ISSN 0711-6659

canadian acoustics
acoustique canadienne

Journal of the Canadian Acoustical Association - Revue de l'Association canadienne d'acoustique

JUNE 2021 JUIN 2021
Volume 49 - - Number 2 Volume 49 - - Numéro 2

canadian acoustics

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Canadian Acoustical Association/Association Canadienne d'Acoustique P.B. 74068 Ottawa, Ontario, K1M 2H9

Association canadienne d'acoustique B.P. 74068 Ottawa, Ontario, K1M 2H9

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Acoustique canadienne est publié quantre fois par an, en mars, juin, septembre et décembre. Cette revue trimestrielle est envoyée gratuitement aux membres individuels de l'Association canadienne d'acoustique (ACA) et aux abonnés institutionnels. L'Acoustique canadienne publie des articles arbitrés et des rubriques sur tous les aspects de l'acoustique et des vibrations. Ceci comprend la recherche, les recensions des travaux, les nouvelles, les offres d'emploi, les nouveaux produits, les activités, etc. Les articles concernant les résultats inédits ou les applications de l'acoustique ainsi que les articles de synthèse, les tutoriels et les exposées techniques, en français ou en anglais, sont les bienvenus. L'Association canadienne d'acoustique a sélectionné Paypal comme solution pratique pour le paiement en ligne de vos frais d'abonnement. Paypal prend en charge un large éventail de méthodes de paiement (Visa, Mastercard, Amex, compte bancaire, etc) et ne nécessite pas que vous ayez déjà un compte avec eux. Si vous désirez procéder à un paiement par chèque de votre abonnement, merci de remplir le formulaire d'inscription et de l'envoyer au secrétaire exécutif de l'association (voir adresse ci-dessus). - Canadian Acoustical Association/Association Canadienne d'Acoustique c/o JASCO Applied Sciences 2305–4464 Markham Street Victoria, BC V8Z 7X8 - - - secretary@caa-aca.ca - Dr. Roberto Racca

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It is time for recovery and restart by setting a new soundscape

Dear reader, I am writing you this editorial, with the hope that we are recovering our normal lives and soon, we will be able to make more noise! We are hence almost ready to re-start with a series of activities we planned before COVID-19, among which the International Year of Sound and the Acoustics Week in Canada (AWC) 2021. AWC is planned for October 5 to 7, 2021, so do not miss sending contributions and paper proposals by July 12!

Now, it is my great pleasure to present you our cover image, and share with you some (personal) notes about a great mentor, colleague, and friend of many of us. Prof. Ramani Ramakrishnan to whom this issue is dedicated as he retires on July 1st, 2021. Ramani has been a pillar of our association, this journal, and the entire community of Canadian acousticians over the last 40 years. He served this journal as editor-in-chief for 15 years!

I probably arrived in Canada mainly thanks to his role and influence in the Department of Architectural Science at Ryerson. He read my resume and decided to advocate about the possible contribution I could provide to a department that probably was not ready to hire another acoustician. His kind words about me convinced the rest of the department that I was a good choice, and thanks to his prestige, we teach acoustics to architectural students.

After I landed in Toronto, he invited me for a beer and to his house, where his unique love for his home country and the traditional culture (and food) was alternated to nice discussions about Canadian acousticians and research innovations in both architectural acoustics and noise control, his great passions. I traveled with him to some conferences, and he introduced me to his wide knowledge of people from all over the world. I will never forget the advice and nice memories of the trip to Argentina for ICA 2016 or the trips for concerts.

He was the kind of person who with the example, teaches a lot, more than with words. In brief, I had the great privilege to be able to see how he treats students, the passion he put for excellence at our common university and department. Covid-19 has prevented us to enjoy his presence over the last two years. We will miss him a lot!

Umberto Berardi
Editor in Chief.

Il est temps de récupérer en définissant un nouveau paysage sonore

Chère lectrice, cher lecteur, je vous écris cet éditorial, avec l'espoir que nous reprenions notre vie normale et bientôt, nous pourrons faire plus de bruit ! Nous sommes presque prêts à reprendre les activités que nous avions planifiées avant COVID-19, parmi lesquelles l'Année internationale du son et la Semaine de l'Acoustique au Canada 2021. Celle-ci est prévu du 5 au 7 octobre 2021, alors ne manquez pas d'envoyer vos contributions et propositions d'articles avant le 12 juillet !

Maintenant, j'ai le plaisir de vous présenter notre image de couverture et de partager avec vous quelques notes (personnelles) sur un grand mentor, collègue et ami de beaucoup d'entre nous. Prof. Ramani Ramakrishnan à qui ce numéro est dédié alors qu'il prend sa retraite le 1er juillet 2021. Il fut un pilier de notre association, de cette revue en tant que rédacteur en chef pendant 15 ans ; et de toute la communauté des acousticiens canadiens au cours des 40 dernières années.

Je suis probablement arrivé au Canada principalement grâce à son rôle et son influence au Département des sciences de l'architecture à Ryerson. Il a lu mon curriculum vitae et a décidé de plaider en faveur de la contribution possible que je pourrais apporter à un département qui n'était probablement pas prêt à embaucher un autre acousticien. Ses paroles aimables à mon sujet ont convaincu le reste du département que j'étais un bon choix, et grâce à son prestige, nous enseignons l'acoustique aux étudiants en architecture.

Après mon arrivée à Toronto, il m'a invité pour une bière chez lui, où son amour unique pour son pays d'origine et la culture (et la nourriture) traditionnelle a alterné avec de belles discussions sur les acousticiens canadiens et les innovations en acoustique architecturale. Lors de conférences et il m'a fait découvrir sa vaste connaissance des gens du monde entier. Je n'oublierai jamais tous les bons souvenirs du voyage en Argentine pour l'ICA 2016 ou des voyages pour les concerts.

C'était le genre de personne qui enseigne beaucoup plus par l'exemple, qu'avec des mots. En bref, j'ai eu le grand privilège de pouvoir voir comment il traite les étudiants, la passion qu'il met pour l'excellence dans notre université et notre département communs. Le Covid-19 nous a empêché de profiter de sa présence ces deux dernières années donc je suis sûr qu'il va beaucoup nous manquer !

Umberto Berardi
Rédacteur en chef


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AUTOMATED DETECTION OF CANNABIS-INTOXICATION FROM SPEECH

Arian Shamei *[1], **Peter R. Sullivan** †[1], **Yadong Liu** ‡[1], **Muhammad Abdul-Mageed** §[1], **and Bryan Gick** ¶[1]
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Abstract

Machine learning can reliably distinguish a variety of mental and physical states based on acoustic alterations in the speech stream. Recent acoustic research found that cannabis intoxication results in significant differences in several acoustic correlates. Encouraged by these observations, we report models aimed at detecting cannabis intoxication from human speech. Using a small number of speakers (4 male,4 female) we exploit mel spectrograms from sober and intoxicated productions of sustained vowels, to train models under various gender-nuanced conditions (i.e., male-only, female-only, gender-agnostic) using convolutional neural networks (CNNs). In speaker-independent cross-validation, we report encouraging model performance ($avg\ macro\ F1$ - females : 68.6%, males : 67.9%).

Keywords: state detection, cannabis intoxication, automatic detection

Résumé

L'apprentissage automatique peut distinguer de manière fiable une variété d'états mentaux et physiques sur la base des altérations acoustiques du flux vocal. Des recherches acoustiques récentes ont montré que l'intoxication au cannabis entraîne des différences significatives dans plusieurs paramètres acoustiques. Encouragés par ces observations, nous présentons des modèles visant à détecter l'intoxication au cannabis à partir de la parole humaine. En utilisant un petit nombre de locuteurs (4 hommes, 4 femmes), nous exploitons des spectrogrammes de mélanges de productions sobres et intoxiquées de voyelles soutenues, pour entraîner des modèles dans différentes conditions de genre (c'est-à-dire, homme seulement, femme seulement, sans considération de genre) en utilisant des réseaux neuronaux convolutifs. Dans le cadre d'une validation croisée indépendante du locuteur, les performances du modèle sont encourageantes ($avg\ macro\ F1$ - femmes : 68,6%, hommes : 67,9%).

Mots clefs: détection d'état mental, intoxication au cannabis, détection automatique

1 Introduction

With the recent legalization of cannabis in Canada, accurate detection of cannabis intoxication is a necessity in legal and medical contexts. Aside from a blood test, which is undesirable for both ethical and logistical reasons, there is currently no reliable detection method for cannabis intoxication. The goal of this work it to investigate the feasibility of automated methods to detect cannabis intoxication from acoustic speech data. In particular, we present effective neural network models trained to detect intoxication from sustained vowels. Crucially, we obtained these results using a relatively simple and easily available network architecture and minimal data preprocessing. We believe these results highlight the robust effect of cannabis intoxication on phonation and the effectiveness of deep learning for this task.

Acoustic analysis has been shown to reliably distinguish a range of mental and physiological states, including alcohol intoxication [1] Parkinson's disease [2], heart disease [3], MDMA intoxication [4], head and neck cancer patient intelligibility [5] and emotional state [6]. Accurate classification using machine learning methods has been demonstrated for many of these states (Alcohol - see [7], Parkinson's - see [8]). A preliminary acoustic analysis on cannabis-intoxicated speech [9] found significant spectral and phonetic alterations in the speech of eight participants following cannabis intoxication. We use this very same dataset to train models based on 2-layer 2D CNNs (Convolutional Neural Network) to detect cannabis intoxication from sustained vowel articulations. Our models perform binary classification, predicting whether samples from unseen speakers were produced in sober or intoxicated conditions.

2 Related Work

To date, we know of no previous research investigating automated detection of cannabis intoxication from speech data. However, there has been substantial work on detecting related speaker states such as alcohol intoxication from the speech stream. Much of this work was fuelled by the Interspeech 2011 Intoxication Speaker State Challenge [10]. The challenge utilized the Alcohol Language Corpus [11], which contained audio recordings of German speakers performing language tasks at a variety of intoxication levels. A gender balanced set (n=144) was randomly selected and partitioned into speaker-independent training, development and test sets. [10] reported a baseline model employing Support Vector

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Machines which obtained an accuracy of 65.9%. The top performing model in the task [1] used Gaussian Mixture Model supervectors alongside normalized hierarchical features to obtain an accuracy of 70.5%. More recently, [12] used a gated recurrent neural network to achieve 75% speaker independent accuracy using FBANK features as input.

More recent work on state detection incorporates deep learning architectures and spectral imaging methods [13]. In such frameworks, audio classification tasks often make use of CNNs as their sensitivity to time-invariant data has proven to extremely valuable [14]. For example, there is a substantial body of literature reporting state-of-the-art classification of a speaker's emotion using log-mel spectrograms and 1D [15], 2D [6], and 3D CNNs [16, 17]. The use of deep learning and spectral imaging methods have recently been applied to alcohol-intoxication with promising results [7, 18]. In sum, successful state detection methodologies have been reported using traditional machine learning or more modern deep learning methods, employing either representative features of the audio or spectral imaging mediums.

3 Data

The dataset consists of eight participants (4 male, 4 female) completing a set of speech tasks in sober and intoxicated conditions using a pretest - retest format. Human research ethics approval was obtained from the University of Victoria HREB. Recordings took place in a sound-attenuated booth at the University of Victoria using a the internal microphone of a Zoom H4N Stereo recorder with a sampling rate of 44.1KHz and a bit rate of 16. Participants were asked to sit comfortably and maintain a consistent distance from the microphone. Participants arrived after abstaining from Cannabis use for at least 24 hours and completed the sober pretest tasks. Participants were then given a thirty minute break to consume their cannabis and perform the identical retest tasks. Participants provided their own cannabis and consumed varying amounts based on their medical needs. All participants consumed their cannabis by either smoking or vaporizing. Participants were asked to self-report their frequency of use and degree of intoxication on a 1-7 scale, however as this metric was highly subjective it was not utilized in the present analysis. It should be noted that accurately identifying the degree of cannabis intoxication and its interaction with a participant's individual tolerance level is difficult without real time monitoring of THC levels in the blood. Habitual users of cannabis have detectable THC levels in the bloodstream even when cannabis has not been recently consumed, which further adds to the complexity of blood-level monitoring [19]. As this study was preliminary in nature, we opted to assess the data in a manner naive to degree of intoxication and tolerance, however it is likely that these factors will influence model performance.

All participants were native speakers of English, between 20-24 years of age with no reported speech or hearing disorders. Participants included medicinal users of cannabis with a wide range of experience, frequency of use, and tolerance levels. Participants were asked to sustain seven vowels embedded within carrier words (e.g. *see*, *sue*, *saw*) for approximately five seconds each although the exact duration was not enforced. Two iterations were collected from each participant. Our decision to include only the sustained vowel task is motivated by our desire to base our models on purely *phonetic* components of speech, while avoiding the effects of *suprasegmental* or *non-phonetic* components such as speech rate, lexeme choice, or loudness. Each audio file contained either the pretest or retest recording of one participant, for a total of 16 audio files, each consisting of approximately 40 seconds of sustained vowels and their onsets following the manual removal of silences.

4 Models & Experiments

4.1 Model settings

We develop models under two main settings based on how we split our data : **(1) Gender specific** : Here we train two distinct models, each using male (n=4) or female (n=4) data exclusively. **(2) Gender agnostic** : Where we use the combined data (n=8) from both the males and females. For each setting (i.e., *male-only*, *female-only*, and *gender-agnostic*), we run *n*-fold cross validation experiments. Similar methodology has recently been applied to train models for MDMA intoxication from a small number of speakers (n=31), and presents a reasonable alternative to independent training, validation, and test sets for smaller datasets.

Our treatment of each speaker's data as an independent fold allows us to obtain both (a) speaker-independent (i.e., across all speakers) and (b) speaker-specific (on each individual speaker) results. In all cases, allowing individual scores for each participant without including their data in the training set. In our *gender-agnostic* version, this meant we trained on 7 speakers at each and tested on the eighth fold in a model which did not account for gender. In our *gender-split* versions, independent models were trained on female speakers and male speakers respectively, allowing an evaluation of whether gender-dependent speaker characteristics such as *F0* might be a factor in classification.

4.2 Model architecture

Model architecture was invariably a 2-layer 2D CNN implemented in the PyTorch [20] Python Deep learning framework. Each layer of the CNN was fed into a ReLU activation function [21] and then max pooled. Dropout [22] was applied to the second CNN layer and the subsequent dense layer. The model culminated in an output node for binary classification of speaker state (sober vs intoxicated). We use the Adadelta optimizer [23] with the default learning rate of 1.0 - note that pytorch does not recommend adjusting the adadelta learning rate. Specific model hyperparameters were selected by random search function as outlined in subsection 4.5.

4.3 Baseline

For our baseline, we train a Support Vector Machine (SVM) with a radial basis function (RBF) kernel on the data using eight-fold cross-validation.

4.4 Data extraction

For each of these settings (agnostic, specific, baseline) we extract a total number of 500 mel spectrograms (250 from each class) from each participant, for a total of 4,000 spectrograms. The duration (in milliseconds) of each sample was determined by random search function, with possible values including 250, 500, and 1000ms. We use Librosa [24], the Python audio analysis package, to produce mel spectrograms from each sample by randomly sampling the specified duration 250 times from each of the 16 files. Specific hyperparameters for the generation of mel spectrograms were selected by random search function as outlined in subsection 4.5.

4.5 Random search optimization

To better understand the impact of both model structure and data preparation on the task, we randomly search 128 different combinations of model tuning hyperparameters and data settings for the creation of the mel spectrograms. Approximately one fifth of the combinations failed due to excessive memory requirements or training times and are thus omitted (male n=27, female n=27, agnostic n=25). Hyperparameters included in the random search (and their possible values) are listed in Table 1 alongside the hyperparameters selected by the top performing model (selected by highest Macro F_1) for each type (e.g, agnostic). All other hyperparamters were left to the Librosa or PyTorch defaults.

Table 1: Hyperparameters included in the random search.
Possible values for each hyperparameter are summarized in the second column. Hyperparameters selected by the top performing models are provided in their respective column. n_fft refers to FFT window size. n_fft and mel banks are sampled using a uniform distribution in the given range, while the max frequency is sampled from a log uniform distribution to better probe lower thresholds of frequency. Window length defaulted to match n_fft, and hop length indicated as fraction of n_fft.

Data Hyp.	**Range**	**Agnostic**	**Male**	**Female**	**SVM**
Duration (sec)	.25 / .5 / 1	250	250	500	250
n_fft	32 - 2048	2048	64	2048	1024
# Mels	50 - 256	244	51	78	59
Hop Len.	1/8, 1/4, 1/2	1024	8	1024	256
Max Freq. (Hz)	148 - 8100	7368	3659	2330	752
Model Hyp.					
L2 Reg.	0 - .01	.001	.001	.003	-
Dropout CNN	0.1 - 0.9	.40	.45	.19	-
Dropout Dense	0.1 - 0.9	.74	.48	.23	-
Batch Size	4 - 128	88	90	55	-
Epochs	200	6	81	2	-
CNN1 Filters	2 - 64	63	56	56	-
CNN2 Filters	2 - 64	7	38	45	-
Kernel Size	3 , 5	3	3	3	-
Dense Units	64-256	181	82	191	-

5 Results

Results for the top performing models (baseline, gender-agnostic, gender-dependent) are shown in Table 2. Results for each model are summarized in the second column in terms of $macroF_1$, the metric used to select the top performing models. Subsequent columns provide *positive* (intoxicated) and *negative* (sober) F_1 scores. Group averages are provided followed by scores for each participant. As the number of items in each class was balanced no weighting of scores was necessary (i.e. chance is equal to 50%). Mean accuracy as calculated from the mean of negative and positive recall (the metric of choice for the Interspeech Intoxication Challenge [10]) did not noticeably differ from Macro F_1 scores (SVM = 57.0%, gender-agnostic = 60.5%, female = 67.2%, male = 68.2%)

All three models (i.e., gender agnostic, male, and female) outperformed the SVM baseline metrics (F_1, positive/negative precision, recall, and F_1). Despite training on much smaller datasets, the F_1 of gendered combinations (male = 67.9, female = 68.6) are substantially higher than the gender agnostic model (59.0). A multivariate regression evaluating the effect of model type and speaker on F_1 values found that gender-dependent models significantly outperformed the SVM (p=.01) and the gender-agnostic model (p=.02). A type II multivariate analysis of variance (MANOVA) suggests that the effect of speaker (p=.004) is stronger than that of model (p=.025). These observations are reflected in the tendency for certain speakers to perform extremely well across all experiments.

For the gender-agnostic model, performance is highly variable across participants, while notable improvements to the consistency of precision and recall across participants can be observed for the gendered models. Between the two gendered models, the male-only model demonstrates better consistency in performance across participants (St. Dev of F_1 - Males : 8%, Females : 18.8%). The rate of false positives is highest for the female-only model, but lowest for the male model (positive precision - Female : 63.0%, agnostic : 64.5%, male : 69.3%). The rate of false negatives is highest for the gender-agnostic model, but lowest for the female model (negative precision - agnostic : 61.2%, male 68.8%, female 75.2%).

6 Discussion

In this study, we present further evidence that cannabis intoxication results in salient alterations to the speech stream. We have also demonstrated that a deep learning system can successfully exploit these alterations to predict cannabis intoxication from the vowel phonations of a previously unseen speaker at a rate substantially higher than chance. Considering the simplicity of the model architecture and the limited dataset, these results are encouraging. We believe this reflects the substantial degree to which cannabis intoxication affects voice quality. We suspect more training data from a larger number of speakers will help further improve the system and achieve state-of-the-art performance comparable to the detection of alcohol [7] and MDMA intoxication [4] from speech.

Our results indicate that biological speaker characteristics, such as sex, may influence the necessary data and model hyperparameters for accurate discrimination. This is evidenced by our gender-specific models outperforming the gender-agnostic model, despite the latter having more than double the pool of training data when testing on each fold. This suggests that acoustic correlates used by the model may differ in their manifestation in male and female speech. We note that the most notable acoustic difference between males and females is that of fundamental frequency (F0). Our previous work on

Table 2: Model performance for 8-fold gender-agnostic, and 4-fold male & female models.

Model	**Macro F_1**	**Pos/Neg**	**Avg**	**F1**	**F2**	**F3**	**F4**	**M1**	**M2**	**M3**	**M4**
SVM	55.0	+ F_1	56.6	69.5	37.3	75.8	82.3	59.6	53.9	39.2	35.0
		- F_1	53.8	42.6	39.0	76.1	85.4	20.2	61.3	65.5	40.3
Agnostic	59.0	+ F_1	56.0	38.8	35.2	74.3	88.8	43.1	68.7	44.1	54.9
		- F_1	62.0	72.0	52.1	69.7	89.5	51.0	52.7	64.2	44.8
Female	68.6	+ F_1	71.7	45.0	62.6	74.8	86.8				
		- F_1	60.9	41.6	78.4	76.4	89.3				
Male	67.9	+ F_1	67.6					74.2	75.7	54.7	66.0
		- F_1	68.1					67.8	74.2	55.2	75.3

this dataset [25] found notable alterations to several features of F0, namely range, trajectory, and acoustic shimmer. We acknowledge that the small dataset and aggressive hyperparameter search likely resulted in arbitrary selection of some hyperparameters. In spite of this, we find it noteworthy that the length of the fourier transform (n_fft) differed for top performing male and female models. Figure 1 provides the n_fft for the top ten performing models of each CNN variant (female, male, combined).

