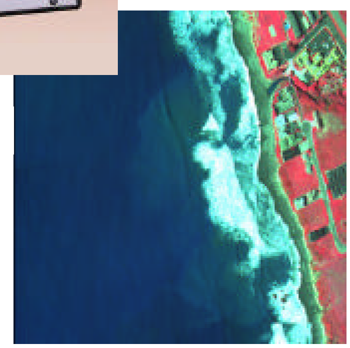
NASA Office of Technology Transfer

John C. Stennis Space Center

Hydrogen Flame Imaging System Soars to New, Different Heights


DT1100

DT4000

Duncan Technologies newest cameras the DT1100 and DT4000 along with examples of images taken with the cameras.

Initial markets for the imaging system included hydrogen suppliers, refineries, petroleum companies, food and semiconductor processors, the fertilizer industry, cosmetics companies, the hydrogen vehicle monitoring and maintenance industry, and the racecar industry. Today, in its next generation, the Duncan camera creates higher resolution images that have given the company a foothold in several more generic arenas including industrial inspections, scientific imaging applications, and even amusement park rides.

When Judy and Dave Duncan of Auburn, Calif.-based Duncan Technologies Inc. (DTI) developed their color hydrogen flame imaging system in the early 1990s, their market prospects were limited. “We talked about commercializing the technology in the hydrogen community, but we also looked at commercialization on a much broader aspect. While there were some hydrogen applications, the market was not large enough to support an entire company; also, safety issues were a concern,” said Judy Duncan, owner and CEO of Duncan Technologies.

Using the basic technology developed under the Small Business Innovation Research (SBIR) program; DTI conducted market research, identified other applications, formulated a plan for next generation development, and implemented a far-reaching marketing strategy. “We took that technology, reinvested our own funds and energy into a second-generation design on the overall camera electronics, and deployed that basic technology initially in a series of what we call multi-spectral cameras; cameras that could image in both the visible range and the infrared,” explains Duncan. “The SBIR program allowed us to develop the technology to do a 3CCD camera, which very few companies in the world do, particularly not small companies.

The fact that we designed our own prism and specked the coding as we had for the hydrogen application, we were able to create a custom spectral configuration which could support a varying types of research and applications." As a result Duncan Technologies Inc. of Auburn, CA, has achieved a milestone $ 1 million in sales.

HOW THE SYSTEM WORKS

The system uses three different sensors to visually detect the flame—two sensors in the near infrared and one in the visible portion of the electromagnetic spectrum. Of the two near-infrared sensors, one is centered at a spectral band that picks up strong water vapor emissions from the flame, while the other is at a band that detects minimal emissions to measure just the background image. The flame is detected by subtracting the background image from the flame image and filtering the result. This process isolates an image of the hydrogen flame and then superimposes it into a color video image. The camera system uses state-of-the-art, low-cost, charge-coupled device (CCD) technologies to produce a color image of invisible hydrogen flames.

If there is not a hydrogen fire present, the user sees normal color video of the scene. If a flame is present, the user sees a red depiction of the flame overlaid on the color video. The system has the capability to detect a three-inch flame from up to 150 feet away. "We felt that by isolating the flame image and then overlapping it onto standard color video, the resulting image would be more useful to the end user. Additionally, when no fire is present the camera can be used as a standard color surveillance camera," explains Judy Duncan. DTI was granted a patent on the hydrogen flame imaging system in October 1997.

HOW NASA BENEFITED

NASA's John C. Stennis Space Center used the prototype system developed to monitor hydrogen flame stacks during turbopump and other rocket component testing at its E-2 Facility. Stennis also purchased six systems for use in its E-1 Facility for use in testing hybrid rocket motors, turbo machinery and small rocket engines. Bud Nail, NASA technical systems lead engineer at the time, decided after seeing the prototype that his job would be made safer by using the system. "There's simply nothing else on the market that performs the way this system does," Nail said. " It takes the guess work out in identifying the hydrogen fire."

WHAT IS THE FUTURE

Duncan Technologies found a solid market in remote sensing, where multi-spectral imaging was well established. "There was a great market there for us because there were no digital cameras; 3CCD allowed us to image a specific band that we were after," said Judy Duncan. "Our largest standing market is creating a camera that is similar to the Landsat spectral band; this allows people with a local camera under local control either on the ground or aerially to acquire imagery that matches the satellite Landsat Imagery. And it turns out that's not in direct competition with the satellites; it's a good complementary technology." Software and analysis tools available today allow users to mix those data types, opening the market to people in a variety of fields such as precision agriculture, forestry management, environmental applications, industrial inspections, and petroleum companies. The company has also gotten involved in some other arenas of multi-spectral imaging. We are working with some groups that are doing research on multi-spectral imaging for the poultry processing industry to detect fecal contamination, as well as, fruit and vegetable producers where you can see some of the defects with multi-spectral imaging that you can not see with a normal, visible camera Working off of the basic architecture that we created for the camera, we have continued to develop more generic digital cameras, standard RGB, three-chip cameras, and single-chip cameras using the same fairly sophisticated digital imaging." The next generation cameras include single-chip and remote hand cameras that contain the camera electronics in a box and the small imaging sensors on the end of a cable so they can be positioned more easily and three of them can be operated at once.

WHY SBIR WAS IMPORTANT

"The SBIR program enabled us, through a combination of development funds and our own reinvestment, to bootstrap and commercialize the technology into several different markets. We still follow a strategy of working within the SBIR program to address the government's needs, enhance our technology, and continue the development of commercial products," said Duncan. SBIR is a highly competitive multi-phase program that provides small U.S. businesses with federal funds reserved for conducting serious research and development. Phase I is the start-up segment with awards up to $70,000; if chosen, Phase II awardees are granted up to $600,000 to conduct research and development for two years. The SBIR Program at Stennis Space Center is managed through the Office of Technology Transfer; for more information regarding the NASA Small Business Innovation Research Program contact the Office of Technology Transfer at Stennis Space Center at (228) 688-1929 or visit our website at http://technology.ssc.nasa.gov.

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