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Sensible Things that Communicate

PART OF MID SWEDEN UNIVERSITY

Antenna Based Passive UHF RFID Sensor Tags.

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Abstract:

RFID, as a low cost technology with a long life time, provides great potential for transmitting sensor data in combination with the ordinary ID number. The sensor can be integrated either in the chip or in the antenna of an RFID tag. This thesis focuses on the design of low cost antenna-based UHF RFID sensor tags and the applications are mainly targeted on remote humidity sensing.

Antenna-based sensory UHF RFID tags utilize the influence of the sensing physical parameters on the electrical properties of a tag antenna. The variations of the electrical properties of the tag antenna can be measured by many ways. In this thesis, it is described how these variations are normally measured by an RFID reader without any other assistant equipments.

In this thesis, three structures of antenna-based RFID sensor tags are presented and characterized. The first one utilizes the sensitivity of the antenna to the surrounding environment to construct RFID sensor tags. In this concept, the moisture absorbing material serves as wetness/humidity sensor and is placed on the RFID tag antenna to increase the humidity concentration surrounding the tag antenna. The second one directly integrates the small volume sensor element into RFID tag antenna and the sensor information can thus modulate the antenna performance through galvanic contact. The third one embeds the small volume sensor element into a loop which is positioned on top of tag antenna and the sensor information can thus modulate the performance of the tag antenna by means of electromagnetic coupling. Both theoretical analysis and full wave simulations are presented, for the later two sensor tag structures, to characterize the performance of the sensor tags.

An ultra-low cost humidity sensor with memory functionality is designed for integrating into the RFID tags through galvanic contact or electromagnetic coupling. The sensor is a 1-bit write-once-read-many (WORM) memory printed using conductive ink based upon nano-sized silver particles. The WORM works as a pure resistive humidity sensor and can tell the historical event. The WORM sensor is presented through introducing the its geometry, characterizing its behavior in humidity and explaining the principle of the humidity effect. The WORM sensors are also integrated into the RFID tags by means of both galvanic contact and electromagnetic coupling in order to experimentally verify the two concepts.

To lower the cost of the RFID tags, the antennas are normally printed on flexible substrates using low-cost high-speed manufacturing methods which are commonly associated with high roughness. In the last chapter, the effect of the edge roughness on the antenna is investigated.