範例

國立屏東科技大學教師出席國際學術活動補助申請書

一 、申請補助之國際學術活動資料

申請日期：102 年 3 月 5 日

<table>
<tr><td>申請人姓名</td><td></td><td>單位</td><td colspan="3"></td></tr>
<tr><td>職稱</td><td></td><td>電子郵件</td><td></td><td>電話</td><td></td></tr>
<tr><td rowspan="2">會議、活動
正式名稱</td><td colspan="5">中文：</td></tr>
<tr><td colspan="5">英文：</td></tr>
<tr><td>舉行時間</td><td colspan="5">自（西元） 2013 年 4 月 5 日 至 2013 年 4 月 13 日</td></tr>
<tr><td>舉行地點</td><td colspan="5">埃及開羅 Egyp, Cairo （國別、州、城市，請加註英文）</td></tr>
<tr><td rowspan="2">發表
論文題目</td><td colspan="5">中文：</td></tr>
<tr><td colspan="5">英文：</td></tr>
<tr><td>方式
（可複選）</td><td colspan="5">☐受邀請主持會議、受邀請演講
☐參加國際期刊編輯會議
■發表學術論文-口頭報告(☐獲得會議論文獎項，請附證明)
☐發表學術論文-壁報報告(☐獲得會議論文獎項，請附證明)
☐國際展演
☐國際競賽：共_____組參與，名次:__________
☐其他______________________________________</td></tr>
<tr><td colspan="6">會議、活動之性質及其學術地位、重要性：(如參與之人員國別數、大約人數）

本研討會隸屬於國際理論與應用力學聯盟之重要國際聲學與振動學會主辦，迄今已經辦理了第 20 屆，為振動噪音領域相當重要之會議。會議主題涵蓋：主動與被動振動與噪音控制、量測技術、噪音振動診斷、聲音品質、實驗模擬分析、NVH 等應用領域，共有 53 個國家，超過 800 多人與會註冊，有超過 700 篇的振動與噪音相關領域論文發表；另也有儀器廠商做產品展示，除可於研討會上得知最新的科學與噪音領域結果外，可經由廠商得知最新進的理論、技術與應用，足堪稱振動噪音領域之重大盛會。</td></tr>
</table>

二、申請人近三年內曾參加**或**曾獲本要點補助於國外舉辦之國際學術活動

會議、活動名稱	時　間	地　點	經費補助機構
中文：第十七屆聲音與振動國際研討會	自 99 年 7 月 17 日 至 99 年 7 月 29 日	埃及開羅	國立屏東科技大學
英文：The 17th International Congress on Sound and Vibration			
後續相關 SCI 等級論文發表情形： □未發表■已接受或發表	Wang, B. T., and Cheng, D. K., 2010, "Modal Analysis of MDOF System by Using Free Vibration Response Data Only," *Journal of Sound and Vibration*, Vol. 311, No. 3-5, pp. 000-000.		
中文：	自　年　月　日 至　年　月　日		1.
英文：			2.
後續相關 SCI 等級論文發表情形： □未發表□已接受或發表	(請填寫論文題目、期刊名稱、卷號、頁數、年份)		
中文：	自　年　月　日 至　年　月　日		
英文：			
後續相關 SCI 等級論文發表情形： □未發表□已接受或發表	(請填寫論文題目、期刊名稱、卷號、頁數、年份)		
中文：	自　年　月　日 至　年　月　日		
英文：			
後續相關 SCI 等級論文發表情形： □未發表□已接受或發表	(請填寫論文題目、期刊名稱、卷號、頁數、年份)		
中文：	自　年　月　日 至　年　月　日		
英文：			
後續相關 SCI 等級論文發表情形： □未發表□已接受或發表	(請填寫論文題目、期刊名稱、卷號、頁數、年份)		

***依本補助規定，已接受本要點補助二次之教師，第三次以後之申請案應另提供與前二次獲本要點補助出國發表文章相關之 SCI 等級期刊論文被接受或刊登之證明以利審查；接受補助之次數起算年度自民國 97 年起。**

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外界補助總金額(III)=B+D+F+H

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	生活費	日支費 US$ 200 元 x 10.3 天= 小計 US$ 2060 C 已獲＿＿＿＿（單位)補助（幣別）$ 0 D	NT$ 61,800 b
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請參考附件 1

(I)=(II)+(III)

請參考附件 2

請參考附件 3

檢附參考文件

■1. 大會、活動正式邀請函及詳細會議日程（議程）。

■2. 證明論文、作品被接受之文件。

■3. 擬發表之論文全文、作品說明。

■4. 本會議活動已向國科會或其他相關單位申請補助，**結果**：
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□5. 有個人計畫結餘款。

（資料不齊者，恕不受理）

請參考附件 4

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申請人簽章		單位主管簽章	

International Conference on Bioinformatics and Biomedical Engineering

iCBBE

http://www.icbbe.org

Invitation

April 13, 2010

Dear Li-Wen Chen,

Thank you very much for your support to the 4th International Conference on Bioinformatics and Biomedical Engineering (iCBBE 2010).

Paper ID: 40057
TITLE: Thermal Contact Simulation of Drill Bit and Bone During Drilling
AUTHORS: Yung-Chuan Chen; Yuan-Kun Tu ; Li-Wen Chen et. Al

has been accepted as a full paper for the final program. Congratulations!

The 4th International Conference on Bioinformatics and Biomedical Engineering (iCBBE 2010) will be held from June 18th to 20th, 2010 in Chengdu, China. iCBBE 2010 will bring together top researchers from Asian Pacific areas, North America, Europe and around the world to exchange research results and address open issues in all aspects of bioinformatics and biomedical engineering.

We cordially invite you to participate in the 4th International Conference on Bioinformatics and Biomedical Engineering (iCBBE 2010) in Chengdu, China from June 18-20, 2010.

This conference is sponsored by IEEE Engineering in Medicine and Biology Society (IEEE EMBS), Sichuan University, Wuhan University and Scientific Research Publishing. There will be many distinguished scholars from all over the world to join this meeting and you will see many exciting new fronts in bioinformatics and biomedical engineering fields.

We are looking forward to seeing you in Chengdu, China!

