POSTER SESSION

1080 Computers in Cardiology I: Imaging and Diagnosis

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 4:00 p.m.-5:00 p.m.

1080-1 Software for Quantification of Pericardial Effusion Volume by Two-Dimensional Echocardiography

Richard J. Lucariello, Ying Sun, Prasad Paturu, Salvatore A. Chiaramida. *Our Lady of Mercy University Hospital, Bronx, NY, University of Rhode Island, Kingston, RI*

Background: The pericardial effusion volume (PEV) does not possess a known regular shape. Therefore, the standard methods for volume estimation based on 2-D echocardiography can not be applied. This study was conducted to evaluate a new computer algorithm for acoustic quantification of PEV. **Methods:** Borders of the pericardial sac and the heart were identified either by hand tracing or with the help of an automated border detection algorithm in the apical 4-chamber view. A 3-D disk model was developed to represent the pericardium and the heart with stacks of circular or elliptical disks along the long axis. Volumes were calculated based on the modified Simpson's rule. For comparison the standard area-length method for volume estimation was also applied. PEV was determined as the difference between the pericardial volume and the heart volume. The methods were implemented in C++ for the Macintosh computer. **Results:** Preliminary results demonstrated the advantage of the 3-D disk model for asymmetric and non-ellipsoidal volumes. For the example shown in the figure PEV was estimated to be 657 ml by the 3-D disk model and 523 ml by the area-length method. The actual fluid volume drained was 700 ml. **Conclusion:** The 3-D disk model does not rely on the assumption of symmetrical and ellipsoidal volumes. The software should be useful for obtaining an accurate estimate of the pericardial effusion volume by use of 2-D echocardiography.

1080-2 Indexing and Summarization of Echocardiogram Videos

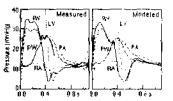
Shahram Ebadollahi, Shih-Fu Chang, Henry Wu, Shin Takuma. *Department of Electrical Engineering, Columbia University, New York, NY*

Echocardiograms are being used in analog format without efficient tools for browsing their content. Our goal is to automatically annotate and summarize them and to create tools for efficient browsing and searching the digital archives of these videos. The first step is to segment the Echocardiogram video into its constituent views (e.g., Parasternal long axis view, etc.). We have observed from the structure of the Echocardiograms that the shape of the 'Region of Interest' (ROI) in each view is different from its neighboring ones. Based on view type the shape can be 'triangular', 'trapezoidal', etc. By preprocessing each frame with appropriate morphological filters and extracting masks for the ROI we find their shape. The difference in the shape of the ROI in different views and the presence/abscence of color has been exploited to segment the Echocardiograms. The next step is to summarize the Echocardiogram videos. There are two types of summaries: 'static' and 'dynamic'. The static summary is a table of images each representing a particular view. Each image is extracted from the view it represents by processing the ECG available from the Echocardiogram video. The representative frame corresponds to the peak of the Rwave in the ECG. Therefore they show a snap shot of the heart at end-diastole in each view. In the dynamic summary every view is represented by a short segment consisting of a few cardiac cycles between two Rwaves at a predetermined distance. The segments are concatenated to each other to form the summary. Hence the dynamic summary captures the time information and is a good abstract of the entire video, while the static summary is useful as a visual cue for randomly accessing the content of the Echocardiograms. The method has been tried on ten different Echocardiogram videos. We have acheived 90% accuracy in view segmentation. The 10% failure is because of the Parasternal Short Axis views. These are temporally adjacent views without any other view type in between. The ROI is triangular in all of them, therefore the segmentation method fails. The current software can be used clinically to help doctors access the digital Echocardiograms of patients and browse their content to find view(s) they are interested in.

1080-3 Quantitative Analysis of Hemodynamic Data by Using Computer Model Coupled With System Identification Method

Ying Sun, Richard J. Lucariello, Salvatore A. Chiaramida. *University of Rhode Island, Kingston, RI, Our Lady of Mercy University Hospital, Bronx, NY*

Background: It was shown previously that a computer model can produce physiologically relevant hemodynamic data. By incorporating a system identification method, this study demonstrates the applicability of the model software to the analysis of clinical cardiac catheterization data. **Methods:** A computer program in C++ was developed for Macintosh computers to implement a set of differential equations representing the cardiovascular dynamics and a simplex-based optimization method for identifying model parameters. The hemodynamic data of interest included cardiac output, ejection fraction, and pressure waveforms in right atrium (RA), right ventricle (RV), pulmonary artery (PA), pulmonary capillary wedge (PW), left ventricle (LV), and aorta (Ao). **Results:** Data from 5 patients were analyzed. For each patient the model was fitted simultaneously to all hemodynamic indexes and waveforms. By iteratively applying the optimization algorithm under user guidance the model quickly converged to the patient's data. Figure shows a typical result of measured (left) vs. modeled (right) waveforms. By lumping all waveforms together linear regression analysis yielded: modeled pressure = 0.94 x measured pressure + 1.2 mmHg; r = 0.994, p < 0.001; n = 1308. Consistent results were observed in all 5 patients. **Conclusion:** This study has demonstrated a method of combining a computer model and a system identification method to achieve an accurate representation of patient's cardiovascular system. The model parameters allow for quantitative assessment of clinically meaningful circulatory variables such as contractility, vascular resistance and capacitance.



