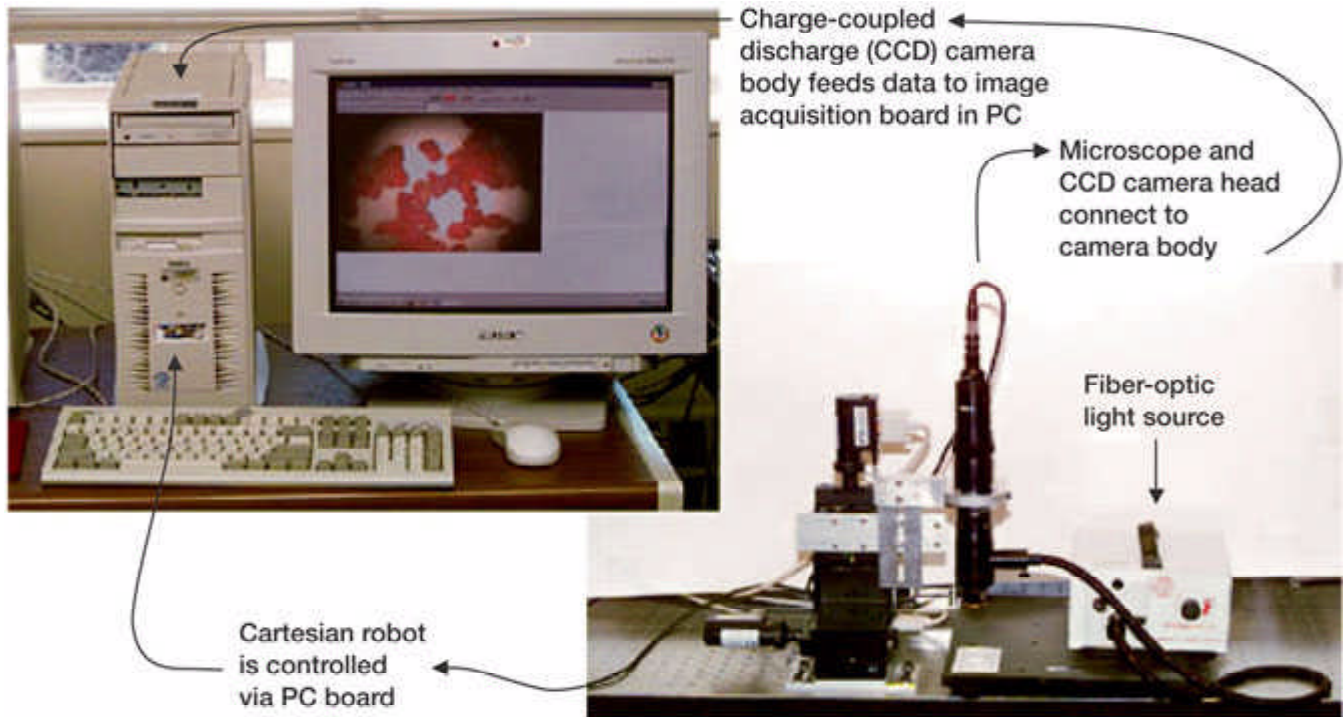# Compact Video Microscope Imaging System Implemented in Colloid Studies

CMIS setup.

Long description Photographs showing fiber-optic light source, microscope and charge-coupled discharge (CCD) camera head connected to camera body, CCD camera body feeding data to image acquisition board in PC, and Cartesian robot controlled via PC board.

The Compact Microscope Imaging System (CMIS) is a diagnostic tool with intelligent controls for use in space, industrial, medical, and security applications. CMIS can be used in situ with a minimum amount of user intervention. This system can scan, find areas of interest in, focus on, and acquire images automatically. Many multiple-cell experiments require microscopy for in situ observations; this is feasible only with compact microscope systems.

CMIS is a miniature machine vision system that combines intelligent image processing with remote control. The software also has a user-friendly interface, which can be used independently of the hardware for further postexperiment analysis.

CMIS has been successfully developed in the SML Laboratory at the NASA Glenn Research Center and adapted for use for colloid studies and is available for telescience experiments. The main innovations this year are an improved interface, optimized algorithms, and the ability to control conventional full-sized microscopes in addition to compact microscopes. The CMIS software-hardware interface is being integrated into our SML Analysis package, which will be a robust general-purpose image-processing package that can handle over 100 space and industrial applications.

CMIS provides automated online inspection of precision parts, medical imaging, examination of currency in automated teller machines, fingerprint identification in secure entry locks, automated examination of soil and water samples, automated blood and cell analysis, and improved microscopy.

