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Program & Abstract

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プログラム・抄録集

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Classification of pick and grasp manipulation based on fingertip grip force and velocity

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Abstract
Finger manipulation plays an important role in daily life, and the importance of its analysis is increasing in a variety of research fields. However, due to the difficulty of measurement, it is difficult to understand the essentials of fingertip manipulations, such as the differences and functions of each manipulation. Although many previous studies have examined finger manipulations, quantitative differences between finger manipulations are not clarified, or time-series information of measurement values is lost by converting time series data to one-dimensional features such as their average values. Few studies have analyzed finger manipulations data in time series. The current study focused on pick and grasp manipulations, exploring dynamic features of the thumb, index finger, and middle finger. In the past, we conducted research on pick and grasp manipulations [1], but the time-series information of measurement values was lost by converting time series data to one-dimensional features. Although the result showed that two manipulations were identifiable, it is not obvious whether the method of converting time series data to one-dimensional features is optimal. Therefore, the analysis method that calculates one-dimensional features for one manipulation is extended to the analysis method that calculates N-dimensional features for one manipulation, and we analyzed the pick and grasp manipulations based on N-dimensional features. The 6-channel measurement data on the contact force and velocity of the thumb, index finger, and middle finger are divided into N sections, and the feature value is calculated in each section to obtain a $6 \times N$ dimensional feature vector. We conducted user experiments with nine subjects while they manipulated Poly-Lactic-Acid objects. We discriminated pick and grasp manipulations based on time-series and multi-dimensional features and clarified the number of effective divisions $N = 6$ and the combination of effective channels for the discrimination of two manipulations.
Keywords: Feature analysis, Fingertip manipulation, Haptics.

Reference
[1] Tatsuya Yamashita, Megumi Nakao, Tetsuya Matsuda, Analysis of Fingertip-based Dynamic Features during Pick and Hold Manipulation, Transactions of Japanese Society for Medical and Biological Engineering, Volume 57 Issue 2-3 Pages 68-74, 2019. https://doi.org/10.11239/jsmbe.57.68

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A preliminary study for improving image quality of cone-beam CT images using 3D generative adversarial network

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Abstract

Cone-Beam Computed Tomography (CBCT) images have been widely used in medical field, such as radiation therapy, surgery diagnosis. However, CBCT images contain inaccurate CT values because of artifacts and missing pixel information. Although deep learning has achieved great success in image-to-image translation, it is difficult to obtain the paired CT and CBCT images from the sole patient for supervised training. This difficulty is solved by unsupervised learning, such as Generative Adversarial Network (GAN) and CycleGAN. Especially CycleGAN has been proposed for the purpose of image-to-image translation based on unsupervised training and does not require the paired CT and CBCT images. However, CycleGAN may deform anatomical structures or create new ones, even though it effectively removes artifacts and corrects CT values.

This study aims to improve the image quality of CBCT images in the abdominal region based on unsupervised training. We propose a method to translate CT values to correct values while keeping the anatomical accuracy by adversarial training considering the three-dimensional features of CBCT images. Experiments using test data have confirmed that the proposed method is effective for improving the image quality of CBCT images.

Keywords: unsupervised learning, CBCT, Generative adversarial network, artifact reduction.

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Development of support system during breast reconstruction using real-time three-dimensional information processing

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Abstract

Reduction of the moldability of the postoperative breast shape during breast reconstruction has been cited as an issue. We have developed a system that obtains three-dimensional shape difference information before mastectomy and during reconstruction, and maps the local shape difference information to the patient's skin superficial. The system evaluation by a plastic surgeon using this system revealed that it was desirable to be able to grasp shape information more quickly. Therefore, the purpose of this study was using KinectV2 to develop a system that calculates the shape difference information in real time based on the left and right breast shapes. As a system evaluation, the shape difference during reconstruction was reproduced using a mannequin simulating a patient, and measurement and projection experiments were performed. It is now possible to project the shape difference information onto the skin surface without the process of pasting the shape difference texture onto the three-dimensional shape data.

Keywords: Breast reconstruction, KinectV2, Real-time information projection.

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Hearing in the right ear: A neurophysiological approach

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Abstract

A dichotic listening test is presenting two different auditory stimuli simultaneously to the patient, one to each ear. When used with speech stimuli, the typical finding for dichotic listening is the so-called right-ear advantage which means that more stimuli are correctly reported from the right ear. Right ear-advantage is commonly explained as the left temporal cortex being dominant for perception of elementary speech units and that the dichotic mode of presentation gates the contralateral input from the ear to the auditory cortex. On the other hand, so far the relationship between right-ear advantage and neurophysiological auditory processing is not clear. Therefore, we used a frequency tagging approach to explore auditory neural processing during dichotic listening. To get such information, we labeled the input at each ear by tagging the speech stimuli with amplitude modulation of different frequencies at each ear and by following cortical responses at the modulation frequencies.

