Methods and Experiments for the Sensing and Evaluation of Ionosphere Changes and Their Impact on the Human Organism

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Abstract— The impact of the environment upon living organisms constitutes a crucial problem examined by today's science. In this context, research institutes worldwide have analysed diverse positive and negative factors affecting the biological system of the human body. One such factor consists in the influence of the surrounding electromagnetic field. This paper presents the results of an investigation focused on ionosphere parameter changes and their impact on the basic function of the nervous system. It is a well-known fact that the frequency of the alpha waves of brain activity [1] ranges between 6–8 Hz. Changes in the electromagnetic and chemical structure of the Earth's surface may cause variation of signals in the above-defined frequency region of 6–8 Hz. Detailed examination of the overall impact of environmental factors upon the human organism is performed within a large number of medical disciplines. The research presented in this paper is concentrated on the sensing and detection of changes in the region of very low electromagnetic field frequencies; the authors test theoretical and experimental procedures to define the effects that influence brain activity.

1. INTRODUCTION

The low-level measurement of low frequencies (0.01–10 Hz) performed to evaluate the effect of magnetic fields on the human organism can be regarded as an interdisciplinary branch of science that comprises different types of research.

At this point, it is important to consider applied research disciplines, for example the measurement and radar technology in the following ranges: the ULF (Ultra Low Frequency Band: 300 Hz–3 kHz); the SLF (Super Low Frequency Band: 30 Hz–300 Hz; and the ELF (Extreme Low Frequency Band: 0.1 Hz–30 Hz).

If external magnetic fields influenced a human being to such an extent that the man or woman could change their behaviour within the social community at a higher level of statistical significance, it would be necessary to employ various questions of economics, mainly the evolution of economic value as a market phenomenon based on human behaviour and decision-making. Scientists and researchers are currently almost ready to solve special tasks related to objectivising the impact of low-level magnetic fields upon the human organism; such impact will be examined from the perspective of physical harm to cells [2] and mental condition of humans [3–6].

The state of the art in this field is relatively unsatisfactory, and certain hasty conclusions have been made and applied even in hygienic standards. An example of such standards is the guideline issued by the Council of Europe and implemented by the ICNIRP (International Commission on Non-lonising Radiaction Protection) in 1999 to establish the boundary values of magnetic flux in relation to the speed of magnetic field changes for very slowly changing currents. More concretely, this guideline introduces the value of 50 mT/s as the maximum magnetic flux change acceptable in an environment characterised by permanent presence of humans and exhibiting a variable magnetic field at the frequency of 1 Hz. This value is many millions higher than the largest changes hitherto measured during the processes referred to as magnetic storms, in which the Earth was exposed to charged particles from the Sun.

In this paper, the authors attempt to design an experiment with a comprehensive set of measurable parameters related to the human body and acquired within a homogeneous group of subjects. All the subjects were examined repeatedly to provide a dependable basis for the subsequent evaluation of these parameters in light of changes in the external magnetic field.

2. ORIENTATION OF THE METHODS FOR DETECTING IONOSPHERE DISTURBANCES

According to the conclusions produced by secondary research, there is mutual interaction between the low-level electric or magnetic fields irradiated by humans and the geomagnetic system of the Earth. This paper presents a portion of the research conducted in this province by the DTEEE, FEEC BUT; the research is built upon the current knowledge of low-level magnetic fields generated by the geomagnetic system of the Earth and the solar system. The authors of this article have focused on examining the effect of the changes in the Earth's geomagnetic system that are due to solar activity. In this context, the research was also centered on proving the existence of the effect as a result of geomagnetic storms, which substantially influence low-level magnetic fields affecting the human organism, including its behavioural patterns and decisioning. The detection of changes in geomagnetic field disturbances could be performed by means of the Schumann resonances. Until recently, this oscillation occurred at the frequency of $f_{sch} = 7.83\,\mathrm{Hz}$; this frequency changes as a result of the impact exerted by phenomena such as solar wind or greenhouse gases. In 1953, Professor W. O. Schumann of Munich university, Germany [6, 7] had found out that the cavity between the ionosphere and the Earth's surface could be interpreted as a spherical resonator. After Schumann's results were published in the Technische Physik journal, Dr. Ankermueller, a medical specialist, immediately related the resonances to brain wave rhythm (EEG). In 1954, the measurements conducted by W. O. Schumann and Herbert Koenig (who was to become Schumann's successor) confirmed the pulsation of the Earth at the frequency of $f = 7.83\,\mathrm{Hz}$. Koenig then validated the correlation between the Schumann resonances and brain wave rhythms [8]. In light of these facts, he chose a set of experimental measurements of certain instantaneous parameters of human physiology, depending on external conditions.