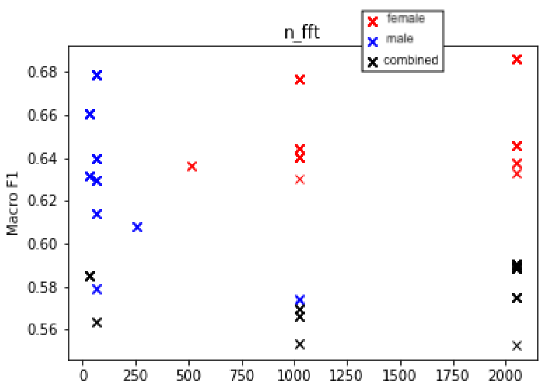

Figure 1: Performance ($macro\ F_1$) of top 10 gender-dependent models sorted by n_fft.

This may suggest that increased temporal resolution was necessary for male classification, and frequency resolution for female classification. It is possible that temporal aspects of F0 such as jitter and shimmer were more predictive for the male model, whereas F0-dependent features such as trajectories, range, and deltas were more predictive for both the female and gender-agnostic models. Another hyperparameter which differed consistently between top performing model variants was the maximum frequency (fmax) of the mel spectrogram. Figure 2 provides the maximum frequency of the spectrogram for the top ten performing models of each CNN variant (female, male, combined) and the respective F1 score of each configuration. Top performing female models had a tendency to select a lower fmax than the male model or combined models. In sum, higher temporal resolution and maximum frequency range produced better classification for the male dataset. Whereas higher frequency resolution and lower range produced higher performance on the female datset.

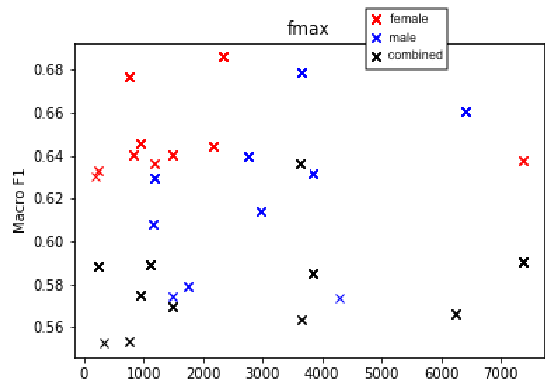

Figure 2: Performance ($macro\ F_1$) of top 10 gender-dependent models sorted by fmax

The results of our MANOVA suggest that individual speaker characteristics substantially influence model performance. Considering the small number of speakers, the risk for individual speaker differences to influence hyperparameter selection is high. Future work including a larger number of speakers may allow more confident insight into the utility of correlates and more nuanced evaluations of individual differences such as degree of intoxication, tolerance, and frequency of use.

Acknowledgments

This research was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) and Compute Canada.

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INFLUENCE OF DIFFERENT DISTRIBUTION PATTERNS OF HOLES ON SINGLE MICRO-PERFORATED PANEL SOUND ABSORPTION BEHAVIOUR

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Résumé

Les panneaux micro-perforés sont devenus ces derniers temps une option valable d'absorption acoustique à large bande. Leur champ d'application est large puisqu'ils sont prometteurs pour l'absorption de l'énergie sonore dans plusieurs applications, telles que l'automobile, les systèmes de chauffage, de ventilation et de climatisation, les murs antibruit, etc. Cette étude étudie l'effet de différents modèles de distribution des trous, du taux de perforation, de la profondeur de l'entrefer et de la géométrie des trous sur le comportement d'absorption acoustique des panneaux micro-perforés individuels. Quatre modèles de distribution différents (cercle, carré, triangle et aléatoire) des orifices sont conçus et fabriqués sur une surface de tôle d'une épaisseur de 1 mm avec un diamètre de trou de 1 mm et une profondeur d'entrefer de 100 mm entre le panneau et la paroi arrière. Chaque motif de distribution des quatre différents motifs a été perforé avec sept rapports de perforation (0,12 %, 0,36 %, 0,48 %, 0,60 %, 0,84 %, 1,1 % et 1,9 %) Les mesures ont été effectuées à l'aide du tube d'impédance à deux microphones dans la gamme des basses fréquences de 100 Hz à 1000 Hz. Bien que les résultats n'aient pas révélé de différence significative entre les coefficients d'absorption des différents modèles de trous pour tous les rapports de perforation, le modèle aléatoire est légèrement plus élevé que les autres modèles de distribution. L'augmentation de la profondeur de l'entrefer a amélioré le coefficient d'absorption acoustique moyen dans la gamme de fréquences allant de 160 Hz à 630 Hz de 0,29 à 0,51. De plus, le changement de la géométrie des trous, qui est passée du cercle au carré et au triangle, a amélioré le coefficient d'absorption acoustique d'environ 11 % et 12 %. On obtient une bonne cohérence entre les calculs théoriques et les résultats expérimentaux.

Mots-clés : Absorbeur à panneau microperforé, modèle de distribution, géométrie des trous, modèle Maa.

Abstract

Micro-perforated panels have become a valid broadband sound absorber option lately. Their applicability is wide since they are promising for absorbing sound energy for several applications, such as automotive, HVAC systems, noise barriers, etc. This study investigates the effect of different distribution patterns of holes, perforation ratio, air gap depth, and the hole geometry on single micro-perforated panels' sound absorption behavior. Four different distribution patterns (Circle, Square, Triangle, and Random) of orifices are designed and fabricated on a surface of sheet metal of thickness 1 mm with hole diameter 1mm, and air gap depth between the panel and the back wall 100 mm. Each of the four different distribution patterns was perforated with seven perforation ratios (0.12%, 0.36%, 0.48%, 0.60%, 0.84%, 1.1%, and 1.9%).The measurements were carried out using the two-microphone impedance tube in the low-frequency range from 100 Hz to 1000 Hz. Although the results revealed no significant difference between the absorption coefficients of different holes' patterns at all the perforation ratios, the random pattern is slightly higher than other distribution patterns. Increasing the air gap depth improved the average sound absorption coefficient in the frequency range from 160 Hz to 630 Hz from 0.29 to 0.51. Moreover, changing the hole geometry from circle to square and triangle enhanced the sound absorption coefficient by about 11 % and 12 %. Good consistency between the theoretical calculations and the experimental results is obtained.

Keywords: Micro-Perforated Panel Absorber, Distribution Pattern, Hole Geometry, Maa Model.

1 Introduction

In the form of a micro-perforated panel (MPP), the sound absorber has drawn researchers ' concern because of its benefits over porous absorbent materials. It has been recognized as the next generation of conventional absorbing material because it has the merits of an excellent sound absorption performance, high strength, excellent wash ability, eco-friendly, and can be used in a harsh environment [1, 2]. Moreover, they can be designed to provide wideband sound absorption for a specific frequency range by changing MPP parameters such as the hole diameter (d), panel thickness (t), perforation ratio (σ), and the cavity depth (D).

The essential acoustic concept of MPP is strain forward, it is to produce a surface with a built-in damping which concretely absorbs sound waves. To realize this, the acoustic impedance of a MPP absorber is normally tuned to be of the order of the in air). When the oscillating air molecules penetrate the MPP, the friction between the air in motion and the

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surface of the MPP dissipates the acoustical energy Maa [1, 3, 4] first proposed the MPP concept, its theoretical basis, and design guidelines. MPP is a thin panel or membrane made of wood, plastic, or metal with thickness t ≤ 1.0 mm, perforation ratio σ ≤ 1.0 %, and air gap of rigid back [5]. Hua and Herrin set the perforation ratio to 5.0 % [6]. Now MPP is widely used in different applications such as automotive, room acoustics, HVAC systems, compressors, turbines, and window systems [7-11]. When compared to the traditional porous and fibrous sound absorber materials, high sound absorption coefficients can be achieved with a relatively small thickness. MPP absorbers' sound absorption mechanism is due to the oscillatory air movement through MPP's small orifices, resulting in dissipated sound energy. It has been proposed that many small perforations should be used instead of a few large apertures to achieve more excellent absorption [6]. Maa Dah-You [11] studied the sound absorption coefficient of micro-perforated panels with a sub-millimeter size of diameter (0.5–1) mm, to provide enough acoustic resistance and low acoustic mass reactance, which are necessary for wideband sound absorber, without using additional fibrous or porous materials. To enhance the acoustic performance of the single MPP absorbers, numerous experiments and trials have been suggested. K. Sakagami [12] revealed that the honeycomb in the air cavity of an MPP absorber has not only made the MPP stiffer, but it has also improved the sound absorption performance, especially at low frequencies. Liu and Herrin [13] investigated that partitioning the air gap by using the honeycomb only, increases the overall sound attenuation by about 4 dB. Sakagami [14] showed that the absorption peak value becomes slightly lower by inserting a porous absorbent layer into the back cavity. Liu [13] concluded that MPP's attachment with porous material in front of the air gap broadened the sound absorption frequency range because the porous material layer damped the air resonance in the air gap. Iman Falsafiet [15] concluded that the absorption's magnitude and bandwidth are rely on the hole diameter and the perforation ratio rather than the panel thickness. Moreover, the cavity depth is the parameter that controls the position of the resonance frequency of MPP. A literature gap was found on the influence of different perforation patterns and perforation geometry on MPP's sound absorption [16-18]. They studied only the heterogeneity (unevenly) distribution of orifices over the panel surface. In contrast, this study aims to investigate the influence of four different distribution patterns of perforations (Circle, Square, Triangle, and Random), perforation ratio, air gap depth, and the hole geometry on the acoustic performance of single MPPs to attain the best distribution pattern, which provides the optimum absorption as a good solution for the low-frequency noise problems.

The paper is organized as follows: Section 2 presents the theoretical background of single MPP.
.Section 3 focuses on the experimental arrangement of the used method and the MPP samples preparation. Section 4 describes the results obtained and the explanation for both the experimental results and the theoretical calculations.

2 Theoretical background of single MPP

Micro-perforated panel sound-absorbing construction consists of a thin panel perforated with a large number of sub-millimeter holes together with an air space behind it. The structure and its equivalent circuit are shown in figure 1.

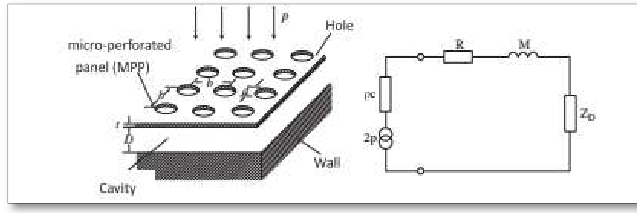


Figure 1: Micro-Perforated panel sound absorber construction and its equivalent circuit.

The holes of MPP may be considered a lattice of short narrow tubes separated by distances much larger than their diameters but small compared to the impinging sound's wavelength. For the sound wave's normal sound incidence on the micro-perforated panel, the wave motion in all the short tubes is in phase and additive. Maa [1] derived the relative (to the characteristic impedance ρc in the air) acoustic impedance of MPP with end corrections:

$$Z_{MPP} = (R + jM)/\rho C = r + j\omega m. \quad (2.1)$$

Where r and m are the normalized specific acoustic resistance (the real part) and the normalized acoustic reactance (the imaginary part), respectively, and ω (equal to 2πf) is the angular frequency.

$$r= \frac{32\eta t}{\sigma\rho_0 C_0 d^2}\left(\sqrt{1+\frac{x^2}{32}}+\frac{\sqrt{2}}{8}\frac{xd}{t}\right); \quad (2.2)$$

$$m= \frac{t}{\sigma C_0}\left(1+\left(9+\frac{x^2}{2}\right)^{-0.5}\right)+0.85\frac{d}{t}; \quad (2.3)$$

$$X = d\sqrt{\omega\rho_0/4\eta}. \quad (2.4)$$

Here, η is the air's viscosity coefficient, $1.506*10^{-5}$ m^2/s, ρ is the air density, 1.225 Kg/m^3, x is the perforation panel constant d, t is the hole diameter and the panel thickness, respectively. In this study, the holes are not evenly distributed on the total panel area (holes localized in a part of the panel area), assuming cylindrical perforations with the same diameter d, the perforation ratio is given by [19]

$$\sigma= \frac{n*\pi*d^2}{4S_p}. \quad (2.5)$$

Where n is the number of holes on the panel, S_p is the panel area. The normalized specific acoustic impedance of air cavity with thickness D behind the MPP panel is determined by [20]

$$Z_D = -jcot\left(\frac{\omega D}{C}\right). \quad (2.6)$$

And the total specific acoustic impedance Z_{total} of a conventional single MPP under normal incidence can be determined by [20]

$$Z_{total} = Z_{MPP} + Z_D \quad (2.7)$$

By having the total impedance of MPP, the sound absorption coefficient can be calculated from [15]

$$A= \frac{4r}{(1+r^2)+(\omega m-\cot\ (\omega D/C))^2} \quad (2.8)$$

And the maximum absorption coefficient is calculated by

$$\alpha_{max}= \frac{4r}{(1+r)^2} \quad (2.9)$$

3 Experimental arrangement

3.1 Experimental setup

Following ASTM 1050-12 standard [21], the acoustic absorption was experimentally measured using a two-microphone impedance tube technique. The measurements were carried out at 22.0^0 C laboratory ambient temperature and 56 % relative humidity. Figure 2 displays the laboratory test setup, where the B&K impedance tube type 4206 was used to measure the samples' sound absorption coefficient. The impedance tube's internal diameter was 100 mm, and the acoustic properties were measured in the frequency range from 100 to 1000 Hz. In this method, a loudspeaker that produced a random sound signal was put at one end, and the sample was mounted on the sample holder at the other end. The samples were fitted firmly with the inner diameter of the tube. The edges between the panel and the walls of the tube were sealed by clay to prevent leakage. Finally, the normal incidence sound absorption coefficient is measured using a software program.

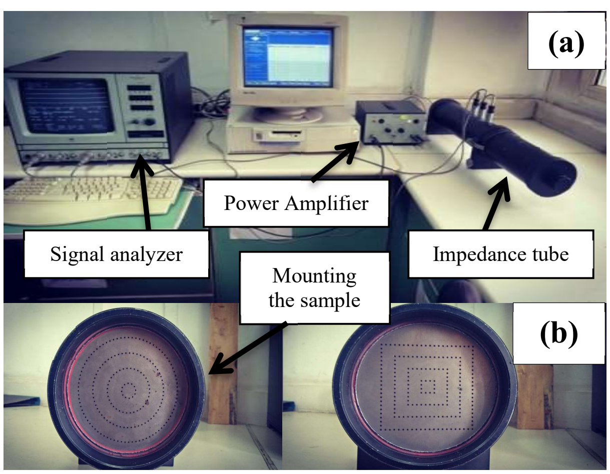


Figure 2: (*a*) B&K 4206 Impedance tube measurement setup, (*b*) Mounting of the sample inside the tube.

3.2 MPP samples preparation

In this study, 34 samples have been used; the samples are divided into 28 samples related to the different distribution patterns of holes and six samples related to the different hole geometry. Samples are in the form of a 1mm metal sheet of diameter 100mm.The samples are named (A, B, C, D, E, F, and G) with perforation ratios are 0.12%, 0.36%, 0.48%, 0.6%, 0.84%, 1.1% and 1.9% respectively [22, 23]. The holes in each sample were distributed with four different patterns (Circle, Square, Triangle, and Random), as shown in figure 3. Maa [1] clearly states that the open area ratio's value is important, noting that while a small change of its value is usually permitted, the exact value is required for a perfect model prediction [24]. So, the parameters of thickness, hole diameter, and the cavity depth are kept constant for groups A to G. AutoCAD software was used to draw the different distribution patterns of orifices on the surface of the panel. The orifices have been perforated using laser drilling with diameter 1mm and with the 7 previously listed perforation ratios. Figure 3 shows the four different distribution patterns at different perforation ratios.

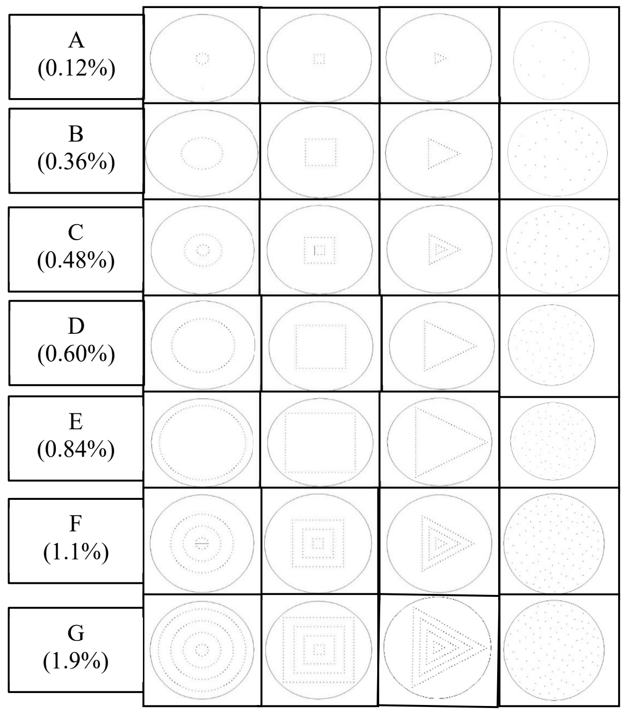


Figure 3: Schematic diagram of different distribution patterns of orifices at each perforation ratio.

4 Parametric survey

The perforation ratio's influence on single MPPs' sound absorption coefficient figure 4 for the same panel thickness, hole diameter, and cavity depth, as listed in Table 1.

Table 1: Geometrical properties of MPPs.

Spec.	Sample	t (mm)	d (mm)	D (mm)	σ (%)
Changing Perforation Ratio	A	1	1	100	0.12
	B				0.36
	C				0.48
	D				0.60
	E				0.84
	F				1.1
	G				1.9

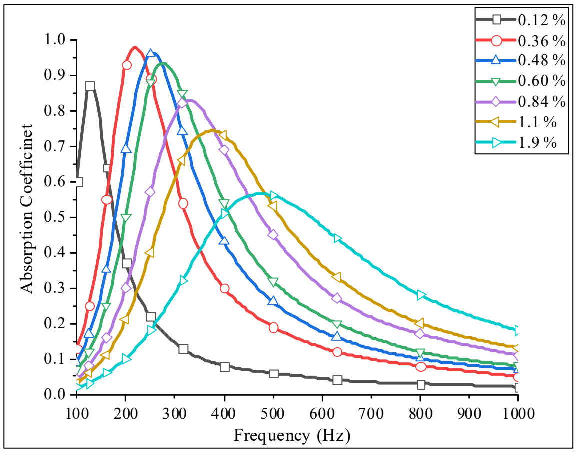


Figure 4: Sound absorption at different perforation ratios – Maa's Model.

Table 2: Absorption coefficient and acoustic resistance characteristics of single MPPs for Different perforation ratios.

σ (%)	f_0 (Hz)	α_{max}	r
0.12	125	0.87	2.1
0.36	200	0.93	0.8
0.48	250	0.96	0.7
0.60	250	0.90	0.5
0.84	315	0.82	0.4
1.1	400	0.73	0.3
1.9	500	0.56	0.2

Considering the perforation ratio in Equation (2.5), this parameter affects the acoustic impedance resistance. The maximum absorption needs the resistance part to be close to 1, as clarified by Equation (2.9). Table 2 shows that the MPP with resistance part close to 1 has a higher absorption coefficient. It is revealed from a parametric survey that the acoustic resistance value close to 1±0.5 allows the absorption coefficient value of the MPP panel (α = 0.90 - 0.96) [25]. In contrast, the acoustic resistance value higher or smaller than that value will result in a lower absorption coefficient.

5 Result and discussion

5.1 Effect of perforation ratio

Figure 5 reveal the comparison between the measured sound absorption coefficients of 28 samples. The air gap between the back wall and the samples was kept constant at 100 mm.

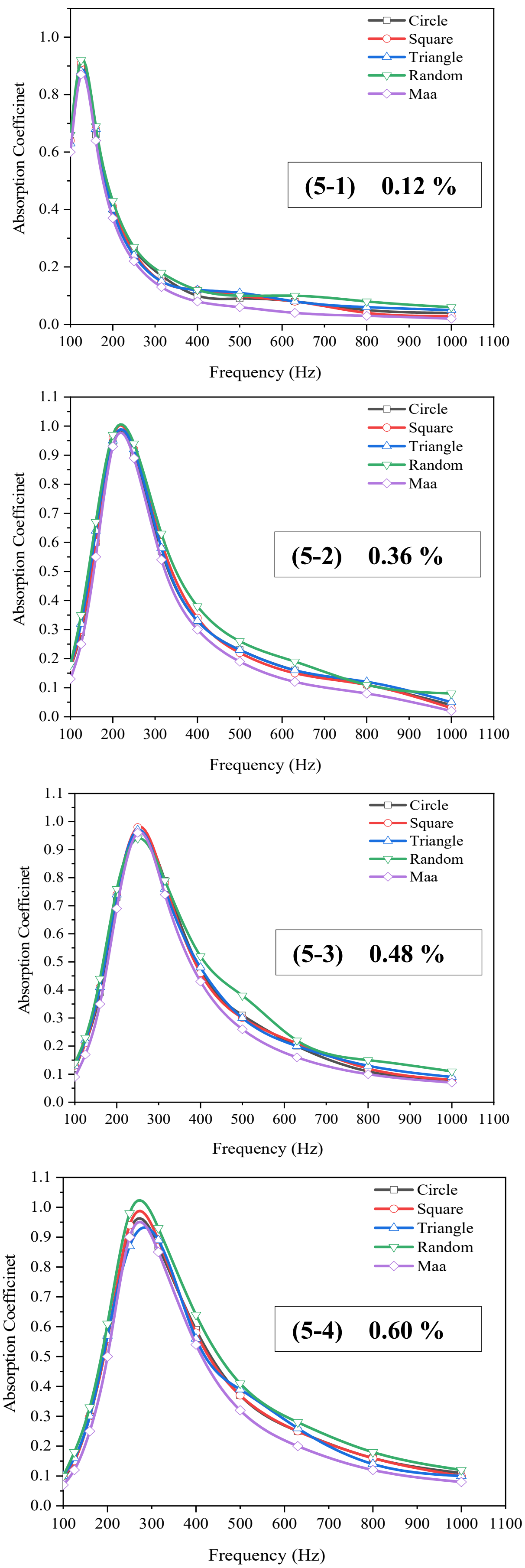
From figures (5-1) to (5-7), it is found that, at all perforation ratios, there is no significant difference between the measured sound absorption coefficients of the four different distribution patterns of orifices. In other words, at each perforation ratio, the absorption coefficients of four distribution patterns have the same behavior and approximately the same amplitudes. It is also revealed that, when the perforation ratio increased, the resonance frequency shifted to higher frequencies. However, increasing the perforation ratio broadened the frequency of the sound absorption; the amplitude of the absorption coefficient decreased. This was due to the decrease in the panel's acoustic mass, which consequently reduces the acoustic resistance. By comparing all distributions patterns of holes at all perforation ratios, it is revealed that the Random pattern is slightly higher than other distribution patterns, and this may be due to:

1. The random distribution of holes on the sample surface covers most of the sample surface, and thus the absorption area over the sample surface increases.

