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Head Localization and Orientation by Pruned Neural Networks in Thermal Images – A Method for a Robust and Automatic Pain Detection

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Many patients such as dementia patients, coma patients or children are not able to communicate their pain sensations adequately. This leads in consequence to an incorrect medication. Current body attached methods such as wearables measuring ECG are often removed by dementia patients, which results in non continuous measurments. To overcome this issue, we propose a non-contact based method to quantifying pain in thermal images automotically.
A first step in our approach is the determination of the head in a thermal image by binarisation and the usage of horizontal diagrams. The subsequent determination of the heads orientation by a pruned neural network is important to locate the face regions accurately. This is followed by a local integration of pixels and the extraction of the mean temperature. Subsequently, the temperatures in the facial regions are compared over time to determine pain.
In order to generate a method for the head determination and its orientation we created a database consisting of 16 persons with overall 364 images for training and testing. The actual pain assessment is carried out with 22 probands (13 male, 9 female) by applying pain in the cold pressor test. Thereby, the probands have to hold a hand into icewater and rating their pain. During the tests reference systems measuring vital parameters such as ECG, HRV, SPO2 and skin conductance for verification of the results obtained by a thermal camera.
We could show that it is possible to determine the pain by means of thermal images. Furthermore, we have developed a fast method for determining the head position in thermal images. Further investigations have to focus on a better quantification of the measurements and a verification in experiments with chronic pain patients.

Inverse Relationship Between Electrode Size and Voltage During Intracardiac Mapping

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Introduction

Catheter ablation targeting low voltage areas is a common form of treatment for patients with atrial fibrillation. Despite the importance of the clinical bipolar voltage maps, different types of catheters are still being used. These differences can influence the signals, altering the areas defined as low voltage. Previous work has been done to assess how the angle of the catheter, the distance to the tissue and other factors affect the voltage. However, the relationship between the electrode size and the voltage is yet to be examined.

Methods

Bidomain simulations were performed on a patch, containing tissue and blood surrounding the tissue. The Courtemanche et al. human atrial cell model was used to simulate the electrophysiology of the tissue. Two electrodes with high conductivity of different sizes (0.8 mm to 3.6 mm length and 0.8 mm to 2.4 mm in diameter) were placed in the bath, parallel and in contact to the tissue and perpendicular to the wavefront. A planar wave was then initiated in the patch and the extracellular potentials of the electrodes were extracted as the unipolar signals. The bipolar signal were then obtained by subtracting the unipolar signals.

Results

It was found that increasing the length of the electrode caused a linear decrease in the voltage, $y = -0.52x+0.66$, where y is the voltage in mV and x the electrode length in mm. Additionally, an inverse relationship was found when increasing the diameter of the electrode. However, with a quadratic relationship between the voltage and the size of the electrode instead of linear, $y = 0.58x^2-3.93x+9.59$.

Conclusion

The simulation allowed to assess the effect that the electrode size has on the voltage, showing an inverse relationship between them. It remains an open question if the electrode size can be compensated for robustly when evaluating voltage maps to determine low voltage areas.

Use of artificial intelligence and neural networks for analysis and gesture detection in electrical impedance tomography

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Introduction

Artificial intelligence and neural networks are getting more and more relevant for several types of application. The field of prosthesis technology currently uses electromyography for controllable prosthesis. The precision of the control suffers from the use of EMG. More precise and more collected data with the help of EIT allows a much more precise analysis and control of the prosthesis. In this paper a neural network for gesture detection using EIT is developed and presented in a user-friendly way.

Methods

The acquired EIT data was used to train multiple models of artificial neural networks. One frame at a time was classified, which results in an input layer with 256 neurons, whereas for each cycle three individual values are always set to zero. Because of the image-like nature of the frames, next to multilayer perceptrons, convolutional NN where used to test the classification.

Results

The validation of the data turned out positively. A quite trivial multilayer perceptron with two hidden layers, containing 128 neurons each, turned out as the optimal model for the given problem. To each hidden layer, a dropout-rate of 0.5 was applied. The high accuracy of the first split validation tests indicate, that calibrating the network to the current position of the system would result in a vast increase in validation accuracy. This calibration was simulated by separating a small amount of validation data an adding these samples to the training data.

