Nanometeric Accuracy Positioning Servo Mechanisms

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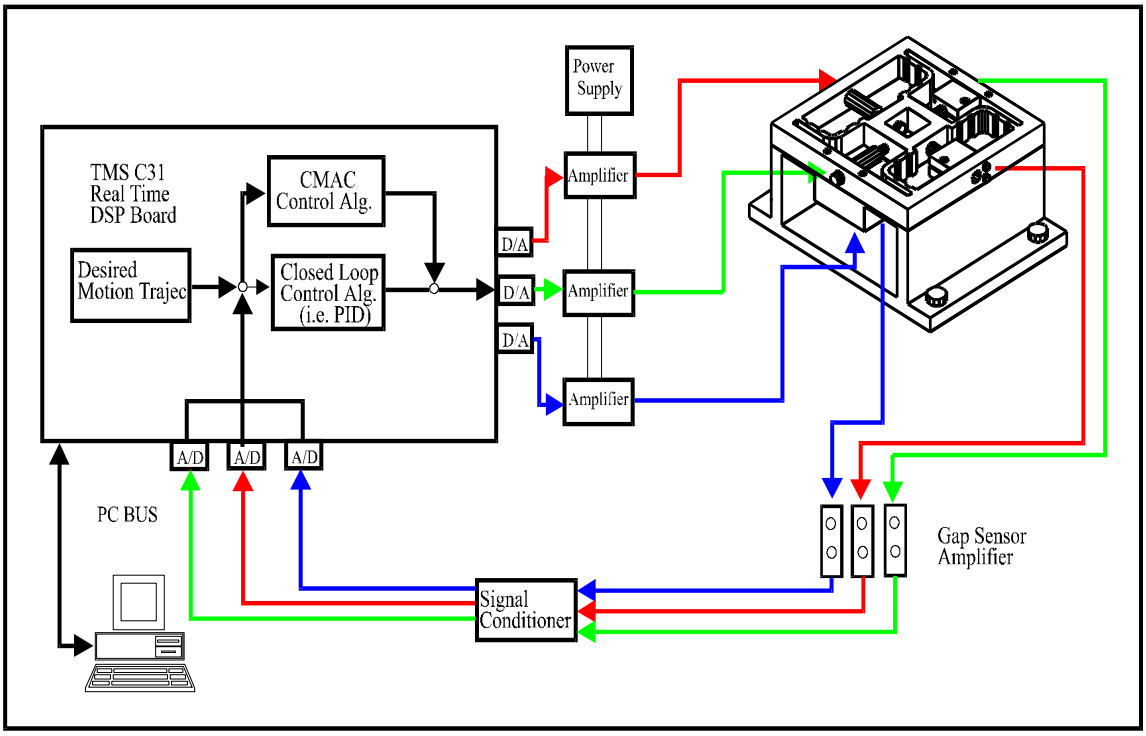
Novel devices for nanometer resolution positioning are being developed, designed, fabricated and tested at Mechatronics Laboratory at UIC. A nanometric positioning mechanism is designed using piezo-electric actuators. Currently, we have two different designs: 1. one degree of freedom (X-motion) device, 2. three degree of freedom (X,Y,Z motion) device.



The piezo-actuator is actuated by a voltage amplifier built in-house specifically for the high precision positioning applications. The actual displacement is measured by capacitive gap sensors in each motion direction. Absolute position calibration is performed using a laser interferometer measurement system. The sensor signal is sampled by a high resolution data aquisition board on PC bus. The sensor and sampling system has 0.77 nanometer resolution. The desired position history is programmed to the real-time controller board using C-language. The controller samples the actual measured position, calculates the desired position trajectory, and calculates the voltage that must be applied to the amplifier of the piezo-electric actuator based on the difference between the desired and actual position. Various PID type servo control algorithms as well as neural network and fuzzy logic based servo control algorithms are being developed and tested. The industry standard PID control serves as reference to evaluate the additional benefits, if any, that can be gained by using advanced control algorithms based on neural nets and fuzzy logic. The current status is as follows: positioning resolution achievable is plus-minus 2 nanometer, motion range 10 micrometers, bandwidth of the closed loop system is about 250Hz.