RFI MITIGATION IN MICROWAVE RADIOMETERS FOR INTERNAL BODY THERMOMETRY VIA ADAPTIVE FILTERING

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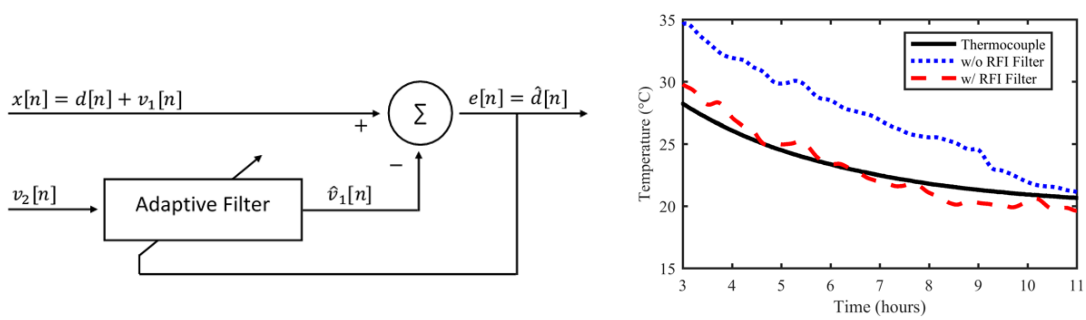
Measuring internal body temperature has important biomedical applications ranging from diagnostic evaluations to therapeutics. For a non-invasive, wearable device, a microwave radiometer can be used. The radiometer presented here operates at 1.4GHz, which falls within the quite band allocated for radio-astronomy. Due to limited filtering, as well as required integration time, the bandwidth of the radiometer can result in susceptibility to radio frequency interference (RFI) emanating from devices such as fluorescent lighting and cellular phones. The thermometer has a probe that is placed on the skin and measures the total black-body power from all tissue layers, estimating the internal temperature through a set of weighting functions. The RFI can significantly degrade the ability to accurately estimate internal body temperature from the signal received by the radiometer. Furthermore, error in the estimation increases when measurements are performed over long periods of time, as required by the monitoring application. The effect of RFI on the microwave radiometer signal can be modeled as a noise corrupted observation, $x[n]$, that is the superposition of the desired radiometer signal, $d[n]$, and RFI, $v_1[n]$. Because the relative power of the radio frequency interference is often much greater than that of the black body radiation detected by the radiometer, the observation is primarily driven by $v_1[n]$. Furthermore, $d[n]$ and $v_1[n]$ are generally unknown, and it is therefore not possible to separate these signals using linear techniques. An adaptive filter can be applied as shown in the figure below. An additional probe is used to observe the environmental RFI in order to capture a signal $v_2[n]$ that is statistically correlated to $v_1[n]$. This signal is then processed by a recursive least squares (RLS) adaptive filter that produces an estimate of the noise, which is then subtracted from $x[n]$, resulting in an estimate of the black-body power detected by the radiometer. An experiment is performed where the temperature of a water phantom is estimated with a radiometer and compared to a thermocouple measurement, in the presence of RFI.



(a) (b)

Figure 1: Left: Block diagram of adaptive noise cancellation filter used to estimate the desired radiometer signal, d[n]. Right: Adaptive filtering applied to a measured signal from a 1.4GHz microwave radiometer on phantom tissues.