Conclusion

Our work has shown that gesture detection using AI and EIT can be realized with very high detection rates. Therefore calibration is very important for the rate.

Habituation of steady-state visual evoked potentials during peripheral stimulation

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Introduction

Visual evoked potentials (VEP) are widely used for functional diagnostics. Therefore, foveal as well as peripheral stimuli are presented, e.g. in multifocal VEP or electrophysiological stray light measurement. To record VEP, prolonged repetitions of the stimuli are required, leading to habituation effects. This work aims to analyse the habituation of steady-state VEP during peripheral stimulation.

Methods

We studied 14 healthy subjects (9w, mean age±SD: 25±7.5 years) using a circular layout. The dimensions of the ring-shaped stimuli were scaled according to cortical magnification published by Horton and Hoyt, resulting in four eccentricities (1.6–3.5°, 3.5–6.4°, 6.4–10.9°, 10.9–18°). The stimuli had a luminance of 350cd/m^2 with a stimulation contrast of 99% and were presented in a random order at a stimulation frequency of 7.5Hz. For each eccentricity, 75 cycles were recorded. The procedure was repeated in total for 10 times, resulting in 750 cycles per eccentricity. A background luminance of 30cd/m^2 was added to supress foveal stray light effects. The active electrode was placed at Oz, reference electrode at FCz and ground electrode at FPz. The recorded steady-state VEP were transformed using short time Fourier transformation with a rectangular window with a length of 2s and no overlap. The data were checked for normal distribution with Shapiro-Wilk test. Confidence Intervals (CI) of the differences of the amplitudes at stimulation frequency for consecutive time intervals were used for statistical analysis.

Results

In our investigations, no significant differences for the consecutive time intervals for the 4 eccentricities were found. For 1.6°–3.5, the amplitudes showed a mean change with SD of -0.03±0.14µV/Hz (CI:[-0.31 0.07µV/Hz]; [-0.14 0.24µV/Hz]; [-0.09 0.34µV/Hz]; [-0.41 0.08µV/Hz]). For 3.5–6.4°, a change of 0.11±0.10µV/Hz can be seen (CI:[-0.05 0.5µV/Hz]; [-0.12 0.29µV/Hz]; [-0.28 0.24µV/Hz]; [-0.1 0.36µV/Hz]). For 6.4–10.9°, the amplitude showed a change of 0.06±0.14µV/Hz (CI:[-0.04 0.49µV/Hz]; [-0.31 0.13µV/Hz]; [-0.24 0.17µV/Hz]; [-0.15 0.41µV/Hz]). For 10.9–18°, the amplitudes changed by 0.00 ± 0.07µV/Hz (CI:[-0.14 0.25µV/Hz]; [-0.14 0.28µV/Hz]; [-0.29 0.13µV/Hz]; [-0.24 0.17µV/Hz]).

Conclusion

No significant habituation effects can be observed in steady-state VEP during peripheral stimulations for a stimulation duration of 10s.

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Quantification of Interpatient 12-lead ECG Variabilities within a Healthy Cohort

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Introduction

The morphology of the electrocardiogram (ECG) varies among different healthy subjects due to anatomical and structural reasons, such as for example the shape of the heart geometry or the position and size of surrounding organs in the torso. Knowledge about these ECG morphology changes could be used to parameterize electrophysiological simulations of the human heart.

Methods

In this work, we detected the boundaries of ECG waveforms, i.e. the P-wave, the QRS-complex and the T-wave, in 12-lead ECGs from the 918 healthy subjects from the Physionet/Computing in Cardiology Challenge 2020 Database with the IBT openECG toolbox. Subsequently, we obtained the onset, the peak and the offset of each P-wave, QRS-complex and T-wave in the signal. In this way, the eleven timing and amplitude features were extracted from the 918 healthy ECGs. Their statistical distributions and correlation between each other were assessed.

Results

The highest variabilities among the 918 healthy subject were found for the RR interval and the amplitudes of the QRS-complex. The highest correlation was observed for feature pairs that represent the same feature in different leads. Especially the R-peak amplitudes showed a strong correlation across different leads.