Using CMIS, we were able to detect full and partial cells, which gave us information on the centroid of each cell and its position in relationship to all other cells in the image.

We first use a contrast filter to determine the outer ring of each cell. We then use an adaptive background subtraction algorithm to subtract the background from the image. This distinctly separates the cells from the background while preserving the integrity of the cell perimeters. Next, we find the number of cells, their positions, and their nearest neighbors, and identify the particle closest to the center of the image. Finally, we combine the identified cells with the original image and determine cell displacements.

This application is applicable to any experiment that requires cell detection, displacements, and tracking. This microscopy innovation will be incorporated into future microcopy experiments in Glenn's microgravity program.
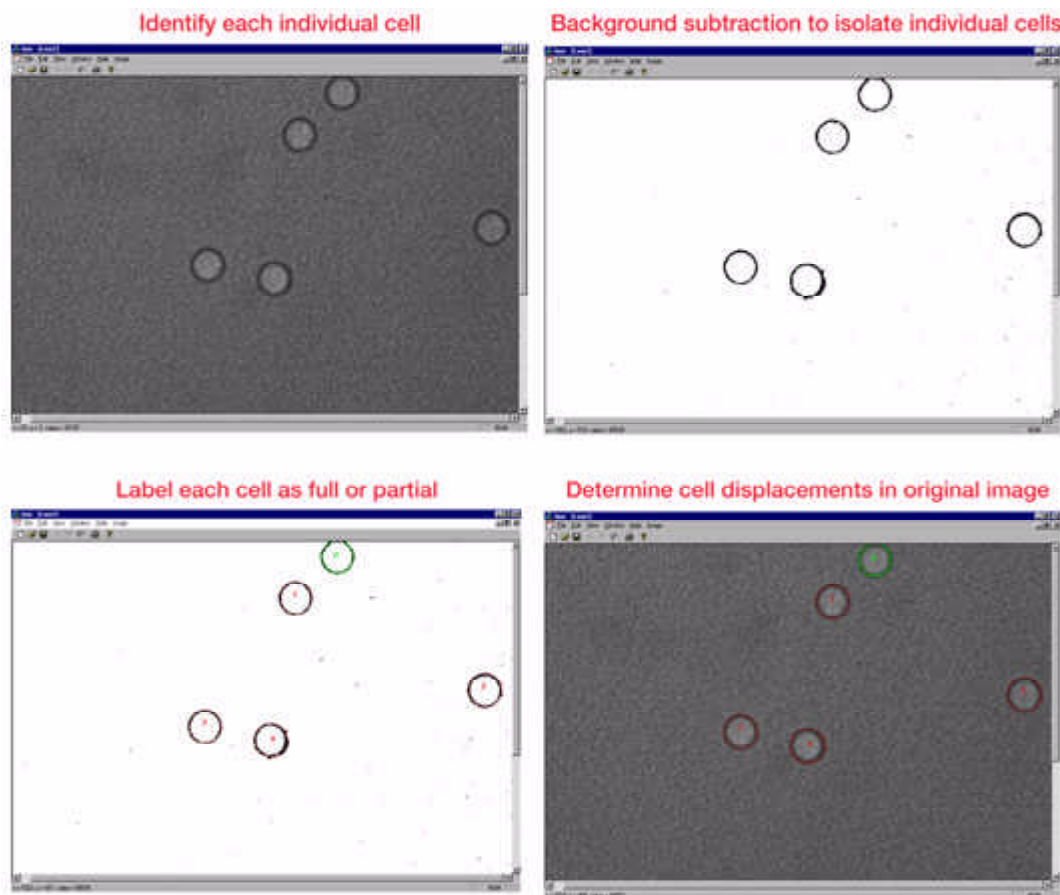
Top left: Raw data exhibiting a vertical disorder-order interface. Top right: Raw data exhibiting horizontal disorder-order interface. Bottom left: Vertical interface located by CMIS is highlighted. Bottom right: Horizontal interface located by CMIS is highlighted.

Long description Four images showing process (1) Identify each individual cell, (2) use background subtraction to isolate individual cells, (3) label each cell as full or partial, and (4) determine cell displacements in original image.

Glenn contact: Dr. Mark McDowell, 216-433-8161, drmm@easy.grc.nasa.gov
Author: Dr. Mark McDowell
Special recognition: Given 2000 Imaging Solution of the Year award by *Advanced Imaging* for significant advancement in the fields of medical imaging, bioscience, and scientific analysis. *Advanced Imaging* is an international magazine that highlights the latest state-of-the-art advancements in imaging processing.