Magnetic Measurements in Melotherapy

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Key words:

Introduction

Many technologies are used in present for monitoring biomedical signals [1,2,3]. As we know Biosignals can be understood as any activity that measures the expression of a living organism. In case of "TRANSILVANIA" University of Brasov was of real interest to develop (together with the students from the Master on Melotherapy) different measuring technologies to detect the effect of music on body biomedical signals.

The heart and the brain communicate with each other thru 4 main channels: neurologically thru the nervous system, biochemically thru hormones and neurotransmitters, biophysically thru variations of the blood flow pressure and energetically thru the electromagnetic field [4].

The electric field of the heart is 60 times more powerful than the one of the brain. It can be measured anywhere on the surface of the body as an electrocardiogram (ECG). On the other hand, the magnetic field of the heart is 5000 times more powerful than the one of the brain. [4], page 21.

To measure low magnetic fields, a technology called SQUID (Superconducting Quantum Interference Devices) is used now in medicine. Devices with several measuring channels for MagnetoCardioGrams (MCG) were developed thru improvement of the super-conducting magnetic sensors and cryogenic technology. The more used ones [5] are developed by Quantum Design MPMS3 and by Cryogenic, like the model SX700. Both producers use superconducting magnets that allow measuring the magnetic field without direct contact with its source.

Because of the cryogenic technology involved, these devices are big ones, and they cannot be easily moved.

Using the SQUID technology, Keiji Tsukada, Hitoshi Sasabuchi and Toshio Mitsui have developed and noninvasive technique that analyzes the magnetic-physiological signals of the heart. The researchers used the MCG technique to diagnose the heart of an unborn child. MCG allows measurements to be performed without interfering with the amniotic fluid. Also, the interference with the magnetic field of mother's heart is low because the power of the magnetic field is inversely proportional with the squared distance between the sensor and the source. The power of the magnetic field measured in such cases is maximum 5 pT, which is about 10% of the power of the magnetic heart field of an adult.

To investigate this signals the research team have the idea to develop one new sensing technologies based on magnetic signals noncontact measurements of produced by human heart activities.

First idea was to develop and/or to use one sensible sensor but having in view to be a small one together with the afferent electronics and in the same time with the corresponding portability.

Preliminary test was done using the AICHI STEEL magnetic sensor [7,8] and NI ELVIS National Instruments technology used in class activities with master students in the Medical Acoustics and Data Acquisition laboratories done inside the "Creativity Laboratory" of Center for Valorization and Transfer of Technologies" CVTC.

Magnetically measured biosignals

For any enterprise, a key success factor is the quality of the product it delivers. In the education sector, this "product" is the delivery process itself, while in medicine; the customer – i.e. the student – actually takes part in the process as a "co-producer". This ideas was promoted in Creativity Laboratory of CVTC where the students work and do research in direct interaction with the university teachers based on model of "affective education".

In these laboratories we started to test the AICHI nT (nano-Tesla) sensors (MI-CB-1DH and new MI-CB1DJ) from Aichi Micro Intelligent Corporation https://www.aichi-mi.com. MI-CB-1DH series is a sensitive magnetic sensor which can detect magnetic field variations at nano-tesla level (noise fluctuations of around nT). This sensor consists of a 1-axial magnetic head (MI element) and an electric circuit to operate this MI element. By restricting the cut-off frequency on the low frequency side to 0.1Hz, this model (sensor) cancels static magnetic fields such as geomagnetism and responds to only variable magnetic fields (see sensors properties in Table 1).

Students build on Data Acquisition Classes simple LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) applications to visualize, filter and acquire the heart magnetically induced signals. This first system presented in Fig.1 offer to our students the semi-quantitative images of sensor sensibility.

In the next stage the AICHI MI-CB-1DH sensor was tested inside the laboratory. To do not have problems with the power network influences (220V and 50Hz) were selected the solution to power the sensor from a cellular phone backup well screened battery (see Fig.2). Was applied also one active filter 0-10Hz using one Stanford Research Preamplifier/Filter SR 650 and the signal was visualized on Agilent DSO 6032A Oscilloscope. As can be seen the stability and low noise signal was obtained from sensor.

