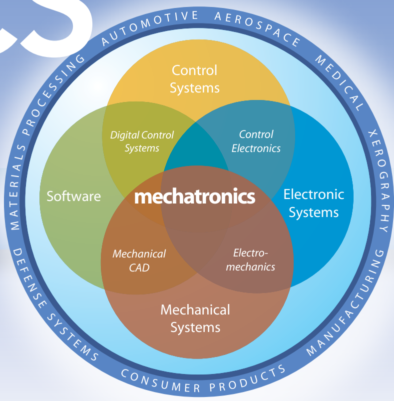
MECHATRONICS IN DESIGN

FRESH IDEAS ON INTEGRATING MECHANICAL SYSTEMS, ELECTRONICS, CONTROL SYSTEMS AND SOFTWARE IN DESIGN



Mama Don't Take My Kodachrome Away!

BY KEVIN CRAIG

Photographs do give us nice bright colors and the greens of summer and they do make you think all the world's a sunny day! But we don't need Kodachrome film anymore as the digital image sensor (figure 1, below) — the heart of all digital cameras — has replaced film. It is the component that converts the light coming from the subject being photographed into an electronic signal.

Figure 1

The magic of capturing moments has been transformed by technology and the digital camera is indeed becoming a part of everyone's daily life! Integration of sensors, actuators, electronics, materials, microprocessors and controls with the lens, aperture and shutter of a camera — that is, mechatronics — made it all happen!

To learn more about digital cameras, I turned to two sources. Mark Nagurka, a fellow mechatronics professor at Marquette University, is a photographer and he provided guidance and insight, while the book "How Digital Photography Works" by Ron White provided some of the best illustrations and descriptions I have ever seen.

How has mechatronics enabled the digital camera? Today, autofocus has all but eliminated fuzzy pictures. Common active autofocus systems have an emitter and detector and use either the echo technology of radar and sonar or triangulation used in range finders. Passive autofocus uses the light from the image to focus the camera. Any autofocusing camera must have a motor to move the lens elements to bring the subject into focus. Speed, accuracy and precision are required and there is so little space! The ultrasonic motor meets those requirements! The ultrasonic motor exploits a phenomenon called the piezoelectric effect. When a voltage is applied to a strip of piezoelectric material like PZT, it expands in one direction and contracts in the other. Reverse the applied voltage and the mechanical deformation reverses direction. PZT is bonded to both sides of a flexible member, in an alternating top-and-bottom fashion, which is then shaped into a circle. An elastic material studded with flexible nubs is bonded to the circle's rim creating a stator (the stationary part of the motor) which moves the motor rotor, which in this case is the lens. By sending an alternating current that switches polarity to the alternating sections of the rim, the rim seems to ripple as the adjacent sections bend first one way and then the other, looking like waves that have up-and-down motion but no lateral movement. As the piezo strip makes waves, the feet press against the rotor, turning the lens elements (figure 2, right).

A sharp image is the photographer's elusive goal, but even when focus and depth of field are just right, a photographer's hands are still wiggling. Even on a tripod, a gust of wind or a truck rumbling by is enough to ruin a photo. A vibration reduction system must counteract vertical vibration (pitch) and side-to-side vibration (yaw), and every direction in between, and it needs to make the correction within a few milliseconds! Any system that seeks to reduce blur caused by camera movement must do something to put the light beams back on the right path before they hit the image sensor. How does a camera detect movement and how does it get the light beams back on the right path? When the system is active and something jostles the camera, the movement is detected by two gyro-sensors; one is used to detect yaw and the other, mounted 90 degrees away from the first, detects pitch. A microchip calculates the distance and direction the lens has moved. There are two actuating approaches analogous to either deflecting an arrow on its way to the target — adjust the lens orientation — or holding the target and moving it to wherever the arrow is coming in — adjusting the position of the image sensor. Of course, there is always the option to correct the blur with software after it has occurred, but this doesn't always give a crisp image.

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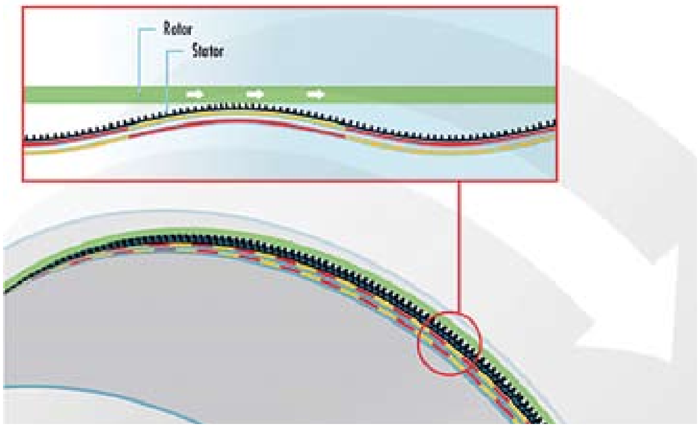
Figure 2



View the Digital Camera — A Mechatronic Marvel at the Mechatronics Zone: http://rbi.ims.ca/5707-519