2. By comparing the random distribution with other distribution patterns such as the circular, triangle, and square distribution, for instance, in the case of 0.6 %, it can be seen that the holes are concentrated in a specific area on the sample surface. The rest of the sample surface is a reflective part; accordingly, a great part of the incident sound energy on the sample is reflected. In contrast to the random distribution in which the holes are distributed larger on the sample's surface, consequently, the bulk of the incident sound energy is absorbed.

Table 3: Theoretical and experimental resonance frequency and maximum absorption coefficient at different patterns and different perforation ratios.

σ (%)	Theo.		Exp.							
			Circle		Square		Triangle		Random	
	f_0	α_{max}	f_0	α_{max}	f_0	α_{max}	f_0	α_{max}	f_0	α_{max}
0.12	125	0.87	125	0.9	125	0.91	125	0.88	125	0.92
0.36	200	0.93	200	0.96	200	0.96	200	0.95	200	0.97
0.48	250	0.96	250	0.98	250	0.98	250	0.97	250	0.94
0.60	250	0.90	250	0.94	250	0.94	250	0.87	250	0.98
0.84	315	0.82	315	0.89	315	0.89	315	0.87	315	0.94
1.1	400	0.73	400	0.79	400	0.79	400	0.8	400	0.82
1.9	500	0.56	500	0.66	500	0.62	500	0.61	500	0.69



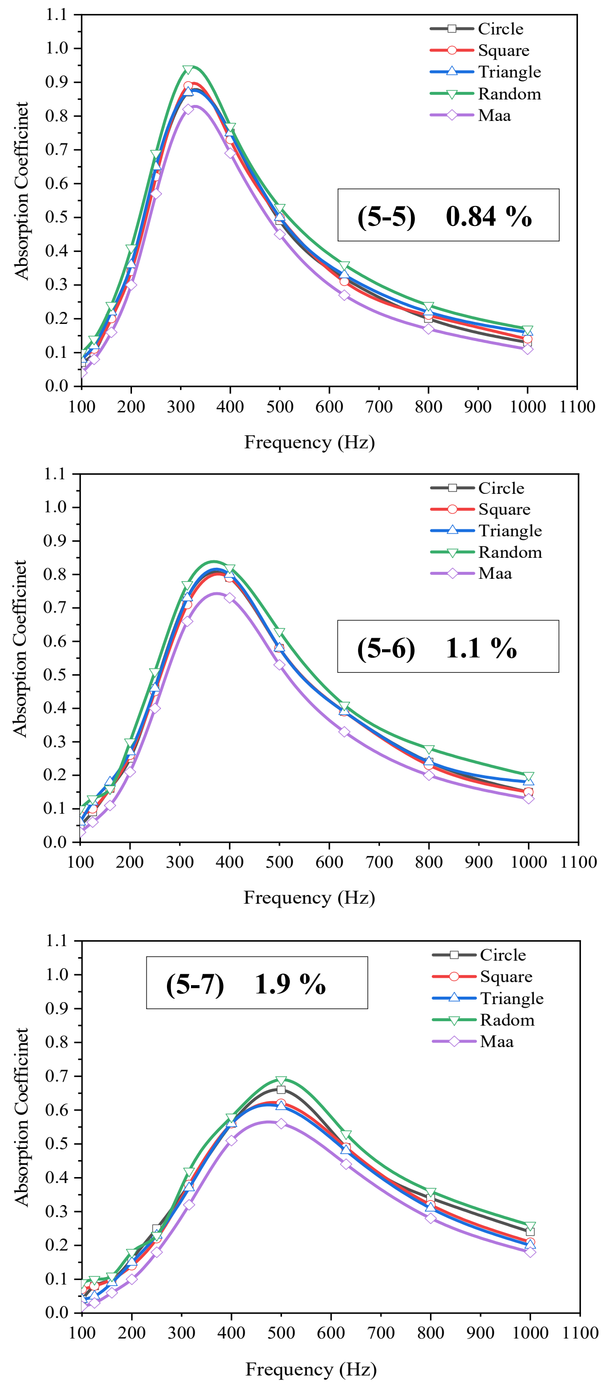


Figure 5: Measured sound absorption coefficient of different samples at different patterns of holes.

It is also demonstrated that there is a proper consistency between the theoretical calculations using Maa's model and the experimental results. Also, there is a coincidence between the calculated resonance frequencies, and those found experimentally at different distribution patterns circle, square, triangle, and random patterns. Moreover, it is revealed that the experimental results have wider frequency bandwidths and higher absorption amplitudes than the theoretical calculations. The inconsistencies between the experimental results and the theoretical calculations could be ascribed to the accompanying reasons: (i) the laser-drilled orifices were not perfectly circular in shape, as shown in figure 6 [26]. (ii) The shavings inside the perforations due to the drilling process are not easily observable for tiny perforations, and consequently, this may alter or change the MPP acoustic behavior [24]. Since all the drilled holes were not consistent and not equal to the designed values of 1mm. (iii) the theory did not consider the variation in the kinematic viscosity coefficient of air μ and the sound speed in air C_0 due to the temperature change in experiments. (iv) The depth of the air gap in the measurements was challenging to be completely consistent with the theoretical values [2].

Figure 6: Profile projector image of laser drilled perforations in imperfect circular shapes.

Figure 7 below compares between the random distribution pattern at each perforation ratio.

However, increasing the perforation ratio broadened the sound absorption, the value of the sound absorption coefficient decreased. The average absorption coefficient of Random pattern at perforation Ratios A, B, C, D, E, F, and G in the frequency range from 100 to 630 Hz are 0.39, 0.51, 0.49, 0.50, 0.46, 0.43, and 0.33, respectively. This means that the samples which provide average sound absorption coefficients above 0.5 are B and D. Furthermore, the maximum absorption coefficient which occurs at the resonance frequency increased by increasing the perforation ratio to a particular value of 0.60 % then it decreases after this ratio, and this coincides with Maa's theory which stated that the optimum sound absorption occurs at perforation ratio ≤ 1.0 %.

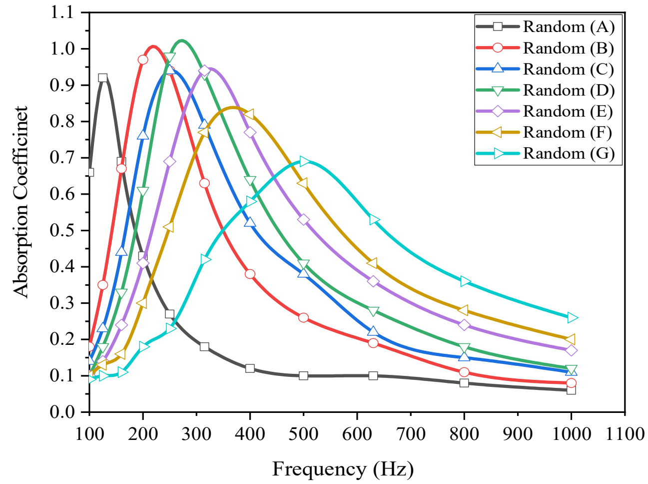


Figure 7: Measured sound absorption coefficient of different samples at Random Pattern.

5.2 Effect of air gap depth

The sound absorption coefficient was experimentally measured at air gap depths of 20 mm, 50 mm, and 100 mm for B and D samples, which have the highest average sound absorption coefficient at random patterns, and the findings are shown in figures 8 and 9.

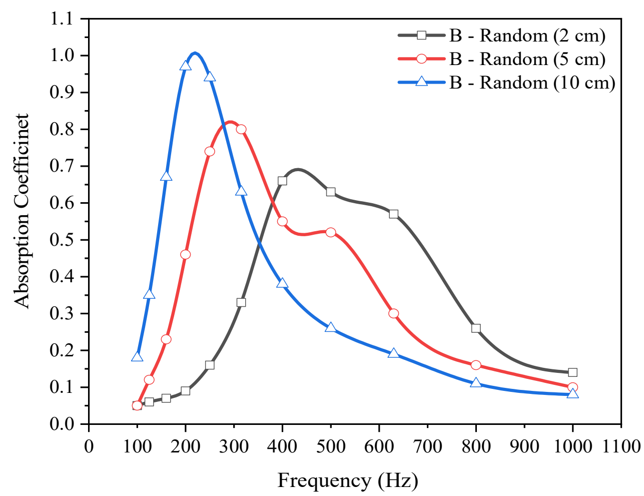


Figure 8: Sound absorption coefficient of sample B at different cavity depths.

It is revealed from figures 8 and 9 that increasing the air gap depth results in shifting the resonance frequency to lower frequencies. The explanation behind that is the MPP and the air gap act as a mass-spring system where the MPP represents the mass, and the cavity represents the spring. Increasing the air cavity depth reduces the stiffness of the spring [26], which in turn shifted the resonance frequency from 400 Hz to 200 Hz in case of sample B and from 630 to 250 Hz in case of sample D. Furthermore, increasing the air gap depth improved the average sound absorption coefficient in the frequency range from 160 Hz to 630 Hz from 0.29 to 0.51 in case of sample B and from 0.30 to 0.50 in case of sample D.

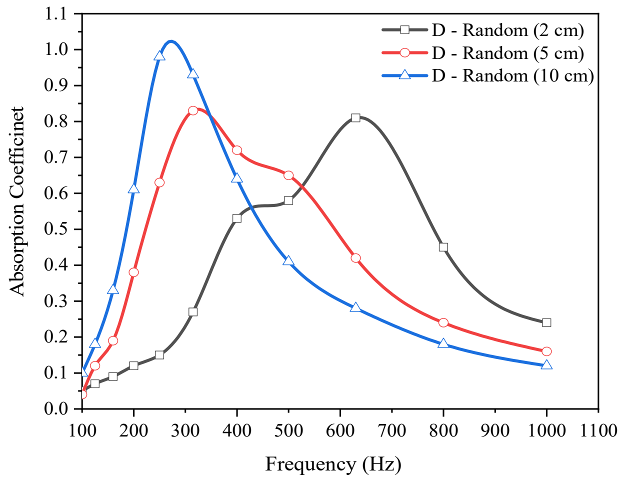


Figure 9: Sound absorption coefficient of sample D at different cavity depths

5.3 Effect of hole geometry

The influence of hole geometries on single MPPs' sound absorption performance at different distribution patterns of holes at a perforation ratio of 0.6 % are presented in figures 10,11 and 12.

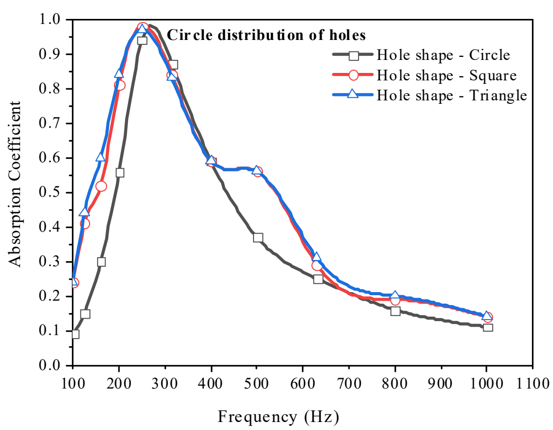


Figure 10: Measured sound absorption coefficient of different hole geometries at Circle distribution pattern.

It is demonstrated from figures 10,11 and 12 that the sound absorption coefficient at square and triangle hole geometries is higher than that of circle hole geometry at different distribution patterns of holes. In other words, in the case of circle distribution of holes, the average sound absorption coefficient is 0.55, 0.66, and 0.67 for circle, square, and triangle hole geometry respectively in the frequency range from 160 to 630 Hz. which means that, when the hole geometry changed from circle to square and triangle, the sound absorption coefficient enhanced by about 11 % and 12 % respectively.

In triangle hole distribution, the average sound absorption coefficient is 0.55, 0.65, and 0.65 for circle, square, and triangle hole shape, respectively, in the frequency range from 160 to 630 Hz, which means that there was an increment of about 10% when the hole shape changes from circle to square and triangle.

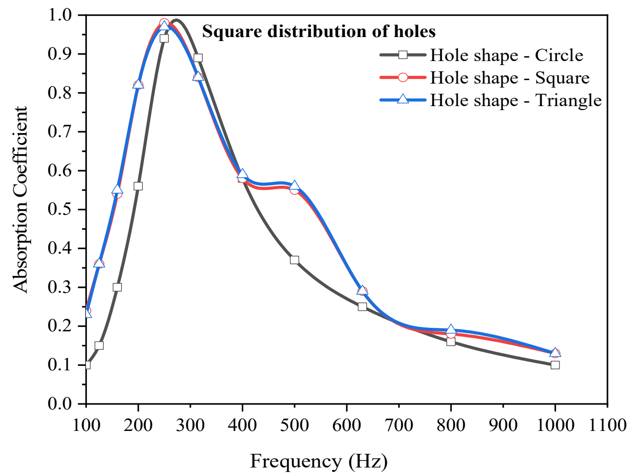


Figure 11: Measured sound absorption coefficient of different hole geometries at Square distribution pattern.

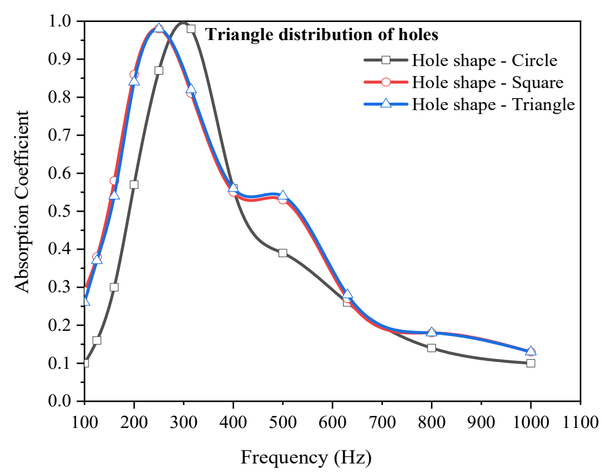


Figure 12: Measured sound absorption coefficient of different hole geometries at Triangle distribution pattern.

6 Conclusion

The influence of different distribution patterns of orifices, air gap depth, perforation ratio, and the hole geometry on single MPPs' sound absorption behavior is investigated. It is concluded that there is no significant difference between the sound absorption coefficients of the different patterns of holes at all perforation ratios. In other words, at all perforation ratios, the absorption coefficients of the four distribution patterns, circle, square, triangle, and Random, have the same behavior and approximately the same amplitudes. Perforation ratios of 0.36 and 0.60 % at a Random pattern provided the highest absorption coefficients where the average sound absorption coefficient was 0.51 and 0.50, respectively, in the frequency range from 160 Hz to 630 Hz. This study also revealed that increasing the air gap depth improved the average sound absorption coefficient in the frequency range from 160 Hz to 630 Hz from 0.29 to 0.51 at perforation ratio 0.36 % and from 0.30 to 0.50 at perforation ratio 0.60 %. Changing the hole geometry from circle to square and triangle enhanced the sound absorption coefficient of about 11 % and 12 %, respectively. Furthermore, a good consistency between the experimental results and the theoretical calculations using Maa's model is obtained.

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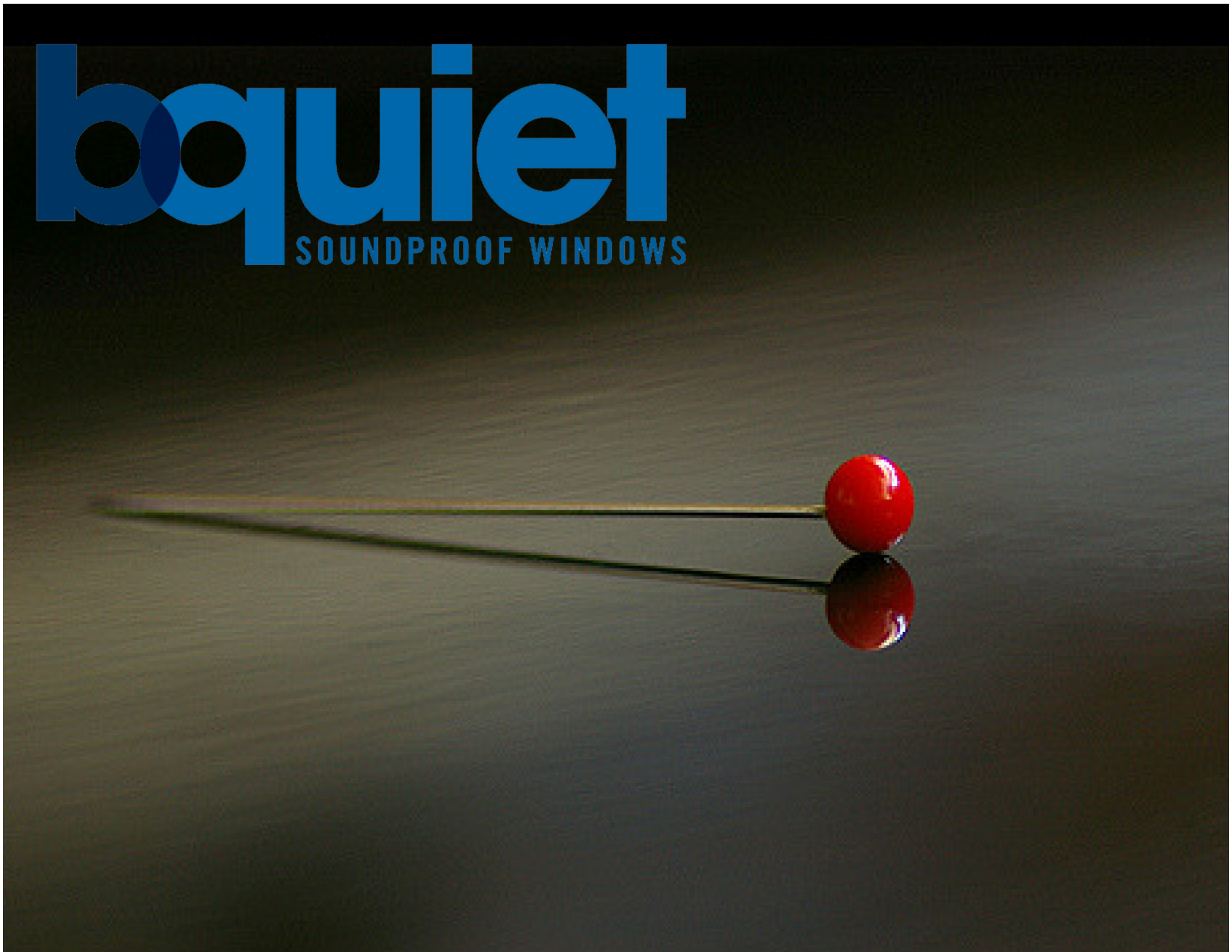
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SOUNDPROOF WINDOWS

Shape Optimization of Extended Tube Muffler Using Threshold Acceptance, Simulated Annealing and FEM Methods

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Résumé

Le bruit d'échappement des moteurs industriels doit répondre aux attentes des clients, aux objectifs législatifs et à la réduction des coûts. Dans cet article, l'optimisation du bruit acoustique d'un silencieux à chambre d'expansion unique doté d'un tube allongé dans un espace limité est effectuée par la maximisation de la perte de transmission sonore (STL) et cela en utilisant la méthode de la matrice de transfert (TMM) et la méthode des éléments finis (FEM). L'optimisation de la géométrie est réalisée à l'aide de nouveaux algorithmes appelés Threshold Acceptance (TA) et Simulated Annealing (SA). Les résultats montrent que les meilleures performances acoustiques sont obtenues avec l'algorithme TA et que la perte de transmission acoustique maximal est précisément localisée sur la tonalité souhaitée. Par conséquent, l'approche optimale sur la conception d'un silencieux à chambre d'expansion unique avec tube allongé présentée dans cette étude fournit une méthode rapide et précise pour l'optimisation de la forme géométrique du silencieux acoustiques dans un espace limité.

Mots clefs : Silencieux réactif, Méthode des éléments finis, Acceptation du seuil, Recuit simulé, Méthode de la matrice de transfert et Puissance acoustique.

Abstract

Exhaust noise must meet customer expectations, legislation targets, and cost reduction that call for design optimization of the exhaust systems. In this paper, a numerical assessment of single expansion-chamber muffler with extended tube used under limited space is performed by the maximization of the sound transmission loss (STL) using the Transfer Matrix Method (TMM) and Finite Element Method (FEM). This shape optimization analysis is performed using novel schemes called Threshold Acceptance (TA) and Simulated Annealing (SA) algorithms. Results show that the best acoustical performance is obtained with TA optimizer and the maximal STL is precisely located at the desired targeted tone. Consequently, the optimal approach on the design of single expansion-chamber muffler with extended tube presented in this study provides quick and novel schemes for the shape optimization of muffler under limited space.

