This is an author produced version of Radio-frequency resonant cavity measurements for rapid, accurate assessment of body composition and human exposure to electromagnetic fields.

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Introduction
The electromagnetic radiation dosimetry study on human body is of great interest today, not only because of the safety exposure problems, but also because of its applications to communications such as the indoor radio channel modelling. It is clear that morphology determines the electromagnetic power absorption. This research focuses on the inverse problem, which is inferring morphology from absorption cross section, especially parameters such as body surface area and average fat layer thickness.

ACS and morphology
Absorption cross section (ACS): ACS equals to the ratio of power losses in an object to the power density of a plane wave incident from a specific direction \((\theta, \phi)\).

\[
\sigma^\alpha(\theta, \phi) = \frac{p^a(\theta, \phi)}{\text{Sinc}}
\]

where \(<\psi^a>\) is the averaged absorption efficiency; \(<\sigma^\alpha>\) is the ACS averaged all different angles; \(<g>\) is the averaged silhouette area of subject over all directions. The surface structure of the lossy object can make a huge difference to the absorption efficiency.

Measurement of ACS in the reverberation chamber
Reverberation Chamber (RC): The reverberation chamber is a cavity loaded with a moving stirrer which creates a stochastic field configuration inside. The object inside the reverberation chamber is illuminated by plane wave coming from all directions.

Chamber time constant \(\tau\): The charged reverberation chamber would lose stored energy experientially. The higher the loss inside the chamber is, the quicker the energy decays. The chamber time constant is the time for a reverberation chamber to lose its stored energy to \(1/e\) of the initial level when the input power is cut off.

Formula for calculating averaged ACS
\[
<\sigma > = \frac{V}{c_0} \left( \frac{1}{\tau_{\text{loaded}}} - \frac{1}{\tau_{\text{empty}}} \right)
\]

where \(V\) is the chamber volume; \(<\sigma >\) is the averaged ACS.

Results
Human study: A preliminary study on the ACS of 18 Human subjects has been conducted. The participants laid on a 60 cm high polystyrene block (2 times of the wave-length at 1 GHz). The morphology data, including the age, sex, height, weight, skin fold thickness are recorded.

Conclusions
The ACS measurement of a single participant can be achieved in 10 minutes. A Preliminary study shows a close correlation between ACS and height above 6 GHz, but below 6 GHz, the correlation between ACS and morphology parameters is weaker. More subjects will be collected for a full statistical study, and an optimizer is being designed to enable the reverse mapping of ACS to morphological parameters.

References

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