EXAMPLES OF COMPUTER SOFTWARE FOR ACOUSTIC ANALYSIS

BY:
EGBEIYON LEONARD OSARO
ARC/09/7373

AND

BRAIMAHO AYOMIDE OLAITAN
ARC/09/7371

IN PARTIAL FULFILMENT FOR THE REQUIREMENTS OF THE course
ARC 507 (ENVIRONMENTAL CONTROL II)

JULY 2014
TABLE OF CONTENTS

Abstract
Introduction
Aims and Objectives

Acoustic Simulation Techniques
Geometrical Acoustics
Computer Software Used In Acoustic Analysis

Electronic and Acoustic System Evaluation And Response Analysis, (EASERA).

Speech Studio
Room EQ Wizard (REW)
Features of REW
Conclusion
**ABSTRACT**
This paper gives the synopsis of the various types of software used in acoustic analysis all over the world and also attempts to clinically examine its methods of task operation and its basic functions and processes.

**INTRODUCTION**
Analysis of acoustic signals of the human voice has many purposes. From a technological standpoint, there is an ever-growing need to store, code, transmit, and synthesize voice signals. The telecommunications industry has dichotomized transmission of information into either *voice* or *data*, suggesting that voice signals are a class of their own. From a basic science standpoint, investigators have traditionally studied the microphone signal to understand speech production and perception, given that the acoustic signal is the common link between them. In acoustic analysis, Computer generated patterns can be used to generate the spatial data explaining the behavioural response of performance halls, recording studios and any other interior spaces to different degrees of sound level and pressures and as such, ample amount of information can be generated for the designer of such spaces by using computer graphics to display the multi-dimensional data obtained.

**AIMS AND OBJECTIVES**
In this paper, we will attempt to relate the concept of acoustic analysis, various computer software used and the processes and functions of these applications in attaining a standard and error free acoustic analysis.

The objectives at the end of this paper are as follows;

- The reader will distinctively understand the ideas and concepts of acoustic analysis.
- The various applications/software available today as regards acoustic analysis will be detailed.
- The recommended steps to operating some of this software will be itemised for the sole purpose of in-depth understanding on the part of the student as well as the reader.
- The student/reader will at will be able to differentiate and analyse the type of applications and their functions as well as their manufacturers.
ACOUSTIC SIMULATION TECHNIQUES

In many technical professions, simulation software has become an essential tool for the Planning, design and the evaluation of complex systems. Today, simulation software is also used for electro-acoustic design to closely predict possible results.

Acoustical simulation is a technique that assists users in the evaluation of room acoustics or the performance of sound systems. This acoustical program can simulate the sound as it would be heard after the project is built and this is referred to as auralization. Before the advent of acoustic simulation software model measuring techniques were commonly applied. Models were usually designed with a scale of 1:20, and signals were transformed by a factor of 20, Today, acoustic CAD simulation techniques provide visualisation of sound fields and auralisation of acoustic signals, i.e. listening in virtual rooms.

For room simulation the geometric parameters of its boundaries must be entered as well as their frequency dependent absorption coefficients (and, if necessary, their diffusion coefficients). Sound sources are normally entered as point sources, and their directivity is shown in balloons. Direct sound dispersion is determined geometrically while both statistical and geometrical methods are used to calculate room influences.

GEOMETRICAL ACOUSTICS

Geometrical acoustics examine the frequency range of a room in which sound is described by its particle character, i.e. wavelength is rather short relative to room dimensions. This approach ignores the wave character of sound.

Geometrical acoustics regard sound as rays which are dispersed from a source in rectilinear fashion and mirrored, i.e. reflected, at the room boundaries.

The source is regarded as the sender (of an infinite number) of sound particles with a certain amount of energy. Source directivity is determined by the directional sound particle density.

The sound particles travel from the sender to a receiver directly or via single or multiple reflections (respectively scattering) at the room boundaries.

Absorption at the boundaries and air damping is regarded as a frequency dependent decrease of energy, and the sound field is calculated by the energy of the arriving sound particles.

As the number of direct rays and their reflections increases the paths of individual rays cannot be traced anymore, and only statistic data on the sound field can be established. In such a case the number of room resonances is rather high.
COMPUTER SOFTWARE USED IN ACOUSTIC ANALYSIS

Since the advent of the computer, there has been a rapid growth and development in the methods of measuring sound level as well as pressure. Generally speaking, easier and more effective ways have been devised for taking more accurate measurements when it comes to acoustic analysis and this is due to the use of software or applications which aid these processes. Some of these applications work based on existing / recorded sound (Audio processing) while others work from the first principles by generating analysing and processing sounds based on information fed to it.

Outlined below is a table containing some of the software used for acoustic analysis, the modes of operation and the manufacture’s name as applicable.