Keywords: Reactive muffler, Finite element method, Threshold Acceptance, Simulated Annealing, Transfer Matrix Method, and Sound Acoustic Power

1 Introduction

The most common element used to reduce generator exhaust noise are reactive mufflers. Reactive mufflers are available in a wide range regarding cost and performance. The noise is reduced by forcing the exhaust air to pass through a series of tubes and chambers. Each element of the muffler has sound reduction properties that vary greatly with acoustic frequency.

Research works on the sound attenuation of mufflers started by Davis and al. in 1954 [1]. To predict the acoustic performance of mufflers Bilawchuk and Fyfe [2] presented a comparison of various numerical methods to analyze the sound behavior of mufflers.

The most common type of linear acoustic model applies classical electrical filter theory widely known as the transfer matrix method [3] also referred as the method of 4-poles parameters Munjal 1987 [4-6]. Later Craggs in 1989 [7-9] developed a technique that combines the Transfer Matrix method and the Finite Elements Method to study the acoustic attenuation of a duct.

The space volume of mufflers is often limited for maintenance and operation reasons. Therefore, there has been an increasing interest in designing mufflers used under space constraints by optimizing the STL using shape optimization methods. In 1986, Bernhard [10] proposed the shape optimization of simple expansion muffler using a non-constrained space.

In 2002, Yeh et al [11] presented a shape optimization method of a simple-chamber muffler, designed to work in a limited space, by using Transfer Matrix Method (TMM) conjugated with a three-dimensional graphic analysis. To obtain a good acoustic performance for the shape optimisation of mufflers, novel schemes have appeared such as Genetic Algorithm (GA) and Simulating Annealing (SA) [12-14]. Min-Chie and Yeh [15] used Boundary Element Method, Mathematic Gradient Method and Genetic Algorithm to optimize a constrained muffler composed of a single chamber connected to inlet/outlet sides. The results of this optimization showed that those methods are very

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important to predict and attenuate the noise of mufflers. This paper discusses the noise attenuation.

2 Theoretical and numerical assessment

2.1 Silencer representation

Reactive silencers, commonly used in automotive applications, reflect the sound waves back towards the source and prevent sound from being transmitted along the pipe. The design of silencer is based on the principle of a Helmholtz resonator. It requires the use of acoustic transmission line theory. The Figure 1 shows an outline of the muffler used in this paper, it consists of a concentric expansion chamber with an extended inlet pipe and an end outlet pipe.

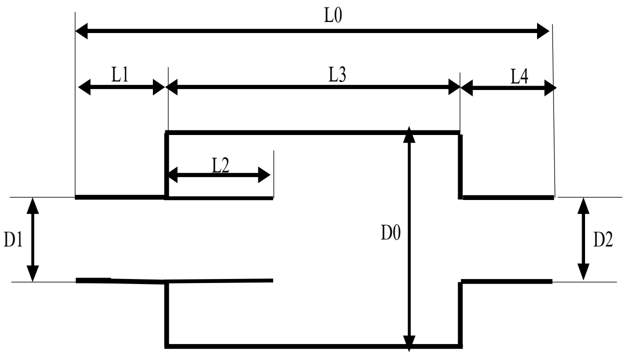

Figure 1: Sketches of the expansion-chamber muffler with extended inlet tube.

The most widely used performance characterizing mufflers is the transmission loss (STL), other indexes are however available such as insertion loss (IL) and the pressure loss (PL). STL only depends on the muffler and not on the source (inlet and outlet length) nor on impedance. It is considered as the best parameter to use when comparing different methods, and designs [7]. In this paper, two approaches were used to analyze the acoustic performance of single expansion-chamber muffler with extended tube under chosen limited space (L= 1.6 m, D0 = 0.5 m) [11, 14]. These approaches are the Sound acoustic power and the Transfer matrices methods. The computational models are developed using Matlab Tool for the shape optimization by Threshold Acceptance and Simulated Annealing algorithms and the COMSOL Multiphysics Tools for the finite element analysis.

2.2 Shape optimization method

Transfer Matrix Method (TMM) is based on the plane waves models that can offer fast initial prototype solutions for the assessment of muffler's optimal shape design. In this paper, the four-pole system matrix evaluating the acoustic performance using sound transmission loss parameter (STL) is derived by using a decoupled numerical method [10]. Two optimization methods using Threshold Acceptance and Simulated Annealing algorithms are applied on the shape optimizations of the expansion-chamber muffler with inlet extended tube. Figure 2 represent the acoustical elements of the muffler, the acoustic pressure ***p***, and the acoustic particle velocity ***u***.

Notation

dw	*acoustic energy*
Di	*diameter of muffler's components (m)*
$iter_{max}$	*maximum iteration*
Li	*length of muffler's components (m)*
Mi	*mean flow Mach number at i*
P	*total flow pressure (Pa)*
Pi	*pressure; acoustic pressure at i (Pa)*
pb(T)	*transition probability*
Q	*volume flow rate of venting gas (m3 s-1)*
Si	*section area at i (m2)*
To	*initial temperature (°C)*
v_i	*Acoustic mass velocity at i (kg s-1)*
w_i	*Incoming power at the inlet*
w_o	*Outgoing power at the outlet*

As shown in Figures 1 and 2, the single-expansion chamber muffler with extended inlet tube is composed of one-inlet tube elements, two straight ducts and one contraction duct element. Seven nodes represent the related acoustic pressure ***p*** and acoustic particle velocity ***u*** within the muffler. Because of the remarkably pure tone noise effect at 300 Hz [16], noise elimination at this frequency by shape optimization is applied.

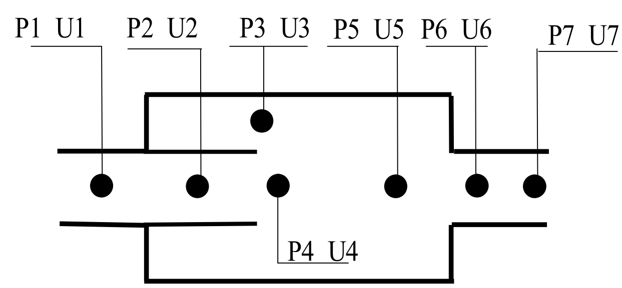

Figure 2: Sketches of the one-dimensional plane wave propagation expansion-chamber muffler with extended inlet tube.

2.3 Theoretical formulation

The four-pole system matrix evaluating the acoustic performance known as TMM uses 2 x 2 matrices to relate two variables at planes on either side of an acoustic component. The matrices for individual components can be readily combined to form a single, overall matrix that describes the behavior for a multi-component muffler system [6].

$$\begin{pmatrix} p_1 \\ u_1 \end{pmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{pmatrix} p_7 \\ u_7 \end{pmatrix}. \qquad (1)$$

As per the plane wave theory, the individual transfer matrices between the following distribution points: 1 and 2; 3 and 5; 5 and 6; 6 and 7 are calculated, below is an example between points 1 and 2:

$$\begin{pmatrix} p_1 \\ \rho_0 c_0 u_1 \end{pmatrix} = e^{-j\frac{jM_1 kL_{12}}{\left(1-M_1^2\right)}}$$

$$\begin{bmatrix} \cos\left(\frac{kL_{12}}{1-M_1^2}\right) & j\sin\left(\frac{kL_{12}}{1-M_1^2}\right) \\ j\sin\left(\frac{kL_{12}}{1-M_1^2}\right) & \cos\left(\frac{kL_{12}}{1-M_1^2}\right) \end{bmatrix} \begin{pmatrix} p_2 \\ \rho_0 c_0 u_2 \end{pmatrix}; \quad (2)$$

where $\rho 0$, k, M and c_0 represent respectively the air density, wave number, Mach number and wave celerity.

For the Extended Tube, the equation of mass continuity between point 2 and point 4 is used with mean flow [5-11], the transfer matrix is illustrated as:

$$\begin{pmatrix} p_2 \\ \rho_0 c_0 u_2 \end{pmatrix} = \begin{bmatrix} t_{1,1} & t_{1,2} \\ t_{2,1} & t_{2,2} \end{bmatrix} \begin{pmatrix} p_4 \\ \rho_0 c_0 u_4 \end{pmatrix}. \quad (3)$$

Assembling the individual matrices for all points, we can write:

$$\begin{pmatrix} p_1 \\ \rho_0 c_0 u_1 \end{pmatrix} = \begin{bmatrix} T_{1,1} & T_{1,2} \\ T_{2,1} & T_{2,2} \end{bmatrix} \begin{pmatrix} p_7 \\ \rho_0 c_0 u_7 \end{pmatrix}. \quad (4)$$

The STL of a muffler calculated as [5]

$$STL\ (f, Q, R_1, R_2, R_3, R_4) = 20\log\left(\frac{T_{1,1} + T_{1,2} + T_{2,1} + T_{2,2}}{2}\right) + 10\log\left(\frac{S_1}{S_2}\right); \quad (5)$$

where f is the wave frequency, S_1, S_2 the sections and Q represent the sound flow.

$$R_1 = \frac{D_1}{D_0}; R_2 = \frac{D_2}{D_0}; R_3 = \frac{L_3}{L_0}$$

$$R_4 = \frac{L_2}{L_0} \quad L_1 = \frac{1}{2}\left(L_0 - L_3\right) \quad L_4 = \frac{1}{2}\left(L_0 - L_3\right)$$

$L0=L1+L3+L2$

.

2.4 Simulated annealing algorithm

Simulated annealing is a generalization of a Monte Carlo method for examining the equations of state and frozen states of n-body systems [Metropolis et al. 1953] [17]. The concept is based on the way liquids freeze or metals re-crystallize in the process of annealing. In the annealing process of a melt, initially at high temperature and disordered, the metal is slowly cooled so that the system at any time is approximately in thermodynamic equilibrium. As cooling proceeds, the system becomes more ordered and approaches a "frozen" ground state at T=0. Hence, the process is considered as an adiabatic approach to the lowest energy state. If the initial temperature of the system is too low or cooling is done insufficiently slowly, the system may become quenched forming defects or freezing out in metastable states (means trapped in a local minimum energy state) [18].

To imitate the evolution of the SA algorithm, a new random solution (X') is chosen from the neighborhood of the current solution (X). If the change in objective function (or energy) is negative (ie. ΔF≤0), the new solution will be acknowledged as the new current solution with transition property (pb(X')) of 1.

If not (ie. ΔF>0), the new transition property (pb(X')) varied from 0~1 will be first calculated by the Boltzmann's factor (pb(X') = exp (pb (X') =exp (ΔF/CT)) as shown in mufflers [16].

$$\text{pb(X')} = \begin{pmatrix} 1, \Delta F \le 0 \\ \exp(-\frac{\Delta F}{CT}), \Delta f > 0 \end{pmatrix}; \quad (6)$$

$$\Delta F = F(X') - F(X)$$

where C and T are the Boltzmann constant and current temperature respectively; moreover, compared with the new random probability of rand (0, 1). If the transition property (pb(X')) is greater than a random number of rand (0, 1), the new worse solution which results in a higher energy condition will then be accepted. Otherwise, it is rejected. The algorithm repeats the perturbation of the current solution and the measurement of the change in the objective function. To reach an initial transition probability of 0.5, the initial temperature (T0) is selected as 0.2 [16]. Each successful substitution of the new current solution will lead to the decay of the current temperature as:

$$Tnew = kk * Told; \quad (7)$$

where kk is the cooling rate.

The process is repeated until the predetermined number (iter) of the outer loop is reached.

2.5 Threshold acceptance algorithm

The Threshold Accepting metaheuristic algorithm (TA) is a modification of the Simulated Annealing metaheuristic [19]. TA algorithm uses a predetermined deterministic sequence to decide whether a new point is selected or not (if worse than the current point), whereas the simulated annealing algorithm probabilistically determines in every iteration. Dueck and Scheurer [20] simplified the Simulated Annealing procedure by leaving out the probabilistic element in accepting worse solutions. Instead, they introduced a deterministic threshold,$\boldsymbol{\tau}$ and a worse solution is accepted if its difference to the incumbent solution is smaller or equal to the threshold. The new procedure is named Threshold Accepting algorithm.

The key components of TA are the function g(t) that determines the lowering of the threshold during the procedure, stopping criteria as well as the methods used to create initial and neighboring solutions. The main advantages of TA are its conceptual simplicity and its excellent performance on different combinatorial optimization problems [21].

2.6 FEM analysis method

In this paper, the finite element analysis method is used to analyze the acoustic performance of the shape optimized expansion-chamber muffler by using the available COMSOL Multiphysics tool including 3D linear acoustic codes. The analyze is programmed with and without mean flow, where the most important effect of flow, without considering the mean flow, is included by altering the boundary conditions of the muffler [22].

The FEM model solves the problem in the frequency domain using the time-harmonic pressure acoustics mode [23]. The equation of the model is a slightly modified version of the Helmholtz equation for the acoustic pressure, *p*:

$$\nabla . \left(-\frac{\nabla p}{\rho} \right) - \frac{\omega^2 p}{c_s^2 \rho} = 0 \; ; \qquad (8)$$

where $\omega = 2\pi f$, and where ω, ρ, c_s are respectively the angular frequency, the fluid density, and the speed of sound.

The software computes integrals in the power expressions using boundary integration coupling variables, and it plots the resulting attenuation versus frequency.

The following equation defines the attenuation of the acoustic energy $d_w(dB)$:

$$d_w = 10 \log \left(\frac{w_0}{w_i} \right) \cdot \qquad (9)$$

Here w_0 and w_i denote the outgoing power at the outlet and the incoming power at the inlet, respectively. Each of these quantities calculated as an integral over the corresponding surface *A*:

$$w_0 = \int_{\partial\Omega} \frac{|p|^2}{2\rho c_s} dA \cdot \qquad (10)$$

$$w_i = \int_{\partial\Omega} \frac{p_0^2}{2\rho c_s} dA \cdot \qquad (11)$$

The sound transmission loss is calculated directly in COMSOl tool using the acoustic power at the inlet and the outlet of the acoustic system. The shape-optimized muffler is simulated using a three-dimensional model and meshed by using the Lagrange-quadratic elements. A harmonic pressure of 1Pa is specified at the inlet's muffler and a radiation boundary condition is applied at the inlet and outlet. Then a material with default values of air is created with density of 1.2 kg/m3, and the sound speed is 340 m/s. using the default values of air, the acoustic damping of air is not considered.

3 Case studies

To check the transmission loss model on the basic single-chamber muffler a comparison between theoretical and experimental data is performed in this paper [3]. As shown in figure 3, there is a coherence between the theoretical results based on transmission matrix method (TMM) and experimental data. Hence, the transmission loss model is acceptable and can be used to the studied models.

The available space selected for the muffler is 0.3 m in width, 0.3 m in height, and 1.5 m in length. To obtain the best acoustical performances of the muffler within a fixed space; a pure tone noise of 300 Hz is introduced as a numerical case.

A maximization of the sound transmission loss is performed with respect to the shape-optimized muffler obtained by simulated annealing and threshold acceptance algorithms. For the purpose of an accuracy check, various targeted pure tones (250, 500, 700, 800Hz) are applied.

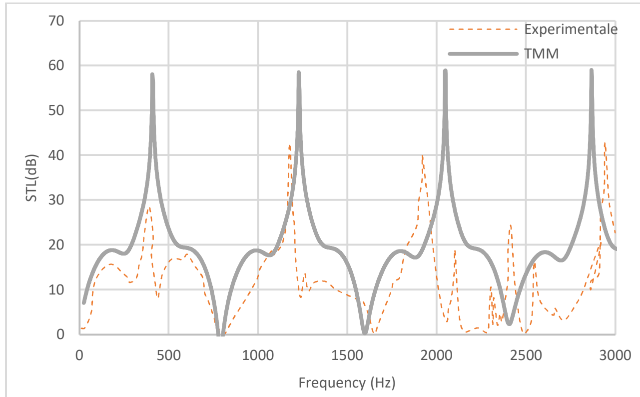

Figure 3: Performance curves of Sound transmission loss (STL), comparison between TMM theoretical model and experimental values of simple expansion chamber muffler [3].

In the second part of this work, we examine the sound transmission properties of the idealized expansion-chamber muffler with extended inlet tube by finite element method with a data tool COMSOL Multiphysics. 3D simulation analysis is used in this step with parametric solver providing results for a range of frequencies. The software computes integrals in the power expressions using boundary integration coupling variables, and it plots the resulting attenuation versus frequency.

Objective function

As per formula (5) and under the assumption of the symmetric design (L1 = L2 = (L0-L3)/2), the objective function maximizing the sound transmission loss at a pure tone (*f*) [11] is

$$Obj = STL\left(f, Q, R_1, R_2, R_3, R_4\right) \cdot \qquad (12)$$

The related ranges of parameters are $Q = 0.01\ (m3/s)$; R_1: [0. 2, 0.8]; R_2: [0. 2, 0.8]; R_3: [0.5, 0.9]; R_4: [0.5, 0.9].

As mentioned, the optimization process done by simulated annealing and threshold acceptance algorithms with respect to the objective function *Obj* is performed by varying the control parameters: cooling rate (*kk*) and the number of iteration ($iter_{max}$).

4 Results and discussion

One of the important parameters for the optimization accuracy used by the SA and TA algorithms are the cooling rate (*kk*) and the number of iteration ($iter_{max}$) (cave et al., 2002). The Shape optimization of the muffler is performed with Matlab tool by varying the two parameters gradually during optimization process, then the numerical prediction is compared with the finite element's solution.

The sound control of pure tone noise with 300 Hz is introduced as the numerical case.

Various sets of parameters are tested during optimal process; Table 1 and 2 show the simulated result optimized with respect to the pure tone of 300Hz. The optimal design data is obtained at the cooling rate kk = 0.99 and iteration number $iter_{max}$ =5000 for the Simulated Annealing (SA) and kk = 0.94 and iteration number $iter_{max}$=5000 for Threshold Acceptance (TA).

The acoustic performances of sound transmission loss, with respect to frequency in various design case, are plotted in figures 4 and 5, for the SA and TA methods respectively, we notice that at frequencies higher than approximately 750 Hz, which represent the cut-off frequency, there is generally less damping.

The plots reveals also that the highest values of the parameters (kk, $iter_{max}$) gave the highest STL and these attenuations are roughly maximized at the desired frequencies, therefore, kk and $iter_{max}$ parameters variation play essential roles in SA and TA optimizations and using these optimization methods in finding the optimal design solution is reliable.

By using the optimal design in a theoretical calculation of the expansion-chamber muffler, the muffler's optimal sizes with respect to various pure tones are shown in Tables 3 and 4, for the SA and TA methods respectively.

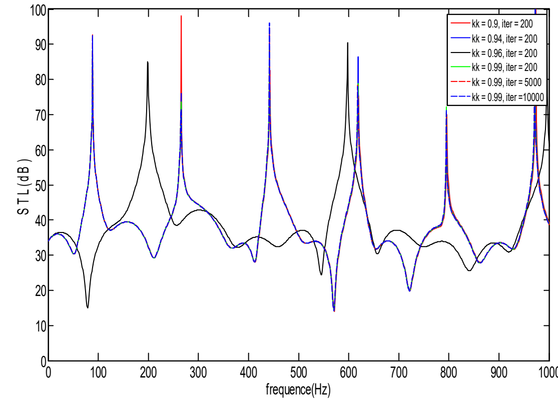

Figure 4: Performance curves of STL with respect to various maximal iterations ($iter_{max}$) by Simulated annealing (To = 0.2).

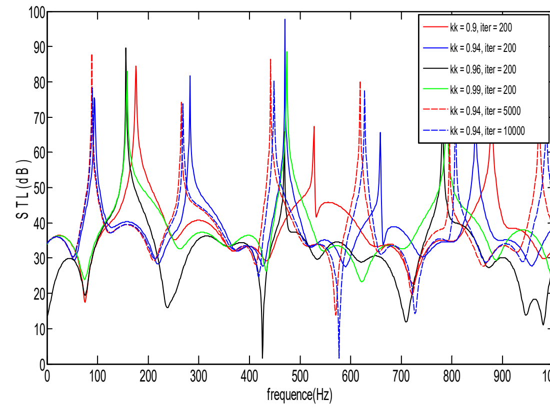

Figure 5: Performance curves of STL with respect to various maximal iterations ($iter_{max}$) by Threshold acceptance (To = 0.2).

Table 1: Optimal STL by SA method with targeted tone of 300 Hz and various kk and $iter_{max}$ (iter).

Case	SA parameters	Results				
		R1	R2	R3	R4	STL (dB)
1	kk = 0.9, $iter_{max}$ = 250	0,100000000	0,100005595	0,799180631	0,799289484	34,239752
2	kk = 0.93, $iter_{max}$ = 250	0,100001448	0,100243207	0,79995194	0,799371918	34,232275
3	kk = 0.96, $iter_{max}$ = 250	0,100000008	0,100010386	0,799902935	0,35483868	33,049906
4	kk = 0.99, $iter_{max}$ = 250	0,100000008	0,100000000	0,799773512	0,799833439	34,245198
5	kk = 0.99, $iter_{max}$ = 500	0,100000002	0,100000003	0,799999629	0,798960195	34,241627
6	kk = 0.99, $iter_{max}$ = 1000	0,100000001	0,100000000	0,79999991	0,799998591	34,246961
7	kk = 0.99, $iter_{max}$ = 1500	0,100000000	0,100000000	0,799999964	0,799999797	34,246967
8	kk = 0.99, $iter_{max}$ = 2000	0,100000000	0,100000039	0,79998701	0,799998671	34,246908
9	kk = 0.99, $iter_{max}$ = 5000	0,100000000	0,100000000	0,799999989	0,799999981	34,246968
10	kk = 0.99, $iter_{max}$ = 10000	0,100000000	0,100000000	0,799980814	0,799998117	34,246882

Table 2: Optimal STL by TA method with various kk and $iter_{max}$ (Targeted tone of 300 Hz).