Best regards,

iCBBE Organizing Committee

Karen Wong

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Part I Conference Schedule

Registration June 18 ~ June 20, 2010

Time	Date	Location:
9:00-20:00	June 18th, 2010	**Lobby, 1st floor, Crowne Plaza Chengdu**
8:00-18:00	June 19th, 2010	**Lobby, 1st floor, Crowne Plaza Chengdu**
8:30-14:00	June 20th, 2010	**Lobby, 1st floor, Crowne Plaza Chengdu**

Saturday Morning, June 19

Time	Activity	Location: Grand Ballroom ABC, 3rd floor, Crowne Plaza Chengdu
08:30-09:00	Opening Ceremony	
09:00-09:40	Plenary Speech 1: *NMR Studies of Membrane Proteins* **Prof. James J. Chou** (Harvard Medical School, USA)	
09:40-10:20	Plenary Speech 2: *From Mice To Man: Towards Clinical Utility of Optical Tomographic Imaging* **Prof.Andreas H. Hielscher** (Columbia University, USA)	
10:20-10:40	Coffee Break	
10:40-11:20	Plenary Speech 3: *Knowledge Mining from Large-scale Protein-Protein Interaction Networks* **Prof. Fuchu He** (Chinese Academy of Sciences, China)	
11:20-12:00	Plenary Speech 4: *Model Based Decision Support in Medicine* **Prof. Knut Möller** (Furtwangen University, Germany)	

Saturday Noon, June 19

12:00-13:30	Lunch Buffet	Location: 2nd floor, Crowne Plaza Chengdu

Saturday Afternoon, June 19

Time	Activity (Coffee Break 15:40 – 16:00)	Location: Crowne Plaza Chengdu
14:00 – 18:00	Oral_1: Algorithms and Models in Bioinformatics	Grand Ballroom B, 3rd floor
	Oral_2: Biomedical Devices, Sensors, and Artificial Organs	Grand Ballroom C, 3rd floor
	Oral_3: Biomedical Imaging, Image Processing & Visualization	Huanhua Room, 2nd floor
	Oral_4: Biomedical Imaging, Image Processing & Visualization	Zongfu Room, 3rd floor
	Oral_5: Protein Engineering	Zengliu Room, 3rd floor
	Oral_6: Bio-Signal Processing and Analysis	Yinzhu Room, 3rd floor

Saturday Evening, June 19

18:30-20:00	Welcome Banquet	Location: Grand Ballroom ABC, 3rd floor, Crowne Plaza Chengdu

Sunday Morning, June 20

Time	Activity (Coffee Break 10:00 – 10:20)	Location: Crowne Plaza Chengdu
08:30 – 12:00	Oral_7: Gene Engineering	Grand Ballroom B, 3rd floor
	Oral_8: Clinical Engineering	Grand Ballroom C, 3rd floor
	Oral_9: Biomedical Imaging, Image Processing & Visualization	Huanhua Room, 2nd floor
	Oral_10: Novel Approaches to Bioinformatics Problems	Zongfu Room, 3rd floor
	Oral_11: Frontiers in Biomedical Engineering	Zengliu Room, 3rd floor
	Oral_12: Any Progress in Biomedical Engineering	Yinzhu Room, 3rd floor

Sunday Noon, June 20

12:00-13:30	Lunch Buffet	Location: 2nd floor, Crowne Plaza Chengdu

Sunday Afternoon, June 20

Time	Activity	Location
14:00-15:00	Poster_1: Bioinformatics	Grand Ballroom ABC, 3rd floor, Crowne Plaza Chengdu
15:00-16:00	Poster_2: Biomedical Engineering (1)	
16:00-17:00	Poster_3: Biomedical Engineering (2)	

PaperID	Paper Title	Author
40317	Boundary Roughness Analysis of Skin Lesions using Local Fractals and Wavelet Transforms	Li Ma
40913	A High Quality Reflectance Model in Medical Image Visualization	Yunpeng Zou
40844	Content-Based Retrieval Of Calcification Lesions In Mammography	lixin song
40740	A Multi-Dimension Method For Brain Tissue Extraction	Jia Di
41062	The Algorithm of Rapid Medical Image Registration by Using Mutual Information	Yongjun Ma
41166	A Multi-Scale Phase-Based Optical Flow Method for Motion Tracking of Left Ventricle	Xiaomei Yang
41034	Heart sounds in Identity Recognition	TAO Ye-wei
40172	ICA Based Fixed-Point Algorithm for Blind Separation of Mixed Images	Chao Ma
40571	The Discussion of the Location of Iris	Li Ye
41176	Real-time Face Detection using FFS boosting method in Hierarchical Feature Spaces	Ji Hao
40180	Sublingual Veins Extraction Method Based on Hyperspectral Tongue Images	Qingli Li
40968	A Preliminary Observation of Intra-operative Ultrasound Backscatter Microscopy of Spinal cord injury	Haijun Niu
40056	An Addtive Operator Splitting Method for Microscopic Image Segmentation	Zhiming Han
41020	Quantitative Assessment of Supraorbital Osseous Bar Stability and Symmetry after Frontal Orbital Advancement for Unilateral Coronal Craniosynostosis	Chia-Chi Teng
40774	Frequency Compounding for Ultrasound Freehand Elastography	Yangjie Cheng
40514	Dirichlet Markov Random Field Segmentation Of Brain MR Images	Wentao Wang
41079	Graphics Processing Unit-Based High Frame Rate Ultrasonic Tissue Motion Visualization	Anyuan Zhao
41019	Automatic recognition of microarray images using projection algorithm	Liu Yan

Poster 3: Biomedical Engineering (2)

