

Moon Technology for Skin Care

Use of space-developed image processing techniques in cosmetic research heads an array of spinoff developments in the field of health and medicine

Digital image processing is the art of using computers to convert sensor data into informative images—for example, the exciting pictures of distant planets sent to Earth by imaging spacecraft.

NASA centers have led the way in developing this technology and their work has inspired a number of spinoff applications, most notably in medicine and industrial quality control. Digital image processing promises a much broader impact on everyday life because it is showing utility in a wide variety of new applications, some of them still experimental, others demonstrably practicable but not yet in widespread use.

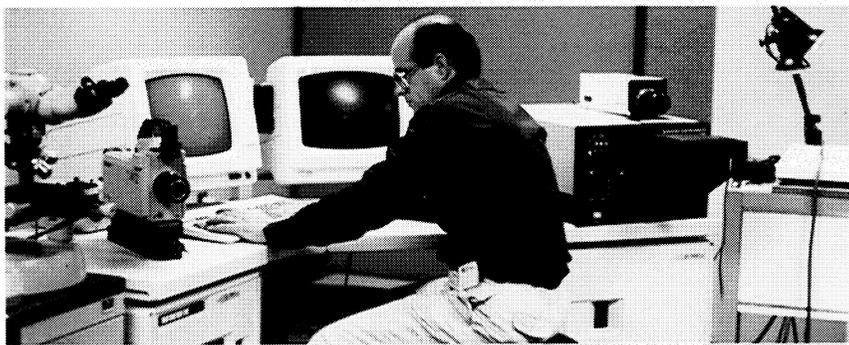
An example in the latter category is the application of the technology to research,

Further, the moon's shadow pattern, different from Earth's due to the lack of light filtering atmosphere, made it difficult to determine certain details essential to topographic mapping, for example, the height of a large boulder or the depth of a crater.

NASA's Jet Propulsion Laboratory (JPL) came up with an innovative solution: converting the analog imaging signals from the spacecraft to digital signals. That would make it possible to computer-enhance the images by programming the computer to adjust the imagery as directed. JPL began developing the software necessary to allow such adjustments as correction of sensor errors, changes in contrast, emphasis on certain features, in general manipulation of the satellite imagery to improve and amplify the information that could be extracted.

Included in the JPL software was a technique called "photoclinometry" to resolve the problems of depth perception occasioned by the unusual shadows of the airless lunar environment. This technique considered such factors as the location of the Sun and the reflective properties of the lunar surface in a process of "decoding" the shadow pattern to produce accurate elevation data for making topographic maps from satellite photos. That is the basis for the software used in skin care research because, odd as it may sound, the moon's topography and human skin have a lot in common.

