Wide-Area Accurate Passive RFID Real-Time Tracking System

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Overview

• Cambridge Wide-Area DAS RFID System
  – Introduction to RFID
  – Employing Advanced RF Techniques for near 100% Tag Detection
  – Demonstrations and Pilot Studies

• Wireless Wide-Area RFID Architecture
  – Challenges
  – Single Hop Wireless RFID Repeater
  – 30m Range Wireless RFID Repeater
  – Wide-Area Distributed Antenna System(DAS) RFID Wireless Repeater
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# Background to RFID

Enables remote object detection and identification

<table>
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<th>Passive</th>
<th>Active</th>
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<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
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<td>Simple tag requires no local power source or maintenance</td>
<td>Short range in practice</td>
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<td>Low cost</td>
<td>Reduced read reliability</td>
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<td></td>
<td>Difficult to determine location</td>
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**Passive**
- Simple tag requires no local power source or maintenance
- Low cost

**Active**
- Long range tag
- Good read reliability
- Battery powered
- High cost (200 times more cost than passive)
Meeting the Passive RFID Challenge

• Conventional Passive RFID readers have a reliable read range much less than the maximum read range - due to points where the interrogating signals are cancelled due to reflections (nulls)

• Resulting in: a short practical range 1-2 m, often mis-reading tags and difficulty in determining tag location

• Many systems require:
  • High tag reading reliability
  • Longer range
  • Precise location
  • Robust installation

• The Cambridge approach meets these requirements
Conventional Passive RFID System

Small Area Portals

- Conventional systems give reasonable detection accuracy BUT over short range (a few metres)

- Detection accuracy rapidly degrades over longer ranges (~10 m), even if individual tags support this distance

- Location is defined by the location of the portal where a tag was last seen – only suitable for highly controlled environments.
New wide-area DAS RFID system gives a near 100% tag detection compared with <60% in a conventional system!
Four antennas are distributed over a 10 m x 8 m office area.

115 tags are placed on desks.
Passive RFID Tag Detection

Conventional system <60% read success rate

New system with effectively 100% success rate

Antenna location  Successfully read tag  Null
Four antennas are distributed over a 20 m x 15 m hall

11 ‘on metal’ tags are placed on assets
Read Success Rate of Metal Tags over Large Area

Conventional system <50% read success rate

New system with 100% success rate

Successfully read tag
Failed read
Antenna location
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Wireless RFID Repeater

The ultimate aim, is to use multiple wireless repeaters to form a DAS to leverage work to date on tag reliability enhancement and location accuracy, while eliminating co-ax cabling. Will enable much simpler and quicker deployment in factory environment.

Target 30 m
Wireless RFID Repeater

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Target 30 m

Area for coverage to be provided

Tag reading limit of repeaters

Master to repeater wireless links
Wireless RFID Repeater

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RFID
Master + Repeater

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Elimination of Coaxial Cables

Strong drive from factory not to require poles for antenna mounting. Solve with ceiling mounted master, and multiple repeaters around edge of area with carefully chosen radiation patterns.
Low power master and short Master to repeater transmission to allow testing in small lab space.

200 Impinj Monza-4 tags are placed at a height of 2m on a 20cm grid interval within an 8m x 3m area.
Single Hop Wireless RFID Repeater

Probability of failed reads for a wired single antenna system

Probability of failed reads for single hop wireless repeater system.

- Wired single antenna system and single hop wireless repeater system give a detection accuracy of 92.99% and 92.92% respectively.
30m Range Wireless RFID Repeater

**30m range downlink RFID repeater**

- Master Tx (+35dBm)
- 30m Range
- RFID Master Controller
- 20dB attenuator
- Master Rx
- 3m
- Repeater Rx
- 45dB Gain
- Repeater Tx (+35dBm)
- 2m Downlink Repeater
- Tag Array

**30m range downlink and uplink RFID repeater**

- Master Tx (+35dBm)
- 30m Range
- RFID Master Controller
- 20dB attenuator
- Master Rx
- 1.8m
- Repeater Rx
- 45dB Gain
- Repeater Tx (+35dBm)
- 2m Uplink Repeater
- Tag Array

- Separation between the master hub unit and wireless repeater or antenna of 30 m.
30m Range Wireless RFID Repeater

Probability of failed reads for a 30m range downlink wireless repeater

Probability of failed reads for a 30m range downlink and uplink repeater system

- Wired single antenna system and single hop wireless repeater system give a detection accuracy of 92.30% and 93.53% respectively.
Demonstration of Wireless Repeater DAS RFID

- Array of 100 tags used as the target
- Experiment carried out with:
  - Wired RFID DAS
  - Wired RFID DAS with optimisation
  - Wireless repeater RFID DAS
  - Wireless repeater RFID DAS with optimisation
Demonstration of Wireless Repeater DAS RFID

Wired DAS RFID

Wireless repeater DAS RFID

Wired DAS RFID with optimisation

Wireless repeater DAS RFID with optimisation
Demonstration of Wireless Repeater DAS RFID

- Full wireless repeater DAS RFID has shown error free operation similar to a full wired DAS RFID.
Cambridge RFID Solutions

• By using the Cambridge patented technology, integrated solutions are now possible for passive RFID tracking over large areas – 20 m x 20 m demonstrated to date
  • Error free detection accuracy (100%)
  • Accurate real-time location coverage

• A new wireless RFID repeater system, facilitating remote interrogation without the need for arrays of wired antennas, despite using entirely passive, low-cost UHF RFID tags.
  • Error free detection accuracy (100%)
  • An extended range wide-area coverage in passive RFID using wireless RFID repeaters.
  • 30m range passive RFID tag detection demonstrated to date.
Thank You