3rd floor, Grand Ballroom ABC, Crowne Plaza Chengdu　　Time: 16:00-17:00, June 20

PaperID	Paper Title	Author
40848	Isolation of Enterobacter sp. S080 and its decolorization of textile wastewater containing Reactive Black 5	Gang Chen
40151	AhZFP1, a cDNA encoding C2H2-type zinc finger protein, induced by salt stress in peanut (Arachis hypogaea L.)	Lijuan Pan
41248	The Study on Classification for Marine Mammal based on Time-frequency Perception	Xie ZhiGang
41052	The Smarandachely Strong Adjacent Vertex Total Coloring of Join Graph	wang zhiwen
41208	Development of Acupuncture Manipulator and Its Application in the Animal Shock Model	Haowei Zhang
40800	Dose-response function of an amorphous silicon electronic portal imaging device	Wenting Lu
40951	The acute toxicity test of Phaseolus vulgar saponin	Xiao mei Li
40144	Research on the Self-organization of the Ecosystem of Cyber-society	Xiaolan Guan
41108	Cytological characteristics of hybrids between wheat- Thinopyrum elongatum 7E addition lines and wheat-gametocidal chromosome addition lines 2C	Guohui Xu
40884	In Vivo Antioxidant Activity of Black Glutinous Corncob Pigment	Zhang Zhong
40174	Pharmacokinetics of Metronidazole Colon-targeted Capsules in dogs	Hui Li
41077	Study on water consumption rule and impact factor on potted cultural pear	Fuhou Cheng
40522	Numerical Simulation of the Horizontal Rotating Bioreactor	Yanfang Zhang
40772	Optimization of liquid culture conditions of protease from Mucor by Box-Behnken design	Na Zhang
41053	The Adjacent Vertex Distinguishing Total Chromatic Number of Graphs	Zhiwen Wang
40901	Construction and Expression of Human Coagulation Factor IX in the Pichia Pastoris	Dai Yong-gang
40345	Hypoglycemic and Hypolipidemic Activity of Total Saponins in Cinnamon	Jian Li

PaperID	Paper Title	Author
40732	A New Method of Sorting of Heart Sound Signal Based on Wavelet Transform and Parameter Model Method	Tianhua Chen
40733	Removal of Pulse Waveform Baseline Drift Using Cubic Spline Interpolation	Lin Yang
40902	A Compact High-Accuracy Rail-to-Rail CMOS Operational Amplifier	Xiaoying Wang
41192	Arrhythmia Recognition Based on EMD and Support Vector Machines	Wang Yu-Jing
40829	A Method of Hand Gesture Recognition based on Multiple Sensors	Wei Fan
40679	MP-based method on detecting and eliminating the synchronous ECG artifacts in the EEG signals	Yanbo Zhou
41187	Finite element analysis of cervical spine plate using double cage fusion	Bingzhi Chen
40371	Textural analysis for ultrasound breast tumor images	Qi Liu
40805	Ultrasound Image Enhancement using Correlation Techniques	Bo Peng
40279	Comparative study on boundary Structural Irregularity using Local FD and Curvature analysis for Melanoma detection	Bo Qin
40297	Detection of pulmonary nodules among monochrome LCDs with different resolutions - an observer performance study	Jiandong Yin
40729	Simulation research on evaluation of EIT image reconstructed by different algorithms	Juan Deng
40295	The varifocal scanning Micro-zooming technique: a new method for measuring the neurite length in three dimensional spaces	Zhang Wei
40100	The Intellectual Detection and Classification	Guo peiyuan,
40707	3D Anatomical Investigation of Achilles Tendon Using a Freehand Ultrasound Imaging System	Fan Gao
40428	Simulation Analysis on the Bionic Intervention Robot in the Vascular Environment	Sun Chen
40430	Modeling and Analyzing of Screw-in Propulsion Mechanism for a Bio-Inspired Swimming Micro-Robot	Bai Chen
40057	Thermal Contact Simulation of Drill Bit and Bone During Drilling	Yungchuan Chen
40173	Lipreading Recognition Based on SVM and DTAK	Jun He
41182	Influence of geometric parameters on the flow drag of a streamlined body of revolution	Dan Xia
40475	Study of Epileptiform Discharges in Hippocampal Slices Using Multi-channel Recording System	Xinwei Gong
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40885	Purification and identification of soluble catechol-O-methyltransferase from rat liver	Lina Yang
41115	Head Movement Based Assist System for Physically Challenged	MANOGNA S
40978	Regional Cold Stress Leads to an Upforward Shift in the Whole Elastance Curve of Arterial Wall	Jia-Jung Wang
40908	Simulation of Bileaf Curved Surface Mechanical Heart Valve :A steady flow anlaysis	Yang Jie
40124	Biomechanical Analysis of Anterior Cruciate Ligament Elongations	Yanxin Zhang
40205	Interval-censored Data Analysis of Gaps Between Recurrent Events with Cure Fraction	Bing Yang
40204	Analysis of Baldder Tumor Recurrence Data with the Ternimal Event and Cure Fraction	Cuiliu Xiao
40304	Blood Biochemical Responses of Juvenile Chinese Sturgeon (Acipenser sinensis) to Anesthetic Tricaine Methanesulfonate	Guangpeng Feng

附件2

主要識別身分

寄件者:
收件者:
副本:
傳送日期:
主旨:
[redacted]

Bor-Tsuen Wang:

Congratulations, your submission Model Verification and Percussion Sound Characteristics of Metallophone with Chord Sound has been accepted for presentation at ICSV 17 which is being held 2010-07-18 at Cairo.

Thank you and looking forward to your participation in this event.

Eman Zidan

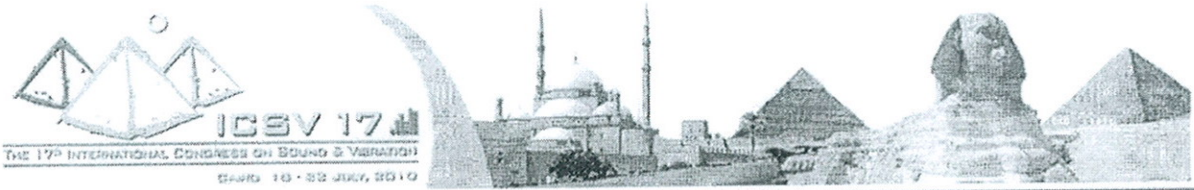
[redacted]

__________ Information from ESET NOD32 Antivirus, version of virus signature database 5051 (20100422) __________

The message was checked by ESET NOD32 Antivirus.

http://www.eset.com

附件2



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SUMMARY | REVIEW

Submission

Authors	Bor-Tsuen Wang, Xiao-Ming Jian
Title	Model Verification and Percussion Sound Characteristics of Metallophone with Chord Sound
Submission Type	Single Presentation
Original file	376-438-1-SM.PDF 2010-04-02
Supp. files	None ADD A SUPPLEMENTARY FILE
Submitter	Bor-Tsuen Wang
Date submitted	April 2, 2010 - 10:21 PM
Track	T16 Musical Acoustics
Director	Wael Akl (Director)
Abstract Views	15

Status

Status	Posted
Initiated	2010-04-22
Last modified	2010-04-22

Submission Metadata

EDIT METADATA

Authors

Name	Bor-Tsuen Wang
Affiliation	National Pingtung University of Science and Technology
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Bio statement	Professor and Dean Department of Mechancial Engineering College of Engineering

Principal contact for editorial correspondence.

