National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Sensors

Hyper-Distributed RFID Antenna (HYDRA) System

Novel multiplexing RFID antenna system improves range while reducing cost and complexity

Innovators at NASA Johnson Space Center have developed a method and apparatus to multiplex Radio Frequency Identification (RFID) signals efficiently. The resulting Hyper-Distributed RFID Antenna (HYDRA) system enhances distribution of the RFID reader signal, providing improved coverage for large areas as well as for small, fixed regions requiring a high density of reader antennas. This greater coverage translates into better RFID sensing capabilities, higher localization accuracy, and enhanced logistics awareness.

Many conventional RFID applications require adding more readers and antennas to increase coverage in existing areas and to improve localization. Employing conventional multiplexer switches can reduce the need for additional readers but require additional control and power cabling. Both conventional options will increase mass, size, and cost of the overall infrastructure to improve sensing performance. The HYDRA system, which uses microprocessor-based low-mass multiplexers, reduces the need for additional readers and cabling over the conventional prior art, and it operates with smaller-sized antennas. As a result, the advantages of the HYDRA system include the ability to transmit data at low power, improve coverage performance, increased capability to localize RFID tags, along with reduced cost, complexity, and mass.

BENEFITS

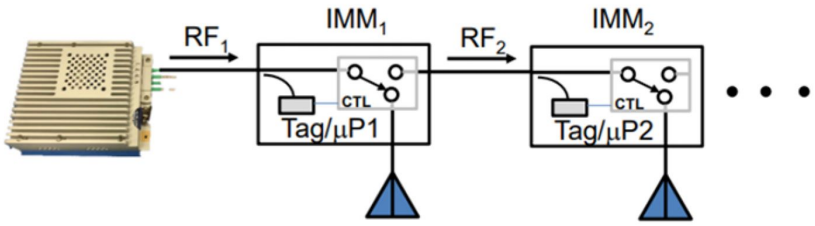
- Plug-and-play installation allows direct drop-in replacement for existing antennas in many RFID systems.
- Improved functionality over conventional RFID antenna systems by extending sensing range of RFID readers and improving location accuracy.
- Lower cost for enhanced performance: reduces overall costs by eliminating the need for multiple RFID readers and additional cabling infrastructure.
- Small form-factor requires minimal space for implementation including number of cables and connections.
- Versatile: adaptable functionality provided by numerous alternate configurations and embodiments.

THE TECHNOLOGY

Components of the HYDRA system include an RFID reader (aka an RFID transceiver or interrogator), RF cables, antennas, and one or more Intelligent Multiplexer Modules (IMMs). The IMM is the core building block of the HYDRA system. In one of its basic embodiments, the IMM comprises an RF directional coupler, RF switch, RFID chip, micro-controller, and power generation and management hardware. In this basic implementation, a single RF port from the RFID reader is attached to the IMM and transfers power thereto. Internally within the IMM, the RF directional coupler diverts a small amount of RF power to rectification and power management circuitry for conversion to DC power that drives the RFID chip, microcontroller, and RF switch. The RFID chip enables communication with the RFID reader and allows the reader to administer changes to the microcontroller's embedded software. The microcontroller controls the RF switch, which passes power along to one or more output channels. Connections to the output channels can include antennas, additional IMMs, or other sensors.

The HYDRA system may include numerous alternate embodiments to enhance and customize the basic functionality. In one embodiment, the microcontroller is replaced with a simple timer. In another embodiment, the switch has multiple output ports to connect to a distributed chain of HYDRA system or local antennas. Also, the entirety of RF power exiting a HYDRA module can be rectified and used to power a local sensor node, which could be implemented via WiFi or Bluetooth Low Energy (BLE). Features of the HYDRA system include the ability to cover both open regions and enclosures, the ability to switch RF power to an unused load for assisting in the resolution of tag antenna ambiguities, and the ability to accept plug-and-play add-ons such that the reader's software can use the system without requiring any embedded modifications.

The HYDRA system is technology readiness level (TRL) 7 (system prototype demonstrated in an operational environment) and is now available for patent licensing. Please note that NASA does not manufacture products itself for commercial sale.



Schematic drawing of a basic HYDRA implementation with two or more Intelligent Multiplexer Modules (IMMs) containing control circuitry and two-way RF switches with connected antennas. As shown by the dots in the diagram, more IMMs can be added to the chain - enabling more antennas require fewer readers and less cabling. For example, 8 antennas would normally require 8 cables, but with the HYDRA design, would only require 1 cable.

APPLICATIONS

The technology has several potential applications:

- Aerospace: locates inventory of mission items in and around vehicle
- Agriculture: helps farmers determine health condition of produce: technology allows supply chain to add information remotely to tag
- Medical: helps staff manage medical devices and supplies; can track patients
- Retail: tracks inventory and shipment check-in, automates ordering

PUBLICATIONS

Patent Pending

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More Information

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