Conclusion

The calculated feature distributions can be used to optimize the parameters of populations of cardiac electrophysiological models. In this way, realistic in-silico generated surface ECGs can be simulated in large scale and could be used as input data for machine learning algorithms for a classification of cardiovascular diseases.

Mechanistic insights into arrhythmogenesis in atrial fibrillation – Exploring the underlying electrical activity in AF and effects of targeted focal ablation of the critical substrate in-silico

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Introduction

Atrial fibrillation (AF) is the most common cardiac arrhythmia. Catheter guided radiofrequency-ablation is a curative therapy used to create scar tissue to terminate the arrhythmia. Identification of atrial sites that perpetuate AF, and upon ablation terminate AF, is challenging. Electrogram characteristics can identify AF-termination sites. The major electrogram characteristics are low-voltage, increased local AF cycle length (CL) coverage and lower mean local AF CL compared to coronary sinus AF CL. In this work, we examine the mechanisms leading to these EGM characteristics in-silico. Furthermore, we reproduce selected clinical ablation approaches.

Methods

The simulations used the electrophysiology simulator software acCELLerate. A 10x10x0.1 mm^3 region containing fibrotic elements was centered in a 30x30x0.1 mm^3 tissue patch. Fibrotic tissue was modeled as non-conductive elements. For mechanistic insight two setups were created. A plane wave setup with a conduction velocity (CV) of 800 mm/s and a rotational activity with tissue CV set to 220 mm/s. Both used a Gaussian fibrosis distribution affecting 40% of elements inside the fibrotic area. A third setup with 10% fibrosis and a CV of 800 mm/s in the non-fibrotic area mimicked clinical observations and ablation points were added in locations of focal activities.

Results

During plane wave propagation, electrogram voltage amplitude was decreased by 80% in the fibrotic area and delayed wave propagation by 23 ms inside the fibrotic tissue. The rotational source setup revealed recurring activity around the fibrotic border zone that displayed an electrogram CL coverage of >70%. In the clinical scenario the first ablation point shortened the time of self-sustaining activity by 27%. A second ablation point led to termination of fibrillatory activity.

Conclusion

In this simulation study presented the mechanisms leading to the electrogram characteristics observed in clinical practice. We also showed that ablation of sites exhibiting these electrogram characteristics can terminate AF.

An approach to a real time FastICA

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Introduction

It is still a challenge to measure and analyze biomedical signals in real time. Independent component analysis (ICA) can be used to separate signals into statistically independent source signals. An important application is to separate fetal ECG from superimposed maternal and fetal ECG recordings, which can be done by FastICA. However, the computation of independent components is time consuming, takes a lot of computation steps, often needs a lot of data points, and has to deal with time varying signals. Thus real time analysis is expensive. The aim of this work is to introduce an running/realtime FastICA in combination with computational efficiency.

Methods

The data used are two ECG recordings from volunteers, which were filtered and sampled with 1 kHz. The recorded signals were mixed by randomly chosen matrices. To simulate instationarity, each mixing matrix changed randomly as a funtion of time around 1-10%. The mixtures were broken down over time in segments of 5,000 up to 20,000 samples, subsequently analyzed by FastICA, yielding ICs, de-mixing and pre-whitening matrices. We call this approach running FastICA. Whitening and de-mixing matrices were analyzed by the Frobenius norm.

Results

The Frobenius norm of the difference between two consecutive matrices increases with a decrease in the size of the analysed signal segement and with an increase in the variability of the random mixing matrix sequence. Running FastICA can be used to detect and track signal instationarities. Using current matrices as initial matrices for FastICA reduces computational efforts signficantly.

Conclusion

Our results show that monitoring of de-mixing matrices of running FastICA is useful. A similar finding holds for whitening matrices. Thus stationarity of signals must be addressed carefully. Future work will focus on statistical evaluation of running FastICA, especially with respect to computational efficiency and properties of biosignals.

