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Mathematical Aspects of Sound Neurobics

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Abstract - Psychoneurobics is one of the healing therapies in alternative medicinal world. Sound neurobics consist of healing through sounds. It may contain music, songs or more other forms of sound which may lead to secretion of relaxing or relief hormones resulting in healing of ailments in the body.
This study focuses on mathematical aspects in sound neurobics.

Key Words*: *Psychoneurobics, Sound neurobics, Mathematics..

I. INTRODUCTION

As science states that everything in the universe is vibration, thus using vibrations we can definitely reverse the diseases. It is a part of practice i.e. healer and the patient. Without prior knowledge one is unable to heal patients.
Some researchers tried to find out the inter-relations by performing various experiments either in the labs concerning their research or in outdoor public gatherings calling as *Shakti-pat*. Some use Mantra to remove deformities and stabilizes the human body. It is scientifically proven by some researchers that proper sound effects can result in faster improvements in the patients
This all discussion indicates towards the medicinal use of sound. This study covers the mathematical aspects used in this method to some extent.

II. LITERATURE REVIEW

[1] Based on mathematical rules, *Yuri Iserlis* in the research studied physiotherapy actions among the patients of hypertensions. [2] *Bruce Kessler* used music to teach mathematical concepts in trigonometry based on "Sound waves created by sine and cosine waves can be used to built any function. [3] *Gunjan Chhabra-et-al* studied changes in human mood and emotions using Emotion Detector system giving new approach to real-time emotions along with biofield analysis (human biofield and energy of human soul). [4] *Marius Georgescu-et-al* in their study investigated the effects of 3 different auditory stimuli (S1, S2, S3) on cerebral biopotentials (activity) by means of mathematical functions using electroencephalographic (EEG). [5] *Victor Christianto-et-al* introduced a field called cymatics along with sound healing which can impact research in spirituality and consciousness. [6] *Rachael Linton* in her doctoral research studied the therapeutic use of sound, colour and form in motion in complementary therapy with visual form and motion of sound. [7] *Madhukar Krishnamurthy* studied meditational OM and Vedic chants to convert it into time series at a frequency of 44100 Hertz and summarise that meditation songs are perfect for meditation since it is Lyapunov and asymptotically stable. [8] *Fariborz Alipour-et-al* in their critical study about human phonation process provided various mathematical models on the basis of material properties and geometry with boundary conditions. [9] *Entesar Alasaad-et-al* considered an algorithm adopting polynomials of various degrees as mathematical representation for speech signal. Based on level of clarity & possibility of adoption, retrieved speech was studied it an alternative signal as proximity to original sound adding noise resulting in best sound representation and closed to the original one. [10] *Dr. Hari Om Singh Tomar* studied mathematical aspects of O and M chanting. The abovementioned and other researches can be considered to think sound neurobics with mathematical aspects.

III. MATHEMATICAL ASPECTS OF SOUND AS HEALING TOOLS

Aspect1:
Analysis of *already existing available methods* of the sound therapy can be classified as:

A] based on frequencies:

a. Infrasonic frequency ($F_I < 20\ Hz$)
b. Audible Sound frequency ($20\ Hz < F_A < 20\ kHz$)
c. Ultrasonic frequency ($F_U > 20\ kHz$)

Sound can be expressed as function of frequencies:

$$S = S(F_I, F_A, F_U) \quad (1)$$

B] based on signal forms:

a. Sine form:

$$y(x,t) = A\sin(kx \pm \omega t + \phi) \quad (2)$$

where, A = amplitude
$\omega(= 2\pi f)$ = angular frequency
t = time
$k(= 2\pi/\lambda)$ = wave number
ϕ = phase angle

b. Square form:

$$x(t) = \frac{4A}{\pi}\sum_{k=1}^{\infty}\frac{\sin(2\pi(2k-1)ft)}{2k-1} \quad (3)$$

where, A = amplitude
$2\pi f$ = angular frequency
t = time
$k(= 2\pi/\lambda)$ = wave number

c. Triangle form:

$$s(t) = \frac{8A}{\pi}\sum_{k=0}^{\infty}\frac{(-1)^k}{(2k+1)^2}\sin(2\pi(2k+1)ft) \quad (4)$$

