medical instrumentation

Heart sonar images

The latest in a variety of cardiac instruments that have been spun off from space technology—such as the pacemaker and biomedical electrodes— an echo-cardioscope now has emerged.

NASA-Ames engineers developed the instrument to monitor cardiac functions of astronauts in flight. It forms images of internal structures using high-frequency sound—in much the same way that submarines detect underwater objects with sonar. The instrument is compact, lightweight and portable, and dc-powered for safety.

The new technique could replace catheterization, a difficult procedure in which plastic tubes are threaded through blood vessels until they reach the heart. In that technique, a dye is injected into the tube, or catheter, and X-ray motion pictures are taken. Obviously the method is cumbersome and even risky.

Stanford University cardiologists validated the image quality and ease of operation of the ultrasonic device while working with a test group of 100 patients, including 40 infants. Results were excellent.

Twenty of the infants were acutely ill, housed in incubators and monitored with a variety of electrical equipment. These babies are particularly susceptible to electric-shock hazards and repeated doses of X-rays. The battery-powered ultrasonic device, being isolated from its electrical environment, has an inherent safety advantage.

Biomedical conferences

Frequently in science, one highly specialized discipline is unaware of relevant advances made in other areas. In an attempt to familiarize researchers in a variety of disciplines with medical problems and needs, NASA has sponsored conferences that bring together university scientists, practicing physicians, and manufacturers of medical instruments.

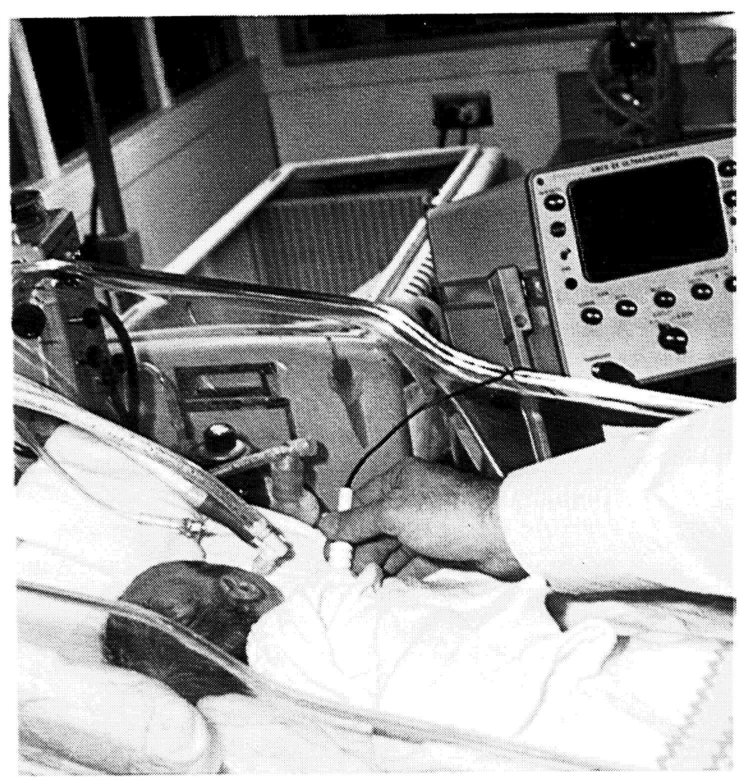
The first International Conference on Biomedical Electrodes Technology, held in 1973 at Stanford University, was one of these. Another, last July, was held on Cardiovascular Imaging and Image Processing.

The heart-imaging conference related NASA technology developed for processing satellite photographs to improving pictures of the heart. X-ray motion pictures and sonar images of the beating heart can be enhanced by computer techniques just as are space photographs.

Both conferences were held by the NASA Biomedical Application Team at Stanford University Medical School. As a result of the electrode conference, several companies have adapted the space technology to make a soft, flexible, surface electrode for long-term monitoring of heart patients. In Vivo Metric Systems Co., Redwood Valley, Calif., already has produced cardiac electrodes based on NASA technology.

Arteriosclerosis detection

Early detection of arteriosclerosis, or hardening of the arteries, is extremely important since, among diseases, it is one of the leading killers in the U.S.