3. DESCRIPTION OF THE EXPERIMENTAL RESEARCH

The laboratory research comprising a homogeneous sample of 49 subjects (men and women aged 19 to 25) was launched on April 22, 2014 and lasted until June 26, 2014. The total time required for the examination of psychophysiological parameters in a subject corresponded to 19 minutes. We used a Nickelodeons Infiniti (Thought Technology Ltd.) unit to perform the entire task, and the measurement proper involved four phases: Rest; Color; Rest; Math; and Rest. At the Color stage, a special (Stroop) test was utilized to acquire the psychophysiological responses of each subject to a load on their organism. Generally, this tool demonstrates that a person performing the given task can be easily distracted due to their automatic reactions and habits; the procedure is named after John Ridley Stroop (1897–1973), an American psychologist who first described the phenomenon in 1929. In the Math phase, then, the respondents were asked to progressively subtract the number 7 from the initial value of 1081, and we examined the psychophysiological stress generated during such quiet countdown. The total number of measurements was 210, with the average of 4.29 per respondent.

The relationship between the former indicator and the number of subjects who completed the task is shown in Tab. 1. The respondents were measured in special laboratories to ensure comparable parameters and constant temperature, noise, humidity, lighting, concentration of positive and negative ions, and a homogenized component of the geomagnetic field, Fig. 2(c)).

Table 1: The relation between the number of completed measurements and the number of respondents.

Number of respondents	**Number of measurements**
4	1
1	2
4	3
12	4
24	5
4	6
49	**SUM**

4. COLLECTION OF PSYCHOLOGICAL DATA PRIOR TO THE RESEARCH

A major part of the laboratory research consisted in large-scale collection of psychological data from all participants (respondents) via several psychological tests, of which one was an ASS-SYM test; this tool measures a respondent's sensitivity to changes in the transition from load to relax. All the results were then correlated with the psychophysiological measurements.

4.1. During the Research Process

After entering the laboratory, each respondent was introduced into the input measurement according to Tab. 2. The average measurement period corresponded to 7 minutes.

Table 2: The initial measurements.

Input variables	**Unit**	**Number of measurements**
Body temperature	°C	210 (420)
Blood pressure	mmHg	210 (420)
Instant history	Writing current state of health	210
Assay for alcohol (positive only in one case)	%	0.1
Luscher psychological test colors	Index	210

The discussed input cycle was followed by the sensing of psychophysiological parameters via a BioGraph Infiniti apparatus; the related variables are listed in Tab. 3.

Table 3: An overview of dependent variables.

Dependent variable — psychophysiological measurements	**Unit**	**Number of measurements**
Skin conductance	μS	210
Skin temperature	°C	210
Peripheral blood flow BVP	%	210
Cardiac events BVP	puls/min	210
Thoracic breathing	f/min	210
Abdominal breathing	f/min	210
Trapezius muscle contractions EMG	μV	210
Contraction of muscles forehead EMG	μV	210

The final measurements performed before the respondent being dismissed from the lab included variables according to Tab. 4:

Table 4: The output variables established during the final sequences of the session.

Output variables	**Unit**	**Number of measurements**
Mirror-drawing tests: adaptability measurement	S	210
Relation to risk	index	210
Body temperature	°C	210 (420)
Blood pressure	mmHg	210 (420)

The average measurement time related to the output variables was 7 minutes.

4.2. Description of the Measurement Procedures for the Given Sample of Respondents

To measure the psychophysiological characteristics of the human body on the respondents, we used the BioGraph Infiniti devices providing bio- and neurofeedback. The following variables were measured:

B: BVP amplitude mean (Rel), B: BVP HR mean (beats/min), B: BVP HR std. dev., B: BVP peak freq. mean (Hz), B: BVP IBI std. dev. (SDRR), B: BVP VLF % power mean, B: BVP LF

% power mean, B: BVP HF % power mean ,B: BVP VLF total power mean, B: BVP LF Total power mean, B: BVP HF total power mean, B: BVP LF/HF (means), Total spectral power, C: EMG mean (uV), D: EMG mean (uV), E: Skin conductance mean (uS), E: SC as % of value mean (%),F: Temperature mean (Deg), F: Temp as % of value mean (%),G: Resp rate mean (br/min), B&G: (HR max-min) mean (b/min), G: Abd amplitude mean (rel), H: Thor amplitude mean (rel), G&H: Abd-tho ampl diff (means).

