A DISTRIBUTED COMPUTER SYSTEM FOR FETAL WEIGHT DETERMINATION

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Two microprocessors and a larger computer are being combined into a distributed system for measuring fetal volume and weight. Since fetal weight is a significant part of obstetrical practice there have been many attempts at its estimation using ultrasound. Previous studies utilized measurements derived from the circumference or diameter of the fetal trunk and/or skull. The accuracy achieved was around plus or minus 200 grams/kilogram (2 SD), which is not accurate enough to determine weekly fetal growth rates [1]. We are developing a system which utilizes three-dimensional information on the hypothesis that accurate volumes will lead to accurate weight prediction.

The method involves the reconstruction of the fetal head and trunk as a series of arbitrarily oriented cross-sections taken throughout the fetus using a high resolution real-time scanner. Each cross-section is obtained by outlining the fetal borders with a light pen; the three-dimensional position of each scan is obtained with an acoustic position locating system [2]. The reconstruction is then used to find volume employing a technique which assumes no a priori shape for the object. A previous engineering study of this method on balloons in a water tank gave a correlation of 0.99 between measured and calculated volume [3].

The present system is centered around a local microprocessor based video graphics system which performs the dual function of collecting the data and acting as a graphics terminal when it is connected to the larger computer for data analysis. The video graphics system (VGS) is an adaptation of a cardiac measurement system developed by Varian Associates. In this system an overlay memory is mixed with video input from the ultrasound scanner so that graphics may be superimposed on the cross-sectional image. A light pen and computer program allow length, area and simple volume measurements to be made on the image. The extended system includes the original Varian software enabling simple measurements to be made on the fetal cross-sections. In addition, a floppy disk has been added, and serial communication facilities allow the VGS to be interfaced to the separate microprocessor based position locator and the larger PDP-10 computer.

During the data collection phase the video graphics system and position locator are used to develop a floppy disk file. This file contains about 20 cross-sections, each consisting of light pen coordinates defining the outline and position vectors defining the location of the scan in space. For the next phase a program is run on the video graphics system which causes it to look like a graphics terminal to the larger PDP-10 timesharing computer. The VGS program listens to characters received from the PDP-10 or keyboard. Ordinary characters are passed to the display or to the PDP-10 as appropriate while special control character commands cause various actions to occur. For example, one such command causes a file transfer program to be activated so that the floppy disk file may be transferred to the PDP-10. The protocol used in the file transfer involves error checking including packets, acknowledgements and checksums, and is based on the DIALNET protocols being developed at the Stanford Artificial Intelligence Lab for sending data over phone lines.

Once the file of outlines and positions has been correctly received an analysis program is run on the PDP-10 which builds the three-dimensional reconstruction and determines volume. The resulting image is displayed on the video graphics system by means of a three-dimensional line drawing package running on the PDP-10. This package generates the display by sending control characters to the VGS causing it to draw primitive vectors and points on the overlay.

The advantage of this distributed system is that it allows data collection, which requires real-time capabilities, to be done on a dedicated computer while the more complicated analysis can be done on a large time-sharing computer which cannot be used for real-time analysis. In addition, the video graphics system can still be used as a stand alone unit for simple measurements.

References:

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