Sick babies were among a test group of 100 patients whose cardiac functions were determined by ultrasonics instead of X-rays. The safer instrumentation was derived from that used to monitor heart functions of astronauts in space.

The usual test involves inserting a hollow needle into an artery and directly measuring the arterial pulse. It's time-consuming and painful. External instruments have been made, but they are bulky, insensitive, costly, or imprecise.

NASA-Goddard's work with transducers used on spacecraft was applied to the problem. The result: an arterial pulse-wave transducer that can determine the flexibility of arteries externally. The device employs a pressure-sensitive transistor that converts arterial pulses into electrical signals. These are amplified and recorded on a standard electrocardiogram machine. The whole examination takes only a few minutes.

The transducer uses a fluid-filled cavity sealed by a soft membrane placed next to the patient's skin. The transducer is simple, inexpensive, small, and highly sensitive.

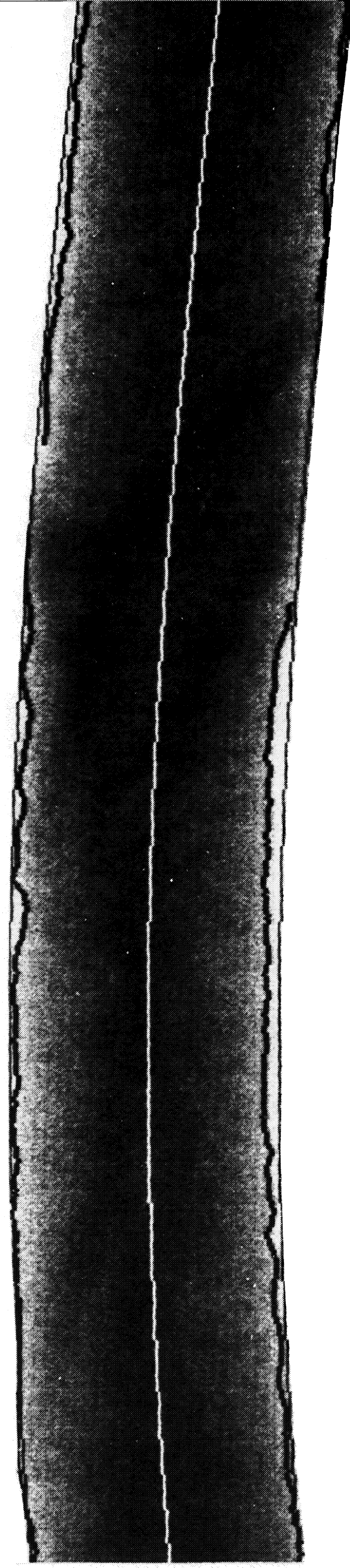
The Veterans Administration Hospital in Washington, D.C., which cooperated with Goddard in adapting the device for arteriosclerosis detection, is in the midst of a three-year evaluation. The hospital is using the instrument to record responses of the heart and arteries to drugs given to lower blood pressure.

In a related development, NASA-JPL's computer technology for clarifying televised pictures from space has been applied to the detection of a specific type of aerteriosclerosis.

Research is underway in collaboration with the University of Southern California, funded by grants from the National Institutes of Health. About 100 heart patients undergoing exercise and weight-loss therapy are having their arteries measured each year to determine whether they are becoming occluded or more flexible.

The computer scans X-ray film of the blood vessels, tracks the edges of the vessels' shadows, estimates the location of the original or pre-diseased vessel wall, and then derives a measurement of the roughness or irregularity of the existing vessel edges.

The work began in 1971 on the laboratory's computer used for space pictures. It was expanded last year, utilizing a stand-alone computer image-processing system to perform the analyses. The instrumentation will be expanded again in 1976 to analyze the coronary arteries and the blood vessels of the retina.



Computer image-processing techniques originally developed by NASA to enhance spaeecraft pictures have been applied to biomedical imaging problems. A digital-enhanced image of a femoral artery is shown . The computer-detected edges are shown along with an estimate of the location of pre-artherosclerosis vessel wall. The difference between the two (taken in the root-mean-square sense) represents the relative amount of disease in the blood vessel.