MagCPP: A C++ toolbox for Combining Neurofeedback with Magstim transcranial magnetic stimulators

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Introduction

Electroencephalography (EEG) and Magnetoencephalography (MEG) with its high temporal resolution in combination with real-time data processing offer the possibilities for dynamic and adaptive Neurofeedback (NF) scenarios. In conjunction with Transcranial Magnetic Stimulation (TMS) specific cortical regions can be directly stimulated and the induced changes in connectivity and activity can be measured. With the aim of a closed loop EEG-TMS stimulation setup, a C++ toolbox for Magstim TMS devices is established.

Methods

MagCPP was inspired by MagPy (a Python toolbox to control Magstim TMS) devices and has a similar class structure. To compare MagCPP, MagPy and MAGIC (a MATLAB toolbox to control Magstim TMS devices) 15 measurements of complete runs with all necessary TMS functions were taken using a Windows 10 PC and a Magstim Rapid² device, connected by a QuickFire cable.

Results

The outcome of this work is MagCPP, a standalone free open source software. The software is hosted on GitHub (https://github.com/MagCPP). MagCPP is platform independent (Windows, Linux, MacOS). For 20, 40 and 80% power and the fire command, the MagCPP toolbox (1.19 ± 0.00 s, 1.19 ± 0.00 s, 1.19 ± 0.00 s) works faster than the MagPy (1.59 ± 0.03 s, 1.59 ± 0.01 s, 1.53 ± 0.01 s) and MAGIC (1.47 ± 0.05 s, 1.44 ± 0.02 s, 1.43 ± 0.02 s) toolboxes.
An intregration of MagCPP in a real-time data processing platform MNE-CPP with an optional GUI demonstrates its ability as part of a closed-loop NF-scenario.

Conclusion

We implemented and tested the open-source toolbox MagCPP for real-time control of Magstim Rapid² TMS devices. In contrast to the MagPy and the MAGIC toolboxes, the presented MagCPP toolbox is faster and can be integrated into C++ based frameworks, such as MNE-CPP. As a first step towards a closed loop NF scenario, it offers possibilities for novel study designs.

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Deep learning-based recognition of cell structures in fluorescence microscopy sequences with respect to their morphology on cells infected with Marburgvirus

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Introduction

The Institute for Virology, Philipps-University, Marburg, is currently researching for potential medicines against the Marburgvirus. To help analyzing subviral particle tracks recorded in fluorescence microscopy sequences, cell structures need to be marked and labeled. Doing this manually is impractical and costs time. In this work an application of the Mask R-CNN model for the automation of this task is presented.

Methods

Mask R-CNN is a machine learning approach using deep network structures and deep learning. The Mask R-CNN model is trained with micropscopic images provided by the Institute for Virology, Philipps-University, Marburg. Due to the low quantity of training data, artificial transformations like rotation and shift in contrast have been applied to half of the images, thus increasing the input data in order to equip the network with more flexibility and robustness. Testing was done by comparing the Mask R-CNN results with the experts' judgements.

Results

The results of the application indicate good classification of cell structures, i.e. most cell structures of the microscopic images are recognized and masked correctly. Adjacent or overlapping cells are sometimes identified as one large cell. The reason for this may be due to the limited training data.

Conclusion

With regard to the results, the model is suited for the detection of cell structures in fluorescence microscopy sequences . While not all cell structures are always recognized, the application delivers satisfactory results despite the low amount of training due to limited data. In order to improve the Mask R-CNN capabilities future work will focus on training the deep neuronal network with larger and better datasets.

Evaluation of HRV extraction algorithms from PPG data using neural networks

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Introduction

Heart rate variability (HRV) is a powerful measure to gain information on the activation of the central nervous system and is thus a strong indicator for the overall health and emotional state of a person. Currently, the gold standard for HRV analysis is the examination of R-peaks in electrocardiograms (ECG), which requires a placement of electrodes on the torso. This is often impracticable, especially for the use in daily routines or 24/7 measurements.

Methods

Photoplethysmograms (PPG) are an alternative to ECG assessment and are easier to acquire, e.g. by using fitness trackers or smart watches. Nevertheless, PPG data is more susceptible to motion artifacts. Hence, goal of this work is to develop and evaluate an artificial neural network (ANN) approach to estimate the R-peak locations in complex PPG signals. Public data collections were used as benchmark to compare our ANN-based approach to state-of-the-art methods. Results show that ANNs can improve HRV estimation during motion.

