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Implementation of Remote Passive RF Sensor System and Its Applications

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원격 RF 수동 센서 시스템의 실현 및 그 응용에 관한 연구

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ABSTRACT : This paper describes about the realization of a remote RF sensor system and its applications. RF Sensor System was designed and realized on DSP over the range of high frequency such as about 200[KHz]. It should be "wireless", "implantable" and "batteryless". Futhermore, the system should be consist of passive components such as R, L and C. The measurement was given using the inductive coupling principle between primary source part and secondary sensor part. This newly developed parameter estimation system can be easily applied to the Ambient Intelligent System including the ubiquitous computing and the sensitive environmental changes.

KEY WORDS : *Remote RF sensor system, inductive coupling, Ambient Intelligent System*

1. *Introduction*

This article is focused on a newly designed and implemented capacitive sensor system. Under the constraints that it should be "wireless", "implantable" and "batteryless", this system was simply consisted of passive components R, L and C by inductive coupling between the primary source part and the secondary measured capacitance part. Inductive coupling makes the power consumption reduce. This system can be easily implanted in the target object to process compiled data online. Also, the sensor unit does not require a separate power supply. UKF algorithm which could be coped with the drawbacks of the extended Kalman filter in noisy nonlinear systems was applied to estimate the capacitive parameter with nonlinearity. The input/output learning data for UKF Algorithm were acquired from the specially designed Phase Difference Detector and Amplitude Detector.

2. *Conventional Inductive Coupling Model*

Figure 1 shows a typical equivalent circuit of a remote RF sensor system designed based on the inductive coupling principle for small and low-power applications[1-5].

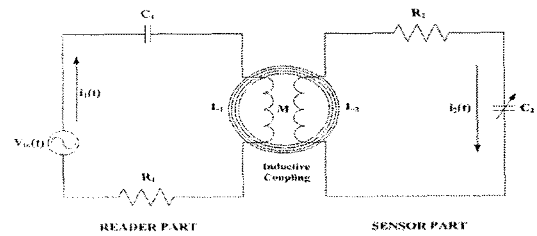
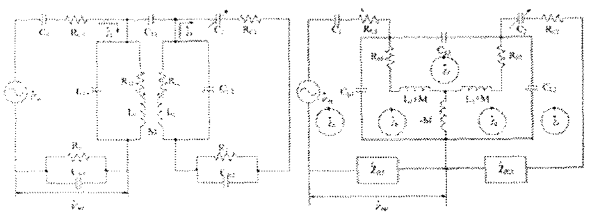


Fig. 1. Remote RF Sensor System

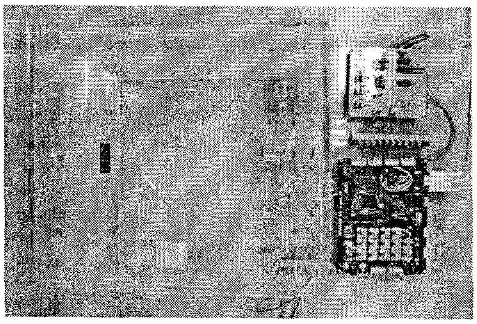
3. *New System Model with Parasitic Parameters*


(a) RF sensor system (b) Inductive coupling part
Fig. 2 Equivalent circuit of Remote RF Sensor system

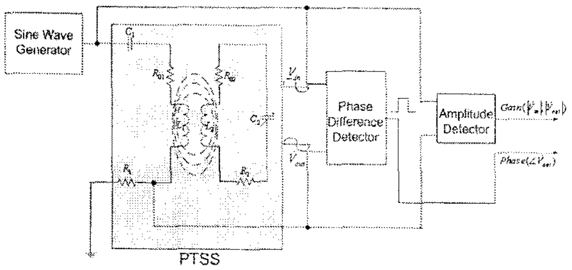
Every physical component has parasitic characteristics. Those are varying according to the types of materials and environmental circumstances. And also they can hinder to the estimation accuracy and can restrict the applicable fields.

4. *Experimental Apparatus Setup*

The remote RF sensor system proposed in this study can be implemented as in Figure 3.



(a)



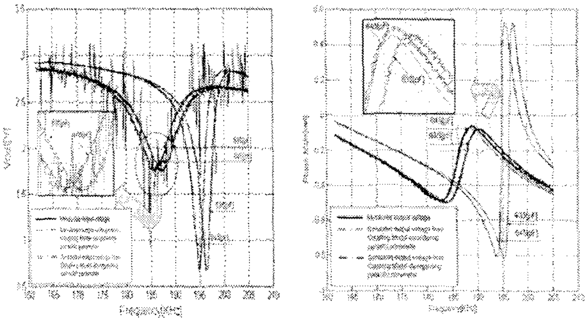
(b)

Fig. 3. (a) Implemented System (b) Block diagram

The system in Figure 3 consists of the reader part, which generates a sine wave and detects variations in the sensor's capacitive value, and the sensor part, which includes the capacitive sensor.

5. *Experimental Results*

Figure 4 compares the measured output voltage with the model incorporating the parasitic capacitance and the result of the simulation that disregards stray parameters. The results of the simulation that did not take parasitic capacitance into account display a higher resonant frequency than the secondary sensor frequency. On the other hand, the simulation result of the model that incorporated parasitic capacitance was similar to the measured output voltage. In particular, the two graphs are almost identical near the 180[KHz]~190[KHz] frequency band, which indicates the resonance of the secondary sensor part that is important for estimating parameters, allowing precise estimation. Figure 5 depicts the frequency response curve that indicates the amplitude and the phase of the output voltage.



(a) Amplitude Curves (b) Phase Curves

Fig. 4 Frequency Response of Output Voltage

6. *Conclusion*

In this paper, a remote RF sensor system was implemented on DSp board. In order to enhance the estimation accuracy of the remote RF sensor system, parasitic parameters was adopted. Its estimating performance was satisfactory and was confirmed through simulations and experiments. This approach did not require any tedious additional linearization or realignment processes. It could be directly applied to the Ambient Intelligence Sensor system.

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