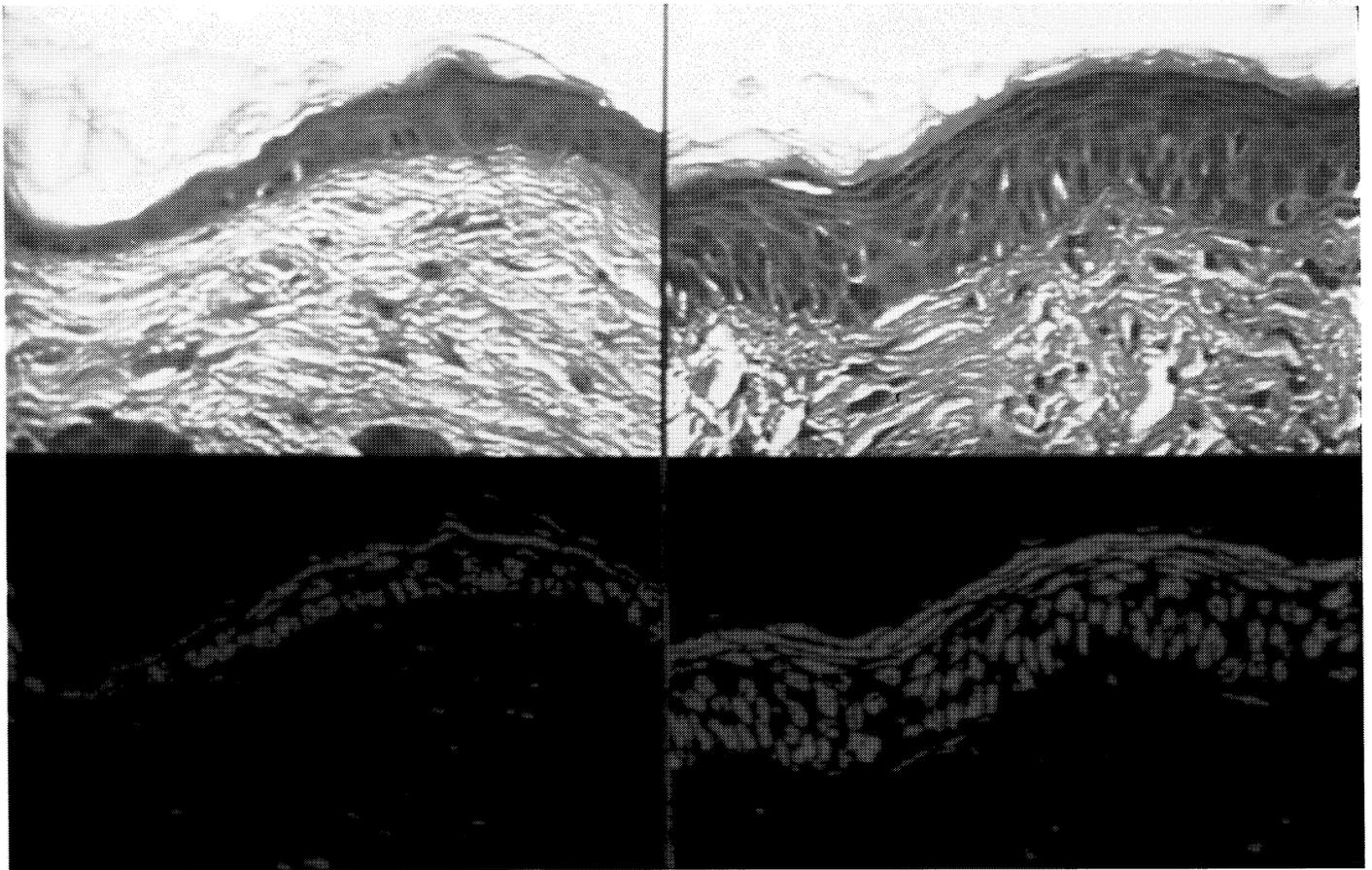
"Close inspection of the human skin surface at any region of the body will reveal that it is not featureless but rather is characterized by geometric patterns and other topographical features," said Dr. Gary Lee Grove and his wife Mary Jo Grove in a technical paper. They pointed out that skin has folds and



Estée Lauder researcher Paul Vallon uses a digital image analyzer and software based on NASA lunar research in evaluation of cosmetic products for skin care. Digital image processing brings out subtleties otherwise undetectable and allows better determination of a product's effectiveness.

evaluation and demonstration of skin care products. Cosmetic and pharmaceutical firms like Estée Lauder, Ortho Pharmaceutical and Hoffman-LaRoche, and independent research/testing laboratories working for such firms, are using image processing software originally developed to provide accurate topographic maps of the lunar surface.

In the early days of the Apollo program, NASA employed telescopic photography from unmanned lunar orbiting satellites to get information on possible landing sites for manned missions. The photos, however, were subject to a variety of distortions caused by camera problems or noise contamination from the spacecraft's electronic equipment.



furrows and hills and valleys that can be approximately measured by such visual means as photo magnification, but can be more accurately measured by computerized image processing.

Dr. Grove is director of the Skin Study Center, a unit of K.G.L. Inc., Broomall, Pennsylvania. Mary Jo Grove is an image processing specialist at the center, whose researchers perform contract work for cosmetic firms, pharmaceutical companies and government regulatory agencies to evaluate the safety and efficacy of cosmetics and topically applied drugs. The Groves developed a computer program, based on the original JPL software, for non-invasive assessment of skin surface topography in evaluating the performance of such skin care products as moisturizers and antiwrinkle creams. They use it in conjunction with a Joyce-Loebel Magiscan Image Processing System.

