Electronics/Computers

Infrared Instrument for Detecting Hydrogen Fires

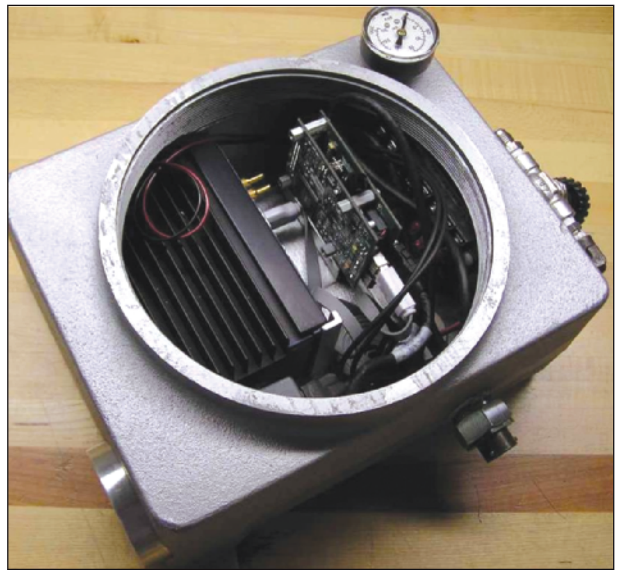
Spatial information is utilized to discriminate against reflected light from other sources.

John F. Kennedy Space Center, Florida

The figure shows an instrument incorporating an infrared camera for detecting small hydrogen fires. The instrument has been developed as an improved replacement for prior infrared and ultraviolet instruments used to detect hydrogen fires. The need for this or any such instrument arises because hydrogen fires (e.g., those associated with leaks from tanks, valves, and ducts) pose a great danger, yet they emit so little visible light that they are mostly undetectable by the unaided human eye. The main performance advantage offered by the present instrument over prior hydrogen-fire-detecting instruments lies in its greater ability to avoid false alarms by discriminating against reflected infrared light, including that originating in (1) the Sun, (2) welding torches, and (3) deliberately ignited hydrogen flames (e.g., ullage-burn-off flames) that are nearby but outside the field of view intended to be monitored by the instrument.

Like prior such instruments, this instrument is based mostly on the principle of detecting infrared emission above a threshold level. However, in addition, this instrument utilizes information on the spatial distribution of infrared light from a source that it detects. Because the combination of spatial and threshold information about a flame tends to constitute a unique signature that differs from that of reflected infrared light originating in a source not in the field of view, the incidence of false alarms is reduced substantially below that of related prior threshold-based instruments.

The camera in the present instrument is a palm-sized commercial one wherein the image sensor is an array of microbolometers that are sensitive in the wavelength range from 7.5 to 13.5 μm. The camera includes circuitry that preprocesses the microbolometer readings to generate digital output. The camera output is coupled to an embedded image-processing computer via a high-speed serial data interface, conforming to standard 1394 of the Institute of Electrical and Electronics Engineers (FireWire). The instrument includes a custom circuit board designed to act as interface between (1) the rest of the instrument and (2) external power supplies and external electronic instrumentation and alarm circuits, such that from the perspective of the external instrumentation and alarm circuits, this instrument exactly mimics an older ultraviolet-based hydrogen-fire-detecting instrument to be replaced.



A **Commercial Explosion-Proof Housing** contains the electronic circuitry of the instrument. The housing is fitted with a 2-in. (5.08-cm) germanium window for the infrared camera, and with a pressure port and pressure gauge so that the interior of the housing can be pressurized with inert gas for additional safety in a hazardous environment.

This work was done by Robert Youngquist and Curtis Ihlefeld of **Kennedy Space Center** *and Christopher Immer, Rebecca Oostdyk, Robert Cox, and John Taylor of ASRC Aerospace Corp. Further information is contained in a TSP (see page 1).*
KSC-12845

Modified Coaxial Probe Feeds for Layered Antennas

Coaxial shields are connected to radiator and ground planes at standing-wave nodes.

Lyndon B. Johnson Space Center, Houston, Texas

In a modified configuration of a coaxial probe feed for a layered printed-circuit antenna (e.g., a microstrip antenna), the outer conductor of the coaxial cable extends through the thickness of at least one dielectric layer and is connected to both the ground-plane conductor and a radiator-plane conductor. This modified configuration simplifies the incorporation of such radio-frequency integrated circuits as power dividers, filters, and low-noise amplifiers. It also simplifies the design and fabrication of stacked antennas with aperture feeds.

It is often desirable to incorporate the aforementioned integrated circuits into antenna structures in order to obtain better performance or more compact packaging than would be achievable by packaging these circuits as electrically connected but structurally separate units. In a typical conventional coaxial probe feed configuration, the integrated circuitry is located beneath the ground plane. Incorporation of the integrated circuitry into the antenna entails difficulty in (1) making solder connections at locations that are partly or totally inaccessible and (2) ensuring the necessary precise alignments between hidden coupled transmission lines. In contrast, in the modified configuration, the integrated circuitry is mounted on the outside, where it is visible and accessible.

The figure shows examples of simple conventional and modified coaxial probe feeds. In the example of the conventional configuration, the outer conductor of a coaxial cable is connected to, and terminated at, a ground-plane metal layer, while the central conductor extends through a single dielectric layer to a connection with a patterned metal radiator element (e.g., a microstrip patch).