Case	TA parameters	Results				
		R1	R2	R3	R4	STL (dB)
1	kk = 0.9, $iter_{max}$ = 250	0,100001665	0,100003713	0,799999117	0,402021553	33,1111
2	kk = 0.94, $iter_{max}$ = 250	0,100049917	0,100455321	0,79788546	0,753029291	33,9849
3	kk = 0.96, $iter_{max}$ = 250	0,343493076	0,100000031	0,767402627	0,471203302	30,6808
4	kk = 0.99, $iter_{max}$ = 250	0,100394942	0,100003418	0,743257284	0,481595607	32,8829
5	kk = 0.94, $iter_{max}$ = 500	0,10000002	0,100377302	0,798539371	0,799987046	34,2238
6	kk = 0.94, $iter_{max}$ = 1000	0,101163199	0,100004002	0,799895123	0,470203404	33,1370
7	kk = 0.94, $iter_{max}$ = 1500	0,100060575	0,102657842	0,767058504	0,795454055	33,9477
8	kk = 0.94, $iter_{max}$ = 2000	0,107972696	0,100286787	0,788587376	0,608442604	32,7582
9	kk = 0.94, $iter_{max}$ = 5000	0,10000466	0,100007901	0,799544694	0,799988801	34,2441
10	kk = 0.94, $iter_{max}$ = 10000	0,100000893	0,10059617	0,788518539	0,799312242	34,1680

Table 3: Optimal STLs by SA for expansion-chamber muffler with extended inlet tube with respect to various targeted frequencies (kk=0.99, itermax =10000).

Case	Target frequency	Results				
		R1	R2	R3	R4	STL (dB)
1	250Hz	0,100000000	0,100000000	0,799999993	0,799999989	33,4685
2	500Hz	0,100000000	0,100000040	0,800000000	0,800000000	37,9647
3	700Hz	0,181190078	0,350935552	0,792555241	0,640175448	113,1414
4	800Hz	0,115139572	0,155598287	0,719181217	0,61730614	118,0296

Table 4: Optimal STLs by TA for expansion-chamber muffler with extended inlet tube with respect to various targeted frequencies (kk= 0.99, itermax = 10000).

Case	Target frequency	Results				
		R1	R2	R3	R4	STL (dB)
1	250Hz	0,100507767	0,100843896	0,79543887	0,790742762	33,2806
2	500Hz	0,1	0,1	0,8	0,8	37,9647
3	700Hz	0,180830576	0,131903453	0,678432782	0,747856159	122,4975
4	800Hz	0,184036953	0,496377168	0,767474176	0,578452178	131,5955

The optimal STL curves with respect to targeted frequencies are plotted in figure 6 and 7 according to SA and TA methods respectively. The case studies show that increasing the pure tone expands the frequency bandwidth and the STLs are precisely maximized at the desired frequencies and TA method improves the acoustical performance of the muffler better than SA method.

The second part of this study, concern a 3D analysis by FEM of the propagation modes of the shape optimized expansion-chamber muffler with extended tube with target tone of 800Hz.

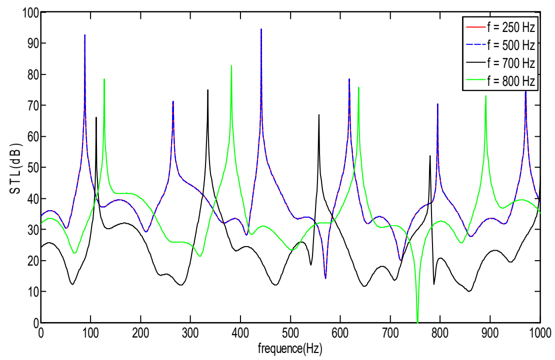

Figure 6: STL with respect to frequencies of the muffler for various pure tones of SA (Targeted frequency: 250, 500, 700 and 800 Hz

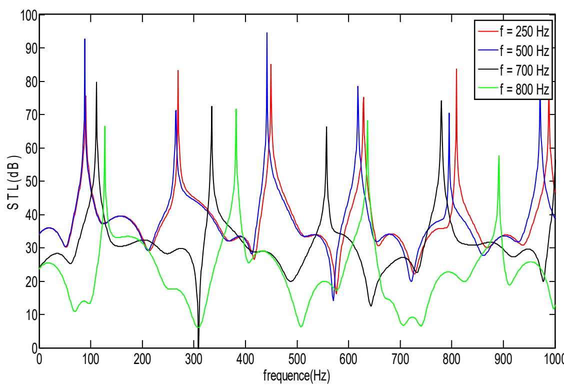

Figure 7: STL with respect to frequencies of the muffler for various pure tones of TA (Targeted frequency: 250, 500, 700 and 800 Hz).

This analysis method is performed using COMSOL tool, the optimal shape design of the muffler according to the SA and TA methods are designed, we applied the required boundary conditions and performed the meshing with a coarse predefined mesh sizes with 0.25 x – direction scale. The internal sound pressure distribution at 1500 Hz of the shape-optimized mufflers using the two methods is displayed in figure 8 and 9.

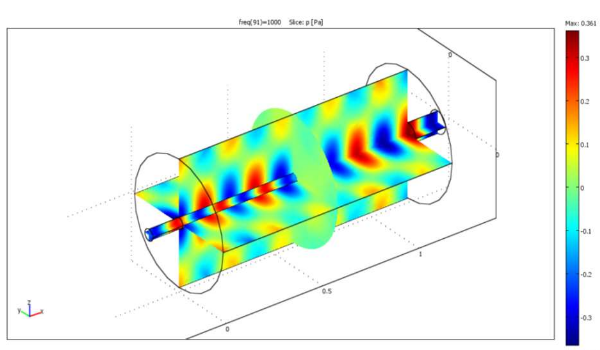

Figure 8: Optimized FEM model of the muffler using SA and internal sound pressure distribution at 1500 Hz (3D View)

We notice that the attenuation is more important in the shape optimized muffler with TA method than with SA method. In addition, the pressure field varies primarily with

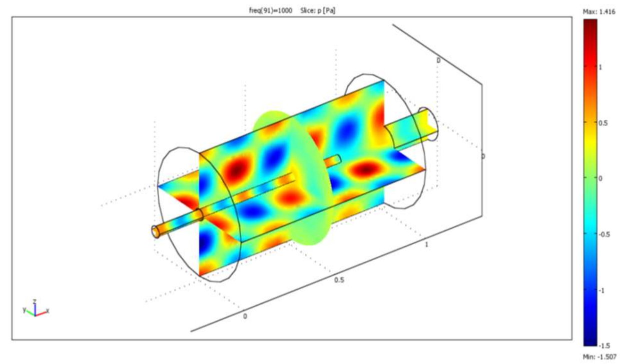

Figure 9: Optimized FEM model of the muffle using TA and internal sound pressure distribution at 1500 Hz (3D View)

the y-coordinate, while it is nearly constant in the z direction as the frequency 1500 Hz is just higher than the cut-off frequency for the first symmetric propagating mode excited by the incoming wave. We can also observe for the selected frequencies how the distributions of the sound pressure level near the muffler extended inlet and outlet tube is important.

Figures 10 and 11, plots the theoretical transmission loss based on the TMM (blue line) and the COMSOL Multiphysics solution (red line) as a function of frequency for the two shape optimised mufflers by SA and TA method.

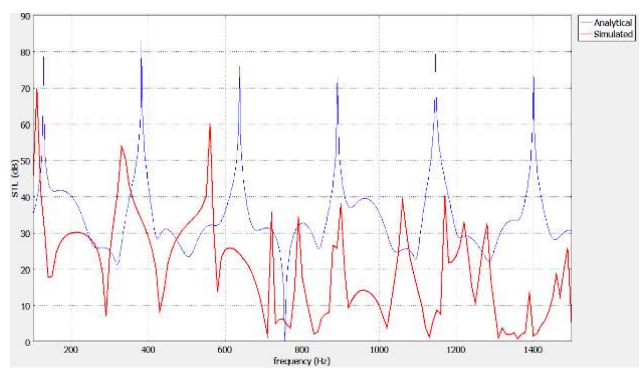

Figure 10: Shape optimization by SA; STL versus Frequency: theoretical solution (blue line) and COMSOL Multiphysics solution (red line) (Targeted frequency: 800Hz).

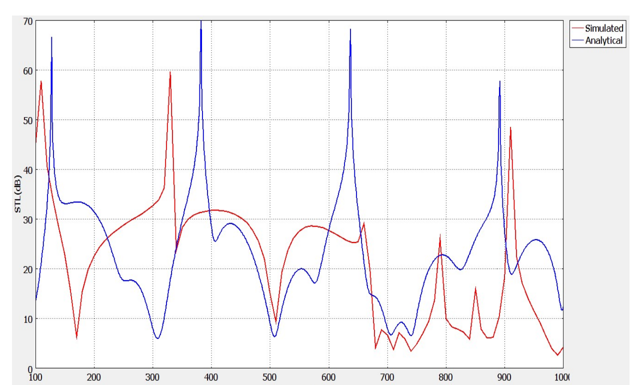

Figure 11: Shape optimization by TA, STL versus Frequency: theoretical solution (blue line) and COMSOL Multiphysics solution (red line) (Targeted frequency: 800Hz).

The FEM solution has an upper frequency limit for its validity known as the cut-off frequency, which defines the frequency range where only plane waves can propagate; above this frequency, also higher modes can propagate.

At frequencies higher than approximately 750 Hz, the plot's behavior is more complicated and there is generally less damping. This is because, for such frequencies, the tube supports not only longitudinal resonances but also cross-sectional propagation modes.

We notice from figures 10 and 11 that a discrepancy exists between the theoretical and the FEM solution. Even below the cut-on frequency, this discrepancy is due to those the elementary transfer matrices depend on the element that is modelled. The transmission loss (STL) calculated by TMM is independent of the source and does not involve neither the source nor the radiation impedance of the termination, whereas for the sound acoustic power method, it depends only on the sound source and does not allow the transfer matrices of the acoustic system to be obtained.

The differences obtained in the results plot may also be attributed to finite element formulation used in COMSOL tool that is Lagrange elements or to the computational applied meshes (density and refinement).

In figure 12, we compare the theoretical results between SA and TA optimization methods, as shown in the figure, the attenuation discrepancy between the TA and SA method is about 10dB. Same comparison and result is done for the attenuation obtained by the FEM solutions between the SA and TA optimization methods, as shown in Figure 13.

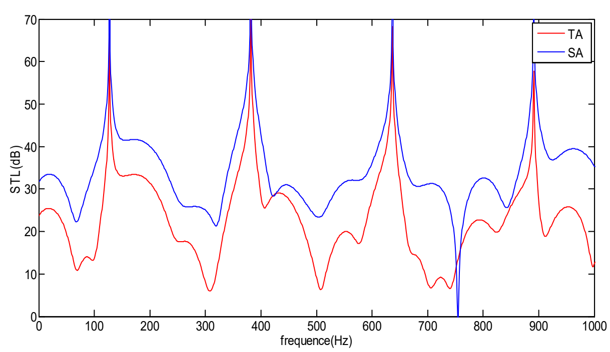

Figure 12: Comparison of the theoretical solution based on the TMM between SA and TA (Targeted frequency: 800Hz).

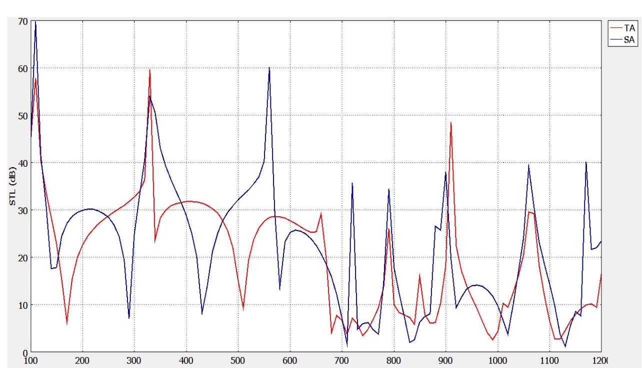

Figure 13: Comparison of the FEM solution between SA and TA (Targeted frequency: 800Hz).

5 Conclusion

The shape optimization of Expansion chamber Muffler with inlet extended tube under space constraints is applied in this paper by using two novel schemes Simulated annealing and Threshold Acceptance coupled with 3D Finite Element analysis,

The SA and TA optimizers are based on the Transfer Matrices Method applying the plane wave theory as well as four-pole transfer matrices. The optimization process of the reactive muffler showed the importance of the parameters (kk*,* $iter_{max}$), also it reveals that this method is valid when the influence of high order modes can be neglected.

This numerical analysis using SA and TA optimizers has shown to be an interesting method to optimize reactive mufflers under space constraints.

The comparison between the numerical prediction based on the TMM and the FEM solution based on the sound acoustic power has shown discrepancies in the curves. This is due to that the first method depends only on the element, which is modelled, and not on the sound source. Whereas for second method depend on the sound source and does not allow the transfer matrices of the acoustic system to be obtained, also it depends on the finite element formulation and the computational meshes used in COMSOL tools.

The optimization method coupled with the FEM analysis revealed that the TA has a better acoustic performance than SA. Consequently, the approach used for the optimal design of the STL proposed in this study is interesting in dealing with the reactive muffler within a space-constrained situation.

Acknowledgments

Many thanks to all the staff of the Mechanical Engineering Department of the University of Bejaia for supporting me to achieve this work.

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Screening For Diotic Acoustic Context And Headphones In Online Crowdsourced Hearing Studies

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Résumé

Des preuves expérimentales suggèrent que les expériences en ligne financées par la foule, lorsqu'elles sont adaptées, peuvent produire des données de qualité comparable aux études en laboratoire (Buhrmester, Kwang, Gosling, 2011). L'absence d'une méthode de filtrage fiable pour les casques et le contexte auditif diotique (séparation parfaite des canaux stéréo) est l'une des principales raisons pour lesquelles le crowdsourcing en ligne est rarement possible pour les études auditives. Nous montrons ici que le phénomène des battements parasites peut être utilisé comme méthode de dépistage du contexte diotique avec des résultats satisfaisants. Nous avons recueilli des données par le biais d'une expérience en laboratoire auprès de plus de 2000 participants afin de tester les performances de la méthode par rapport à la référence. Le Kappa de Cohen est de 0,79 (IC 95%, [0,52, 1,06], p<0,001), ce qui donne un "accord substantiel". Les résultats obtenus en laboratoire et en ligne suggèrent que la méthode introduite dans cette étude est adaptée et, par conséquent, qu'elle permet de réaliser des études auditives en ligne basées sur le crowdsourcing.

Mots clefs : dicotique, écouteurs, dépistage, crowdsource, étude en ligne

Abstract

Experimental evidence suggests that crowdsourced online experiments, where suitable, may produce data with quality comparable to in-lab studies (Buhrmester, Kwang, Gosling, 2011). The absence of a reliable screening method for headphones and diotic auditory context (perfect separation of the stereo channels) is one of the main reasons why online crowdsourcing is rarely possible for auditory studies. Here we show that the interference beating phenomenon can be used as a screening method for diotic context with satisfactory results. We collected data through an in-lab experiment from over 2000 participants to test the method's performance against the reference, achieving Cohen's Kappa of 0.79 (95% CI, [0.52, 1.06], p<0.001), yielding "Substantial agreement". The in-lab and online results suggest that the method introduced in this study is suitable, and therefore, an enabler of auditory online crowdsourced studies.

Keywords: diotic, headphones, screening, crowdsource, online study

1 Introduction

The benefits of the interconnected world enable some scientific research to be conducted online with the help of crowdsourced participants, increasing the ability to collect data with large sample sizes. Such studies cost less than if conducted in-lab. Especially in present years (2020, 2021) when people are isolated due to the COVID 19 pandemic, the ability to perform online research is imperative. Researchers are already using Internet-based services to recruit participants from all around the world, such as Amazon's Mechanical Turk or the advertising Google's AdWords service [1-4]. The findings in [3] and [5] even suggest that the samples collected through Amazon's Mechanical Turk are at least of the same quality and as diverse as those collected through traditional means; of course, this is true only for studies where online experiment are appropriate. Considering that, one would think that auditory studies could largely benefit from using online services. Unfortunately, that is not yet the case because online participants are using hardware devices and software (and the rest of the auditory context) that are not under the researcher's control. Therefore, when the experiment design requires strict diotic auditory context (*diotic* means perfect auditory separation between the stereo channels), the absence of control may allow an introduction of bad data in the sample that cannot be identified as such, causing unwanted bias in the results, as suggested in [4], section *2.5. Bias and other possible issues*.

To continuation of our study on tonal consonance [6] required us perform a large number of online listening experiments, differentiating between those conducted in diotic-, from those conducted in non-diotic conditions. Because in online experiments, the researcher has no control over the participant's playing device, we need a listener's diotic context detection method. The requirement for the the participant to use headphones shows insufficient for various reasons, mainly because the playing device (computer hardware, software, headphones) may be defective, or the "spatial sound" features are mixing the stereo channels [7].

The oposite holds true as well – even without wearing headphones, the participant may be able to detect if the

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sound is coming from the left or right speaker, yielding a false positive diotic response from the participant [8].

The inherent doubt in participants' responses collected through online experiments creates a necessity for usage of additional prediction method(s) when validating those responses. More details regarding the insufficiency of these questions can be found in the *Supplementary Information* package [9].

2 Method

2.1 The baseline State Interference (SI) method–basic principles

The method we initially attempted to use is briefly explained in this section. We denote this method as the *Stationary Interference* method (SI) because it uses the interference phenomenon (to differentiate from the *non-stationary* interference, such as the interference beating phenomenon). The full description of the SI method is found in the paper where it is introduced initially [1].

The SI method requires the participants to wear headphones; by agreeing to take part in the experiment, the participants *implicitly* declare that they are wearing headphones (as a response to the unasked question: "Are you wearing headphones?"). The implicit response to this implicit question is used as a first predictor of the participant's diotic auditory context - *SI's Declarative* (SI_D) predictor.

The authors of [1] introduced an additional applied acoustics predictor - *SI Acoustic* (SI_A) predictor. In essence, the SI method uses the difference of the perceived loudness between S_0 and S_π sounds presented diotically or not. After obtaining the results from both predictors, the SI method compares them, and in case of a mismatch, it disqualifies the data record. Otherwise, it accepts the result.

2.2 The new BI method–basic principles

The screening method for a diotic acoustical context introduced in this paper is inspired by the baseline SI method. It attempts to mitigate the causes of the SI method's unsatisfactory performance (that we speculated), by improving the accuracy of the SI_D predictor, introducing the new *BI Declarative* (BI_D) predictor, and by improving the accuracy of the SI_A predictor, introducing the new *BI Acoustic* (BI_A) predictor.

Similarly as with the SI method, the BI method compares the results predicted by its two predictors; if they are equal, the method considers the predictions accurate. Otherwise, it disqualifies the data record.

As opposed to the SI method, which classifies the data in two classes: diotic and disqualified, the BI method attempts to classify the data in three classes: diotic, non-diotic, and disqualified. Also, the BI method explicitly asks the participants if they are wearing headphones, as opposed to the SI method, which instructs the participants to wear headphones, but it does not ask them. The responses are collected in initial and interim variables, and later after certain disqualifications, only final list of variables is used (see Table 2).

Abbreviations

BI: Beating Interference – a screening method for diotic auditory context, introduced in this paper

SI: Stationary Interference – a screening method for diotic auditory context (of other authors – a baseline)

BI_D: Beating Interference Declarative Predictor – a predictor used by the BI method, based on the participant's responses to the questions if they are wearing headphones, and the channel separation questions

SI_D: Stationary Interference Declarative Predictor - a predictor used by the SI method, based solely on participants' response to the question if they are wearing headphones

BI_A: Beating Interference Acoustic Predictor – a predictor used by the BI method, based on perception cues produced by beating interference acoustic causes

SI_A: Stationary Interference Acoustic Predictor – a predictor used by the SI method, based on perception cues produced by stationary interference acoustic causes.

2.3 The website of the BI method

The BI method is designed for online listening studies. Therefore it is contained within a website. A demo of the BI method can be found at this website (also, the interference beatings "shadow" stationary zones) [10]. By reviewing the demos, the reader may facilitate her/his understanding of the method.

All the sounds used in the following steps have the following common properties: mp3 file format, 1000 ms duration, 48k Hz sampling frequency, linear ramp-up, and ramp-down, each with a duration of 50 ms. For the in-lab batch, we presented the sounds within a 40 dB SPL quasi-white noise in an attempt to simulate everyday home sounds that the on-line participant would usually face [11]. Their particular properties are specified in the corresponding steps described below.

Step 1: Initial instructions

After accepting the participation through the consent form, the participant is faced with the initial instructions. Important instruction is that the participant is not moving the head during the experiment. One reason for this instruction is to avoid additional bias [12].

Step 2: Channel separation (*ChanLeft* and *ChanRight*)

This step presents two questions, inspecting the volume balance across the left and the right sound channels, and the channel separation. The resultant response is stored in the variables *ChanLeft* and *ChanRight*.