Estée Lauder Inc., Melville, New York uses similar software with a Zeiss 2001 Image Analyzer to determine the effects of cosmetic products and ingredients on the skin. "The system," says a company spokesperson, "stores, enhances and displays images to make subtleties otherwise undetectable by

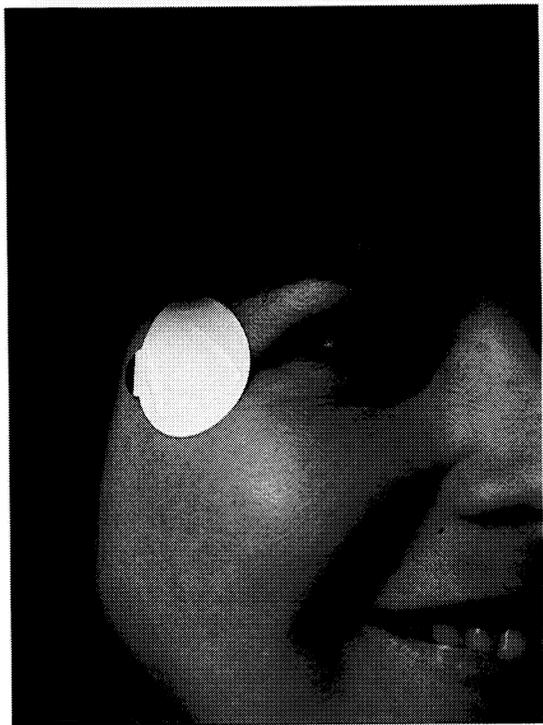
the human eye or camera apparent to the scientist."

The technique allows Estee Lauder to quantify the changes in skin surface form and structure caused by application of cosmetic preparations. The structure of the epidermis, its roughness, dryness, wrinkles, cracks and other features can be translated into numerical descriptions that allow exact and unambiguous assessment.

Formerly, skin examinations and comparisons were done by panels of experts making judgments based on their own experience; that method has disadvantages in time, cost and subjective interpretation. "The use of the digital analyzer technique," says the Estée Lauder spokesperson, "allows us to perform these examinations at lower cost, with more flexibility, much more frequently and with greater assurance of reproducibility of results. It aids us in developing, screening and marketing new products that might otherwise not be made available, because the benefits of the product are not readily apparent to visual inspection or touch."

(Continued)

This is a before and after composite illustrating the effects on skin surface of an Estée Lauder preparation for smoothing rough skin. The upper images are magnified photos of the skin surface before (left) and after (right) treatment. The lower images are enhanced digital representations of the same area. The digital imagery reveals skin "peaks" not otherwise visible (lower left) and shows the degree to which the peaks have been smoothed by treatment (lower right).



Above, a client at the Skin Study Center is having a silicon rubber impression made of the "crowsfeet" wrinkles around her eye for assessment by digital image processing. At right above, the impression is being photographed by a video camera.



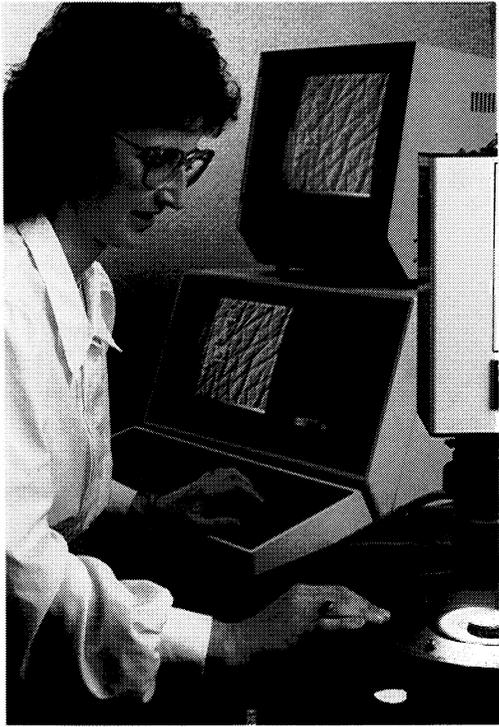
A great many otherwise healthy adults exhibit signs of "photoaging," changes in the skin—particularly the face—that result from aging or excessive exposure to the Sun. These changes produce the stigmata of a yellowish, mottled, wrinkled, leathery, rough skin often studded with small growth.