Name	Xiao-Ming Jian
Affiliation	National Pingtung University of Science and Technology
Country	—
Bio statement	Graduate student Department of Mechancial Engineering

Title and Abstract

Title: Model Verification and Percussion Sound Characteristics of Metallophone with Chord Sound

Abstract: The metallophone is a common percussion instrument. The percussion sound of the metallo-phone is strongly related to the structural vibration modes. This paper presents the new de-sign geometry of metallophone plate that can produce the C major chord sound. The finite element (FE) model for the metallophone plate is constructed to perform the theoretical mo-dal analysis so as to obtain natural frequencies and mode shapes. The experimental modal analysis (EMA) is then carried out on the metallophone plate to determine the structural mo-dal parameters. Base on the experimental results the FE model can be verified and further ap-plied to design modification analysis. The percussion sound of the specially designed chord metallophone is also measured and shown its chord sound characteristics. The new designed metallophone that can produce chord sound is a brand new concept for the percussion in-strument. The integration of FEA and EMA techniques is shown effective for the design of percussion instruments.

ICSV 17
THE 17th INTERNATIONAL CONGRESS ON SOUND & VIBRATION
CAIRO 18 - 22 JULY, 2010

MODEL VERIFICATION AND PERCUSSION SOUND CHARACTERISTICS OF METALLOPHONE WITH CHORD SOUND

Bor-Tsuen Wang, and Xiao-Ming Jian

Department of Mechanical Engineering, National Pingting University of Science and Technology, Pingtung, 91201, Taiwan
e-mail: wangbt@mail.npust.edu.tw

The metallophone is a common percussion instrument. The percussion sound of the metallophone is strongly related to the structural vibration modes. This paper presents the new design geometry of metallophone plate that can produce the C major chord sound. The finite element (FE) model for the metallophone plate is constructed to perform the theoretical modal analysis so as to obtain natural frequencies and mode shapes. The experimental modal analysis (EMA) is then carried out on the metallophone plate to determine the structural modal parameters. Base on the experimental results the FE model can be verified and further applied to design modification analysis. The percussion sound of the specially designed chord metallophone is also measured and shown its chord sound characteristics. The new designed metallophone that can produce chord sound is a brand new concept for the percussion instrument. The integration of FEA and EMA techniques is shown effective for the design of percussion instruments.

1. Introduction

The metallophone is one of the percussion instruments that are tuned metal bars struck by a mallet to make sound. The metallophone is commonly played in musical performance and has been developed various kinds in different countries [1]. The percussion sound of metallophone or any percussion instrument is strongly related to the structural vibration characteristics that are affected by the geometrical shape and size as well as materials. Rossing [2] presented the acoustical principle of various types of percussion instruments.

The study of percussion sound characteristics is of interest. Wang and Lin [3] conducted experimental modal analysis (EMA) on a simple type of metallophone bar with rectangle shape to characterize the modal properties. They [4] also showed the sound and vibration correlation for the metallophone bar. The percussion sound is mainly dominated by the structural vibration modes and affected by the struck location and even the striking stick materials. Wang *et al.* [5] and Wang and Chen [6] studied the sound and vibration characteristics of two types of copper gongs, respectively, that are frequently used in Taiwan for festival events. The special feature of gong structure is the circular shape made of thin copper plate.

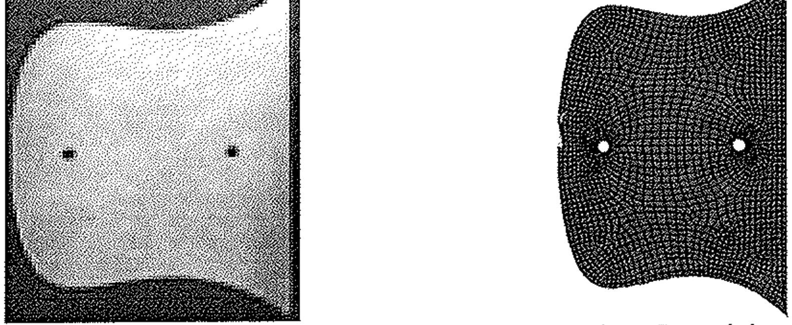
The xylophone, another frequently seen percussion instrument, is made of wood materials. Bork [7] developed mathematical beam model to tune the xylophone bar to improve the inharmonic sound characteristics. Bretos *et al.* [8] applied finite element (FE) method in analyzing and comparing the modal frequencies for two types of undercuts of xylophone bars and verified by frequency measurement. Bretos *et al.* [9] completed the previous work with more detail studies on mode shape characteristics of xylophone bar and the variation of material and size effects. Chaigne and Doutaut [10] formulated the theoretical model including the mallet effect on simulating the transient dynamic response for xylophone bars. Doutaut *et al.* [11] further extended the numerical model to include the resonator effect under the xylophone bar. Wang and Liao [12] adopted the integration of FEA and EMA techniques to perform model verification of a xylophone bar. Other percussion instruments such as bells [13-15] or kettledrum [16] were also studied.

This work will present the use of FEA and EMA techniques on the special designed metallophone plate that can produce C major chord sound. The FE model of the metallophone plate is constructed for analytical solution of modal parameters that are verified in comparison to EMA results. The validated FE model can then be used for further structural modification. The sound radiation characteristics related to the structural vibration modal properties are also discussed and shown the unique spectrum consisting of the triad chord sound. This work leads for the idea of structural shape design for percussion instruments.

