WORK EXPERIENCES

Characterization of Uncertainties in Radiation Thermography Measurements

When using a high-speed thermal spectrum (IR) camera, there are a variety of sources of uncertainties in temperature values attained. I am currently designing and building experiments to characterize uncertainties in temperature measurements due to effects such as non-uniformity, pixel cross talk, polarization, and non-linearity, as well as changes in emissivity due to changing surface texture and oxide layer of metal chips during machining.

Strain Mapping

I perform strain mapping of metal chips during machining using Digital Image Correlation software.

Synchronization of High Speed Imaging Equipment

I designed, built, and am utilizing a high speed imaging synchronization system. The purpose is to synchronize multiple cameras with each other, as well as with force and position data captured during the machining process. I also wrote software to analyze the images and data in a user-friendly way. Multiple cameras with varying frame rates are used, therefore the system was built to be flexible enough to supply different cameras the triggering inputs they require as well as record the differing outputs they produce.

Machine Tool Hardware and Software Used For Machining Research

The Edgetek Superabrasive Machining Center is a four axis CNC high speed grinding machine. I am the primary operator of the machine. Among my duties have been: performing machining research experiments, writing part programs, performing maintenance and upgrades, teaching others to use it, interfacing it to a PC to extend its' functionality, installing temperature, displacement, and vibration sensors, and performing vibration analysis on various components.

The Moore 3 is a refurbished 2-axis machine originally used for making the platens for computer hard drives. I rebuilt the controller and pendant for this machine from scratch. This was the first project where I used a "safety relay" in the design. A safety relay is a relay with built in redundancy. The redundancy helps insure that if there is a failure in the electronics, the machine will shut down in a controlled, safe manner. I have also performed machining research on the Moore 3.

Pulse Heated Kolsky Bar

Based on the traditional Split Hopkinson Pressure Bar, or Kolsky Bar, NIST added the unique feature of rapid electrical resistance heating of the sample. The apparatus is used to measure dynamic material properties for machining simulation and other applications.

I improved the hardware by adding sensors to measure projectile velocity, as well as a safety interlock and timing control system.

To quickly reduce and archive the strain gage records, as well as document other aspects of the tests, I wrote network based software for data management and processing. Called the Kolsky Bar Data PADS (Processing And Distribution System), the software interactively re-computes stress-strain and other curves as the user examines various assumptions. The Data PADS also includes a database containing strain gage data, visible high speed videos, thermal camera videos, high speed pyrometer data, and sensor data measuring the velocity of the projectile, as well as technical papers and associated information. Multiple users may use and add data to the system, allowing for sharing of data maintenance tasks.

Micro-Force Probe

As part of an effort to develop a piezoresistive cantilever sensor suitable for use as a micro-force (10^{-6} Newton) calibration artifact, I used a micro-force probe to press a traditional cantilever against a piezoresistive cantilever. I also designed and utilized a unique imaging methodology to study the tip-to-tip interactions between the cantilevers.

Charters of Freedom

The Charters of Freedom are the original, signed copies of the Declaration of Independence, the United States Constitution, and the Bill of Rights. NIST worked with the National Archives and Records Administration (NARA) to remove the documents from their old encasements and installed them into new encasements, designed and built by NIST. We are also encased George Washington's Transmittal Letter for the Constitution.

My primary responsibility was the design and construction of the data acquisition software and hardware system used to monitor conditions inside the new encasements. This system consists of two systems which I integrated together; a NIST built sensor-based system and a commercially available spectroscopy-based system. Additional responsibilities included aiding our resident gas and pressure expert with sensor calibrations, performing an initial analysis of performance test data of the new encasements, as well as supervising a technician helping with sensor installation.

Reference Bullets

When bullets are found at a crime scene, markings on bullet landings are compared to those of bullets from other crime scenes in order to gather information about the perpetrators. Investigators use special optical microscopes to measure and digitize these markings into their computer systems. As with any measurement, there are always errors associated with this processes. How may the operators of these microscopes insure there proper operation? How do you guarantee that a bullet digitized in one town may be accurately compared with another on the other side of the country (or the world) using a different microscope?

Our answer to this problem was to manufacture many bullet-like objects, called bullet artifacts, each of which is identical to the others down to their fine scratches. These objects are distributed to operators using this type of microscope. Since each artifact is essentially identical, any one digitized version of it must be an exact match with all others. To manufacture the artifacts, we used very sharp diamond tools to literally "carve out" the surfaces one tiny scratch at a time. These tools were controlled by a computer, so the patterns of the scratches may be reproduced time after time. This manufacturing process is called Single Point Diamond Turning.

I was given various digitized profilometer tracings of what sample bullets are shaped like. I wrote software to analyze, manipulate, and plot the profile data. Once we were satisfied with the data, the software output a CNC part program used to manufacture the reference bullets. Included in the data processing steps executed by the program were; high pass filtering, cross-correlation analysis, sum of differences squared testing, radius of curvature corrections, and local slope testing.

Automated Microscopy System

TOPOGEN was system I built to perform advanced optical microscopy and time lapse imaging functions. The system consists of software I wrote, as well as positioning and lighting hardware which the software controls. The primary application of the system was to position an optical microscope and/or the specimen being examined, acquiring images of the specimen from a variety of positions and brightness's. The images were then merged to form a single "best focus" image, and optionally a topographic map of the specimen surface.

Hardware Design of LIGO Optics Characterization System

Quoting the LIGO web site: "The Laser Interferometer Gravitational-Wave Observatory (LIGO) will be a facility dedicated to the detection of cosmic gravitational waves and the harnessing of these waves for scientific research. It will consist of two widely separated installations within the United States, operated in unison as a single observatory. When it reaches maturity, this observatory will be open for use by the national community and will become part of a planned worldwide network of gravitational-wave observatories."

Our involvement with this effort was to measure some of the difficult to measure the million dollar optics used in the LIGO system. We outfitted a laser interferometer measurement instrument specifically for this job. I designed and built a simple five axis control system to position the precious optics. I also operated the instrument and "certified" several optics.

Three Dimensional Surface Profiling Instrument

The machine I am the most proud of during my earlier years was the Three Dimensional Stylus Type Profiling Instrument. It measures small features on surfaces in three dimensions. Such machines may be acquired "off the shelf" today. Back then, however, few people had them, and those that did had to build them. I took a two dimensional profiling instrument, added motion controlled stages, a linear optical encoder, a data acquisition and control system, and wrote software to control the system and then perform analysis of the data. The surfaces I examined using this instrument were primarily worn metal and ceramic surfaces. Since few researchers had experience examining these surfaces in this way, I became somewhat of an "expert." I handled requests for advice from people outside of NIST and wrote a Sub-Chapter in an American Society for Metals handbook.

Micro-Indentation/Scratch Apparatus

I automated what had been a manually driven micro-indentation / scratch apparatus. I designed and built much of the hardware and all of the software involved in the automation. It even included the ability to set up experiments in a spreadsheet format. This was in the days when you had to code every thing from scratch. The program had over 7000 lines of code. I sometimes wonder if younger programmers fully appreciate how wonderful the ability to create a spreadsheet interface by simply manipulating a data grid object really is!

Corrosion of Metal In Bridges Measurement Device

Many years ago, I received the word that one of our co-workers had died. He was building a device to measure the corrosion of metal in bridges, which was due to be delivered to the Department of Transportation in a few months, and left absolutely NO documentation. I was called in to try and make the deliverable date anyway. In a few months I rebuilt from scratch what took him over a year to only partially build. I was mentioned by name in a Popular Mechanics article for this work.