<table>
<thead>
<tr>
<th>S/N</th>
<th>SOFTWARE NAME</th>
<th>MANUFACTURER</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ultra-Vision</td>
<td>ZETEC</td>
<td>Operates efficiently on small laptops as well as high-end desktop workstations, under various Windows® operating systems</td>
</tr>
<tr>
<td>2</td>
<td>vibro-acoustic analysing software</td>
<td>ESI GROUP</td>
<td>Unique methods for impact probabilities and (broadband) force prediction</td>
</tr>
<tr>
<td>3</td>
<td>PROBE SOFTWARE</td>
<td>Böhmer Audio</td>
<td>Professional level Acoustic Measurement software for speaker performance Analysis.</td>
</tr>
<tr>
<td>4</td>
<td>K-SPACE ACOUSTICS SOFTWARE</td>
<td>WAVE IMAGING</td>
<td>For biomedical imaging and underwater acoustics</td>
</tr>
<tr>
<td>5</td>
<td>MSC/NASTRAN</td>
<td>MACNEAL-SCHWENDLER CORPORATION</td>
<td>For Noise, Vibration, and Harshness (NVH) problems</td>
</tr>
<tr>
<td>6</td>
<td>QCREATOR</td>
<td>QSOUND LABS</td>
<td>A 3Dimesional audio software</td>
</tr>
<tr>
<td>7</td>
<td>RplusD (R+D)</td>
<td>ACOUSTISOFT</td>
<td>An analyser for room acoustics measurement for the purpose of hi-fi sound in small and medium sized rooms.</td>
</tr>
<tr>
<td></td>
<td><strong>RAVEN</strong></td>
<td>CORNELL LAB</td>
<td>Raven is a software program for the acquisition, visualization, measurement, and analysis of sounds.</td>
</tr>
<tr>
<td>---</td>
<td>----------</td>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td><strong>ROOM EQ WIZARDS (REW)</strong></td>
<td>JOHN MULCAHY</td>
<td>acoustic and vibration prediction software</td>
</tr>
<tr>
<td>10</td>
<td><strong>SEAM</strong></td>
<td>CAMBRIDGE COLLABORATIVE, INC</td>
<td>acoustic and vibration prediction software</td>
</tr>
<tr>
<td>11</td>
<td><strong>SK-AVAM</strong></td>
<td>SCIENTIFIC AND TECHNICAL SOFTWARE</td>
<td>SK-AVAM is used for low cost data analysis</td>
</tr>
<tr>
<td>12</td>
<td><strong>EASERA (ELECTRONIC AND ACOUSTIC SYSTEM EVALUATION AND RESPONSE ANALYSIS)</strong></td>
<td></td>
<td>EASERA is the unrivalled solution for electronic and acoustic analysis with industry standard quality and incredible flexibility and power.</td>
</tr>
<tr>
<td>13</td>
<td><strong>PRAAT</strong></td>
<td>P. BOERSMA &amp; D. WEENINK, INSTITUTE OF PHONETIC SCIENCES UNIVERSITY OF AMSTERDAM</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td><strong>SPECTROGRAM</strong></td>
<td>Visualization Software LLC</td>
<td>This is an audio spectrum analysis Test Tone Generator (TTG)</td>
</tr>
<tr>
<td>15</td>
<td><strong>FASTBEM ACOUSTICS</strong></td>
<td>ADVANCED CAE TECHNOLOGY CO., LTD.</td>
<td>FASTBEM acoustics is a graphical-user interface (GUI) for acoustics analysis solver program and sound cancellation.</td>
</tr>
<tr>
<td>16</td>
<td><strong>SPEECHSTUDIO</strong></td>
<td>LARYNGOGRAPH LTD.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td><strong>ULTRAVOX</strong></td>
<td>NOLDUS INFO TECH.</td>
<td>Ultravox is used for automatic monitoring of ultrasonic vocalizations</td>
</tr>
</tbody>
</table>
spectral analysis software is mainly used for bioacoustics and underwater acoustics.

The speech Analyser is used for recording, transcribing, and analysing speech files.

Software for estimating the acoustic performance of constructions.

Software for high quality audio, acoustics, and vibrational measurements.

<table>
<thead>
<tr>
<th></th>
<th>SPECTRA SERIES</th>
<th>CETACEAN RESEARCH TECHNOLOGY</th>
<th>spectral analysis software is mainly used for bioacoustics and underwater acoustics</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>SPEECH ANALYSER</td>
<td>CCS SOFTWARE DEVELOPMENT</td>
<td>The speech Analyser is used for recording, transcribing, and analysing speech files.</td>
</tr>
<tr>
<td>20</td>
<td>WINFLAG</td>
<td>MORSET SOUND DEVELOPMENT</td>
<td>Software for estimating the acoustic performance of constructions</td>
</tr>
<tr>
<td>21</td>
<td>WINPITCH</td>
<td>PITCH INSTRUMENTS INC.</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>TRANSANA</td>
<td>WISCONSIN UNIVERSITY</td>
<td></td>
</tr>
</tbody>
</table>

**Table showing examples of software for acoustic analysis**

A detailed overview of some of the above stated applications is outlined below in the ensuing sections;

**ELECTRONIC AND ACOUSTIC SYSTEM EVALUATION AND RESPONSE ANALYSIS, (EASERA).**

EASERA is the unrivalled solution for electronic and acoustic analysis with industry standard quality and incredible flexibility and power.