where, A = amplitude,
$\omega(= 2\pi f)$ = angular frequency,
t = time

$k(= 2\pi/\lambda)$ = wave number

d. Sawtooth form:

$$s(t) = \frac{2A}{\pi}\sum_{n=1}^{\infty}\frac{(-1)^{n+1}}{n}\sin(2\pi nft) \qquad (5)$$

where, A = amplitude,
f = fundamental frequency,
t = time
n = harmonic number

C] based on body organs:

a. ***Brain:*** The mathematical representation of plane progressive harmonic wave is given by,

$$V(r,t) = Ae^{i(\bar{k}.\bar{r}-\omega t)} \qquad (6.1)$$

where, $V(r,t)$ = local surface potential (voltage) of brain neurons at position r and time t
A = amplitude
ω = frequency
$\bar{k}$ = wave vector towards direction of propagation
$\bar{r}$ = position vector

Considering non-linear oscillatory system, the propagation of waves across cortex is considered as dispersion relation as

$$\frac{\partial^2\phi}{\partial t^2} + \Gamma\frac{\partial\phi}{\partial t} + \Omega^2\phi = S(t) \qquad (6.2)$$

where, ϕ = neural potential
Γ = dissipation
Ω = natural frequency
$S(t)$ = Source term

b. ***Ear:*** Sound wave can be considered as propagating in longitudinal pressure wave. The ear detects the pressure wave variation related to displacement is given by,

$$P(x,t) = BkS_0\cos(\omega t - kx) \qquad (7)$$

where, $P(x,t)$ = pressure variation
B = Bulk modulus of medium
S_0 = displacement amplitude,
$\omega(= 2\pi f)$ = angular frequency
$k(= 2\pi/\lambda)$ = wave number

c. ***Skin:*** The sound waves enter the body through skin. Because of absorption, scattering and reflection, the amplitude and intensity of sound decreases as it enters deeper in the body.

$$I = I_0e^{-\alpha x} \qquad (8)$$

where, I = intensity at depth x
I_0 = incident intensity at the surface
α = absorption coefficient

d. ***Heart:*** The sound created in the heart are considered as:
S_1 = "Lub" created during ventricular systole
S_2 = "Dub" created during ventricular diastole
The specific heart sound can be analysed using:

$$m\frac{\partial^2 x}{\partial t^2} + \mathrm{c}\frac{\partial x}{\partial t} + kx = F(t) \qquad (9.1)$$

where, m = mass of blood and tissues
$\frac{\partial^2 x}{\partial t^2}$ = accelaration
c = damping factor in viscoelastic material
k = elasticity of tissue
$F(t)$ = Driving force in turbulent blood flow

To measure heart wall motion using ultrasound, frequency shift is calculated by

$$f_b = |f' - f| \approx 2f\left(\frac{v_{heart}}{c}\right) \qquad (9.2)$$

where, f_b = frequency shift
f' = natural frequency
f = transmitted ultrasound frequency
v_{heart} = speed of heart wall
c = speed of sound in tissue ($\approx 1500\ m/s$)

e. ***Lungs:*** The sound in the lungs can be considered as pressure fluctuations (p') in compressible fluid calculated from:

$$\frac{1}{{c_0}^2}\frac{\partial^2 p'}{\partial t^2} - \nabla^2 p' = s(x,t) \qquad (10.1)$$

where, p' = acoustic pressure fluctuation
c_0 = speed of sound
$s(x,t)$ = source term (turbulent flow, boundary movements)

Breath sounds are generally produced by turbulent airflow. The pressure drop Δp due to turbulence is calculated as:

$$\Delta p = K.\rho.\upsilon^2 \qquad (10.2)$$

where, ρ = air density
υ = velocity
K = resistance coefficient

The frequency of the wheeze (f), common in asthma, can be calculated by Flutter equation giving time taken for a wave to travel down and up the tube:

$$\frac{1}{f} = n\left(\frac{l}{\upsilon} + \frac{l}{u}\right) \qquad (10.3)$$

where, l = length
υ = speed of downstream travelling wave (flow)
u = speed of upstream elastic wave

The sudden opening of small airways to produce a short acoustic pulse is supposed to be Crackles.