In the example of the modified configuration, the outer conductor of the coaxial cable extends through the thickness of the dielectric layer between, and is electrically connected to, both the ground-plane metal conductor and the patterned metal layer on the radiator plane. The central conductor of the coaxial cable extends through the thickness of the dielectric substrate of an integrated circuit to the integrated circuit, which is located on the outer surface. The integrated circuit then excites the cavity formed by the bounding top and bottom planes, by means of an electrical connection passing through an aperture in the patterned metal radiator element (see figure).

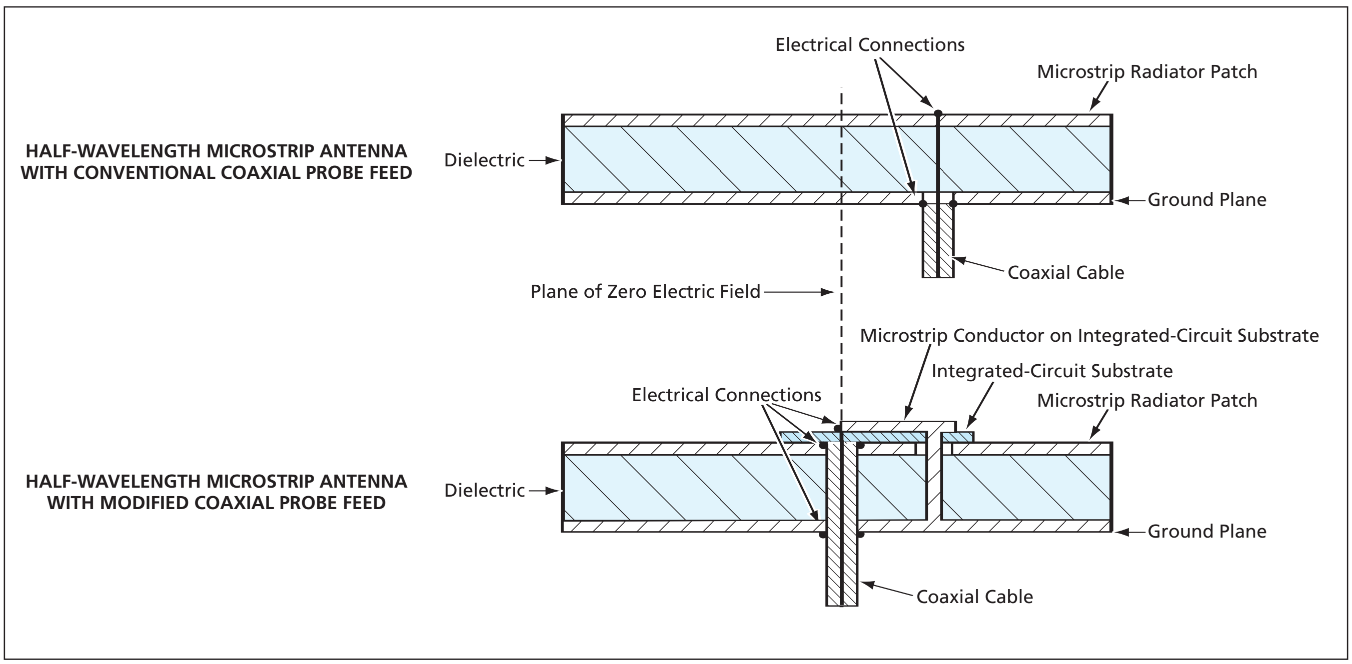
Although the coaxial outer conductor constitutes a short circuit between the ground and radiator planes, the effect of the short circuit is minimal because care is taken to locate the coaxial intrusion at a node of the standing-wave mode of the antenna electromagnetic field; that is, the effect of the short circuit is minimal because at its chosen location, the electric field is nominally zero in the absence of perturbations. In the ideal case, the diameter of the outer conductor of the coaxial cable would be zero and there would be no perturbations. In reality, the outer conductor has a finite diameter, leading to a slight shift of the resonance frequency of the antenna. However, the resonance frequency is easily adjusted by slightly changing the length of the antenna.

In some designs, the metal radiator and ground plane are intentionally short-circuited by use of a post at a specified location to shift the resonance frequency by a specified amount. In an application of the modified configuration to such a design, the coaxial intrusion could be substituted for the post.

The modified feed can also be applied to the so-called PIFA (planar inverted-F antenna), which has achieved great popularity due to its compact size. In this application, the coaxial intrusion provides all or part of the required short circuit between the ground plane and the patterned metal layer on the radiator plane.

This work was done by Patrick W. Fink, Andrew W. Chu, Justin A. Dobbins, and Greg Y. Lin of **Johnson Space Center**.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23549.



In the **Modified Coaxial Probe Feed**, the outer conductor of the coaxial cable constitutes a short circuit between the ground plane and the radiator patch.

Detecting Negative Obstacles by Use of Radar

Changes in diffraction and reflection would be used to detect abrupt downslopes.

NASA's Jet Propulsion Laboratory, Pasadena, California

Robotic land vehicles would be equipped with small radar systems to detect negative obstacles, according to a proposal. The term "negative obstacles" denotes holes, ditches, and any other terrain features characterized by abrupt steep downslopes that could be hazardous for vehicles. Video cameras and other optically based obstacle-avoidance sensors now installed on some robotic vehicles cannot detect obstacles under adverse lighting conditions. Even under fa-