Until recently, the only routes to a more youthful appearance were cosmetic surgery to remove the flaws or makeup to conceal them. Now, however, pharmaceutical and cosmetic houses are offering retinoid preparations for smoother skin. Such drugs naturally have excited wide public attention and are getting intense scientific scrutiny to see if they really have antiaging properties.

One such product is Ortho Pharmaceuticals' Retin-A, which has undergone extensive assessment by Dr. Gary Lee Grove and the Skin Study Center, an independent testing laboratory in the Philadelphia area. This

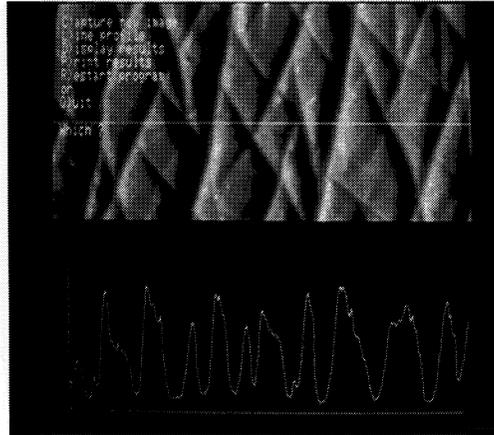
group has developed a number of pioneering non-intrusive testing procedures, some of them based on NASA technology, that have been useful in experimental studies employing human volunteers.

In the Retin-A studies, the Skin Study Center used a spinoff technique, developed by Gary and Mary Jo Grove from Jet Propulsion Laboratory's moon-imaging technology, called "optical profilometry." This technique employs a fiber optic illuminator to sidelight silicon rubber replicas of skin surface specimens, generating an image of assorted shadows and highlights. By computerized image manipulation, the picture of the specimen can be enhanced and analyzed to extract quantitative information regarding the degree of roughness or wrinkling. By comparing processed numerical representations over time, it is possible to determine the degree of effectiveness of drug treatment.

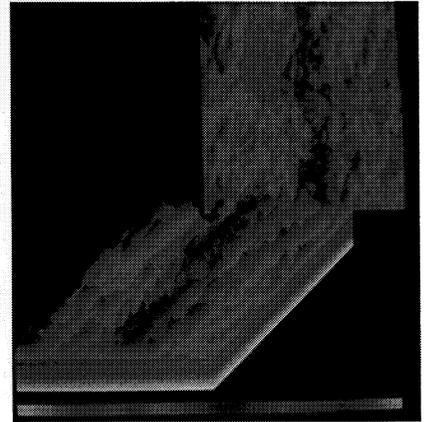
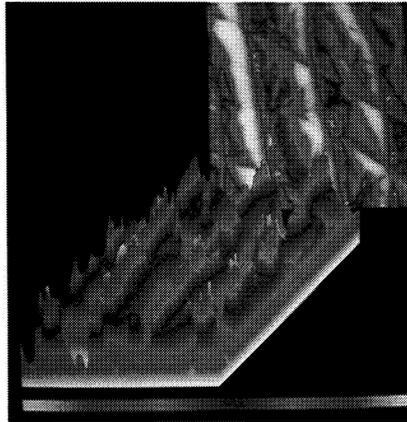


Replicas taken at various times during Retin-A therapy were matched with replicas from a placebo group of similar age. Although the Skin Study Center does not endorse specific products, it reported that it was able to document that Retin-A treatments "do lead to a more youthful appearance with less wrinkled and smoother skin, especially in the crowsfeet area."

Dr. Grove is developing new image analysis techniques based on remote sensing procedures for acquiring data from the NASA-developed Landsat Earth resources survey satellites. These new techniques, along with the earlier developed optical profilometry, will be employed in research and testing of advanced retinoids, in development by pharmaceutical companies, that are expected to be even more effective in countering photoaging changes. ▲



At far left, image processing specialist Mary Jo Grove is examining the crowsfeet impression with the help of a Magiscan digital image analyzer. She rotates the specimen through four different angles and takes measurements at each angle. At near left, the upper image is the camera's view of the specimen; below it is a computer-processed cross-section representation of the peaks and valleys of the skin wrinkles.



Before and after comparisons during treatment with antiaging drugs allow assessment of the preparation's effectiveness.

Above, a "before" view showing many peaks and valleys; above right, an "after" representation in which there are significantly fewer peaks and depressions, attesting to the preparation's skin-smoothing capability.