1080-4 The Effects of Image Quality on Three-Dimensional Electron Beam Coronary Angiography

Bin Lu, Bakhsheshi Hamid, SongShou Mao, Nan Zhuang, Hideya Yamamoto, Steve C.K Liu, Matthew J Budoff. *Harbor-UCLA Medical Center, REI-E5, Torrance, CA*

Background: Intravenous electron-beam angiography (EBA) had been confirmed to be a promising technique for evaluating coronary luminal stenosis. Our purpose was to identify the effects of image quality and analyze the causes for the nonassessability of the coronary segments. **Methods:** One hundred consecutive patients were studied. Contrast-enhanced transaxial coronary images were reconstructed three-dimensionally (3D) using Volume Rendering techniques. The image quality of coronary segments was quantified with a five-point grading system (scaled with 0-4, 0 and 1 were nonassessable). Image artifacts and other effects were analyzed statistically. **Results:** Techniques failed in 7 patients (7%) due to image artifacts of motion, breathing and arrhythmia. Image quality scores were the highest with 3.6 of the left main coronary artery (LM), followed by the right coronary artery (RCA) with 3.0, the left anterior descending (LAD) with 2.7 and the left circumflex (LCX) coronary artery with 2.6 ($p<0.001$). The scores in proximal coronary segments were higher than the middle and distal segments ($p<0.001$). The nonassessable coroanry segments were occurred in 3% of LM, 2%, 8% and 5% of proximal LAD, LCX and RCA, 24%, 22% and 12% of mid coronary segments, 64%, 45% and 20% of distal segments of LAD, LCX and RCA, respectively ($p<0.05$). Multivariate logistic analysis demonstrated that the heart-rate-variance, vessel diameter and contrast attenuation other than image noise and contrast-to-noise ratio were the effects of the 3D image quality ($p<0.05$, $r=0.62$). Coronary motion, breathing, poor distal opacification and small vessel (<2mm) were the major artifacts and causes for the nonassessability of coronary artery segments ($p<0.001$, $r=0.87$). **Conclusion**: The major limitations of coronary imaging on EBA were the suboptimal spatial resolution and artifacts. The effects of 3D image quality were analyzed and considered to be improved by using thinner slice-thickness (<2mm) with higher contrast-injection-rate and optimal ECG triggering as 40% other than 80% R-R interval during the cardiac cycle.

1080-5 Coherent Contrast Imaging Quantification for Myocardial Perfusion Assessment

Manuel Desco, Maria J. Ledesma-Carbayo, Andres Santos, Miguel A. Garcia-Fernandez, Pedro Marcos, Norberto Malpica, Jose C. Antoranz, Pedro Garcia-Barreno. *Hospital General Universitario Gregorio Marañon, Madrid, Spain, ETSI Telecomunicacion, Madrid, Spain*

Interpretation of Contrast Coherent Imaging (CCI) results is difficult without calculating quantitative parameters.This paper presents a new method to quantify myocardial perfusion contrast studies avoiding artifacts due to heart motion. CCI images are obtained with an ACUSON Sequoia scanner. Echo-enhancer is injected during the scan. 150 consecutive frames are acquired using low power (low mechanical index) pulses at 20 fps. A burst of high mechanical index U/S pulses is used to destroy bubbles, thus allowing to detect the contrast wash-in. The study is performed in two conditions: rest and pharmacologically induced stress (Dipiridamole). A software tool has been developed to analyse these image sequences. It allows to select several ROIs within the heart wall. In order to track the wall movement along the cardiac cycle, the position of these ROIs is automatically corrected, on the basis of the gradient field calculated on a selectively filtered image. An interactive tool also allows to manually correct ROI positions. Time curves are analyzed according to a parametric model that incorporates both contrast inflow rate and cyclic variations. A prototype has been completed, tested and deployed to the echocardiography department, where a clinical trial is being carried out. Preliminary results on 63 patients (37 ischemic, 26 non-ischemic) have allowed us to identify normal and pathological patterns and to establish the correlation of quantitative parameters with the real diagnosis. Significant differences were found between the two patient groups (Basal: Control 10.9+-0.4 dB, Ischemic 9.4+-0.4 dB, $p<0.01$. Dipiridamole: Control 13.1+-0.4, Ischemic 10.7+-0.4, $p<0.001$) There are two main new contributions in this paper: 1) A robust procedure for automatic position correction of wall ROIs, that overcomes the problem of heart motion in an efficient way and 2) a parametric analysis of time curves that allows to condense results in a few quantitative parameters.