Table 1 Characteristics of AICHI nT sensor MI-CB-1DH and new MI-CB1DJ prototype (from Aichi Steel Corporation Catalog – October 2016)

Model	MI-CB-1DH (Mass Production)	MI-CB-1DJ (Prototype)	Unit
Mechanical / Electric Characteristics			
Appearance			–
Size	11x35x4.6	13.5x55x4.6	mm
Axis	1	1	axis
Supply Voltage	+5	+15	V
Operation Temperature	-20 to 60	0 to 50	℃
Current Consumption	Single (S) : 14 Multi (M) : 8	Single (S) : 30 Multi (M) : 18	mA
Output Range	0.5 to 4.5	0.5 to 14.5	V
Magnetic characteristics			
Measurable Range	DC: +/- 40 AC: +/- 2	DC: +/- 20 AC: +/- 1	uT
Sensitivity	1	5	V/uT
Frequency Response	0.1 to 1k	0.1 to 10k	Hz(@-3dB)
Output Linearity	≦ 2	≦ 2	%FS
Noise Density (@1Hz)	30	10	$pT/Hz^{1/2}$

Fig.1 AICHI nT sensor MI-CB-1DH firs NI ELVIS test

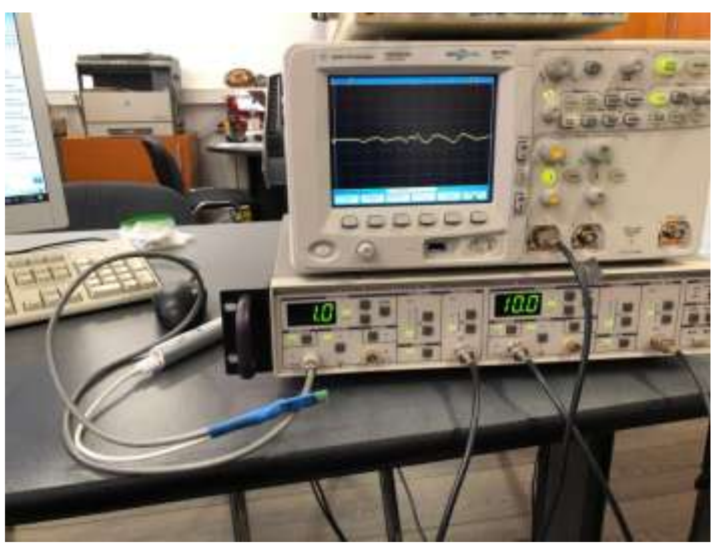
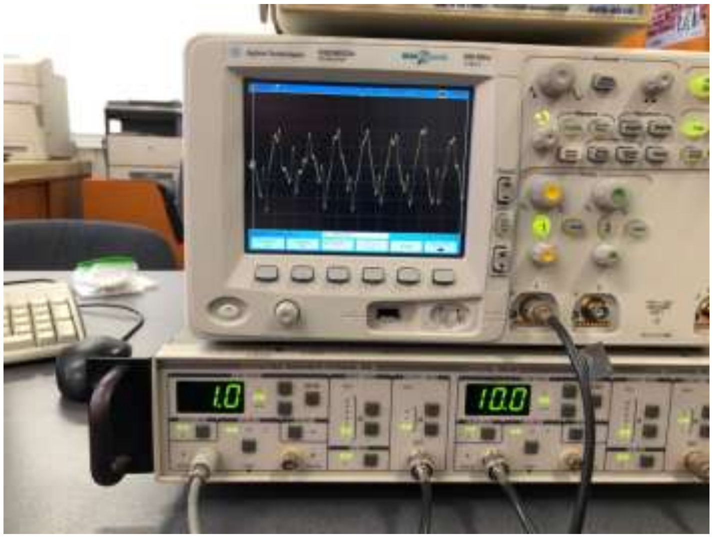