EASERA consists of four logical parts:

- Signal generator
- Measurement
- Real time analyser
- Post processing
EASERA provides both data acquisition with a variety of stimulus signals including Time Delay Spectrometry, sweeps MLS or noise excitation signals and a post processing engine to calculate all acoustic functions.

The real time analyser provides multiple ways to perform a fast onsite analysis or to obtain a precise view of the surrounding acoustic environment.

Although many of these tools are available in one form or another in several products, EASERA is the first to bring them all together in one unified measuring package.

EASERA can be run on Microsoft Windows XP or higher and in conjunction with nearly every modern measurement interface

**SPEECH STUDIO**

Speech Studio is a software and hardware package by LARYNGOGRAPH LTD, which has been specially designed for phoneticians, speech scientists and quantitative work. It supports data recording direct to hard disk, real-time displays, and instantaneous quantitative analysis and pattern target mode for speech training.

Functions of speech studio include;

- Transcribing speech files phonetically with IPA.
- Playback at a slower speed.
- Playback with repetition with variable length delay between repetitions.
- Add phonemic, orthographic, tone and gloss annotations to your transcription in an interlinear format.
- View sound file as a waveform, pitch plot, spectrogram, spectrum and various F1 vs. F2 displays.
- Music Analysis capability

![PLATE 1 Interface of speech studio by laryngograph ltd.](image)
ROOM EQ WIZARD (REW)

REW is room acoustics analysis software for measuring and analysing room and loudspeaker responses. It includes tools for generating audio test signals; measuring SPL and impedance; measuring frequency and impulse responses; generating phase, group delay and spectral decay plots, waterfalls, spectrograms and energy-time curves; generating real time analyser (RTA) plots; calculating reverberation times; calculating Thiele-Small parameters; determining the frequencies and decay times of modal resonances; displaying equaliser responses and automatically adjusting the settings of parametric equalisers to counter the effects of room modes and adjust responses to match a target curve. The audio analysis features of REW help you optimise the acoustics of your listening room, studio or home theatre and find the best locations for your speakers, subwoofers and listening position.

PLATE 02; REW interface
Features of REW are listed below for clarity and better understanding:

- Frequency response measured using logarithmically swept sine signals for fast, accurate room acoustics and audio analysis measurements using either an SPL meter or measurement microphone
- Real Time Analyser with up to 1/48th octave resolution
- Spectral decay plots, waterfalls and spectrograms
- Impulse response, step response and energy-time curves
- Reverberation times derived in accordance with ISO 3382 in octave or one-third octave bands with results for Early Decay time (EDT), T20, T30 and an optimal fit RT60 figure, impulse response can be displayed with octave or one-third octave filter applied.
- Signal Generator offering sine waves, square waves, linear and logarithmic sine sweeps, random pink noise (full range, speaker calibration, sub calibration and custom filtered) and periodic pink and white noise
- Sound level meter with full integrating functionality including equivalent sound level and sound exposure level; mic/meter and soundcard calibration corrections applied; A, C or Z weighting
- Phase & Group Delay (measured, minimum and excess)
- Phase wrap/unwrap, minimum phase generation
- Impedance measurement and Thiele-Small parameter calculation
- Impulse Response delay calculation and adjustment
- Measurement arithmetic functions, add/subtract/multiply/divide/merge measurement
- Automatic identification of peaks in the response, automatic assignment of EQ filters to peaks and optimisation of filter parameters to counter the peaks and track a desired target response
- Room resonance analysis to determine the frequencies and decay times of modal resonances with pole-zero plots of the response and any filters applied
- Frequency response import from and export to text files
- Impulse response import from WAV or AIFF files
- Export impulse responses of measurement or filter settings to WAV files with 16, 24 or 32-bit resolution
Compensation for C-weighting when using an external SPL meter as the input, calibration files can be loaded for soundcard, microphone or SPL meter

Comprehensive help files within the application

**Plate 03: level and sound exposure level metres**
CONCLUSION

The place of acoustic analysis in the technical fields of sound management has been drastically influenced with the use of computers and as such the added value has been immeasurable.

To further buttress the points earlier stated, it is worthy of note to mention that the architecture profession is a beneficiary of this wholesome technological advancement and as such the applications finds its use in the areas of sound regulation and acoustic standardization but in public and private housing schemes. The immeasurable benefits derived from these software are the basis for their continual use within professional circles and this write has attempted to outline its relevance and as such promote its continual adoption.

REFERENCES

http://www.transana.org/
http://www.acousticsbydesign.com/acoustics/acousticmeasurement.htm
http://www.laryngograph.com/pr_studio.htm
http://www.sil.org/computing/speechtools/speechanalyzer.htm
http://www.praat.org