Results

HRV parameter estimations from baseline methods (decision tree-based peak detection, and automatic multiscale-based peak detection) were compared with the best performing neural network (3L-GRU) using the TROIKA dataset with respect to the reference parameters obtained from a manual selection of the peaks in ECG data. In most cases, the neural network based HRV estimation was closer to the reference HRV compared to baseline methods (lower μ and $\boldsymbol{\sigma}$) Additionally, the $\boldsymbol{\sigma}$ is smaller for the best performing neural network approach across most HRV parameters. Inclusion of another PPG or acceleration channel did not affect HRV estimation.

Conclusion

Although, the neural network learning approach outperforms conventional methods, the examined PPG-based HRV estimation has still accuracy limitations. Nonetheless, the proposed estimation approach opens up new directions for further improvement.

Continuous signal quality estimation for robust heart rate extraction from photoplethysmographic signals

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Introduction

This study presents a novel method for estimating the signal quality of photoplethysmographic (PPG) signals. For this purpose a robust classifier is implemented and evaluated. The PPG provides a flexible and cost-effective method for continuous measurement of vital parameters. Due to the mobile application, however, it is highly sensitive to motion artifacts that make the signal unusable.

Methods

A new procedure is proposed, which uses feature reduction to determine the Mahalanobis distance of the PPG-pulses to a statistical reference model and thus facilitates a robust heart rate extraction. For evaluation, the data of a PPG measurement from the finger and the inner ear of 30 healthy patients are used, resulting in an analysis of 160175 pulse waves.

Results

The evaluation of the algorithm is based on a classical binary classification using a manually annotated gold standard, where a sensitivity of 86 ± 15 % and a specificity of 94 ± 13 % was achieved. Additionally, a novel classification method which is based on a continuous signal quality index (SQI) is used. Pulse rate estimation errors greater than 5 BPM can be detected with a sensitivity of 91 ± 13 % and a specificity of 91 ± 15 %. Also, a functional correlation between the signal quality index and the standard deviation of the pulse rate error is shown.

Conclusion

The presented algorithm enables a robust detection of artifacts in PPG-signals with very good results. The SQI can improve autonomous PPG analysis without ECG. Especially in the area of pulse rate variability analysis it can be a great benefit for further analysis. It can also be used in the area of mobile monitoring for battery saving.

Investigating an Optimal Signal Epoch Length for Cardiotocographic Classification

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Introduction

Foetal monitoring commonly depends on the analysis of the fetal heart rate (FHR) and uterine contraction signals. These signals, acquired through a Cardiotocograph (CTG), are visually assessed following proposed CTG guidelines. Unfortunately, the CTG interpretation by this methodology is difficult, which has shown high intra- and inter-observer disagreement. In this context, several signal processing approaches have been proposed, which examine a particular signal segment, also called as FHR epoch. Recent clinical research emphasizes that each foetus presents its own control, and the foetal condition can change over time. In the presence of this non-stationary phenomenon, the selection of an optimal epoch is challenging. Although several FHR epochs have been studied in the literature, there is no precise definition for an optimal epoch.

Methods

This work focuses on investigating an optimal FHR epoch for automatic CTG classification. The main idea is to evaluate a set of epochs of different length and location. For this purpose, we employ a feature extraction operation based on two signal processing techniques, such as the Improved Complete Ensemble Empirical Mode Decomposition with Adaptive Noise and time-varying autoregressive modelling. For each epoch, the features are extracted and evaluated based on their performance in CTG classification. For the proposed evaluation, we make use of real CTG data extracted from the CTU-UHB database.

Results

Results show that the classification performance depends considerably on the selected FHR segment. Likewise, we have found that an optimal FHR segment for foetal welfare assessment during labour corresponds to a segment of 30 minutes long.

Conclusion

These results coincide with several FHR epoch lengths recommended in guidelines. Besides, these guidelines recommend a re-evaluation at least every 30 minutes. However, in order to validate our obtained results, more investigation is required, which should include different classifiers, and analysis of a larger CTG database.