2. Model verification of metallophone plate

Figure 1(a) shows the newly designed metallophone plate that has the percussion sound characteristics of C major chord. Table 1 reveals the musical notes from C6 to C7 and their corresponding frequencies. The C major triad chord consists of C, E and G. This section discusses the main idea about model verification to validate the analytical model of metallophone plate constructed by finite element software.

Figure 2 is the flow chart of model verification on the metallophone plate. The FE model of the metallophone plate is first constructed and performed modal analysis to obtain the structural modal properties, i.e. natural frequencies and mode shapes as well as the frequency response function (FRF) by harmonic response analysis. On the other hand, experimental modal analysis or so called modal testing is carried out by measuring the structural FRFs that will be processed to determine the modal parameters for the real structure. Then, both FEA and EMA results can be compared to validate the FE model base on the experimental data by the correction of system parameters. The equivalent FE model can be validated if modal parameters from both FEA and EMA can agree to each others.



(a) Photo (b) FE model

Figure 1. metallophone plate.

Table 1. Musical notes and corresponding frequencies.

Musical note	C6	D6	E6	F6	G6	A6	B6	C7
Frequency (Hz)	**1046.5**	1174.6	**1318.5**	1396.9	**1568.0**	1760.0	1975.5	2093.0

Table 2. Material properties of metallophone plate.

Young's modulus (GPa)	Density (kg/m³)	Poisson ratio
192.95	7782.92	0.27

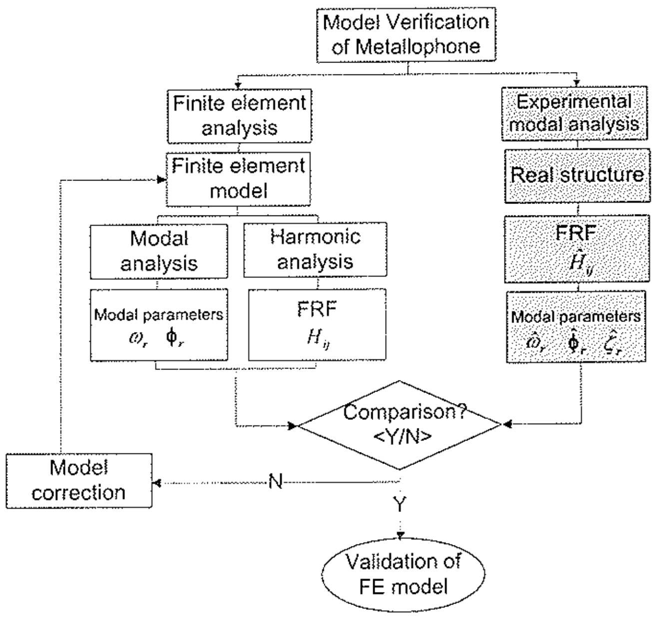


Figure 2. flow chart for model verification of metallophone plate.

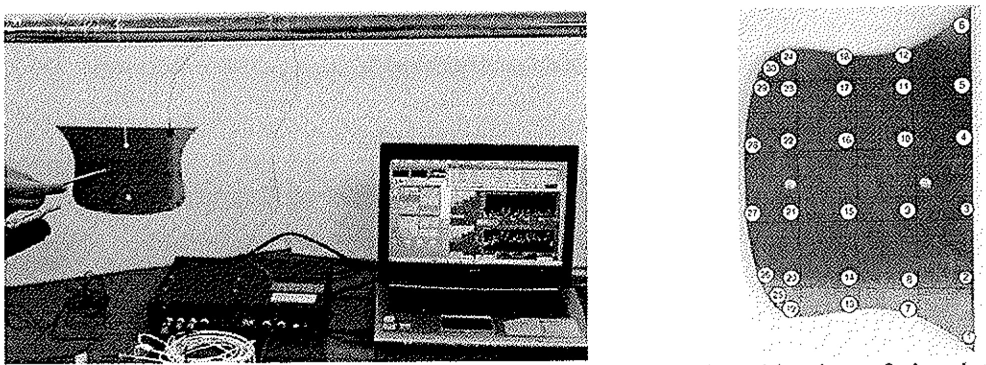
2.1 Finite element analysis

This work adopts the commercial FE code, ANSYS, to build the FE model of the metallophone plate. Figure 1(b) reveals the mesh of the FE model, and Table 2 shows the material properties of the metallophone plate after calibration via model verification procedure. The linear quadrilateral shell element (SHELL63) can be used to construct the model because the plate is relatively thin. The element size is generally about 3mm in width. In corresponding to EMA, the metallophone plate is suspended as shown in Figure 3(a), and thus free boundary is assumed. For modal analysis, no loading condition is required. The theoretical natural frequencies (f_r) and mode shapes (ϕ_r) can be obtained. The unit point force is applied at the struck location by the impact hammer in accordance with EMA for harmonic response analysis to obtain system FRF (H_{ij}).

2.2 Experimental modal analysis

Figure 3(a) is the experimental setup for EMA on the metallophone plate, and Figure 3(b) shows the 30 test grid points on the plate. The mini impact hammer is applied as the actuator to excite the structure and roving over the grid points, while the accelerometer is fixed at point 2 to measure the acceleration. Therefore, the experimental FRF, $\hat{H}_{ij}$, between the acceleration at i-th point and the force input at j-th point can be obtained and used to perform curve fitting so as to determine the experimental modal parameters, including natural frequencies ($\hat{f}_r$), mode shapes ($\hat{\phi}_r$) and modal damping ratios ($\hat{\zeta}_r$). In addition to the use of accelerometer as the sensor, this work also applies the microphone fixed at the direction of 45° and 20cm away from the centre of the metallophone plate by roving the impact hammer. The two independent EMA experiments are performed to compare the extracted modal parameters. Since the actuator is roving and the sensor is fixed, the actuator mode shape can be extracted from the measured FRFs [17]. Here, the impact hammer is the point type force, and thus the displacement mode shape for each mode can be obtained.

The percussion sound of the metallophone plate is also measured by striking on different locations of the plate with a mallet. The sound spectrum is recorded and interpreted to show the sound characteristics of the metallophone.