$$\Delta p(t) = \frac{1}{r}.\frac{\partial^2 V}{\partial t^2} \qquad (10.4)$$

where, $\Delta p(t)$ = pressure wave
r = distance to the source
V = volume change in the alveoli opening

The propagation of snoring sound pressure inside upper airway can be described by Helmholtz equation:

$$\nabla^2 p + \mathrm{k}^2 p = 0 \qquad (10.5)$$

where, ρ = snoring sound pressure
∇^2= Laplacian operator
$k(= \omega/c)$ = wave number
ω = angular velocity
c = speed of sound in air of the airway

f. ***Digestive system:*** The sum of individual wave components (iwc) represents the vibrations of gut wall single contraction producing bowel sound.

$$P_{iwc}(t) = A_{iwc}(t)(2\pi f_{iwc} t) \quad (11.1)$$
$$A_{iwc}(t) = P_m e^{-E.t_b} \quad (11.2)$$

where, $P_{iwc}(t)$ = pressure of bowel sound
$A_{iwc}(t)$ = amplitude of sound
f_{iwc} = resonant frequency of vibration
t = time
P_m = pressure index
E = envelope exponent linked to pressure changes
t_b = shape index controlling damping

The sound propagating from intestine to skin surface passes through layers of fats and muscles measured by stethoscope. This acoustics behaviour is governed by Helmholtz wave equation:

$$\frac{1}{\rho_0 c^2}\frac{\partial^2 p}{\partial t^2} + \nabla.\left(-\frac{1}{\rho_0}\nabla \mathrm{p}\right) = 0 \quad (11.3)$$

where, ρ_0 = mass density of tissue (fat/muscle)
p = sound pressure
c = speed of sound in tissue
t = time

g. ***Excretory system:*** To measure velocity of urine flow,

$$\Delta f = \frac{2\upsilon f_0}{c}\cos\theta \quad (11.4)$$

where, Δf = frequency change
υ = velocity of urine flow
f_0 = frequency of ultrasound
c = speed of sound in tissue
θ = Doppler angle between ultrasound beam and direction of urine flow

Aspect2:

The spiritual awakening theory follows that when inner voice dominates outer physical world noise then one can start self-healing process. Mathematically,

$$Sound\ healing \propto \frac{Inner\ voice}{outer\ noise} \quad (12)$$

Meditation, yoga and many more practices help to strengthen inner voice in the benefit of mankind and all the living beings around the world.

Aspect3:

The overall effect of sound therapy on the related chakras can be modelled [11] using second-order differential equation as:

$$\frac{d^2 I}{dt^2} + \zeta_{chakra}\frac{dI}{dt} + \omega_{chakra}^2 I = 0 \quad (13)$$

where, $I(t)$ = emotional intensity function
ζ_{chakra} = damping coefficient representing emotions
ω_{chakra} = resonant frequency of chakra

The resonant frequencies and associated emotions along with activating (bija) mantra are considered as Table 1:

Table 1: Chakra and related resonant frequency

Chakra	*Resonant frequency*	*Related emotions*	*Bija Mantra*
Root	396 Hz	Fear, Guilt	LAM
Sacral	417 Hz	Emotional flow, pleasure	VAM
Solar plexus	528 Hz	Confidence, transformation	RAM
Heart	639 Hz	Love, compassion, relationship	YAM
Throat	741 Hz	Expressions and communication	HAM
Third eye	852 Hz	Intuition, insight, clarity	OM
Crown	963 Hz	Transcendence, oneness, enlightement	AH

IV. CONCLUSIONS

1) Diseases are the after effects of loss or excess of energies.
2) This difference can be removed by various known or unknown medicinal methods.
3) Alternative medicine is a method which does not harm the body organs.
4) Psychoneurobics is one of them.
5) This study succeeded to apply mathematical concepts to the sound healing therapy.

Limitation of the research:

1) As per the research title, the study covers only the mathematical aspects related to sound healing in psychoneurobics.
2) Only few equations and their relation.
3) Only Psychoneurobics is covered in this study.

Future scope:

1) Such more equations can also be framed for getting the energies of elements, as per the need of the research.
2) More study can be done in the field of various alternative medicines so as to be accepted worldwide.

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