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A new approach to improve the SNR of evoked potentials using a SPHARA-based spatial filter

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Introduction

Evoked potentials are used to diagnose conduction disorders of the nervous system and belong to the essential techniques of neurological and neurophysiological diagnostics. A challenge in determining the evoked potentials is the low SNR. A frequently used method to improve the SNR is trial averaging. In the presented approach, a SPHARA-based spatial low-pass filter is applied to the trials to further improve the SNR.

Methods

The human head possesses spatial low-pass properties due to its conductivity profile. The topography of the potentials on the scalp surface, evoked by sources located in the brain, are mainly manifested in spatial low-frequency components. In contrast, spatially uncorrelated sensor noise affects the entire spatial spectrum. We use these different spatial spectral signatures to suppress the noise by means of a spatial low-pass filter implemented using the recently introduced SPHARA approach, a generalization of the Fourier analysis for spatially arbitrarily arranged sensors. This spatial low-pass filter is applied to EEG data before trial averaging.

Results

We have validated our new approach by means of simulations and measurement data analysis. For simulations, we added spatially uncorrelated noise with different SNRs to the data sets. Subsequently, we applied the new filter to the single trials and we determined the evoked potentials by trial averaging. The SNR improved between 4.3 and 9.2 dB compared to trial averaging alone. We applied the new approach to visually evoked potential recordings. After applying the new filter method, comparable results could be achieved with significantly fewer single trials.

Conclusion

With the new SPHARA-based spatial filter the SNR of evoked potentials can be significantly improved. The number of individual trials that have to be recorded in order to achieve comparable results can be substantially reduced. This allows to save measurement time during clinical application.

AEA based medical diagnostic techniques: Screening and Monitoring of cartilage defects in knee joint osteoarthrosis by Acoustic Emission Analysis

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Introduction

Knee joint osteoarthrosis is a progressive degenerative defect to the articulate cartilage between femur and tibia. Cartilage does not heal, an early diagnosis and intervention is crucial to the success of therapy.
Clinical experiments have shown that during standardized AEA screening registers sound emission significant of lesioned areas on the cartilage. Consequently it is possible to evaluate the joints` surface in order to enhance therapy.

Methods

AEA is non invasive but carried out during controlled stressing, for only active defects produce acoustic emission. Patients were examined performing series of knee bends first on a plain surface to screen the lesioned areas of cartilage. Then patients performed knee bends on surfaces simulating orthopaedic insoles by means of inner and outer edge elevations. AEA signals and the trajectory of the knee bend were recorded by means of the BoneDias system.

Results

The patient of an exemplary case showed distinct acoustic signals significant of damage in the right knee while performing the knee bends on the plane surface. The examination on the boards with the outer edge elevation revealed no acoustic emission significant of damage.

Conclusion

AEA monitoring reveals the effects of load derivation immediately. It is an adaquate tool in diagnosis and in the evaluation of therapeutic measures. In the exemplary case it was possible to find areas of undamaged cartilage and to reroute load transfer paths.

Influence of the polarity on the stimulation resistance of an ocular direct current stimulation using different electrode parameters

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Introduction

Typically, different electrode sizes in combination with different contact media are used due to the different electrode positions for ocular current stimulation (CS). In theory, there should be no polarity dependent difference for the measured stimulation resistance. However, in our studies, subjects reported polarity dependent current sensations which can be releated to higher stimulation resistance. Therefore, this work aims to examine the influence of the polarity on the stimulation resistance when using different electrode sizes and contact media in a study.

Methods

We stimulated 16 healthy subjects (8m, 28.6±6.1years) with an anodal and cathodal direct CS (randomized sequence, different days) of 800µA for 5 minutes each. A ring rubber electrode placed around the eye (30cm²) was used in combination with Ten20 conductive paste. The counter rubber electrode (25cm²) was placed in a saline-soaked (10ml) sponge and positioned at the ipsilateral tempus. The resistance over time was calculated from the current and voltage curves recorded by the current stimulator (fs=8000sps). For analysis, the difference (anodal minus cathodal) for the mean resistance was evaluated and a confidence interval analysis as well as the t-Test for related samples was performed (α=0.05, data normal distributed).

