MULTIPLE SCLEROSIS DIAGNOSTICS BASED ON SIMULTANEOUS USE OF EEG AND INFRARED THERMOGRAPHY

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Abstract

In this paper the subject of simultaneous use of infrared thermography and EEG are investigated. Two different diagnostic methods are reviewed in terms of standard sessions.

1. INTRODUCTION

The ability to detect problems early on is a tremendous advantage that is gained through technological advances in the medical imaging field. Diagnosing patients is becoming easier and less intrusive. Most medical imaging methods, however, are becoming increasingly hard to set up and expensive. Medical thermography is one of these technological advances and provides a diagnostic medical imaging procedure that is non-invasive, objective, and relatively inexpensive. EEG is used in the diagnosis of MS but in conjunction with other tests. Utilizing medical thermography might speed up and ease that process.

2. CURRENT STATE OF THE PROBLEM

Thermal Imaging Cameras can be used for a variety of disease monitoring, trending, and medical applications. Multiple sclerosis causes poor circulation and blood flood to the extremities.

"Multiple sclerosis (abbreviated MS, also known as disseminated sclerosis or encephalomyelitis disseminata) is an autoimmune disease in which the body's immune response attacks a person's central nervous system (brain and spinal cord), leading to demyelination. Disease onset usually occurs in young adults, and it is more common in females. It has a prevalence that ranges between 2 and 150 per 100,000. MS was first described in 1868 by Jean-Martin Charcot.

MS affects the ability of nerve cells in the brain and spinal cord to communicate with each other. Nerve cells communicate by electrical signals called action potentials down long fibers called axons. Those are wrapped in an insulating substance called myelin. In MS, the body's own immune system attacks and damages the myelin. Due to myelin is depletion, the axons can no longer effectively conduct signals. The name multiple sclerosis refers to scars (scleroses—better known as plaques or lesions) in the white matter of the brain and spinal cord. It is mainly composed of myelin. Although much is known about the mechanisms involved in the disease process, the cause remains unknown. Different environmental risk factors have also been found.

MS takes several forms, with new symptoms occurring either in discrete attacks (relapsing forms) or slowly accumulating over time (progressive forms). In between attacks, symptoms may vanish, but permanent neurological problems often occur, especially as the disease advances.

Treatments attempt to return function after an attack, prevent new attacks, and prevent disability. MS medications can have adverse effects or be poorly tolerated, and many patients pursue alternative treatments, despite the lack of supporting scientific study. The prognosis is difficult to predict; depending on the type of the disease, the individual patient's disease characteristics, the initial symptoms and the degree of disability the person experiences as time advances

An EEG is a non-invasive method for identifying seizure disorders.

3. EXPERIMENTS

For experiments the same thermal camera is used for data collection – FLIR E40, with thermal sensitivity of < 0.07°C, accuracy of ±2°C or ±2% of reading and temperature range of -4°F to 1,202°F (-20°C to 650°C) [3], [4]. For maximum accuracy, the camera is fixed on a stand and movement of the object is avoided.
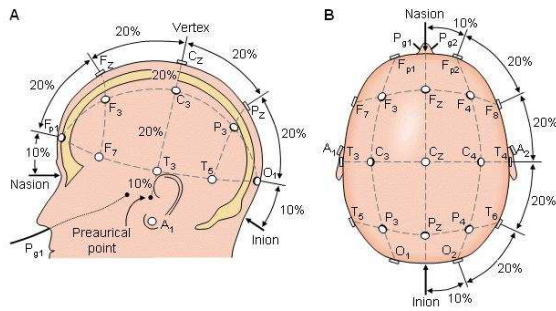
Figure 1. Standard EEG electrode distribution 20-10 System

EEG signals have highly non-Gaussian and non-stationary characteristics. In order to extract any beneficial information signal processing has to be employed. The postsynaptic potentials sum is the range of about 5uV to 100uV and frequency range 3Hz to 70Hz [4]. This narrows down to a few of the shelf solutions as the one chosen for the project – National Instruments USB-6211 data acquisition module alongside the LabView graphical programming language. LabView allows a fast paced and low cost development of smart algorithms for signal processing. Also utilized is the Nihon Kohden EEG 9100.

A setup was prepared to approximate standard EEG acquisition techniques – separated from active electronics and with reduced electromagnetic interference. Signal recordings were made with differentiation in the electrode to electrode comparison. NRSE (detect the ground voltage provided by the signal for all EEG leads) and differential voltage between the electrodes. 7 of the frontal leads are chosen for the measurement – Z (for ground - ear), Fp1, Fp2, F7, F3, Fz, F4 and F8. All are placed on the EEG cap and linked to bridge electrodes.

4. RESULTS

There are 3 points of analysis used in all 19 thermal images taken – SP1, which is where directly next to the point of application of the plates, SP2, which is a control point on the head of the patient and SP3, which is on another place.

The data collected from the recorded session shows a steady temperature rise as for all examined points.

What is observed in a more dynamic temperature increase at the onset of the measurement for some points of analysis (with about 2-2.5 °C) and then a more gradual, but still noticeable increase until the end. It is hard to differentiate a significant increase in any of the points. Thus meaning a more circumspect and segregated analysis should be performed.

5. CONCLUSION

The analyzed data gives one more perspective of the countless applications of thermal imaging cameras for medical purposes. Such analysis can be very useful in providing a new understanding of widely-used technology in terms of safety and effectiveness. Since IR imaging is non-invasive and does not bear and risks, it can be implemented wherever it is useful and possible. It carries a great potential also for diagnostic medicine – early tumor/cancer detection, diagnosing neuropathies, all kinds of inflammation, scanning large groups of people for high body temperature, veterinary purposes and many others. In the near future IR thermography might become a valid single diagnostic method for many diseases that involve intricate changes in temperature field. Allocating cognitive tasks through each measurement would allow better spatio-temporal segregation.

6. APPENDIX AND ACKNOWLEDGMENTS

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