53.53%, 63.63% and 73.73%. Among the rotor blade exposures mentioned above, the 33.33% axial blade cord exposure casing treatment showed the best stall margin improvement. Furthermore, in term of total to total overall efficiency the 33.33% rotor blade axial exposure provided the best performance among the different casing treatments.
In order to validate the results obtained from the numerical simulation, the results were compared to those achieved from the experimental work. This comparison indicates that there are good agreements between the experimental and numerical data.
The results demonstrate that the application of a vane-recessed casing treatment as a passive stall control technique enhances the stall margins and system stability.

Key Words: Axial Flow Compressor, Vane-Recessed Casing Treatment, Rotating Stall, Surge, Stall Margin, Stall Passive Control Technique.

EXPERIMENTAL INVESTIGATION OF STABLE AND UNSTABLE STRUCTURES IN THE POLYGONAL HYDRAULIC JUMPS

M. Mokhlessi
mohsenmokhlessi@gmail.com
A. R. Teimourtash(corresponding author)
teymourtash@um.ac.ir
Dept. of Mechanical Engineering
Ferdowsi University of Mashhad

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Abstract

When a vertical liquid jet impacts on a solid horizontal surface, the first expectation is to have a circular hydraulic jump. However, sometimes the transition from supercritical to subcritical flow occurs in stable or unstable shapes, such as polygons. In this paper, first, the stable polygonal hydraulic jumps are studied. The durability region is defined for the polygonal jumps by experimental observation. The dependency of the durability region on the governing dimensionless groups is determined experimentally. The results show that a polygonal hydraulic jump with several different sides can be created in a certain parameter regime. In this study, in addition to the stable ones, a rare unstable polygonal jump is also presented. This new type of polygonal jump is charactrized by a constant angular velocity. The

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Abstract

Although the direct heat gain method is simple and inexpensive, it suffers from large temperature swings, besides strong directional daylight. In addition, the direct heat gain method can be affected very quickly by outside temperature fluctuations, which results in an indoor bed comfort level. For thermal storage buildings, walls and floors are used as heat storage elements, and stored energy in the walls and floors during the day period can be used for heating during the night. Time lag and decrement factors are very important characteristics for determining the heat storage capabilities of materials. Evaluation of the time lag and decrement factor provides a measure of the developed indoor thermal comfort conditions and, from an energy point of view, the possibility of reducing energy load demands. In the present study, time lags and decrement factors for different building materials utilized in Iran have been investigated analytically. Unlike previous studies, which mainly focused on numerical methods, in this research, the transient heat conduction equation is solved analytically using a Green function under time-dependent convection boundary conditions. According to the climate of Tehran, periodic boundary conditions are applied to the outer surface of the wall for modeling outdoor temperature variations over 24 hours. The effects of different parameters, such as wall thickness and both inner and outer heat transfer coefficients, as well as the effect of thermal insulation layers in sandwich walls, on the time lag and decrement factor, are investigated. The results indicate that the thickness and type of material have a significant effect on the time lag and decrement factor. The results of the present study are applicable for designing more effective passive solar buildings, optimizing the design of walls and other related areas, resulting in a reduction of energy consumption and environmental pollution through diminishing pollutants such as CO_2.

Key Words: Time lag, decrement factor, climate of Tehran, reduction of energy consumption.

STUDY OF ENERGY AND THERMAL COMFORT PERFORMANCE OF PCM SYSTEMS FOR BUILDING IN THE DESERT CLIMATE OF IRAN

M. Maerefat(corresponding author)
marefat@modares.ac.ir

M. Ahangari
ahangari.m@gmail.com

Dept. of Mechanical Engineering
Tarbiat Modares University

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Abstract

Solar energy has an enormous potential for space heating buildings in winter. However, solar radiation is a time-dependent energy source with an intermittent and variable character. Thermal energy storage provides a reservoir of stored energy to adapt to the fluctuations in solar energy. Solar energy may be stored in the Phase Change Material (PCM) panels. As the temperature increases during the daytime, the phase of the material changes from solid to liquid and, thus, the PCM absorbs heat. Similarly, when the temperature decreases during the night, the phase of the material changes from liquid to solid, and the PCM desorbs heat. This process could have a significant impact on thermal comfort and energy consumption in rooms. By considering the high dependency of these materials on environmental temperature fluctuations, employment of these materials in a desert climate with extensive daily temperature fluctuations may have a considerable effect on thermal comfort and energy consumption in buildings.

In the present paper, the energy and thermal comfort performance of a south-facing direct-gain room in a desert climate, with phase change material plates as inner linings (single layer) on all interior surfaces, except the floor, has been studied. The simulation has been carried out for two cases. In the first case, simulation is done by applying ordinary plaster as the inner lining, and, in the second case, the simulation is done by applying single layer PCM as an inner lining. Effects of the main factors on room air temperature are investigated. These factors include the thermophysical properties of the PCM such as: melting temperature, thermal conductivity, and thickness of PCM plates.