Results

The mean anodal stimulation resistance (4.48±0.61kΩ) showed smaller values in 15 of the 16 subjects in comparison to the cathodal stimulation resistance (5.58±0.58kΩ). The confidence interval of the difference does not contain zero (lower limit/upper limit: [-1.49kΩ/-0.72kΩ]), which represents a statistically significant effect. Also, t-Test for related samples (p=0.000*) showed a significant lower mean resistance of anodal stimulation.

Conclusion

We found a dependence of the polarity on the stimulation resistance when using different electrode sizes and contact media. Our hypothesis is, that the different amounts of charge carriers, which are generated by using different contact media and the different current densities, are the reason for the dependency.

Fast Triage of Covid-19 Patients in Hospitals by Means of Remote Respiration Rate Determination

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Due to the Covid-19 pandemic, hospitals are experiencing a significant workload of patients with respiratory diseases. These highly contagious patients require special treatment and isolation to protect other patients and medical staff. Particularly critical is the central admission in the hospital, where all actors come together unprotected. Therefore, a fast triage with a separation into potential Covid-19 patients and the remaining patients is crucial. The two typical symptoms of Covid-19 are fever and coughing or shortness of breath due to a severe infection of the lower respiratory tract. When recording these two symptoms, care must be taken to ensure that no care givers are infected and that there is no physical contact between the measuring devices. While fever can be detected relatively easily and quickly with a non-contact thermal imaging camera, the determination of shortness of breath is more difficult.

As part of a rapid response to these requirements, we propose a deliberately simple measurement setup in the form of an RGB camera and a connected computing unit as well as a method for image-based detection of the respiratory rate. Our method first determines a ROI on the thorax, since this is where the greatest movement occurs during breathing. Subsequently, Minimum Eigen-features are detected in the ROI and tracked continuously by means of the optical flow according to Lucas-Kanade. In addition, a bandpass filter, a PCA and a frequency determination using FFT are applied. An easy-to-use GUI ensures that the application can be operated by anyone. The accuracy of the measurement method was evaluated with the NeXus-10 MKII.

Currently, the proposed system is being used at the Universitätsklinikum Essen. At present, the measuring interval plus processing takes about one minute. We aim to halve this time in the future in order to achieve a higher frequency of measurements.

MONTE-CARLO PARAMETER VARIATION STUDY USING A VARIANCE BASED FEATURE SELECTION TECHNIQUE FOR SIGNAL CLASSIFICATION OF CARDIOVASCULAR AORTIC ANEURYSMS

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Introduction

Pathological bulges of the blood vessels, especially aneurysms in the abdominal (abdominal aortic aneurysm, AAA) or thoracic aorta (thoracic aortic aneurysm, TAA) are a highly underestimated problem and affect 12 to 14% of the population. The aim of this study is the development and validation of a methodology to classify the above mentioned vascular pathologies using non-invasive cardiovascular pressure and flow signal intervals and amplitudes.

Methods

The classification features were extracted from variational data sets generated by the numerical cardiovascular modeling tool SISCA, which describes the blood flow in the cardiovascular network using a zero dimensional lumped parameter approach. The considered variational scenario was built upon a control group of healthy patients, deriving two pathological conditions for AAA and TAA with different severity and location. Therefore, the nominal diameters were enlarged between 200% and 300%, while the length of the aneurisms were modified within a range of 30 and 90mm. Within each statistical set the convergence was tested by the bootstap method. Sensitivity analysis revealed a set of optimal measuring locations, whereas a consecutive ranking and balancing between the classes of diseases led us to the arteria femoralis sinistra and the periphery of the femoralis dextra et sinistra as the most sensitive throughout all diseases. The naive Bayes classifier is trained by a feature vector generated by maximising a distance measure composed by the standard deviation and the mean distance of the signals between the data sets to infer patient state probabilities.

Results

The classification accuracy was 90.5% at the optimal node determined by sensitivity analysis, while we found 89% accuracy in the peripheral measuring location. The marginal deviation recommends the use of the peripheral measuring location in a clinical setting.

Conclusion

The obtained accuracy suggests that cardiovascular diseases can be detected using signal classification on the basis of artificial signals.