The magnetoencephalogram was recorded while participants listened to a pair of stimulus sounds, chosen from 48 kinds of Japanese two syllable sounds ("A-ka", "I-nu", etc.), which were amplitude-modulated at 35 Hz and 45 Hz.

Experiments were carried out for both Active and Passive conditions. In the Active condition, participants were instructed to describe the two syllable sounds that they heard in the left and right ears between trials. In the Passive condition, participants just watched a silent movie during the dichotic stimulation. Behaviorally, the accuracy of reports to stimulation from right ear is higher than from left ear (right-ear advantage) for most participants. The amplitude of the ASSR for the right ear input was significantly greater than the left ear input in right ear advantage participants ($P < 0.05$). This result suggests the frequency tagging method is a useful tool for exploring auditory neural processing during binaural interaction, such as dichotic listening.

Keywords: Dichotic listening, Frequency tagging, Magnetoencephalogram (MEG)

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Preliminary Study on Segmentation of Cervical Intervertebral Disks in Videofluorography by Multi Channelization with Various Image Filters and CNN

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Abstract

In order to elucidate the mechanism of swallowing, it is necessary to analyze the relationship between swallowing and cervical structures. This study proposes a segmentation method of cervical intervertebral disks (CIDs) in videofluorography (VF) by use of *Multi Channelization* (MC) and convolutional neural network (CNN). Each frame of VF is a grayscale image. Forty-five image filters are individually applied to the grayscale image to generate the same number of feature images. In this report, we use eight Sobel filters, two Gaussian filters, two exponential tone curve filters, and so forth. Three feature images are selected and are set to the red (R), green (G) and blue (B) channels of a color image, which is called a *Multi-channelized* image. Patch-based CNN is applied to the MC image to extract CID regions. The extraction accuracy is evaluated by an energy function based on the pixel-based F-measure of the CID regions. The most optimal combination of the three feature images is searched for by the simulated annealing technique. The proposed method is applied to a VF dataset consisting of nineteen patients with cervical vertebral diseases and thirty-nine healthy participants. 50.4%, 16.8% and 32.8% of the VF images are used for training, validation, and testing, respectively. LeNet is used as CNN in this report. The segmentation accuracy is 56.8% when original grayscale images are input into CNN, whereas it is 58.8% when the optimal combination of feature images are input into CNN. The optimal combination is composed of the sigmoid tone curve filter, the morphological top-hat transformation filter, and the posterization filter with more layers. Figures 1, 2 and 3 show an original frame image of VF, the ground truth and the segmentation result with MC and CNN, respectively. The experimental results demonstrated that the MC technique is effective in segmentation of CIDs in VF.

Keywords: Videofluorography, Cervical intervertebral disk, Multi Channelization, Simulated annealing, CNN.

Fig.1

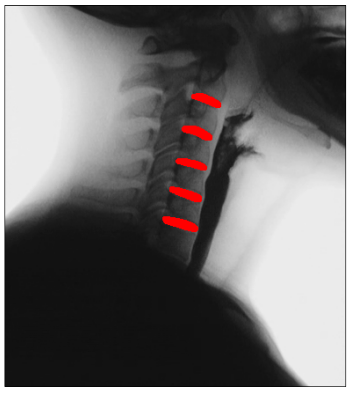

Fig.2

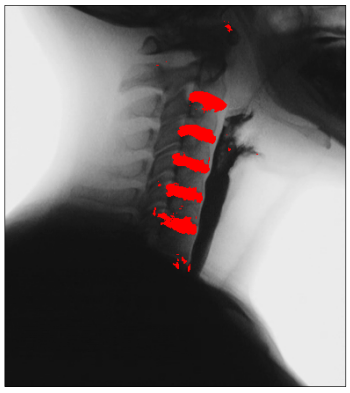

Fig.3

Figures – Fig.1 shows an original frame image of VF. Fig.2 shows the ground truth of cervical intervertebral disks. Fig.3 shows the segmentation result with Multi Channelization and CNN.