(a) experimental setup (b) grid points of the plate

Figure 3. Experimental setup for modal testing of metallophone plate.

3. Results and discussions

This section will show the model verification results of the metallophone plate by combining the FEA and EMA techniques to validate the FE model of the plate. The percussion sound spectrum of the metallophone plate will also be presented.

3.1 Model verification of metallophone

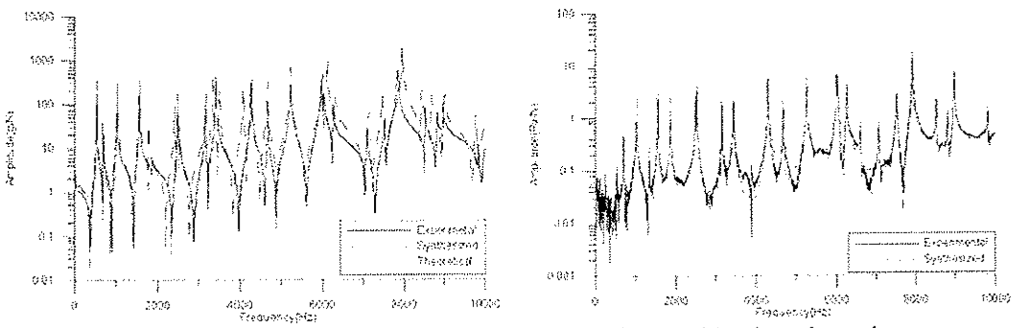
Figure 4(a) and 4(b) show the FRFs obtained from EMA via the accelerometer and microphone, respectively. In Figure 4(a), the solid line denotes the measured FRF, and the dashed line is the synthesized FRF obtained from the extracted modal parameters. That both FRFs agree very well indicates the correctness on the curve fitting procedure. The long dashed line is the theoretical FRF obtained from FEA that generally agrees well with experimental one, i.e. the analytical FE model of the metallophone plate is well simulated. For the microphone as the sensor as shown in Figure 4(b), the experimental FRF is not so smooth due to the background noise resulting in the low response of sound emission from the metallophone plate, in particular at non-resonance regions. However, the resonant frequencies of the metallophone can still be well identified and thus the FRFs can also be used for modal parameter extraction. As one can see the synthesized FRF from the EMA via microphone also match well with the experimental one. Note that the sound radiation simulation is not conducted in this work.

Table 3 shows the comparison of natural frequencies and modal damping ratios obtained from FEA and both EMA results via the accelerometer and microphone, respectively, for natural modes within 10,000Hz frequency range. The error percentages of natural frequencies between FEA and EMA are generally within 2% except a few modes as bolded in Table 3. The modal assurance criterion (MAC) is defined as follows:

$$MAC(\hat{\phi}_r,\phi_s)=\frac{\left|\hat{\phi}_r^{T}\phi_s\right|^2}{\left(\hat{\phi}_r^{T}\hat{\phi}_r^{*}\right)\left(\phi_s^{T}\phi_s^{*}\right)},\quad r=1,2,\cdots,n,\ s=1,2,\cdots,n.. \qquad (1)$$

The *MAC* is a scale to compare the similarity of two vectors. If *MAC* values are close to 1, the two vectors match perfectly in scale. If *MAC* values are zero, the two vectors are orthogonal. As one can observe in Table 3 as well as Table 4 showing those theoretical and experimental mode shapes for the first 6 modes, the *MAC* values between the mode shape vectors obtained from FEA (ϕ_r) and EMA ($\hat{\phi}_r$) are mostly above 0.8 and this indicates the physical agreement of mode shape characteristics. The types of modes are also indicated such as (x,y)=(2,2), i.e. revealed as the typical plate mode shape. The modal damping ratios obtained from both EMA experiments are about the same. It is noted that the averaged modal damping ratio for all modes is determined and used as the constant modal damping ratio in the FE model to determine theoretical FRF as shown in Figure 4(a).

In summary, the model verification of the metallophone plate is performed to validate the analytical FE model base on the modal data comparison. The modal characteristics of the metallophone plate can be well interpreted and match to each others between FEA and EMA. The use of microphone as the sensor for EMA is also shown effectively. Since the microphone is a type of non-contact sensor, the sensor mass effect does not exist in contrary to the accelerometer.



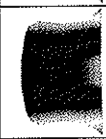
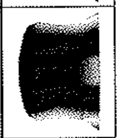
(a) EMA via accelerometer (b) EMA via microphone

Figure 4. Frequency response function (FRF) of $H_{2,2}$.

Table 3. Comparison of modal parameters between FEA and EMA.