Table 1: The parameters of the used sounds and the names of the related variables that contains the response values

Related response and variable name	Frequency (L:left, R:right)	Mono or Stereo	Presentation level inlab		Additional note
			Diotic	Non-diotic	
A: *OmniEven*	540 Hz	Mono	70 dB SPL	80 dB SPL	
B: *OmniRinging*	500 Hz	Mono	70 dB SPL	80 dB SPL	Trully amplitude modulated 20 Hz
C: *Mut500HzA*	L:500 Hz, R:530 Hz	Stereo	70 dB SPL	80 dB SPL	Diotic: even, non-diotic: ringing
D: *Mut500HzB*					
E: *Mut1k8Hz*	L:1800 Hz, R:1835 Hz	Stereo	60 dB SPL	70 dB SPL	Diotic: even, non-diotic: ringing
F: *Mut3kHz*	L:3000 Hz, R:3035 Hz	Stereo	40 dB SPL	50 dB SPL	Diotic: even, non-diotic: ringing

Table 2: The list of final variables. They are derived from the interim variables, describing data records that are cleaned up from the values which are causing the initial disqualifications. Therefore, the values presented in this table are only those that can be found in the non-disqualified data records. Note that all of the final variables are binary.

Variable Identifier	Variable Description	Value	Value Description
ChanLeft, ChanRight	Declared perceived stereo channel separation for the left-channel-only and right-channel-only sounds, respectively.	1	Perfect Separation
		0	Channels Mixed
Mut500HzA, Mut500HzB	Declared preceived sensation for the same stereo sound QUESTION-500L530R.mp3, presented twice.	1	Even
		0	Ringing
Mut1k8Hz	Declared preceived sensation for the stereo sound QUESTION-1800L1835R.mp3	1	Even
		0	Ringing
Mut3kHz	Declared preceived sensation for the stereo sound QUESTION-3000L3035R.mp3	1	Even
		0	Ringing
WearHp	Declared wearing headphones situation	1	Wearing headphones
		0	Not Wearing headphones
SI, SI_A, SI_D, BI, BI_A, BI_D	Predicted dichotic value by the respective predictors and methods	1	Diotic
		0	Non-diotic

Step 3: Interference beating

- **Participant training phase:** In this step, the website teaches the participant to the meaning of the terms *even* and *ringing* by presenting two sound specially designed for this purpose, one sounding as *even* (*OmniEven* - the interference beatings are not audible) and the other *ringing* (*OmniRinging* - the interference beatings are audible). The perception of *even* and *ringing* are independent if the context is diotic or not (see Table 1).
- **Response collections phase:** The participant is invited to play a sequence of sounds, and to classify each sound as *even* or *ringing*, as per the training obtained in the previous step. The following responses are collected: A, B, C, D, E and F (see Table 1).

Step 4: "Are you wearing headphones?" (variable WearHp)

In this step, the participant is declaring if she/he is wearing headphones while performing the experiment.

Step 5: Speaker or headphones type (variable *SpkType*)

Options with types of speakers and headphones are presented as stylized images. Each image contains a caption text advising if that choice means wearing headphones. In case the participant accidentally made a mistake in the previous step, this could help her/him to realize the mistake. This step offers the participant a choice to change her/his "wearing headphones" response from the previous step.

2.4 Initial disqualification

At this moment, the software has all the data it needs to calculate the predictions. The following quality assurance criteria are used to identify bad data records that should be disqualified:

- If at least one of the channel balance (separation) questions is *silent* (indicating a defective playing device, or significant hearing difficulties), disqualify (variables *ChanLeft* and *ChanRight*).
- If the response to the question "A" (see *Step 3*) is *ringing*, disqualify (variable *OmniEven*).
- If the response to the question "B" is *even*, disqualify (variable *OmniRinging*).
- If the responses to the questions "*Are you wearing headphones?*". (variable *WearHp*) and "*Speaker or headphones type*" (variable *SpkType*) are conflicting (for example, the participant declared that she/he is not wearing headphones, but to the type of headphones question she/he responded with *earbuds*), disqualify (variable *WearHpVSSpkType*).

2.5 The BI Declarative (BI_D) predictor

BI's declarative predictor (BI_D) uses the SI_D predictor in its core, additionally acknowledging that the participant's response to the question "Are you wearing headphones" may be not 100% accurate. Therefore, the BI_D predictor additionally considers the participant's responses regarding the separation of the stereo channels (*ChanLeft* and *ChanRight*). Equation (1) shows the model the BI_D predictor uses to produce its result as diotic or non-diotic:

$$BI_D = \begin{cases} 1, & WearHp + ChanLeft + ChanRight = 3 \\ 0, & WearHp + ChanLeft + ChanRight < 3 \end{cases} \quad (1)$$

where the variables are described in Table 2.

More details can be found in the Supplemental Information package [9]. Here we only assert that this predictor attempts to overcome the previously mentioned false positive diotic responses, where the non-diotic participant are able to determine the exact direction of the sound (left or right) (section 5.1 *Determining the Direction of a Sound Source* in [13]).

2.6 The BI Acoustic (BI_A) predictor

The BI_A predictor uses a stereo sound with perfectly separated left and right channels, each playing pure tones with frequencies F_1, and F_2, satisfying the constraint: $|F_1 - F_2| < 40\,\text{Hz}$. Similarly, as with the SI method, when listening diotically, there is no interference, and the participant should perceive the sound as *even* (the volume of the sound is not changing in time). If the participant is listening to the sound non-diotically, she/he will experience interference beating [13, 14]. In this study, the *beating* sound is denoted as *ringing*. Hence, the particpant's task is to declare if she/he has perceived the sound as *even* or *ringing*.

Equation (2) discloses the model used to calculate the predicted diotic context based on the BI_A; if we define *SumOfMut* as:

$$SumOfMut = Mut500\text{Hz}A + Mut500\text{Hz}B + Mut1k8\text{Hz} + Mut3k\text{Hz}\,;$$

then for the BI_A predictor result we have:

$$BI\_A = \begin{cases} 1, & SumOfMut \geq 3 \\ 0, & SumOfMut < 3 \end{cases}; \quad (2)$$

where the variables are described in Table 2.

Similarly to the SI_A predictor [1], the BI_A predictor is using the voting paradigm to derive the resultant prediction. In BI_A's case, a diotic context is predicted if *more than half* (3 or more out of 4) responses to the mutable-amplitude sounds are declared as *even*.

The in-lab preliminary simulations demonstrated the existence of stationary spatial zones where the interference beatings are inaudible ("shadow" zones) – they may affect the accuracy of the BI_A method, yielding a false positive diotic response from the participant. A software simulation in MATLAB has been developed to analyze if these "shadow" zones are produced by the room acoustics (the reflections of the sounds wave from the surrounding objects) – the simulation confirmed the said speculation (see second part of the video [10]). Another phenomenon may additionally impede the BI_A predictor: that is the binaural beating – a phenomenon that causes the participant to experience beatings-like neural sensations, introducing slight bias in the method – false negative diotic responses[13, 15, 16].

2.7 Final disqualification step and result

The predicted value calculated according to the BI_A predictor calculated per Equations (1) and (2) are compared. If these two values are not equal, the BI method is disqualifying the data record, otherwise the result is declared as final.

2.8 Participant, recruitment, and technology

This study is ethics-approved by the Independent Ethics Research Board VeritasIRB (www.VeritasIRB.com, Montreal, Canada). The participation was completely anonymous, and in the online experiments, no information about the participant's age, race, gender, sex, or location were collected (the age and sex information are collected in the in-lab experiment). The participants were not asked if they have hearing problems, or if they are aware of any technical problems with their playing devices they used in the experiment.

In this study, we collected three batches of data samples. The details of the batches are outlines in Table 3. The raw results of the experiments obtained through these batches are located in the Excel files in the Supplementary Information package [9].

Table 3: Descriptions of the participant batches

Batch	Sample Size	Type/Incentive [USD]	Wearing headphones
1	1656	Online/0.15	Choose
2	519	Online/0.15	Asked to wear
3	18	Inlab/0.00	10 weared 8 not weared

The in-lab batch participants provided their demographics ($N = 18$, 55.6% female, 44.4% male). At the time of the experiment, their mean age was 33.6 years (SD = 13.2), and they resided in Montreal, Canada. All the in-lab participants declared that they have a healthy hearing.

The sounds were generated and edited using the software GoldWave version 6.24. The in-lab testing utilized JVC Over-Ear Headphone HA-RX330 with frequency response 12 Hz-22000 Hz for the experiments performed with headphones, and embedded laptop speakers for the in-lab non-headphones experiments. The delivery of the specific dB SPL levels is achieved only in-lab, by using Proster' digital sound level meter HT80A (40 dBA - 130 dBA; Accuracy +/-1.5 dB; Resolution: 0.1 dBA; frequency range 31.5 Hz-8 kHz; standard applied: IEC 651 type 2, ANSI S1.4 type 2). In-lab, the dB SPL measurement was taken at the ear-position when the participant is sitting in front of the laptop and the sound is delivered by the embedded laptop speakers. The headphones dB SPL in-lab delivery was first subjectively calibrated comparing to the one measured for the laptop speakers and ensured the same volume level is selected for every participant. There was no enforcement of the dB SPL delivery for the online experiments. The "spatial sound" and the automatic subjective loudness equalization features were disabled on the laptop used in-lab.

2.9 Procedure

All the experimental batches (online and in-lab) are collected through the same website and by using the same procedure. After completing the BI method's steps, the participants are asked to perform the baseline SI method, which allows for a cross-method pair-wise comparison of the results. The data was cleaned up by the initial disqualification criteria. Over the initially non-disqualified records the BI_A, BI_D, SI_A, SI_D, SI, BI, and in-lab control (CR) predictions are calculated. As a main statistic the Cohen's Kappa inter-rater agreement between two methods/predictors corrected by chance (see Table 4), and ROC analyses are used [17-21].

3 Results and discussion

A large volume of the raw data, the interim, and the final detail results are located in the Supplementary Information package since they cannot fit in this paper. Here we present only the results we consider most representative to the new BI method and its comparison with the baseline SI method.

Table 4: Cohen's Kappa agreement gradations as per [22]:

Cohen's Kappa Value	Descriptive Gradation
<0.00	Poor
0.00 – 0.20	Slight
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Substantial
0.81 – 1.00	Almost Perfect

The results of the in-lab experimental batch (batch 3) are presented in Table 5, where we observe superior results of the BI predictors and BI method over the SI predictors and method, respectively. As a consequence, from the in-lab superiority of the BI over the SI method in-lab (Table 5), in the presentation of the online data (Table 6) the BI method is used as a reference method. Although the SI method does disqualify the non-diotic data records, to fairly compare the methods, in Table 6 we considered a SI method version that does not disqualify the non-diotic data records. The first row of the table shows the most important result, where the SI method classifies 104+43=147 data records as diotic, where the BI method disqualifies them - that means that the SI method declares 8.89% (95% CI, [7.55%, 10.4%]) false diotic results (if we consider the BI's classification absolutely accurate). In addition, the SI method disqualifies 202 data records that are classified by BI as diotic - that is 12.2% (95% CI, [10.7%, 13.9%]) wasted data of the whole sample.

Table 5: Comparison of the performances between the analyzed predictors and screening methods. In order to avoid calculation errors for Cohen's Kappa for lines 5 and 6, additional treatment of the data has been performed (see Supplementary Information package for more details).

Line	Batch	Method or Predictor	In reference to In-Lab Control (true) value	PREDICTION TEST STATISTICS									
				Cohen's Kappa					Accuracy				
				Sample Statistics	Arbitrary Interpretation of the obtained agreement	95% CI Lower Bound	95% CI Upper Bound	p-Value	Sample Statistics	95% CI Lower Bound	95% CI Upper Bound	p-Value [Acc>NIR]	No Information Rate
1	In-lab	**BI_D**		**0.85**	**Almost perfect**	0.57	1.13	0.002	**0.94**	0.73	1.00	0.023	0.72
2		**SI_D**		**0.47**	**Moderate**	0.08	0.86	0.018	**<u>0.72</u>**	0.47	0.90	*0.618	0.72
3		**BI_A**		**0.87**	**Almost perfect**	0.62	1.12	<0.001	**0.94**	0.73	1.00	0.023	0.72
4		**SI_A**		**0.42**	**Moderate**	-0.02	0.85	0.047	**<u>0.72</u>**	0.47	0.90	*0.618	0.72
5		**BI**		***0.79**	**Substantial**	0.52	1.06	<0.001	**0.89**	0.67	0.99	0.034	0.68
6		**SI**		***0.19**	**Slight**	-0.04	0.42	0.014	**<u>0.30</u>**	0.12	0.54	*1.000	0.70
7		**BI (diotic BI only)**		**1.00**	**Almost perfect**	1.00	1.00	0.001	**1.00**	0.81	1.00	0.011	0.78
8		**SI (diotic SI only)**		**0.85**	**Almost perfect**	0.57	1.13	0.002	**0.94**	0.73	1.00	*0.067	0.78

Table 6: Confusion matrix of the Stationary Interference (SI) baseline method, where the new Beating Interference (BI) method is used as a reference standard. This table shows where the SI method classifications differ (or fails, considering Table 5 results) from those of the BI method. To produce this table, we considered an SI method version that does not disqualify the non-diotic data records. The results are obtained from the online Batch 1.

		Beating Interference (BI) Method			
		Diotic	**Non-diotic**	**Initially disqualified**	**Finally disqualified**
Stationary Interference (SI) Method	**Diotic**	**421**	**0**	104	43
	Non-diotic	**61**	**328**	58	113
	Initially disqualified	0	0	0	0
	Finally disqualified	202	100	125	101

Finally, the results obtained from the online Batch 2, where the participants are asked to obligatory wear headphones (same as the original SI study), are used to compare the accuracy of our implementation of the SI method, to its original implementation and the design purpose as described in [1]. As such a measure, we use single statistic: the total disqualification proportion obtained as per the SI method. We obtained an SI disqualification proportion of 37.0% (95% CI, [32.83%, 41.31%]), which is close to the disqualification proportion of 35.3% reported by [1]. The proximity of these two statistics provides confidence that this study replicated the SI method sufficiently accurately.

Lastly, we decided not to use the psychophysics methods of binaural masking level difference (BMLD) and interaural time-difference discrimination (ILD) due to their small magnitude of differences between the diotically and non-diotically perceived sounds. We have not conducted experiments to confirm these concerns (it is out of the scope of this study); another study may be conducted to investigate the viability of the BMLD and ILD paradigms in uncontrolled online experiments.

Regarding the BI method, its magnitude of amplitude fluctuation (the ringing) is easily noticeable (even in high noise level conditions), as long as the top-amplitude portion of the sound is audible – we consider this as the most beneficial feature of the BI method, which makes it suitable for uncontrolled online auditory studies.

Finally, there are many details regarding the BI method including speculated reasons for BI method superiority are not disclosed in this paper due to length constraints. They can be found in the SI package [9].

4 Conclusion

The results of this study demonstrate that the *Beating Interference* (BI) method can be used as a screening method to determine if the participant's auditory context in online crowdsourced hearing studies is diotic. It uses two distinct predictors to predict the diotic context of the data record, disqualifying those that yield mismatching prediction results. The results of this study are obtained in in-lab and online batches, and the results suggest that the *Beating Interference* (BI) method shows somewhat better performance than the baseline *Stationary Interference* (SI) method [1].

The reader can watch a demo of the *Beating Interference* (BI) diotic screening method by following the enclosed link (also, a video demonstrating the beatings "shadow" zones is enclosed): [10], whereas Supplementary Information is also available [9].

Remerciements/Acknowledgments

Ana Pankovska (certified as *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS2: CORE*) helped by verifying some of the calculations, and with editing the text.

Eva Pankovska helped by proofreading the text.

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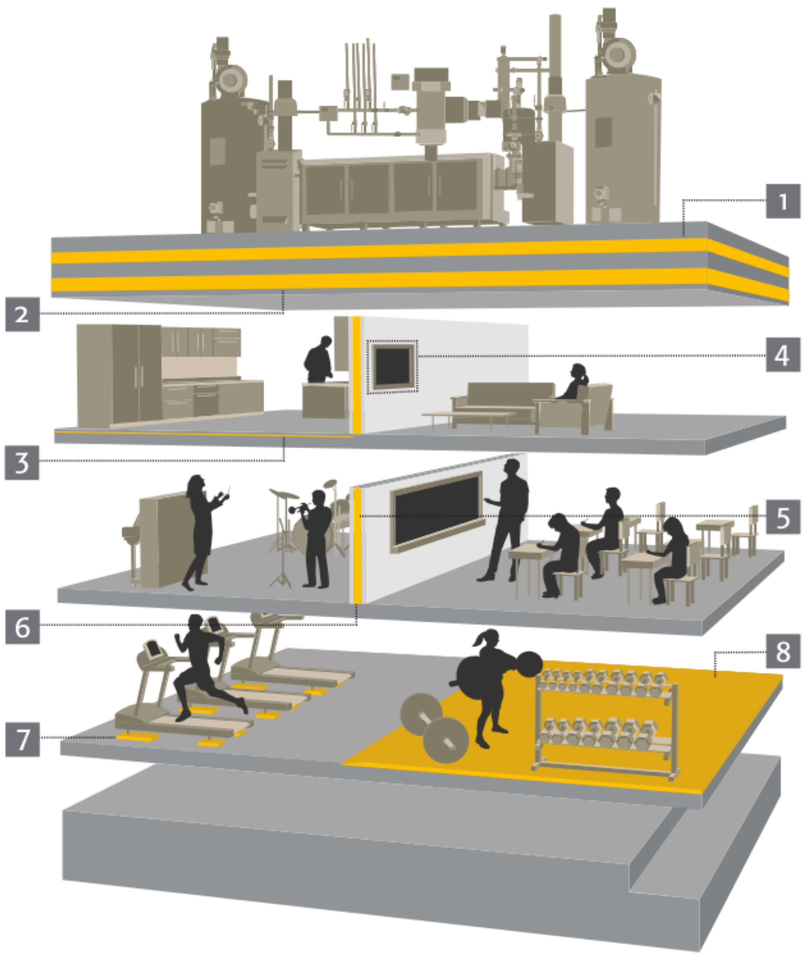
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FAREWELL NOTES FOR PROFESSOR RAMANI RAMAKRISHNAN'S RETIREMENT

J. Gregory Downey[1], **Romain Dumoulin**[2], **Joonhee Lee**[3], **Frank A. Russo**[4], **Shivraj Sagar**[5], **and Jérémie Voix**[6]
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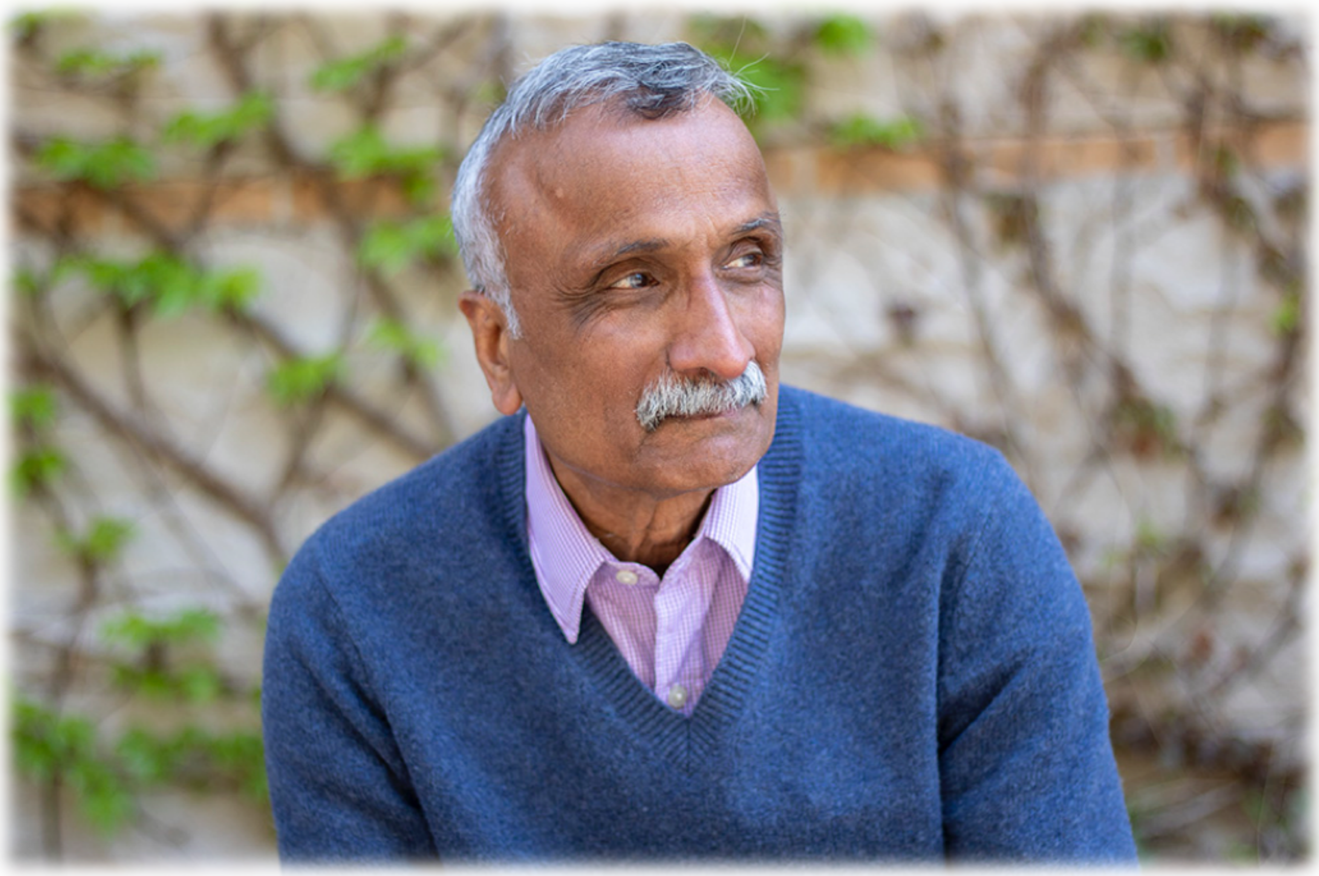


Reflections on Professor Ramakrishnan by Romain Dumoulin

In 2010, a few days before Christmas, newly arrived in Canada I was looking to connect with the local acoustics community and I sent a cold email to Prof. Ramakrishna, not expecting much given the timing.

