Effect of Temperature on Glucose-dependent Dielectric Properties of Blood Plasma

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Within the last decade, developments in electronics and wireless technologies enabled the successful application of wearable sensors as activity tracking devices which can also interact with the humans on a limited level. Although such devices are greatly aiding to maintain a healthy life style, the effort on expanding the scope of wearable technologies is continuing with the hope to develop wearable devices that can aid elderly and chronic disease patients. Diabetes is one example of chronic diseases where a wearable device is needed. Diabetes patients need to monitor the blood glucose levels 3 to 5 times a day. Available off-the-shelf ambulatory monitoring devices require the patient to prick the skin to draw blood, which is dropped to a pre-treated strip. Then, the patient can read the capillary blood glucose levels from a designated monitor. This technique causes tissue deformation complications overtime and reported to be painful. Thus, current method decreases the will of the patient to perform several readings a day and increases the chance of an infection. Additionally, patients can only take readings when they are awake which is dangerous since sometimes the blood glucose levels spike up after sleep. Therefore, there is a need to monitor the blood glucose levels non-invasively and continuously during the day and night time.

To this end, some studies attempting to sense blood glucose alterations non-invasively via microwaves are reported in the literature. Using microwaves has a high potential for such applications since microwave techniques have been effectively employed in breast cancer imaging and stroke detection where the dielectric property discrepancy is examined for abnormalities. It is known that the dielectric properties of blood are glucose-dependent, yet the change in dielectric properties with altering blood glucose levels is very low. Several studies are reported on phantoms and blood plasma to reveal the glucose-dependence of blood dielectric properties, most of which are carried out in the room temperature. However, the average temperature of the human body is 37 degrees and the temperature is known to decrease the relative dielectric constant of biological tissues. In this study, the effect of temperature to glucose-dependent dielectric properties of blood is studied by heating the blood plasma, having different concentrations of dextrose (glucose), to 60 degrees. During the cooling cycle, temperature and the dielectric properties of the blood plasmas are measured. The dielectric properties are collected with Agilent's open ended dielectric probe from 200 MHz to 20 GHz. Also, custom made probes are used to verify the measurements between 1 GHz to 6 GHz. The findings will be given during the presentation.