In the present study, EnergyPlus software has been used in the analysis. Performance of the PCMs has been modeled using the Conduction Finite Difference solution algorithm. This algorithm uses an implicit finite difference scheme coupled with an enthalpy-temperature function to account for the phase change energy accurately. The results show that the PCM, with a melting point of 20^0C, has the greatest impact on improving thermal comfort conditions in the room, and the PCM with a melting point of 22^0C has the greatest impact on reducing energy consumption in the room.

DOF, are investigated. In admittance control, a nonlinear control algorithm with inverse dynamics is utilized. Furthermore, the kinematic and dynamic equations of the haptic device are derived. By employing a six degree of freedom force/torque sensor at the end-effector of the haptic device, the performance and stability of the system are improved substantially. Moreover, the proposed control algorithms are simulated in a MATLAB/Simulink environment to evaluate the effectiveness of the proposed control algorithm, prior to experimental implementation. Next, the results of simulations and implementations are compared. They imply that the impedance control algorithm has a better performance in hard virtual wall impact simulation, and the admittance control algorithm for soft virtual wall interaction. Further, the admittance control method shows better functionality compensating for the massive and high inertia of the haptic interface device. Finally, it is shown that system behavior improves in both approaches, while increasing the gain of the control loops.

Key Words: Haptic interface, virtual environment, impedance control, admittance control, inverse dynamics.

DYNAMICS AND CONTROL OF A SET OF NON-HOLONOMIC ROBOTS FOR HUNTING AND COVERAGE IN UNEVEN PLANES

H. Sayyaadi(corresponding author)
sayyaadi@sharif.edu
M. Taghi Sabet
mohammadtaghi.sabet@gmail.com
Dept. of Mechanical Engineering
Sharif University of Technology

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Abstract
The aim of this article is the ancestral control of a set of 3-wheel robots with non-holonomics dynamics for hunting and covering around a moving target. Robots have mass and inertia and wheel mass has been considered in their dynamics. The output of the controller is the wheel torque and the front wheel steering torque. The saturation and filtering effects of the actuators are also considered here. The robots in the group are controlled in such a way that each robot responds with an appropriate reaction, based on the control algorithm, and the information passed down from other robots and the target (decentralized control). Moving target dynamics have been considered in such a way that it is escaping from an invader, the target has holonomics dynamics and it is assumed that the moving target has no wheels.

To derive the equation of motion, Kane's dynamics procedure has been used. Robots are equipped with sensors for distance assessment, vision angle assessment and also to signal the receiver antenna. To estimate the relative positions and variables of other robot situations and targets, the Extended Kalman filter and the Extended Kalman Smoother (Extended Rauch-Tung-Striebel smoother) have been used. A controller was designed to do group maneuvers using inertia analysis and by optimizing the norm of error between desired and actual acceleration.

The operation was implemented for three planes: ramp, spherical and cylindrical. The results include the hunting and coverage of the target by four invader robots, relative distance diagrams between robots and the target, their velocity and that corresponding to the robots in 3 planes, a comparison between real and estimated variables and also comparison between estimations by the Kalman filter and the Kalman smoother. Based on the results, it can be seen that due to inertia effects in robots and their non-holonomics features, the designed controller and estimator are suitable for implementing the operation to achieve reasonable results.

Key Words: Multi agent system, non-holonomics dynamics, hunting and coverage, Kalman Filter, Kalman Smoother, uneven planes.

ANALYTICAL DETERMINATION OF TIME LAG AND DECREMENT FACTORS FOR WALLS IN TEHRAN'S CLIMATE

A. Hadidi
amin.hadidi@yahoo.com
M. Maerefat(corresponding author)
maerefat@modares.ac.ir
A. Davari
amin_davari_me@yahoo.com
Dept. of Mechanical Engineering
Tarbiat Modares University

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Abstracts of Papers in English

DESIGN, SIMULATION AND IMPLEMENTATION OF ADMITTANCE AND IMPEDANCE CONTROL METHODS ON A HAPTIC DEVICE

B. Behzadpour
bahman.behzadpour@yahoo.com
M.M. Moghaddam(corresponding author)
m.moghadam@modares.ac.ir
Dept. of Mechanical Engineering
Tarbiat Modares University
M. Arbabtafti
mr.tafti@gmail.com
Dept. of Mechanical Engineering
Shahid Rajaee Teacher Training University

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Abstract

The lexical definition of haptic is of the sense of touch. Literally, it means the sensorial and force communication between the user and the virtual environment. A haptic interface is a means to receive the motion and sensed force from a human operator as its input, and lead the motion and force produced in the virtual environment back to the human operator. A haptic interface is commonly used in virtual reality systems and master/slave arms. Off-the-shelf haptic interfaces generally lack force sensors in their structures because of their heavy costs. As a result, the open-loop impedance is usually applied to control the haptic device. While the haptic interface is required to have light mass/weight, in order to reduce the dynamic effect on the function of the simulation, the more the mass is reduced, the less the interface can transmit the force.

The goal of this paper is to investigate the design, simulation and implementation of different control algorithms on a haptic interface. In this study, impedance control with force feedback, and admittance control with position feedback, on a six degrees of freedom (DOF) haptic device, including three active and three passive