Mode	Type of mode	FEA (Hz)	EMA via acc. (Hz)	Diff. (Hz)	Error (%)	MAC	Damping ratio (%)	EMA via mic. (Hz)	Diff. (Hz)	Error (%)	MAC	Damping ratio (%)
1	(2,2)	536.99	537.5	-0.5	-0.095	0.947	0.435	540.6	-3.6	-0.668	0.748	0.416
2	(1,3)	664.98	712.5	-47.5	-6.669	0.824	0.330	709.4	-44.4	-6.262	0.829	0.326
3	(3,1)	1035.2	1028.1	7.1	0.688	0.874	0.244	1031.3	3.9	0.378	0.866	0.246
4	(2,3)	1322.8	1346.9	-24.1	-1.787	0.959	0.160	1350.0	-27.2	**-2.015**	0.949	0.175
5	(3,2)	1572.8	1559.4	13.4	0.861	0.910	0.162	1562.5	10.3	0.659	0.859	0.152
6	(1,4)	1784.7	1868.8	-84.1	**-4.498**	0.892	0.136	1868.8	-84.1	**-4.500**	0.895	0.132
7(E8)	(3,3)	2417.2	2540.6	-123.4	**-4.858**	0.867	0.107	2500.0	-82.8	**-3.312**	0.826	0.104
8(E7)	(2,4)	2492.3	2496.9	-4.6	-0.183	0.932	0.107	2543.8	-51.5	**-2.025**	0.799	0.105
9	(4,1)	3185.0	3156.3	28.8	0.911	0.875	0.109	3162.5	22.5	0.711	0.504	0.096
*10	(2,4)	3354.0	3421.9	-67.9	-1.984	0.844	0.097	3453.1	-99.1	**-2.870**	0.604	0.107
11	(4,2)	3498.2	-	-	-	-	-	-	-	-	-	-
12	(2,5)	4081.2	-	-	-	-	-	-	-	-	-	-
13	(3,4)	4264.7	4287.5	-22.8	-0.532	**0.444**	0.089	4312.5	-47.8	-1.108	**0.233**	0.080
14	(4,3)	4668.1	4681.3	-13.1	-0.281	0.911	0.105	4687.5	-19.4	-0.414	**0.368**	0.093
15	(3,6)	5226.2	5240.6	-14.4	-0.275	0.914	0.126	5257.0	-30.8	-0.586	0.659	0.082
16	(4,4)	6010.5	5978.1	32.4	0.542	**0.328**	0.157	6012.5	-2.0	-0.033	0.558	0.093
17	(※)	6114.3	6031.3	83.1	1.377	**0.497**	0.091	6053.1	61.2	1.011	0.547	0.066
18	(5,3)	6246.2	6271.9	-25.7	-0.409	0.829	0.096	6281.3	-35.1	-0.559	0.570	0.095
19	(4,6)	6312.6	-	-	-	-	-	-	-	-	-	-
20	(4,7)	7115.5	7078.1	37.4	0.528	0.789	0.095	7081.3	34.2	0.483	**0.434**	0.082
21	(5,4)	7463.3	7525.0	-61.7	-0.820	0.834	0.106	7528.1	-64.8	-0.861	**0.238**	0.091
22	(5,7)	7959.3	7837.5	121.8	1.554	0.874	0.160	7931.3	28.0	0.353	**0.398**	0.051
*23	(4,6)	8432.5	8534.4	-101.9	-1.194	0.851	0.081	8537.5	-105.0	-1.230	**0.347**	0.062
24	(3,7)	8676.0	8825.0	-149.0	-1.688	0.732	0.091	8828.1	-152.1	-1.723	**0.208**	0.069
*25	(5,4)	9006.5	8971.9	34.6	0.386	0.712	0.120	8987.5	19.0	0.211	**0.456**	0.068
*26	(3,4)	9774.8	-	-	-	-	-	-	-	-	-	-
27	(6,1)	10119.0	9834.4	284.6	**2.894**	**0.374**	0.0967	9834.4	284.6	**2.894**	**0.297**	0.064

Table 4. Comparison of mode shapes between FEA and EMA.

Target Freq. (Hz)	mode	Type of mode shape	FEA		EMA via acc.		EMA via mic.	
			Natural Freq. (Hz)	Mode shape	Natural Freq. (Hz)	Mode shape	Natural Freq. (Hz)	Mode shape
-	1	(2,2)	536.99		537.5		540.6	
-	2	(1,3)	664.98		712.5		709.4	
1046.5	3	(3,1)	1035.2		1028.1		1031.3	
1318.5	4	(2,3)	1322.8		1346.9		1350.0	
1568.0	5	(3,2)	1572.8		1559.4		1562.5	
-	6	(1,4)	1784.7		1868.8		1868.8	

3.2 Sound characteristics of metallophone

Figure 5 reveals the nodal lines of mode shapes of the metallophone plate for modes 1-5. The numbers at the edge of the plate are the corresponding mode number. The physical insight of the nodal lines is where there is no vibration or in still in the corresponding modal response. Table 5 shows the measured sound spectrum for using the mallet striking at the points 1 and 3, respectively, and Table 6 shows the peak frequencies and their sound pressure levels (dB). Some observations are discussed as follows:

- For the struck point 1, as shown in Figure 5, where is right at the nodal lines of modes 1 and 2, as expected the first and second modes can not be excited, and therefore the sound spectrum only reveals the peak resonant frequencies at modes 3-6 as indicated in Table 5.
- When the mallet is struck at point 3, where is the cross point of the nodal lines for modes 1, 3, 5 and 6, the peak resonances on the sound spectrum are modes 2 and 4. The hearing sound will be only the two modal frequencies.
- The innovation of the metallophone plate is that the modal frequencies of modes 3, 4 and 5 are nearly corresponding to the C major chord as the bolded musical notes shown in Table 2. Therefore, this metallophone plate can produce C major chord sound characteristics for struck at point 1 as well as point 2.
- Different struck points on the metallophone plate will generate different percussion sounds base on the mode shape characteristics. With the proper shape design of the metallophone

plate to tune the modal frequencies and the selection of struck points, the special objective oriented design of the metallophone plate can be made.

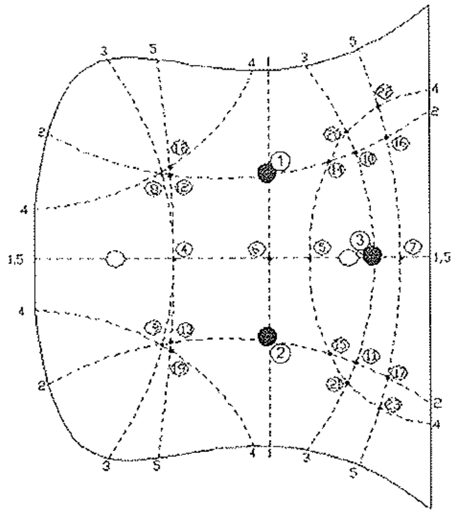


Figure 5. Overlap of nodal lines for modes 1-5.

Table 5. Percussion sound spectrum of metallophone plate.

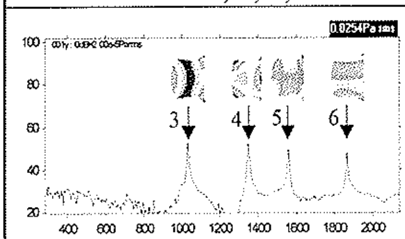
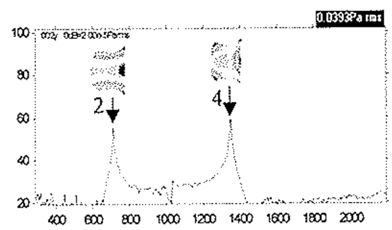
Struck point 1	Struck point 3
Mode 3, 4, 5, 6	Mode 2, 4
	

Table 6. Percussion sound pressure levels and frequencies of metallophone plate.

