MASTER'S PROJECT IN ELECTRONICS SYSTEMS
15 ECTS POINTS, 10 WEEKS

Differential RFID Sensor Design and Characterization

Introduction

This project is part of a larger project at the Electronics Design Division targeting integration of sensor functionality to ordinary passive RFID tags. While a stationary PC-controlled RFID reader is available with specialized software, main project focus is on designing RFID sensor labels. The objective is to design several different sensor labels, each optimized to measure a specific physical or chemical quantity.

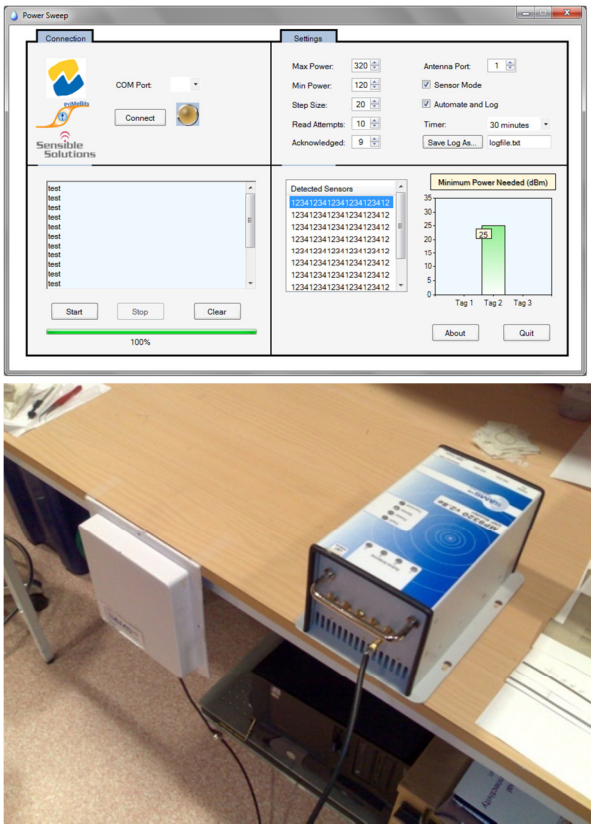

Figure 1. Stationary RFID reader (lower) controlled by a specially developed software to sweep output power and retrieving backscattered signal strength (RSSI).

Objective

RFID tags can be bought at very low cost, with less than SEK 1 per tag if bought in volumes of millions. While these tags are frequently used for wireless identification of objects, so far there exists no passive UHF RFID chip with a general sensor input.

A concept developed at the Electronics Division goes around this limitation by working with pairs of RFID tags and disturbing one of the tags' antennas with a resistive, capacitive or inductive sensor. These sensor labels have the potential to provide wireless sensors at an extremely low cost compared to commercially available wireless sensor systems.

The concept has been verified in its most basic forms and the goal of this project is to take this one step further by designing and evaluating new sensor concepts. You will use standard UHF RFID chips and your work will include design of antennas and searches for suitable sensor components. The sensor labels are to be optimized and characterized for the quantity they are designed to measure.

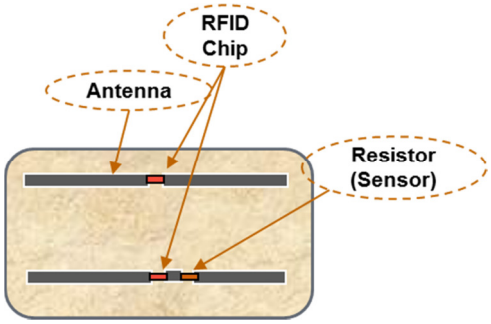

Figure 2. Schematic example of wireless sensor label based on two passive UHF RFID tags where one tag has been equipped with a resistive

sensor that affects the RFID tag antenna in proportion to the measured quantity of interest.

Sensor Technology

The initial RFID sensor setup that will be targeted is illustrated in Fig. 1. Two ordinary passive UHF RFID chips tags are incorporated into one label where one of the tags is equipped with a resistive sensor. The resistive sensor connects one of the RFID chips' two antenna ports to an antenna element. When the sensor is in a high ohm state there is almost no current flowing from that antenna element and the tag is thereby difficult to communicate with. If the sensor on the contrary is in a low ohm state the connection is good and the RFID tag communicates as usual.