The measurement comprised three relaxation and two stress phases, with an emphasis on intensive psychological stress in the respondents. The stress stages were laboratory-generated using a low-level electromagnetic field generator, an amplifier, and Helmholtz coils to interact with the EEG brain waves of the respondent. The resulting low-level field enabled us to simulate the effect of changes in solar activity as an additional offset to the related real intensity indicators prepared for each day by NASA. The field strength in the Helmholtz coil was set to the level of terrestrial magnetic field, and the major parameters were as follows: impulse $f = 1\,\text{kHz}$; start $= 100\,\text{ns}$; $\lambda/2 = 168\,\mu\text{s}$. Fig. 1 shows a diagram of the stimulation and measurement apparatus.

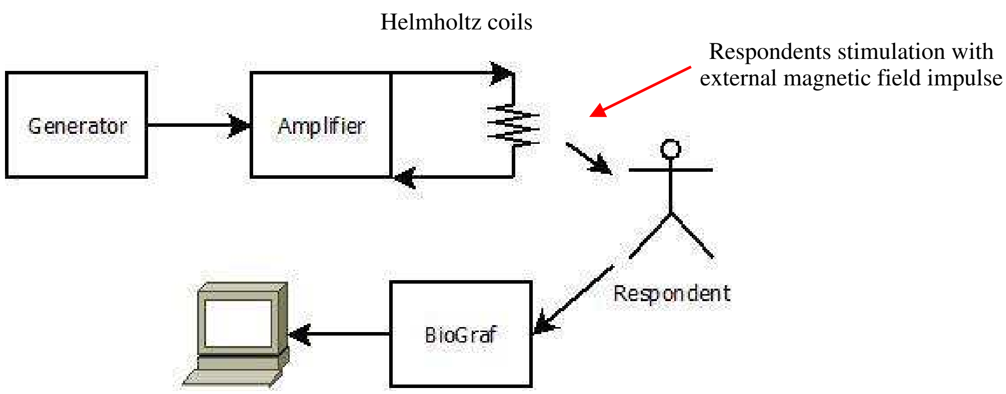
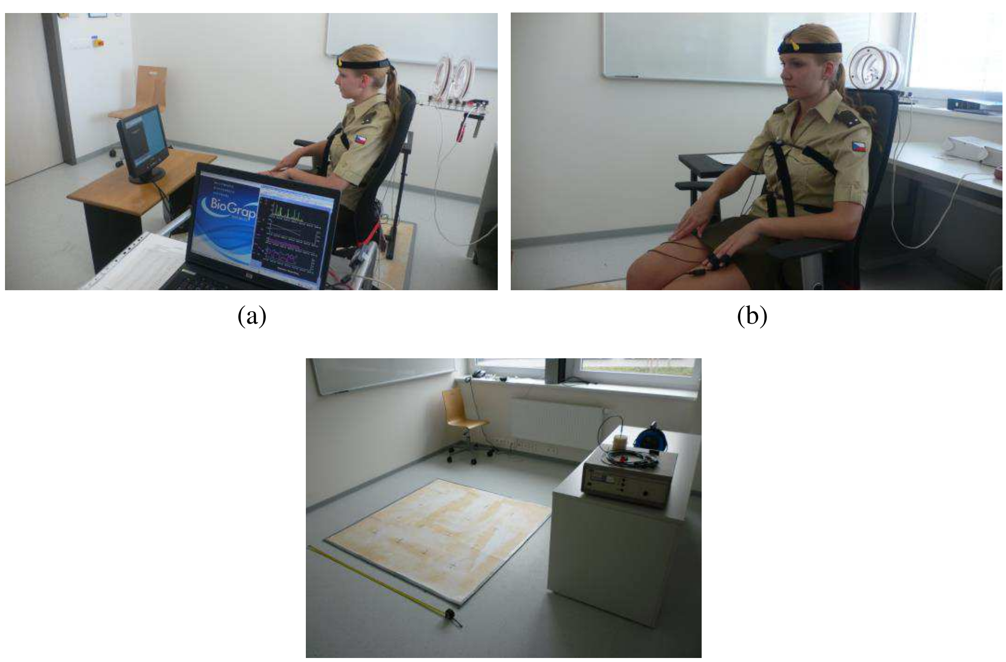


Figure 1: Scheme of measurement and simulation apparatus.

Figure 2, then presents shots of the BioGraph Infiniti measurements.



(a) (b)

(c)

Figure 2: (a), (b) Documentation shots from measurements in laboratory conditions, (c) laboratory space of measurements with geomagnetically stable component of the magnetic field.

5. CONCLUSION

The research results will be compared with the hypotheses and the magnetic field level changes at slowly varying electric currents; further, the investigated aspects will involve possible impact of these changes on the continuous movement of population in an environment exhibiting such variable electromagnetic fields. These relationships have already been are mathematically and graphically outlined within a scientific article. Moreover, the results of the materialized surveys will be processed together with the psychological tests that measure the side effects of the environment affecting human psychophysiological variables.

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