Sensors

Technology Opportunity

Capaciflector-Based Technology

Advanced Capacitive Sensing

The National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center (GSFC) seeks qualified users and/or manufacturers to pursue further development and commercialization of a capacitive sensor and the numerous technologies it enables. The sensor can be used singly or in closely packed arrays for diverse applications. Industries that can benefit from the NASA-developed technology include automotive, industrial robotics, and security.

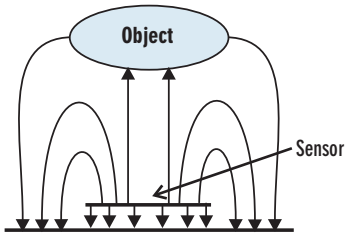
Benefits

- *Versatile:* any number of configurations and combinations are possible — large or small, 2-D or 3-D, single sensors or as an array, all types of shapes, coated or embedded, etc.
- *Compact*: smaller than other sensory devices, it reduces sensor-mounting standoff to virtually zero — the skin is typically less than 0.060 inches (15 m m) thick.
- *Rugged:* in December 1992, the Capaciflector performed flawlessly as a proximity sensor on the feet of the Dante robot, which walked into the extreme environment of an Antarctic volcano.
- *Stable:* there are no thermal drift problems; the Capaciflector provides a virtually crosstalk-free performance.
- *Precise:* dramatically increased detection range and sensitivity over competing technologies. During the Space Shuttle STS-64 mission in September of 1994, the Capaciflector enabled a NASA-record precision alignment of less than 0.004 inches as part of the Robot Operating Materials Processing System.
- *Efficient:* requires milliwatt energy, which makes it practical for industrial, embedded, and remote applications.

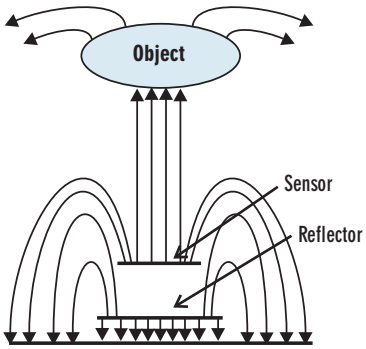
Potential Commercial Uses

The Capaciflector can be used to detect mass and moisture, thereby enabling the Capaciflector to be used for industrial process controls such as fluid monitoring, counting, and capacity monitoring. It also detects motion. This ability enables use for safety, security, and process monitoring such as object detection, human detection, and measurement of rpm.

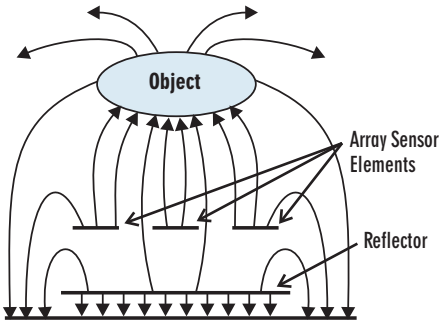
Figure 1 - Capacitive Sensor Principles



(a) Typical Capacitive Proximity Sensor



(b) Capaciflector with Active Reflector



(c) Capaciflector Array

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Applying these sensing capabilities, the Capaciflector lends itself to specific applications, including:

- *Industrial robotics:* can be applied to the manipulator as a guidance system for tool or part insertion.
- *Self-sensing systems:* can be embedded in valves, bearings, clutches, etc. as a pressure-bearing portion of the structure.
- *Clandestine security*: can be embedded in safes or other items as an undetectable sensor.
- *Position sensing*: can detect out-of-position passengers for smart air bag deployment.
- *Proximity sensing*: can detect objects in vehicle blind spots or near machinery for safety.
- *Occupant sensing*: can distinguish passengers from cargo for automotive occupant sensing.
- *Moisture sensing*: transparent sensor can be fixed to windshield to accurately sense rain for smart wiper control.

The Technology

As illustrated in Figure 1, the Capaciflector is a capacitive sensing element backed by an active reflector element that acts as a shield to reflect field lines. The capacitive coupling between the senor and the object is used to control an oscillator. As an object moves closer, the capacitance increases and the oscillator frequency decreases, which allows varying detection ranges for objects. The active shield reflector is electrically isolated from the sensor and follows the oscillator, keeping it in phase with the electric field of the sensor without affecting the oscillator frequency. The reflector therefore reflects the electric field of the sensor without being affected by the coupling between the sensor and the approaching object.

The Capaciflector can be used as a single unit (see Figure 1b), or as a closely packed array (see Figure 1c). Even though the sensors are separated only by a few thousandths of an inch in the array, there is virtually zero cross-talk. In the array configuration, each sensor performs independently as a Capaciflector, operating off a common driven shield and locked to a single oscillator in frequency, amplitude, and phase. Flexible printed circuit boards have been constructed of Capaciflector arrays that can image in 3-D and act as a "Capaciflector camera." The Capaciflector array concept has also been extended to embedding the sensors into structures so that they become load-bearing parts of the structure. Applications for this aspect include self-diagnostic systems and end-effectors for robots.

Commercial Opportunities

NASA's Goddard Space Flight Center seeks a qualified user to pursue further development and commercialization of the advanced Capaciflector technologies. The Capaciflector technology has several U.S. patents. NASA is interested in discussing commercial use and/or licensing of this technology.

Contact

If you are interested in more information, or want to pursue transfer and commercialization of this technology, please contact:

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Related Technologies

- Capaciflector-Guided Mechanisms: U.S. patent 5,539,292
- 3-D Capaciflector: U.S. patent 5,726,581
- Frequency Scanning Capaciflector for Capacitively Determining the Material Properties: U.S. patent 5,521,515
- 3-D Interactive Display (patent pending)

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