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A Review of Passive RFID Technologies

Introduction

From TV remote controls to Wi-fi networks, wireless sensing and communication is essential to the function of many modern technologies. There are many different ways that wireless sensing may be integrated: infrared emitters and receivers, radio waves, and even sound. First developed in the 1970s, Radio Frequency Identification (RFID) is a small, inexpensive, and effective method for engineers to realize wireless sensing and identification in their technologies. This paper reviews existing passive RFID implementations.

Commercial Applications of Passive RFID Technology

The applications of passive RFID tags are very broad, and are ever growing. They have seen widespread use in identification and access cards, such as those used at universities and office buildings - it is likely that the reader owns at least one card of this type! Supply chain engineers have harnessed RFID technology to improve inventory management systems. Conferences and conventions use them to track event attendance. RFID tags are used by automated kiosk machines to verify sales transactions [1, 2]. Clearly the applications are nearly endless.

One of the primary advantages of passive RFID technology is how inexpensive it is. Purchased in bulk, the typical passive RFID inlay that may be used in a device like an ID card costs between 7¢ and 15¢. A standalone reader necessary to interact with such a tag may cost between $500 and $2,000, but the bare reader circuitry could cost less than $200 if the engineer wishes to custom-build a reader unit [3].

The leading manufacturers of UHF RFID inlays in the price range previously mentioned are Avery Dennison, Invengo, and Smartrac Technology. For UHF RFID readers, the largest manufacturer is Motorola, although there are significant competitors [4].

Underlying Technology

The typical inlay in a device like an ID card, such as the Texas Instruments Tag-It, consists essentially of a transponder integrated circuit, a capacitor, and a large coiled antenna. The inlay is typically printed on a thin and flexible polymer tape substrate and delivered on reels. The transponder is a minuscule processor containing about 2 kilobytes of memory and can be programmed to respond to input signals as desired [5].

Passive RFID circuits may at first be mystifying - they're ICs with no power source! Unlike active RFIDs, which must have a battery, passive units rely on the energy from the input waves emitted by the reader for their power. The EM field picked up by the antenna is rectified and voltage multiplied in order to power the transponder. EM field coupling is divided into two categories. Near-field coupling uses Faraday's principle of magnetic induction: a current flowing through a coil in the reader generates a magnetic field in the space around it, which in turn induces a current in the coil in the RFID tag. This kind of coupling is useful at distances of less than five meters and typically operates at lower frequencies (128 kHz & 13.56 MHz). Far-field coupling uses a different principle: EM energy at this range is detected as a potential difference, some of which is reflected back due to the impedance mismatch between the antenna and the load circuit. By changing the impedance of the load circuit, the amount of energy can be reflected, a technique known as backscattering. Far-field coupling is useful at ranges of five to 20 meters and operates in the Ultra High Frequency (UHF) range (860-960 MHz) [6].

Building Blocks for Implementation

There are essentially three elements necessary to consider in the implementation of an RFID system: the RFID inlay or chip, the reader, and the software that interprets the interaction between the two [6, 7]. The inlay/chip element is a fairly simple matter, assuming one does not wish to design a unique one - they are readily commercially available and inexpensive [3]. The manufacturer's data sheet must be consulted in order to determine how to interact with the chip or inlay.

RFID readers are also commercially available, although more expensive. Depending on the application, it may be preferable to make one's own reader by purchasing a receiver/transmitter circuit and building the reader unit around it [3]. In order for the unit to have any useful purpose, there must be software to interpret the returning signals from the RFID unit. Commercial readers may interpret the return signals internally and output a readable format. Custom-making a reader would entail writing code to run on a microprocessor which can parse the constant stream of incoming RF signals and identify meaningful signals [6].

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