Little did I know that the warm response I received would build beyond that first internship, collaborating on several projects (from the acoustical design of church and concert halls to the simulation of wind tunnels' tuning vanes !), publishing papers and presenting at CAA conferences.

Quickly, Prof. Ramakrishna's influence permeated not only my professional career in acoustics, but personally, offering advice, support and generosity at every turn–even in the speech he delivered at my wedding.

His presence looms large, this is clear based on the deference and respect he receives at yearly gatherings of the Canadian acoustical association. He has been a mainstay for decades, and while I wish him the best in his retirement, he will greatly be missed by this community.

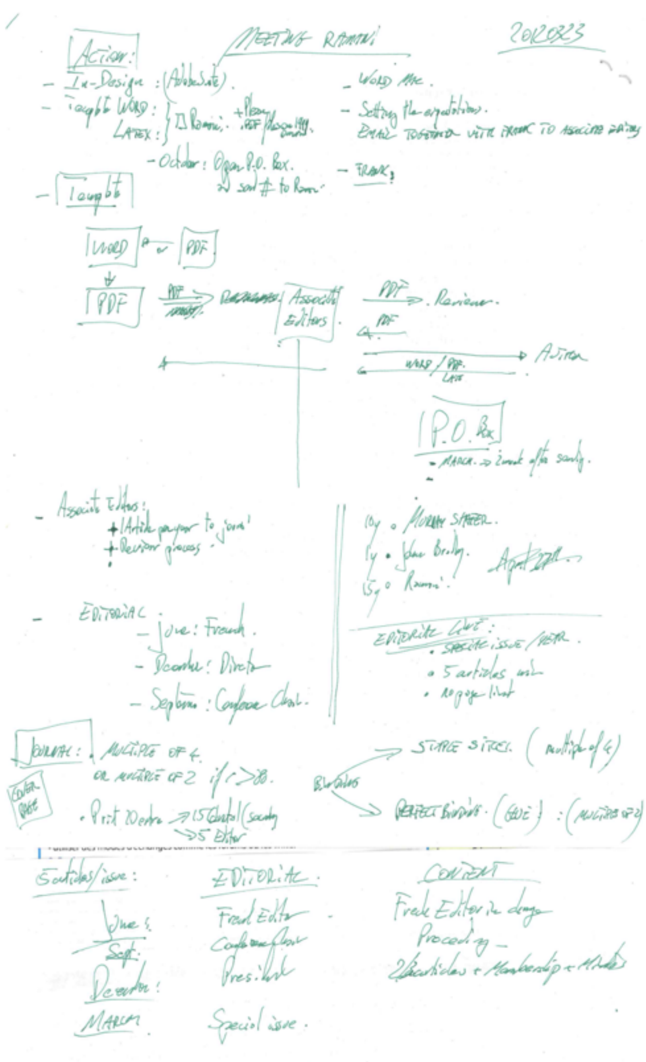
Dear professor, thank you and wishing you all the best. Until I am next in Toronto.

Romain Dumoulin

Ramani Ramikrishnan : Passion, Intensity and Humanity by Jérémie Voix

Ramani, the "scary"

In 2001, when I was a young student attending Acoustic Week in Canada for the first time, in Prince Edwards Island (PEI), Ramani became very soon the "face" of the Canadian Acoustical Association. As I just had received my "Best Student Presentation" award, he gifted me a nice book on acoustics. What a generous man ! He also quickly mentioned that a book review would be much appreciated, to which, I certainly agreed in principle. But I was soon to realize that Ramani is a man of principle and perseverance : I soon received a first email inquiring about the progress of my review, to be followed by a couple others, and eventually had to produce my very first book review ; quite a daunting exercise for a young PhD student suddenly out of his comfort zone.I think I intentionally tried to avoid Ramani during the following few conferences, too scared of what he could ask me or what could unfold from another encounter ! ;-)



A man of passion and intensity

Ramani's passion and intensity cannot be underestimated. In 2012, when I accepted to take over the role of Editor for the Canadian Acoustics journal from Prof. Frank Russo, this latter suggested that I make an appointment with Ramani. Meeting one-on-one with the acclaimed past Editor-in- Chief, who during his magnificent 15-year reign had made the journal bloom, was certainly a little bit intimidating for me. Our meeting in the lobby of Concordia University on March 23, 2012, was amongst my most memorable as a young faculty member. In less than 90 minutes, I turned from a distant reader of Canadian Acoustics to its Editor-in- Chief, with only my one page of notes (reproduced in the adjacent figure) that served as my guidelines until 2017. During these yea rs I was - retroactively - able to understand the important social aspect of running a journal, in soliciting submissions, motivating colleagues to organize special issues, etc. and still nowadays I can admire Ramani's natural gift in human interactions.

A well -deserved retirement

It may be hard to imagine Ramani retiring, given the intensity and energy that he shows every time we meet him. But several of us know the many passions that will keep him busy for yet another long while. As president of the Canadian Acoustical Association, I want to acknowledge Ramani's great contributions to the Canadian Acoustics journal, in its quality and the material that it publishes. On a more personal level, I wish to pay tribute to a fellow acoustician whose generosity and humanity contributed a great idea l to many of our professional lives.

Thank you,Ramani.

Jérémie Voix

Reflections on Professor Ramakrishnan by Joonhee Lee

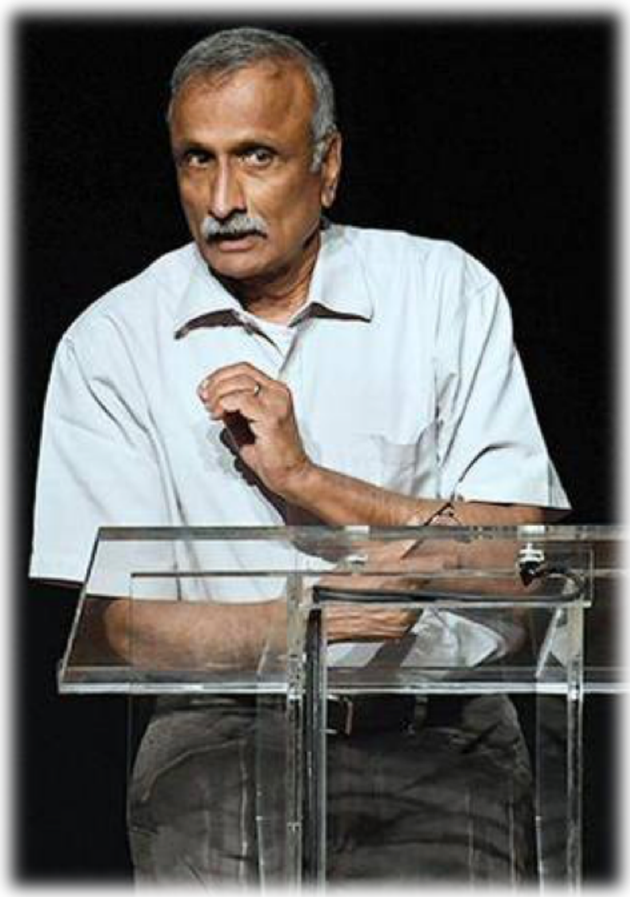
When I first started my career in Canada and introduced my research area of architectural acoustics, every single colleague I met said that "Oh, then do you know Prof. Ramani ?". That was when I sent an email to Prof. Ramakrishnan to ask for his advice. He was indeed a nice and warm scholar who did not hesitate to help the early career researcher. He invited me to Acoustics Week in Canada 2017 in Guelph, and I gave my first talk at AWC. I frequently sent him emails after that whenever I desperately needed thoughtful advice for my career. I have managed to settle my research lab due to his kind support. I wish him the best in his retirement.

Many Thanks,

Joonhee Lee

Reflections on Professor Ramakrishnan by Frank A. Russo

As I reflect on my relationship with Professor Ramakrishnan, it has become clear to me that despite the wide gulf between our respective subdisciplines (architectural and psychological acoustics, respectively), he has somehow been there for me at all stages of my professional life.



Student Mentorship

I first met Professor Ramani Ramakrishnan in October of 1993 at the Canadian Acoustic meeting that was held at what was then the Delta Chelsea in Toronto. It was my very first academic presentation, and Dr. Ramakrishnan was seated near the centre back smiling and nodding about a topic he likely knew little about. Despite this, he showed great interest, seemingly hanging on my every word. His presence in the room made it easy to get the ideas out despite my acute sense of "imposter syndrome". Ramani is an astute listener, and I have observed him playing the same role with junior scholars at many Acoustics meetings over the years. Always listening and asking good questions that force the speaker to broaden their perspective or at least think quickly on their feet. In 2001, it was Professor Ramakrishnan who conferred the Shaw Postdoctoral Award on me at the meeting he convened in Alliston (Toronto).

New Faculty Mentorship

When I arrived at Ryerson University years later, Professor Ramakrishnan was quick to reconnect and to come visit me over in Psychology. He had practical tips for me regarding how to navigate the waters as a new faculty member and good suggestions for how to best equip and accelerate activity in my lab. I also had the pleasure of working alongside him in various service capacities a t the University and in our broader acoustics community. He encouraged me to become part of the CAA board and we eventually planned and executed a successful Acoustics Week in Canada meeting in 2009 (Niagara-on-the-Lake).

Editor Mentorship

Professor Ramakrishnan invited me to follow in his footsteps as Editor of Canadian Acoustics. This was somewhat intimidating given how revered he was by the community and his great service as the longest standing Editor of the journal. I shadowed him for 6 months before taking on the reigns. We had many excellent meetings in that period. The meetings took place in his small office on Church Street with almost all desk surfaces and shelves lined with past journals. These occasions were equal parts business, humor, and philosophy.

Collegiality and Friendship

Over the years, Ramani and I have had the pleasure of sharing many memories at academic meetings around the globe. He seems to always have wisdom to share, often in the form of a parable and always rich with metaphor. I fondly remember an animated conversation that we had about career trajectories, egos and envy, on a post-session walk in 2016 at the International Congress of Acoustics in Buenos Aires, Argentina. This past academic year, Ramani and I had the pleasure of co-supervising a student with interests that intersected Architecture and Psychological Acoustics.

So long, but not goodbye

It is with great sadness, admiration, and respect that I say so long to my dear friend and colleague. Of course, I realize it's not goodbye. Ramani will continue to be consulted on various issues as one of the pillars of our society and keepers of our institutional knowledge. I, for one, fully expect to see him popping up from time to time at future meetings with a smile on his face, twinkle in his eye, and a good story to share.

Frank A. Russo

A few words about Ramani by J. Gregory Downey

Ramani and I first met in 1984 while working at Vibron limited. Ramani a seasoned acoustical engineer fresh from NASA and myself green and right out of Engineering School. We hit it off as friends that first day and he was such a terrific mentor to me in those early days. Even though our paths have taken us in different directions in the industry over the years the strength of the friendship has never diminished.

I recall it was summer 1990 I was developing a new line of rectangular and circular silencers and Ramani was working on computer software that would predict insertion loss and pressure drop data for rectangular silencers. It was a perfect opportunity for us to come together and compare the accuracy of his software with actual silencer data I was receiving from a test company we had retained to test a wide range of silencers. The outcome was that Ramani could fine tune the software and that software was then used to aid in filling out the full line of silencers. It was truly terrific collaborative work that at the end of the day really benefitted both of us and we had so much fun doing it.

To celebrate the successful completion of this collaborative effort Ramani said “Greg I want to take out for lunch. I’m going to take you to one of my favorite Indian Restaurants”. I replied by saying “Okay but I’m not very good with hot spicey foods”. “Not a problem” Ramani replied, “I will make sure you only get very mild dishes”. Well lunch arrived and Ramani lit me on fire. The food was so spicey that I was having a hard time talking. Ramani thought it was hysterical. He was laughing so hard he was crying.

There were a few choice words that day but over the years we’d laugh about that lunch engagement. Needless to say, I never let Ramani pick the Restaurant again. He’d try but there was no biting on that one.

Although Ramani is ‘Retiring’, and I’m not quite sure what that word really means in Ramani’s world, as we know he’s a man in constant motion with fingers in a lot of pies. The good thing is even in retirement he will always be an active part of the acoustical community that he has served so well.

All the very best to you and family my good friend.

J. Gregory Downey

Reflections on Professor Ramakrishnan by Shivraj Sagar

I first met Dr. Ramakrishnan while completing my final year of mechanical engineering. I was seeking special permission to take his acoustics course – the first question he asked me was, “what do you know about acoustics ?” At the time, the answer was very little, and I was intimidated.

When taking his course, I quickly learned that Dr. Ramakrishnan is a professor who wants you to truly understand the material and the “why” behind everything. I appreciated the fact that outside of academics, he has a wealth of industry experience which he shares lessons from. He is kind and never troubled by students asking questions. Dr. Ramakrishnan always encourages and supports his students when they have ideas on writing journal papers, experiments and various ideas outside of the classroom.

Students, clients, colleagues and the CAA have greatly benefited from Dr. Ramakrishnan’s contributions and his continuous demonstration of integrity over his career. He is one of the best professors I have ever met and his dedication to the field of acoustics is remarkable. I congratulate Dr. Ramakrishnan on his retirement and I wish him the best of luck. Thank you, Dr. Ramakrishnan !

Shivraj Sagar

CANADIAN ACOUSTICAL ASSOCIATION

Minutes of the Board of Directors Meeting

Thursday, 15 April 2021 2:00 PM – 4:30 PM (EDT)

by Zoom videoconference

1. Call to Order

Meeting called to order at 14:06 (EDT)

Board members present online: Jérémie Voix (chair), Alberto Behar, Umberto Berardi, Bill Gastmeier, Bryan Gick, Michael Kiefte, Andy Metelka, Hugues Nélisse, Roberto Racca, Joana Rocha, Frank Russo, Mehrzad Salkhordeh.

Agenda approved: mMoved by Jérémie, seconded by Dalila.

2. President's report (Jérémie)

Jérémie informed the Board that he had worked extensively on ensuring through various methods that notifications (general announcements and renewal reminders) sent by e-mail from the Association would not be blocked by increasingly restrictive spam defences on many recipients' systems. First good outcome of this effort was a largely effective delivery of renewal notices at end of December (when the "stimulus benefit" extension ran out for many members), which resulted in a substantial number of renewals.

The CAA was again asked this year for an expression of support for the "Semaine du son UNESCO - Canada", an educational outreach event that mimics its original counterpart in France. Given the Board's concurrence the previous year, Jérémie again provided a letter of endorsement and posted an announcement on the CAA-ACA website.

Jérémie shared a letter from the Standards Council of Canada requesting CAA sponsorship support for the ISO TC43 Acoustics Standards Plenary Meeting 2023 in Montreal, in whose organizing he and some other CAA members are also involved. He proposed that instead of a monetary contribution the CAA host a mini-website or webpage for the event and provide promotion and notifications through our media. Some members of the Board queried about contributing expertise to the activities of the working groups; Jérémie noted that many of the committees are already well established and work to a strict protocol but suggested that anyone interested should contact existing members of groups relevant to them and discuss how external input could be provided.

The CAA was approached by a retired acoustician who would like to volunteer some of his free time assisting the Association in any suitable role. Jérémie noted that such a help could be very beneficial and suggested some tasks in which this volunteer could assist, including the editorial migration of the CAA website to an updated platform, creating an inventory of acoustics training programs in Canada, updating the CAA Operations and Procedures Manual, or canvassing for editorial contribution to journal features like the Practitioners' Corner. There was strong endorsement by Board members for this, with the caveat that whatever tasks are chosen for the volunteer should be a good fit for his skills set and time commitment.

Jérémie put forward a proposal to establish a new category of free membership for retired professionals who volunteer their time to the CAA (would apply to the person mentioned above), for the duration of their commitment. After considerable discussion among the Board about parallel requests that had been raised in the past for discounted rates for retired members, and the nuances of characterizing volunteer involvement, the proposal was restructured to the creation of a new membership category for individuals no longer in gainful employment, with a reduced fee that Dalila Giusti (treasurer) suggested setting at half the normal rate. The proposal was voted on and accepted. It was agreed that due recognition for volunteers in some form or other would remain a topic for further discussion over time.

On a related matter, Jérémie also noted that there had been inconsistencies and lapses in the practice of giving free student membership for one year to winners of CAA awards (would be added to their existing membership term, since being in the

CAA is a precondition for winning the award). He suggested establishing a 1-year award winner membership category with no dues; the Board agreed.

Lastly Jérémie described the concept of making advertiser status a form of "subscription" handled through the online Open Journal System (OJS), with variable duration and prices corresponding to the ad run length purchased. In the open discussion of the proposed approach Dalila stressed that a human intervention would be needed to vet the submitted ads, interact with the advertiser if late with a submission etc. Therefore, an advertising coordinator would still be needed to maintain a rapport with the advertisers, which could remain Bernard Feder's role but now dissociated from the billing and tracking of payments. This transition will require some reprogramming of the OJS, for which Jérémie requested a budget allocation of $700. All agreed.

3. Editor's report (Umberto)

Umberto reported that the March issue of the journal was ready to go online; its publication schedule had been somewhat delayed so that a life tribute could be included for first editor of Canadian Acoustics, Tony Embleton, who passed away in late 2020.

Looking at upcoming issues, Umberto noted that 3 full papers were already accepted for the June issue which would be a regular one, whilst the September issue would be dedicated to Acoustics Week in Canada as per usual and hopefully have strong contributions despite the challenges to the event posed by the pandemic. The December issue would then catch up on regular submitted papers, promising to be a sizable collection.

Umberto indicated that long outstanding payment issues with some advertisers were being gradually resolved, and after a period of issues with a prior printing company the physical journal production process had now smoothed out. He mentioned frequent updating of the OJS publication portal; Jérémie clarified that the support and hosting of the OJS was now outsourced to a professional firm that rolled out regular security updates and version upgrades.

From the standpoint of (volunteer) staffing resources Umberto noted that there were gaps in the journal's editorial board for bioacoustics, physical acoustics, and underwater acoustics; he solicited suggestions of recommended candidates to contact. The search could potentially reach outside of Canada but preferably we should try to keep the editorial board Canadian to accentuate the national focus of the journal.

There is a desire to revitalize the Practitioners' Corner feature section of the journal; Umberto indicated that he would endeavour to copyedit any submissions to make it easier for contributors to provide content.

4. Treasurer's report (Dalila)

Revenues are in good shape; only exceptions are payments from advertisers which should become less of a problem with the new system discussed earlier in the meeting. Transition to the latter will have to be managed carefully in terms of invoicing for the next issue or two while the OJS is updated, and the advertisers notified.

Investments are held in principal guaranteed GIC's that have traditionally performed well, though it is unknown for now how the pandemic will have affected their returns. Maturity dates are in 2022 and 2024. We are in a position where some balance could be transferred from the operating fund to the capital fund and from there to investments, but decisions in this regard can be postponed to the autumn with an updated outlook on the financials. The Board agreed with that course of action.

5. Secretary's report (Roberto)

Roberto began by presenting the tally of memberships at latest count: 155 regular and 21 student members, lower than the peak of 198 and 52 last October that was created by the "stimulus package" introduced in mid-2020. A decrease was expected since in December the revitalized or extended memberships would expire, and some would not be renewed. All the same, the number of regular memberships remains about 40% higher than it was in April 2020 – indicating that the stimulus was successful in bringing members to re-engage.

Another apparent success story, Roberto noted, were the sustaining subscriptions. Having risen from 13 to 19 with the stimulus initiative, they went on to add a further supporter and reached a current count of 20 – meaning that all recently lapsed subscribers had reacted favourably and renewed their commitment. Roberto expressed appreciation and remarked that individual emails of thanks were sent to each sustaining subscriber upon renewal.

In terms of day-to-day activities, Roberto indicated that the cycle of renewals appeared to proceed on a steady keel; he would occasionally respond to queries from members requiring intervention to address difficulties with the online portal (including a small spate of double payments caused by ambiguous user feedback from the pay site) but in general everything operated smoothly. His emphasis remained on maintaining good communications with the membership and providing any support and information that might be requested.

6. Awards report (Joana)

Joana pointed out that she was still waiting to receive nominations on various awards (the deadline being 30 April) and she intended to follow-up shortly with the individual award coordinators about the status of their submissions.

She notified the Board that Stan Dosso would be unavailable as coordinator for the Shaw Award because one of his post-docs was an applicant for the prize, and a substitute would have to be identified. Roberto suggested a name with whom Joana would follow up.

7. Past and Upcoming Meetings

<u>AWC 2021 – Sherbrooke:</u> (guest Olivier Robin, AWC 2021 chair)

- Plan is still for an online event as it is too risky at this point to assume that conditions would allow a full in-person meeting. It is intended to be more than just a conference and to convey a celebration of acoustics in Canada.
- International participation will be welcome especially if connected with Canadian projects or institutes, but strong involvement of the Canadian acoustics community will be emphasized.
- Abstracts and short video submissions will be the key contribution. Extended abstracts and papers for Canadian Acoustics will be submitted on a voluntary basis.
- There will be a core unifying event centred on the interactive creation of the largest noise map ever produced in Canada through the submissions from participants across the country through a common app.
- Event will be structured over three half-days, each of them with a theme. Each day to start with a plenary keynote lecture followed by lightning/ignite talks from researchers, students and exhibitors interleaved with breakout room discussions.
- After Olivier's presentation and some questions to him, the Board had an internal review of the proposed event and discussed the pricing structure for participants and exhibitors as well as what the experience of visiting a virtual exhibitor could be like.
- Jérémie will ask Olivier and his team to provide some tangible examples of what the environment would feel like.

