National Aeronautics and
Space Administration

technology solution

Manufacturing

High-Speed Smart Camera Detects Supersonic Inlet Shocks

A smaller, simpler, and faster approach to high-speed imaging and edge detection

A new smart camera developed at NASA's Glenn Research Center has the ability to process and transmit valuable edge location data for the images that it captures - at a rate of over 900 frames per second. The camera was designed to operate as a component in an inlet shock detection system for supersonic jets. A supersonic jet cannot function properly unless the airflow entering the machine is compressed and slowed to subsonic speed in the inlet before it reaches the engine. When supersonic air is compressed, it forms shock waves that can destroy the turbofan and surrounding components unless they are pinpointed and adjusted. This smart camera uses an edge detection signal processing circuit to determine the exact location of shock waves, and sends the location information via an onboard microcontroller or external digital interface. This highly customizable camera's ability to quickly identify precise location data makes it ideal for a variety of other applications where high-speed edge detection is needed.

BENEFITS

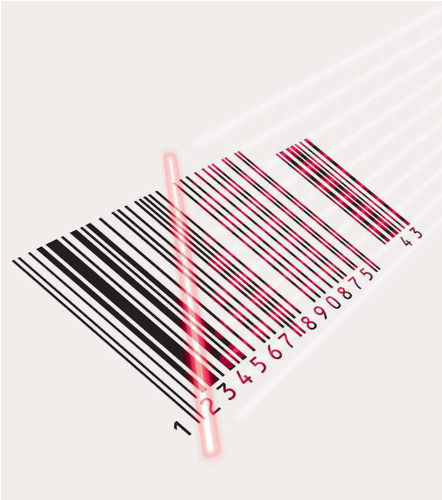
- Fast: Captures and processes linear images at a rate of over 900 frames per second
- Customizable: Responds to digital signal transitions from low to high (positive edges) or high to low (negative edges) and permits threshold sensitivity variations
- Compact: Boasts a reduced size and system complexity when compared to conventional edge detection systems
- Reliable: Features a simple, affordable design that requires very few parts
- Power Saving: Uses lower power components than a typical smart camera

THE TECHNOLOGY

In order for the camera to detect invisible air shocks in an aircraft engine's intake, a fine sheet of laser light is first projected through the airflow. The light is refracted in the densest part of the airflow (the location of the shock), which creates a dark spot that shows up as a dip or negative peak in the pixel intensity profile of the image. The smart camera uses this information to identify a negative going edge and a positive going edge, which is expressed as numeric pixel values within the linear array. Data is output from the circuit as an analog signal or digitally by an onboard microcontroller using a parallel digital bus or a serial interface such as the controller area network (CAN bus), Ethernet, RS-232/485 or USB.

Unlike conventional edge detection systems, which rely on both a high-speed camera and a bulky computer or digital signal processor, this innovation uses an analog technique to process images. Its simple, sleek design consists of three basic parts: a linear image sensor, an analog signal processing circuit, and a digital circuit. The result is a smaller, more reliable technology with increased processing frame rates. The design can easily be tailored to the end use, and can be reconfigured to respond to positive and/or negative going edges. Furthermore, the threshold sensitivity can be varied and algorithmically set, making it well suited for a number of other terrestrial applications from transportation to manufacturing.

An example of a laser sheet technique similar to the one used to illuminate air shocks for this technology



Edge detection finds an important application in decoding linear bar codes

APPLICATIONS

The technology has several potential applications:

- Supersonic jets
- Manufacturing (assembly lines, part placement, and position monitoring)
- Lane line tracking for vehicle control
- Bar code scanners
- Digital photography

PUBLICATIONS

Patent No: 9,160,896; 9,424,654

More Information

National Aeronautics and Space Administration

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