Struck point	1		3	
mode	f_r (Hz)	dB	f_r (Hz)	dB
1	---	---	---	---
2	---	---	709.375	55.368
3	1031.250	52.859	---	---
4	1346.875	51.718	1346.875	59.493
5	1559.375	49.384	---	---
6	1868.750	47.730	---	---

4. Conclusions

This work presents the model verification of a special designed metallophone plate that can produce C major chord sound. The integration of FEA and EMA techniques is applied to validate the FE model of metallophone plate and shown promising. The validated FE model can be further used to perform structural modification for particular shape design of metallophone. Besides the traditional EMA by using the accelerometer as the sensor, the microphone is also shown feasible for modal testing and effective. The advantage of the microphone over the accelerometer is the non-contact type of sensor and lack of mass effect on the test structure, though the background noise has to be well controlled. The percussion sound spectra of the metallophone are also studied to show its special chord sound characteristics depending on the struck location. This work develops the methodology in both analytical and experimental approaches for percussion instrument design and analysis. The systematic approach does provide the tools in analysing and designing the musical instruments, in particular for the metallophone revealed in this work.

5. Acknowledgement

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附件4

98年度【基於聲音特性需求的結構幾何設計方法之發展—打擊樂器之應用】經費核定清單

執行機構：國立屏東科技大學　　主 持 人：王栢村　　教授(機械工程系)

補助項目	申請金額	核定金額	說明
業務費	[redacted]	[redacted]	一、研究人力費[redacted] 1. 補助專任[redacted] 2. 本會依規[redacted] 計) 二、耗材、物品及雜項費用：120,000元
研究設備費	[redacted]	[redacted]	加速度計，麥克風
國外差旅費	[redacted]	[redacted]	一、出席國際會議差旅費：60,000元 二、本項目不核列管理費
管理費	[redacted]	[redacted]	研究主持費不核列管理費
合　　計	[redacted]	[redacted]	執行期限： 98/08/01 ～ 99/07/31 計畫編號： NSC 98-2221-E-020 -009 -

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承辦人： 沈觀葆

研究類型：一般型研究計畫(個別型)
研究性質：基礎研究
應繳報告：精簡報告
研究成果歸屬：國立屏東科技大學
各項費用之支用請依「行政院國家科學委員會補助專題研究計畫經費處理原則」規定辦理。

附件4

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受文者：國立屏東科技大學

發文日期：中華民國99年9月20日
發文字號：臺會合字第[redacted]號
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附件：

主旨：貴校[redacted]系[redacted]教授擬於99年11月赴大陸參加The 25th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Exhibition，申請補助所需費用乙案，業於[redacted]年度專題研究計畫中核定，歉難再補助，請　查照。

正本：國立屏東科技大學
副本：
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國立屏東科技大學

檔 號		頁數	
保存年限		附件	

檔 號：
保存年限：

待辦日期
大以內

行政院國家科學委員會　函

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發文日期：中華民國101年[redacted]月[redacted]日
發文字號：臺會合字第[redacted]號
速別：普通件
密等及解密條件或保密期限：
附件：

裝

主旨：貴校[redacted]系[redacted]教授擬於101年[redacted]月赴[redacted]Congress of[redacted]，申請補助所需費用乙案，復如說明，請查照。

訂

說明：

一、本案補助總額為新臺幣[redacted]元，請就下列補助項目及金額內勻支：

(一)機票費：自台北至[redacted]最直接航程之本國籍班機往返經濟艙機票，機票自行購買(若無法搭本國班機，得由本人填具因公出國人員搭乘外國籍航空公司班機申請書，經任職機構首長或授權代理人核定後，可改搭國外班機。如未附申請書，依照行政院之規定，其購買機票之價款，不予核銷)。

線

(二)生活費：出國會議期間之生活費。依照中央政府派赴國外各地區出差人員生活費日支數額列報([redacted]日支數額[redacted]美元)，凡住宿免費宿舍、過境旅館或在交通工具歇夜及返國當日，生活費按該地區生活費日支數額40%報支，均照院頒國外出差旅費報支要點審核。

(三)註冊費。

(四)手續費(包括護照費、簽證費及機場服務費)。

(五)保險費(因公赴國外出差人員綜合保險金額新臺幣400萬元)。

(六)機票費、生活費、註冊費及手續費、保險費請先自行墊付。

二、補助編號：[redacted]。報銷時請註明補助案編號，以利作業。

三、本案請於返國後一個月內，於本會研究人才個人網頁線上系統繳交出席國際學術會議報告及登錄經費報銷。

四、經費報銷時請檢附機票票根正本或電子機票、國際線航空機票購票證明單或旅行業代收轉付收據及登機證存根、大會所發之註冊費用收據正本、國外出差旅費報告表及支出憑證粘存單，並附外幣兌換水單或以出國前一天(如遇假日往前順推)臺灣銀行賣出即期美元參考匯價證明、手續費、保險費須檢據，本會核准公函影本，經任職機構首長及有關人員，如主辦會計等審核蓋章。

五、受補助機構其經費為原始憑證就地查核之單位：於每月十日或每季結束當月十日前將上月(季)該機構已執行完畢且已上線繳交報告之出席國際學術會議案與前項單據，按本會補助編號順序，裝訂成冊，妥善保管。並將彙整完畢之收支報告表經機構首長及有關人員簽章後併同受補助機構之領據，函送本會核銷歸墊。至有關原始憑證，請依據本會「補助經費原始憑證就地查核實施要點」之規定辦理。為落實查核作業，請加強內部審核，妥為保管相關原始憑証，以備查核。

六、受補助機構其經費為非原始憑證就地查核之單位：各項單據經該機構首長及有關人員簽章後，函送本會核銷歸墊。

七、當年度預算，若於12月10日 前來函辦理報銷，可及早撥款。其後因本會辦理會計年度保留款作業，撥款歸墊將稍為

延後。

八、請於出席會議時使用Taiwan或Taiwan,ROC。

正本：國立屏東科技大學

副本：

101/04/24
16:35:05

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