<u>AWC 2022 – St-John's:</u> (guest Benjamin Zendal & Len Zedel, AWC 2022 chair)

- Ben Zendel informed that plans are for an in-person conventional meeting on the last week of September 2022. They have a signed contract with the Sheraton in downtown St John's as the congress venue, are scouting a location for the banquet, and will set up the conference bank account either late this year or early next one.

<u>ISO TC43 Plenary – Montréal 2023:</u> (Jérémie Voix)

- Everything on course; already discussed briefly earlier in the meeting.

<u>AWC 2023 – Ottawa:</u> (Joana Rocha)

- No planning has started yet.

AWC 2024 – Okanagan:

- Bryan Gick will talk to colleagues at UBCO about organizing.

AWC 2025 – Ryerson: (Umberto Berardi)

- Frank Russo has showed interest to take part in the organization and possibly lead.

8. Social Media Editor report (Romain Dumoulin)

The Board reviewed a brief slide presentation provided by Romain (not attending) with some commentary by Jérémie. LinkedIn and Twitter statistics show a sizable increase in posts volume and following since October 2020. Two “job alerts” posts have been made on each platform; these have great reach to young professionals, especially on LinkedIn.

Emphasis to promote on Twitter anything related to acoustics in Canada with the hashtag #CanadianAcoustics. Still following up on plans to tap legacy content from the Journal for posts of “Gems from the past” and Canadian acoustic industry.

Suggestion from Romain to establish a close coordination between Journal and Social Media editors so that announcements, journal notifications, summary and/or highlights of new issues can be shared consistently on social media.

9. Varia

Hétu prize: Bryan suggested that the book award be complemented by a monetary sum. Joana noted that some express desire from the donor’s estate had dictated the nature of this prize. A decision was postponed to next meeting, after some fact finding can be done about the details of the bequest.

10. Next meeting

Agreed on 12 October 17:30 Eastern time, by virtual conference.

11. Motion to adjourn

By Jérémie, at 17:00 (EDT)

Call for abstracts

Acoustics Week in Canada 2021

October 05-07 / ONLINE

Submissions are now open for Acoustics Week in Canada 2021. The meeting will be held online, and three consecutive half-days (12:00-17:00 EST) will be punctuated by plenary lectures and 30-minute lightning talks sessions, while moving into virtual rooms. The details of a noise-related challenge among Canada will be revealed shortly. Each day will have a general theme: Day1 - Acoustics and structures, Day 2 - Acoustics and living beings, Day 3 - Acoustics and computers.

The organizing committee welcomes 200-word abstracts related to any of these themes. An accepted abstract requires the submission of a 3-min video, while 2-page conference paper submission is encouraged but optional. Virtual rooms will be available for presenting other materials, like posters. The submission deadline is July 12, 2021 (https://awc.caa-aca.ca/index.php/AWC/AWC21).

Appel aux résumés

Semaine Canadienne d'Acoustique 2021

05-07 octobre 2021 / EN LIGNE

Les soumissions sont maintenant ouvertes pour la Semaine Canadienne d'Acoustique 2021. La conférence se tiendra en ligne sur trois demi-journées consécutives (12h00-17h00 HNE), et sera rythmée par des conférences plénières, des sessions éclair de 30 minutes tout en se déplaçant dans des salles virtuelles. Les détails concernant un défi relié au bruit au Canada seront bientôt dévoilés. Chaque journée aura un thème général : Jour 1 - Acoustique et structures, Jour 2 - Acoustique et êtres vivants, Jour 3 - Acoustique et ordinateurs.

Le comité organisateur accueille les résumés de 200 mots liés à l'un de ces thèmes. L'acceptation d'un résumé implique la soumission d'une vidéo de 3 minutes, la soumission d'un article de conférence de deux pages est suggérée mais facultative. Des salles virtuelles seront disponibles pour présenter d'autres supports, comme des posters. La date limite de soumission est le 12 juillet 2021 (https://awc.caa-aca.ca/index.php/AWC/AWC21).

CANADIAN ACOUSTICS ANNOUNCEMENTS - ANNONCES TÉLÉGRAPHIQUES DE L'ACOUSTIQUE CANADIENNE

Looking for a job in Acoustics?

There are many job offers listed on the website of the Canadian Acoustical Association!

You can see them online, under http://www.caa-aca.ca/jobs/

August 5th 2015

Acoustics Week in Canada 2021

Because of the COVID-19 situation, the Acoustics Week in Canada (AWC) originally planned for October 2020 in Sherbrooke (QC) will be postpone to October 2021. Nevertheless, and as a "warm up", Sherbrooke"s organising committee is currently looking into setting up a little 1-day online celebration for October 2020. You can find more information on the AWC20 and AWC21 websites. Please note that St-John's (NL) will host the AWC2022 conference.

May 3rd 2019

COVID-19 Situation

Because of the COVID-19 situation, the Acoustics Week in Canada (AWC) originally planned for October 2020 in Sherbrooke (QC) will be postpone to October 2021. Nevertheless, and as a "warm up", Sherbrooke"s organising committee is currently looking into setting up a little 1-day online celebration for October 2020. You can find more information on the AWC20 and AWC21 websites. Please note that St-John's (NL) will host the AWC2022 conference.

May 13th 2020

Extended: International Year of Sound (2020 – 2021)

Highlighting the importance of sound and related sciences and technologies for all in society

The International Year of Sound is a project that the International Commission for Acoustics (ICA), an Affiliated Member of the ISC, has been preparing for many years. The theme of the international year is the Importance of Sound for Society and the World and is underscored by the UNESCO Charter of Sound and resolution 39C/49 on the ''Importance of sound in today's world – Promoting best practices''. Other partners for the international year include "La Semaine du Son" (LSdS), the International Science Council and ISC members the International Union of Pure and Applied Physics (IUPAP) and the International Union of Theoretical and Applied Mechanics (IUTAM). The main goal of any international year is to to promote international collaboration and to raise awareness on how science contributes to innovation for the benefit for all society. However, for the International Year of Sound, soon after the opening in Paris at the Grand Amphitheatre of the Sorbonne on 31 January 2020, it became clear that the impact of the COVID-19 pandemic would curtail the outreach events that had been planned throughout the year and around the globe. As expected, very few of the activities planned for 2020 were held with physical presence of the participants. Some, including major international conferences, were held online with considerable success, with the international year encouraged by new online technologies. The activities, organized by member societies and affiliates of the ISC, included scientific conferences and workshops, exhibitions, presentations explaining the importance of sound to a general public in collaboration with museums, universities, schools, research centers and cultural organizations, as well as postings in social media, podcasts and concerts. Many events, competitions and conferences have been rescheduled, and ISC members and their communities can find out more by visiting www.sound2020.org.

April 29th 2021

Acoustic Training in Canada Database: Help us to help the younger generation and seasoned professionals

CAA is building a comprehensive list of all training programs offered in acoustics in Canada and we need your help! Below is a survey to help us populate that database that will eventually be available on CAA website. Please return all valuable input at your earliest convenience to Mr. DeGagne (wdegagne@caa-aca.ca)!

Dear CAA members, past members and friends, The purpose of this survey is to develop an online database of all the professional, undergraduate, and graduate acoustical courses and training programs offered through universities, colleges, associations, etc. This database would benefit the entire Canadian acoustic community in the following manner: 1. Track the different acoustical courses and training programs offered nationally 2. Allow CAA members to plan their acoustical training and easily select their perfect training program to meet their career aspirations 3. Allow CAA members to compare and contrast courses and training programs from different institutions 4. Allow institutions and the CAA to determine where the training gaps are and to plan for future programs demands To help us populate this database, simply return the following information at your earliest convenience to Mr. William DeGagne (wdegagne@caa-aca.ca), volunteer for CAA: 1. Place of the Course or Training program (university, colleges, etc.): 2. Name of Course or Training program: 3. Approx. date the Course or Training was followed: 4. Level (graduate, undergraduate, college course or professional training program, etc.): 5. Brief description of the Course or Training program: 6. Webpage of Course or Training program: 7. Location of Course or Training program (City, Province): 8. Course or Training program language: Thanks for you help towards the younger generation and seasoned professionals! :-)

May 31st 2021

Acoustics Week in Canada 2021 (AWC21): Call for abstracts

Acoustics Week in Canada 2021 will be held online October 05-07!

Submissions are now open for Acoustics Week in Canada 2021. The meeting will be held online, and three consecutive half-days (12:00-17:00 EST) will be punctuated by plenary lectures and 30-minute lightning talks sessions, while moving into virtual rooms. The details of a noise-related challenge among Canada will be revealed shortly. Each day will have a general theme: Day1 - Acoustics and structures, Day 2 - Acoustics and living beings, Day 3 - Acoustics and computers. The organizing committee welcomes 200-word abstracts related to any of these themes. An accepted abstract requires the submission of a 3-min video, while 2-page conference paper submission is encouraged but optional. Virtual rooms will be available for presenting other materials, like posters. The submission deadline is July 12, 2021 (https://awc.caa-aca.ca/).

June 12th 2021

À la recherche d'un emploi en acoustique ?

De nombreuses offre d'emploi sont affichées sur le site de l'Association canadienne d'acoustique !

Vous pouvez les consulter en ligne à l'adresse http://www.caa-aca.ca/jobs/

August 5th 2015

Semaine canadienne de l'acoustique 2021

En raison de la situation COVID-19, la Semaine canadienne de l'acoustique (AWC) initialement prévue en octobre 2020 à Sherbrooke (QC) sera reportée à octobre 2021. Néanmoins, et comme "échauffement", le comité organisateur de Sherbrooke étudie actuellement la possibilité de mettre en place une petite célébration d'une journée en ligne pour octobre 2020. Vous pouvez trouver plus d'informations sur le site des conférences AWC20 et AWC21. Veuillez noter que St-John's (NL) sera l'hôte de la conférence AWC2022.

May 3rd 2019

Situation COVID-19

En raison de la situation COVID-19, la Semaine canadienne de l'acoustique (AWC) initialement prévue en octobre 2020 à Sherbrooke (QC) sera reportée à octobre 2021. Néanmoins, et comme "échauffement", le comité organisateur de Sherbrooke étudie actuellement la possibilité de mettre en place une petite célébration d'une journée en ligne pour octobre 2020. Vous pouvez trouver plus d'informations sur le site des conférences AWC20 et AWC21. Veuillez noter que St-John's (NL) sera l'hôte de la conférence AWC2022.

May 13th 2020

Extension : Année internationale du son (2020 - 2021)

Mettre en évidence l'importance du son et des sciences et technologies connexes pour tous dans la société

L'Année internationale du son est un projet que la Commission internationale d'acoustique (ICA), membre affilié de la ISC, prépare depuis de nombreuses années. Le thème de l'année internationale est l'importance du son pour la société et le monde et est souligné par la Charte du son de l'UNESCO et la résolution 39C/49 sur l'"importance du son dans le monde d'aujourd'hui - promouvoir les meilleures pratiques". Parmi les autres partenaires de l'année internationale figurent la Semaine du Son (LSdS), le Conseil international de la science et les membres de l'ISC, l'Union internationale de physique pure et appliquée (UIPPA) et l'Union internationale de mécanique théorique et appliquée (IUTAM). L'objectif principal de toute année internationale est de promouvoir la collaboration internationale et de faire prendre conscience de la manière dont la science contribue à l'innovation au profit de toute la société. Cependant, pour l'Année internationale du son, peu après l'ouverture à Paris au Grand Amphithéâtre de la Sorbonne le 31 janvier 2020, il est apparu clairement que l'impact de la pandémie de COVID-19 réduirait les événements de sensibilisation qui avaient été prévus tout au long de l'année et dans le monde entier. Comme prévu, très peu des activités prévues pour 2020 se sont déroulées avec la présence physique des participants. Certaines, notamment les grandes conférences internationales, se sont tenues en ligne avec un succès considérable, l'année internationale étant encouragée par les nouvelles technologies en ligne. Les activités, organisées par les sociétés membres et les affiliés de l'ISC, comprenaient des conférences et des ateliers scientifiques, des expositions, des présentations expliquant l'importance du son au grand public en collaboration avec des musées, des universités, des écoles, des centres de recherche et des organisations culturelles, ainsi que des publications sur les médias sociaux, des podcasts et des concerts. De nombreux événements, concours et conférences ont été reprogrammés, et les membres de l'ISC et leurs communautés peuvent en savoir plus en consultant le site www.sound2020.org.

April 29th 2021

Répertoire des formations en acoustique au Canada : aidez-nous à aider la jeune génération et nos professionels d'expérience

L'ACA est en train de dresser une liste complète de tous les programmes de formation offerts en acoustique au Canada et nous avons besoin de votre aide ! Vous trouverez ci-dessous un sondage qui nous aidera à alimenter cette base de données qui sera éventuellement disponible sur le site Web de la CAA. Veuillez retourner vos précieux commentaires à M. DeGagne (wdegagne@caa-aca.ca) dans les plus brefs délais !

Chers membres, anciens membres et amis de l'ACA, Le but de cette enquête est de développer une base de données en ligne de tous les cours et programmes de formation en acoustique professionnels, de premier et de deuxième cycle, offerts par les universités, les collèges, les associations, etc. Cette base de données profiterait à l'ensemble de la communauté acoustique canadienne de la manière suivante : 1. Suivre les différents cours et programmes de formation en acoustique offerts à l'échelle nationale. 2. Permettre aux membres de l'ACA de planifier leur formation en acoustique et de choisir facilement le programme de formation idéal pour répondre à leurs aspirations professionnelles. 3. Permettre aux membres de l'ACA de comparer et d'opposer les cours et les programmes de formation de différentes institutions. 4. Permettre aux institutions et à l'ACA de déterminer où se trouvent les lacunes en matière de formation et de planifier les demandes de programmes futurs. Pour nous aider à alimenter cette base de données, il vous suffit de retourner les informations suivantes dans les meilleurs délais à M. William DeGagne (wdegagne@caa-aca.ca), bénévole pour l'ACA : 1. Lieu du cours ou du programme de formation (université, collèges, etc.) : 2. Nom du cours ou du programme de formation : 3. Date approximative à laquelle le cours ou la formation a été suivi. 4 : 4. Niveau (études supérieures, premier cycle, cours collégial ou programme de formation professionnelle, etc :) 5. Brève description du cours ou du programme de formation : 6. Page web du cours ou du programme de formation : 7. Lieu du cours ou du programme de formation (ville, province) : 8. Langue du cours ou du programme de formation : Merci pour votre aide à l'intention de la jeune génération et de nos professionels d'expérience ! :-)

May 31st 2021

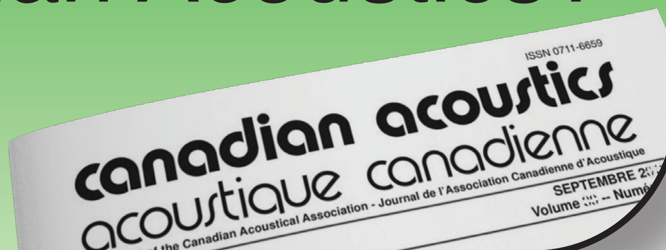
Semaine Canadienne de l'Acoustique 2021 (AWC21) : Appel aux résumés

La Semaine canadienne de l'acoustique aura lieu en ligne du 5 au 7 octobre 2021 !

-=-=-=- Les soumissions sont maintenant ouvertes pour la Semaine Canadienne d'Acoustique 2021. La conférence se tiendra en ligne sur trois demi-journées consécutives (12h00-17h00 HNE), et sera rythmée par des conférences plénières, des sessions éclair de 30 minutes tout en se déplaçant dans des salles virtuelles. Les détails concernant un défi relié au bruit au Canada seront bientôt dévoilés. Chaque journée aura un thème général : Jour 1 - Acoustique et structures, Jour 2 - Acoustique et êtres vivants, Jour 3 - Acoustique et ordinateurs. Le comité organisateur accueille les résumés de 200 mots liés à l'un de ces thèmes. L'acceptation d'un résumé implique la soumission d'une vidéo de 3 minutes. La soumission d'un article de conférence de deux pages est suggérée mais facultative. Des salles virtuelles seront disponibles pour présenter d'autres supports, comme des posters. La date limite de soumission est le 12 juillet 2021

June 12th 2021

Why publish in Canadian Acoustics?



Because, it is...

- A respected scientific journal with a 40-year history uniquely dedicated to acoustics in Canada
- A quarterly publication in both electronic and hard-copy format, reaching a large community of experts worldwide
- An Open Access journal, with content freely available to all, 12 months from time of publication
- A better solution for fast and professional review providing authors with an efficient, fair, and constructive peer review process.

Pourquoi publier dans Acoustique canadienne ?

Parce que, c'est...

- Une revue respectée, forte de 40 années de publications uniquement dédiée à l'acoustique au Canada

- Une publication trimestrielle en format papier et électronique, rejoignant une large communauté d'experts à travers le monde

- Une publication "accès libre" dont le contenu est disponible à tous, 12 mois après publication

- Une alternative intéressante pour une évaluation par les pairs, fournissant aux auteurs des commentaires pertinents, objectifs et constructifs

Application for Membership

CAA membership is open to all individuals who have an interest in acoustics. Annual dues total $120.00 for individual members and $50.00 for student members. This includes a subscription to ***Canadian Acoustics***, the journal of the Association, which is published 4 times/year, and voting privileges at the Annual General Meeting.

Subscriptions to *Canadian Acoustics* *or* Sustaining Subscriptions

Subscriptions to ***Canadian Acoustics*** are available to companies and institutions at a cost of $120.00 per year. Many organizations choose to become benefactors of the CAA by contributing as Sustaining Subscribers, paying $475.00 per year (no voting privileges at AGM). The list of Sustaining Subscribers is published in each issue of ***Canadian Acoustics*** and on the CAA website.

Please note that online payments will be accepted at http://jcaa.caa-aca.ca

Address for subscription / membership correspondence:

Name / Organization ______________________________________

Address ______________________________________

City/Province ________________ Postal Code ________ Country ____________

Phone ____________ Fax ____________ E-mail ________________

Address for mailing Canadian Acoustics, if different from above:

Name / Organization ______________________________________

Address ______________________________________

City/Province ________________ Postal Code ________ Country ____________

Areas of Interest: (Please mark 3 maximum)

1. Architectural Acoustics
2. Engineering Acoustics / Noise Control
3. Physical Acoustics / Ultrasound
4. Musical Acoustics / Electro-acoustics
5. Psychological / Physiological Acoustic
6. Shock and Vibration
7. Hearing Sciences
8. Speech Sciences
9. Underwater Acoustics
10. Signal Processing / Numerical Methods
11. Other

For student membership, please also provide:

________ ________ ________________________

(University) *(Faculty Member)* *(Signature of Faculty Member)* *(Date)*

I have enclosed the indicated payment for:
[ ] CAA Membership $ 120.00
[ ] CAA Student Membership $ 50.00

Corporate Subscriptions (4 issues/yr)
[ ] $120 including mailing in Canada
[ ] $128 including mailing to USA,
[ ] $135 including International mailing

[ ] Sustaining Subscription $475.00
(4 issues/yr)

Please note that the preferred method of payment is by credit card, online at http://jcaa.caa-aca.ca

For individuals or organizations wishing to pay by check, please register online at *http://jcaa.caa-aca.ca* and then mail your check to:

Executive Secretary, Canadian Acoustical:
Dr. Roberto Racca
c/o JASCO Applied Sciences
2305–4464 Markham Street
Victoria, BC V8Z 7X8 Canada

Formulaire d'adhésion

L'adhésion à l'ACA est ouverte à tous ceux qui s'intéressent à l'acoustique. La cotisation annuelle est de 120.00$ pour les membres individuels, et de 50.00$ pour les étudiants. Tous les membres reçoivent ***l'Acoustique Canadienne***, la revue de l'association.

Abonnement pour la revue *Acoustique Canadienne* et abonnement de soutien

Les abonnements pour la revue ***Acoustique Canadienne*** sont disponibles pour les compagnies et autres établissements au coût annuel de 120.00$. Des compagnies et établissements préfèrent souvent la cotisation de membre bienfaiteur, de 475.00$ par année, pour assister financièrement l'ACA. La liste des membres bienfaiteurs est publiée dans chaque issue de la revue ***Acoustique Canadienne***..

Notez que tous les paiements électroniques sont acceptés en ligne http://jcaa.caa-aca.ca

Pour correspondance administrative et financière:

Nom / Organisation ______________________________

Adresse ______________________________

Ville/Province ______________ Code postal__________ Pays ______________

Téléphone ____________ Téléc. ____________ Courriel ______________

Adresse postale pour la revue Acoustique Canadienne

Nom / Organisation ______________________________

Adresse ______________________________

Ville/Province ______________ Code postal__________ Pays ______________

Cocher vos champs d'intérêt: (maximum 3)

1. Acoustique architecturale
2. Génie acoustique / Contrôle du bruit
3. Acoustique physique / Ultrasons
4. Acoustique musicale / Électro-acoustique
5. Physio / Psycho-acoustique
6. Chocs et vibrations
7. Audition
8. Parole
9. Acoustique sous-marine
10. Traitement des signaux /Méthodes numériques
11. Autre

Prière de remplir pour les étudiants et étudiantes:

____________ ______________ ______________ ____________

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