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A feasibility study on predicting synthetic dual-energy X-ray fluoroscopic images using deep convolutional neural network

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Abstract

Pinpoint radiation dose delivery to a target tumor based on accurate and precise target localization is an essential task in radiation therapy. To achieve the pinpoint dose delivery, especially for the moving target during the treatment session such as lung tumors, various X-ray fluoroscopic image-based target tracking methods have been developed. A problem here is that the X-ray fluoroscopic image-based methods are frequently suffering from poor target visibility since the target tumor is obscured by other internal organs such as bones. Hence a hardware-based technique called dual-energy (DE) imaging has been introduced to enhance the visibility of soft-tissues including the target tumor in X-ray images. However, DE imaging technique has a disadvantage in radiation dose reduction and clinically available hardware causes motion artifacts in DE imaging. To resolve the limitations of the hardware-based DE imaging and achieve accurate tracking of the target tumor during radiation therapy, we investigate the feasibility of a deep learning-based method to predict DE X-ray fluoroscopic images from single-energy X-ray images. In this study, we applied simulated du-al-energy X-ray fluoroscopic images as training datasets and trained recurrent residual convolutional neural networks based on U-Net to respectively predict bone and soft-tissue images from high-energy X-ray fluoroscopic images. The experimental results showed that the predicted DE images were highly similar to the original DE images. Thus, the proposed method can be a solution to obtain DE X-ray fluoroscopic images without special hardware and extra-dose and then can assist the accurate target tumor localization.

Keywords: radiation therapy, X-ray fluoroscopic images, dual-energy, U-net.

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Fully Automatic Vertebra Segmentation for Spine and Pelvis Alignment Analysis in a Large-scale CT Database

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Abstract

Our project aims at the analysis of musculoskeletal structures for preoperative surgical planning and prediction of postoperative changes in orthopaedic surgery, specifically in the hip region. We had previously developed a system for automated segmentation of pelvis, femur, and their surrounding muscles in CT [1]. Analysis of the alignment of pelvis and spine is important and has a potential for a variety of clinical applications, while the multi-class segmentation of each vertebrae poses a number of challenges including similarity between the neighboring vertebrae, large variation of the field of view (FOV) and the range of scans in the protocols commonly used in clinical practice. Thus, a global rather than a per-instance approach may work better to ensure a reasonable anatomical labeling.

In this work, we employed a multi-stage iterative approach, which is similar to the method proposed by Lessmann et al. [2], for multi-class segmentation of vertebrae using fully convolutional neural networks based on the prior knowledge that the vertebra is always located next to each other. The prior knowledge allows us to follow the vertebral column from one end to the other during the segmentation process. Furthermore, we fine-tuned the predicted labels according to continuous sequence of vertebrae labels. A 4-fold cross validation study using 74 cases of the public dataset of MICCAI challenge *Verse2019* [3] was conducted. The proposed method was compared with the conventional patch-based 3D U-net. The evaluation was performed by two metrics, dice coefficient and identification accuracy, similar to Lessmann et al. [2]. Dice coefficient was calculated between a vertebra in the ground truth image and the predicted vertebra that had the largest overlap without considering the assigned label. The identification was considered as successful if the label matched with the ground truth. The average dice coefficient and identification accuracy over 74 cases (943 vertebrae in total) was 0.926±0.105 and 89% for the proposed method as compared to 0.744±0.184 and 83% for the conventional 3D U-net. The application of the proposed segmentation method in a large-scale CT database for the analysis of spine and pelvis alignment is underway.

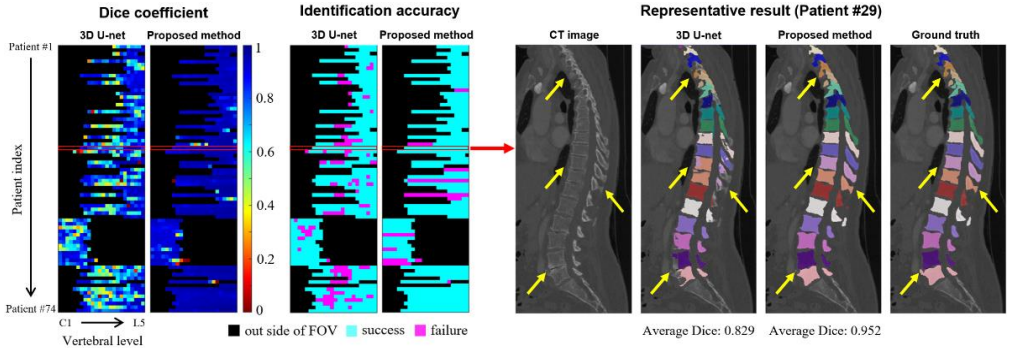

Fig. 1. Heatmap visualization of dice coefficient and identification accuracy for the proposed method and convolutional 3D U-net. The row indicates each patient and the column indicate vertebral level. The sagittal slice on the right shows the representative final segmentation result (Patient #29) marked by the red arrow.

Keywords: Vertebra segmentation, Instance segmentation, Deep learning

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