butions in two and three dimensions. Metabolites observed include choline, creatine, amino acids, N-acetyl aspartate, and lactate. A birdcage volume coil was used to obtain homogeneous two dimensional metabolite images of the brain and the entire rat head (3 mm × 3 mm in plane resolution, 7 mm slice). Subsequently, the greater sensitivity of surface coils was exploited to obtain three dimensional metabolite images of higher resolution (2 mm × 2.5 mm × 2 mm voxel size) than with the volume coil in the same acquisition time (45–60 minutes). Adiabatic excitation and refocussing pulses were employed to circumvent the heterogeneous rf transmission characteristics of surface coils. Volume and surface coil SI acquisitions were compared in terms of sensitivity, water suppression efficiency, and spectral resolution for the acquisition of SI data sets in two or three spatial dimensions. Results will be presented from studies of rat brain under normal and focal ischemia conditions. The image and data processing challenges presented by this application will be discussed.

91-183. Interactive, Image-Guided Surgery

R.L. Galloway, C.A. Edwards, and R.J. Maciunas, Department of Biomedical Engineering, Vanderbilt University

Modern tomographic medical images, computed tomography (CT), magnetic resonance (MR) and positron emission tomography (PET), provide exquisite three dimensional visualization and localization of intracranial lesions. Unfortunately, that information is left on the lightbox during surgery and it is left to the physician's proprioception to determine present location relative to the lesion. A surgical instrument has been developed which allows a neurosurgeon to visualize his or her location within the cranium on preoperative tomographic scans during the course of the operation. The device is designed to provide the same guidance to intracranial lesions as conventional stereotactic systems but without the encumbrance and obstruction required by frame usage. The instrument, an articulated arm, has a mean error of 0.09 mm and standard deviation of 0.23 mm. Intraoperative error, therefore, is almost exclusively a function of the tomographic image voxel size and has been shown to be less than 1 mm for 2 mm thick CT scans. Intraoperative display of location is provided by a 1280 × 1024 computer display showing 4 512 × 512 windows. Each window may be tagged to a different set of images, either by orientation (axial, sagittal or coronal) or modality (CT, MR, PET). Both laboratory and intraoperative use will be demonstrated.

91-184. Asynchronous Modem Versus Synchronous Net for Communicating High Resolution Images in Medical Consultation

R. Gunderson, H. Cronenberger, and H. Hsiao, Biomedical Engineering, University of North Carolina School of Medicine at Chapel Hill

A communications system for clinical consultation in immunonephrology required exchanging and simultaneously viewing digitized high resolution microscopic images (640 × 480 × 256 color) during verbal interaction. Hardware and software for asynchronous modem communications and for synchronous Novell net communications were developed and established between the Chapel Hill Department of Pathology and various sites within a 120 mile radius. The two communications models were compared in installation cost, continuing cost, speed, security, accessibility, reliability and "physician friendliness." Technology was pushed to its limits by upgrading the UART chip, by compression of images via software and hardware, and by programming techniques that take advantage of particular hardware components. Given equal opportunity to select either communications format, the net promises faster rates of exchange, broader capabilities, and lower continued cost.

91-185. Quantitative Measurement of Two-Component Absorption Spectra Using Multilayer Semilinear Neural Networks

C.W. Lin, J.C. LaManna, K.C. Lee, and Y. Takefuji,* Departments of Biomedical Engineering, Neurology, *Electrical Engineering and Applied Physics, Case Western Reserve University*

A PC-based multilayer neural network with sigmoid activation function, generalized delta learning rule and error back-propagation was trained with two individual components (pro-

tonated and unprotonated form) of pH dependent spectra between 400 and 700 nm generated from microspectrophotometry of Neutral Red (NR). The NR spectrum changes from one resembling the acid to one resembling the base as the solution's pH changes from acid to base. The number of nodes in the input layer was based on the degree of resolution required. The number of hidden layer units was related to the storage capacity and could be a function of maximum connection weight between input and the hidden layer. The number of output nodes determined the step size used to distinguish the input spectrum. Teaching patterns are binary encoded to compare to the activity in the output layer. Simulation results show that after successful convergence with the training spectra features of the input spectrum are separated and stored in the weight matrix of the input and hidden layers. A calibration curve can be constructed to interpret the output layer activity and therefore allow prediction of the pH. With its intrinsically redundant presentation, this novel approach to spectrophotometry needs no preprocessing procedures (baseline correction and extensive signal averaging) for spectral identification. Spectral distortion, e.g. due to light scattering effects, such as between phosphate buffer solutions and brain homogenates do not affect the outcome. This method was applied to the in vitro hippocampal slice preparation to measure anoxic pHi changes. The method can be generalized to adapt to any pattern oriented sensory information processing and multi-sensor fusion for quantitative measurement.

91-186. Activation Isochrones Over Infarcted Tissue: A Technique Comparison

Stephanie M. Smith, David B. Geselowitz, and Edward J. Berbari, Bioengineering Program, The Pennsylvania State University and University of Oklahoma Health Sciences Center

The criterion of maximum negative derivative has been very useful in the formation of activation isochrone maps from unipolar electrode signals, mostly of normal cardiac tissue. Over an infarct, however, these normally biphasic signals can become multiphasic. These downstrokes in the signal can be of similar magnitudes and durations, or quite different. The determination of activation is not always as clear as in healthy tissue, and thus the isochrone maps obtained can become complex and difficult to analyze. In this study we used a four day canine infarct model to look at the unipolar signals overlying the infarct. This model is used to generate late potentials. An array of 124 unipolar electrodes was placed over the infarct and border zone during normal sinus rhythm. Of the thirteen dogs analyzed, ten had enough channels with multiple deflections for the study. For a particular dog, the 124 channels were analyzed for the timing of each of its downstrokes, regardless of the magnitude of their derivatives. The downstrokes were then grouped in time, such that all the first downstrokes were together, the second downstrokes, and so on. Isochrone maps were made of each group. There were always enough channels with first and second downstrokes, however, no dog had enough third deflections to make a coherent map. Our results show that the first deflection is almost always a distant event, while the second deflection is a local propagating phenomenon. Since the magnitudes of the derivatives were changing, a better map of this local phenomenon was obtained from our separation of deflection technique than simply mapping the maximum deflection. Thus, the criterion of maximum negative deflection may not be as useful in the production of isochrone maps over an ischemic border zone. (Supported in part by grant HL36625 from NHLBI.)

91-187. Use of an Illumination Model in the Recovery of Blood-Vessel Topology from Human Bulbar Conjuctiva Images

Carl E. Wick, Murray H. Loew, and Joseph Kurantsin-Mills,** Weapons and Systems Engineering Department, U.S. Naval Academy, and Departments of *Electrical Engineering and Computer Science and **Physiology, George Washington University*

The bulbar conjunctiva, or white area of the eye, is a unique site where blood flow in the smallest of the body's blood vessels may be observed noninvasively and conveniently. Those vessels, the microcirculation system, have proven to be of great value in the study of vascular-related diseases. Extracting data from images to perform those studies, however, has been principally a manual and labor-intensive task. Past efforts to automate the recovery of blood-