Fig.2 Measurement setup: MI-CB-1DH Sensor, SR650 fitter amplifier and DSO 6032A Oscilloscope

After preliminary sensitivity test, the sensor was moved in the proximity of the heart and we recorded the sensor signal who presents a good amplified level necessary to be digitized and processed in one LabVIEW application inside the PC. In Fig.3 we inserted one of the images with the measured human heart magnetic fluctuations captured and detected in this developed LabVIEW application. The heart detected frequency well correlated with the measured ones (in the same time) by a medical device (Pulse Oximeter and Blood Pressure measuring devices).



Preliminary Measurement in MELOTHERAPY

Were selected ten melodies (Table 2) and analyzed which of them produce more influences from the point of view of Melotherapy [9]. The preliminary test was done measuring brain wave with the WaveMind2 system [ ] and in the next research steps must investigate haw this results can be correlated with the actual developed magnetic field sensing system.

TABLE 2. Selected songs

	Clasic songs	Observations
1	Domenico Scarlatti- Sonata in D minor K1 / L366, Performed by: Ivo Pogorelich	
2	Tomaso Albioni- Adagio for strings and organ in G minor, Performed by: Berliner Philharmonic	
3	Johann Sebastian Bach- Prelude in C major BWV 846, Performed by: Lang Lang	
4	Gluck / Sgambati- Melody from Orpheus and Eurydice, Played by: Evgeny Kissin	
5	Wolfgang Amadeus Mozart- Lacrimosa, Performed by: Munich Philharmonic	
6	Beethoven- Sonata op. 27, no. 2, pp. I, in C minor, Performed by: Daniel Barenboim	
7	Frederic Chopin- Nocturna in D flat major, op. 27, no. 2, Performed by: Radu Lupu	
8	Frederic Chopin- Vals in A minor, op. post., Played by: Grigory Sokolov	

9	Franz Schubert- Gretchen at the Spinning Wheel, Played by: Yuja Wang	
10	Sergei Rachmaninov- Elegy in E flat minor, op. 3, no. 1, Played by: Vladimir Ashkenazy	

REFERENCES

1. T. Camilo, R. Oscar and L. Carlos, "Biomedical signal monitoring using wireless sensor networks," *2009 IEEE Latin-American Conference on Communications*, Medellin, 2009, pp. 1-6, doi: 10.1109/LATINCOM.2009.5305161.
2. G.Z. Yang. Ed., Body Sensor Networks, Springer, 2006.
3. M.A Hanson et al., „Body Area Sensor Networks: Challenges and Opportunities," IEEE Computer, vol.42/1 Jan.2009.
4. Rollin McCraty, Mike Atkinson, Dana Tomasino, Science of the Heart, 2001
5. M. Buchner, K. Hofler, V.Ney, A.Ney, Tutorial: Basic principles, limits of detection,and pitfalls of highly sensitive SQUID magnetometry for nanomagnetism and spintronics, 2018
6. Keiji Tsukada, D. Eng.Hitoshi SasabuchiToshio Mitsui, MD, Ph. D., Measuring Technology for Cardiac Magneto-field using Ultra-sensitive Magnetic Sensor, 1999
7. H.G. Ramos, A.L. Ribeiro, Electromagnetic Nondestructive Evaluation, vol.42 "Studies in Applied Electromagnetics and Mechanics", IOS Press, 2017, ISBN 1614997675
8. K. Mohri, F. B. Humphrey, L. V. Panina et al., "Advances of amorphous wire magnetics over 27 years," Physica Status Solidi, A, vol. 206, no. 4, pp. 601–607, 2009.
9. Sabau M., Ursutiu D., Samoila C. (2020) High School – University Collaborative Working in Melotherapy. In: Auer M., Tsiatsos T. (eds) The Challenges of the Digital Transformation in Education. ICL 2018. Advances in Intelligent Systems and Computing, vol 916. Springer, Cham