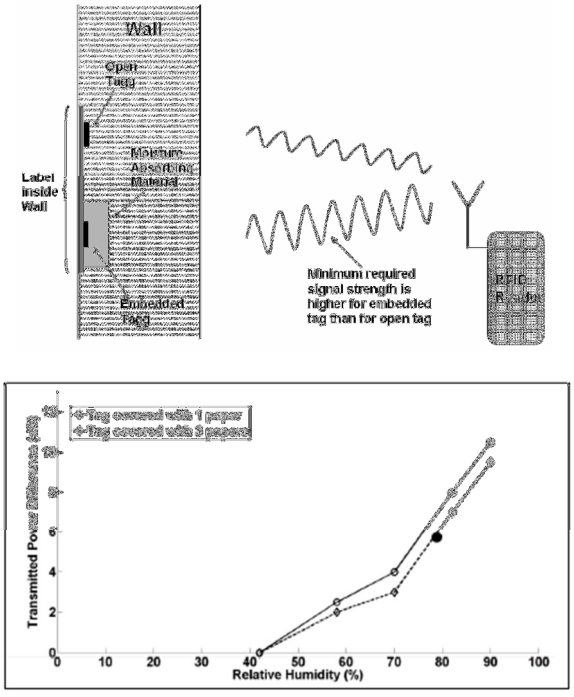

Figure 3. Example of a sensor equipped RFID label designed to measure humidity levels.(Top) Difference in power required to operate respectively the normal and the sensor equipped tag (Bottom)

The level of the quantity the sensor is designed to measure, for example temperature via a thermistor, can be determined for this passive RFID system by comparing the difference in RFID reader output power required to power up respectively the normal and sensor equipped tag. The required signal strength from the reader is thus proportional to for example the temperature at the location of the tag if a thermistor is used as resistive sensor.

Except for comparing the minimum output power required for operating each tag, the work will also compare the difference in backscattered signal strength from the two tags when transmitting at different power levels.

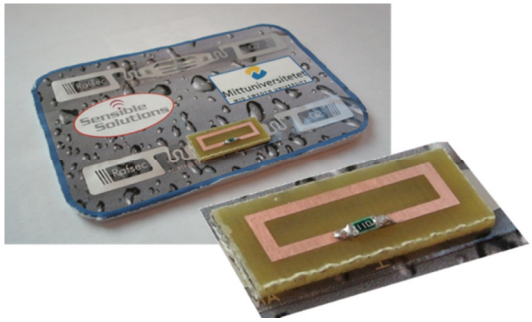

Figure 4. Example of wireless sensor label based on two passive UHF RFID tags where one tag has been equipped with a resistive sensor that affects the RFID tag antenna in proportion to the measured quantity of interest. EM coupled sensor

Implementation

The antenna design is primarily accomplished by hand cutting copper or aluminum tape. The dimensions of the antennas will be calculated together with the supervisors.

First evaluations will take place with pure resistors, which will be replaced by sensor components when suitable tag designs have been verified.

The project also involves the evaluation of adding sensors to commercial tags where the RFID chip is already attached to an antenna.

This is done by either cutting a slot in the antenna structure or by electromagnetical coupling to the antenna as is exemplified in Fig 4.

The concept should also be extended by the design and characterization of at least one triple-tag. In this sensor setup, two sensor equipped tags are used together with a reference tag with the purpose of measuring two different quantities within one sensor label.

The sensor designs involves evaluations of geometrical aspects such as how close the two, or three, tags can be put together, if it is desirable to arrange them in a specific geometrical pattern, how close the sensor component must be to the RFID chip, etc., etc.

While already developed software will be used to retrieve data about RF power the work also includes a comparison between reliability of the two methods of power sweep and RSSI for different kinds of sensor designs. This in turn includes conclusions on the average number of measurements that each time is needed for a reliable readout.

The project includes a supervised pre-study in UHF RFID technology. Additional documents and information about the project will be handed out at project start. The projects first two weeks will be devoted to pre-studies and assembling a project plan together with the supervisors. The project plan will include how the work will be divided between the two students.

Some parts of this project will be accomplished in collaboration with a group performing the nearby task of designing a handheld RFID reader that can accomplish the same task as the stationary reader used in this project.

Figure 5. Example of triple tag, with reference tag in the middle and one sensor equipped tag above and one below

If you are interested in the project, but want to know more before you choose it, please email Johan.Siden@miun.se to set up a short meeting, or try to meet Johan directly at his office, S216 B.

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References

[1] "Remote Moisture Sensing utilizing Ordinary RFID Tags", scientific article describing the concept http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4388398