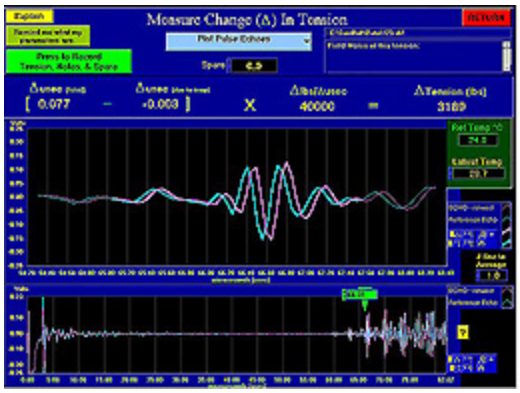
NASA Success Story

SureBolt™ - Ultrasonic Bolt Tension Gage System



A private Florida enterprise is marketing a highly accurate ultrasonic bolt gage invented and patented by NASA at Kennedy Space Center (KSC). American Remote Vision Company (ARVC) of Titusville is offering the SureBolt™ system, a complete unit contained within a laptop computer. NASA engineers used the prototype to remotely measure tension in critical bolts attached to a Space Station structure and its six access hatches during preflight pressurized verification testing. Using a digital signal processing (DSP) technique, the gage proved more reliable on every test and bolt than any other available gages. ARVC says this is because the existing products are "one point" gages that are unreliable due to peak jumping and that they require a high level of training to operate. SureBolt™ analyzes bolt tension instead of torque, and uses the entire echo for more reliability, accuracy and ease of use. Competing products offer at best only a monochrome 5-inch display with cryptic keys and operating systems lacking user-friendly software. ARVC is offering the SureBolt™ for $24,500, including a Panasonic Toughbook laptop with 13.3-inch screen, 64 MB RAM, 3-year warranty, MS Windows 98/2000 operating system, MS Office, and full size keyboard. The SureBolt™ hardware uses the CD bay and one PC laptop memory card type 2 slot. The software interface offers ease of use, with tension change graphing in real-time, and easy to enter notes, special parameters, tension calibration constants and temperatures. Close to one million measurements in Excel-compatible format, with the associated pulse waveform, can be stored automatically.

NASA Involvement The prototype ultrasonic bolt gage with remote operations capability was developed in response to a NASA requirement to measure bolt tension on the International Space Station Node 1 during structural test article (STA) proof tests. The inventors were employed by I-NET, Inc., the former KSC Engineering Support Contractor (ESC). They met NASA's need for a more reliable gage capable of taking multiple measurements (eight bolts at a time), and the ability to read remotely from 400 feet away

Point of Contact
Stuart M. Gleman, Owner
American Remote Vision Company
3561 Alan Drive
Titusville, FL 32780

Phone: (321) 383-4896
Fax: (321) 268-0658
arvcsg@digital.net

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while the node was being pressurized. Also, it was found that commercial bolt gages did not work well on the small 1-inch- and 2.25-inch-long (0.25-inch diameter) Space Station bolts, and torque wrenches were known to be only +/- 20 percent reliable. With its digital signal processing (DSP) technique, the prototype met and exceeded these challenges, working well on 100 percent of all tensions and all bolts. NASA engineers were so impressed with the prototype's accuracy that it was used to test other Space Station bolts.

Social/Economic Benefit In the 30 years since the ultrasonic bolt gage was first invented, many methods have been tried to increase the level of repeatability and confidence in the accuracy of the readings taken with these instruments. When a modern ultrasonic bolt gage and its operator are performing properly, these instruments can measure to an accuracy of +/- 2 percent. However, since bolt gage receivers can and often do "jump peak" or trigger on an adjacent peak in the ultrasonic echo with a corresponding error in the pulse time of flight, a user's confidence in the data collected is significantly reduced. A need has long existed, therefore, for a more reliable ultrasonic bolt gage. The KSC innovation employs the concept of using the entire ultrasonic waveform, rather than just a feature of the waveform such as zero crossing, to find the time-of-flight of the ultrasonic echo. In addition, once the waveform is digitized and captured, features such as zero crossings can be identified and tracked, which again leads to increased performance reliability of the overall instrument. The prototype SureBolt™ combined a correlation bolt gage with three independent feature-recognition bolt gages, all operating on the same captured waveform. The prototype's architecture allowed for operation of the system from a remote host computer and handled multiple bolts (sequentially, not simultaneously). Data from the independent bolt gages were compared by the computer, resulting in a final tension number with a reliability estimate of that number. The final result of NASA's bolt gage research and development will be increased reliability of tension measurements in critical fasteners in all industrial, infrastructure, and military applications, with a corresponding increase in safety and mission success probability.

Industry Partner
American Remote Vision Company

NASA Partner
Kennedy Space Center

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