TOPIC 7 DIGITAL TRANSFORMATION, ARTIFICIAL INTELLIGENCE, AND SYSTEMS METROLOGY

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The Use Of Artificial Intelligence In Diagnostic Imaging

CONTACT INFORMATION
Esteban Temprano, Ángela
aestebant@cem.es

Esteban Temprano, Á.*; Delgado San-Martín, L.*; Ruiz González, S.*; Sáenz Nuño, M.A.**; Fernández Vicente, T.*; Martín Megías, A.I.*

*Spanish National Metrology Institute (CEM), **Institute for Research in Technology (IIT)-ICAI Comillas Pontifical University of Madrid

ARTIFICIAL INTELLIGENCE (AI): KEY ELEMENT OF DIAGNOSTIC IMAGING METROLOGY

AI emerges from current technical challenges and limitations, which require managing large amounts of **data** and combining existing **technological infrastructure** to make this data accessible in all medical centers.

Predictive models based on data collection using **AI** are a reliable support tool that helps to achieve accurate medical prognoses, shortening times and saving costs for the healthcare system. In diagnostic imaging, **AI** is used as a tool to optimize and to improve **Monte Carlo*** algorithms implemented for **dosimetric calculations** and their **uncertainties**.

The **Health Laboratory** of the **Spanish National Metrology Institute (CEM)** develops a project [2] underway based on the design and manufacture of a **phantom** that allows the **traceability** of diagnostic imaging equipment. In the future steps of the project, the aim is to implement **AI** to study the **minimum dose measurement limit** that can be achieved by means of results similar to those that would be obtained with a higher dose.

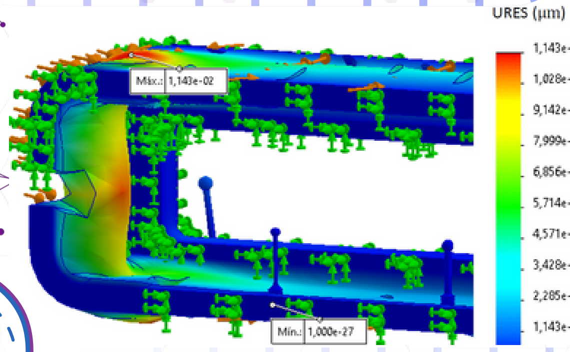
THE HEALTH LABORATORY OF THE SPANISH NATIONAL METROLOGY INSTITUTE (CEM)

Take a look at the QR to get to know the laboratory

***Monte Carlo** method is a method for the propagation of random sampling distributions from probability distributions. It identifies sources of uncertainty, assigns probability distributions to each variable to represent its uncertainty, generates multiple random scenarios based on these distributions, runs millions of repeated simulations, and analyses the distribution of results to assess the overall uncertainty **[1]**.

RESULTS

⇢ To characterise the phantom, **simulations** based on the **Monte Carlo** method are carried out to measure the distance (URES (µm)) between phantom points under different **thermal** and **mechanical conditions** in order to study **thermal expansion and deformations**.



⇢ Numerical simulations with the phantom reveal a variation of **0.1 µm** due to thermal expansion. This contributes significantly to the **uncertainty** of the phantom for CT scanners with a resolution of **1 µm**, but aports less impact on ultrasound scanners with a resolution of **0.1 mm to 2 mm.**

⇢ The analysis of **mechanical deformation** shows an acceptable disturbance of about **0.01 µm/m** for applied forces between **10 N and 20 N**, which is negligible compared to the **maximum allowed error** of **1 µm** for **CT devices** and even less relevant for **ultrasound scanners [3]**.

CONCLUSIONS FUTURE CHALLENGES

⇢ Identify response patterns to different radiation doses and optimize dosing regimens to maximize **efficacy** and to minimize **secondary effects**.
This would reduce adverse effects and **toxicity**, optimize resources and reduce healthcare system costs, as well as personalize treatments based on **individual needs**.

⇢ To implement **AI** to analyze the minimum **radiation dose limit** in order to achieve similar results to those obtained with higher dose values.
This defiance ensures that doses are kept below legal limits with the available **AI** tools.

⇢ To achieve a quality assessment of **dimensional measurement** and **dosimetric calculation** based on **AI** systems for the analysis of medical image data from medical diagnostic equipment.

⇢ To combine **AI**, **Machine Learning (ML)** and **Personalized and Precision Medicine (PPM)** in the healthcare field. This technological convergence will allow for a more **precise**, **personalized**, and **effective** approach to the diagnosis and treatment of diseases.

REFERENCES

[1] Evaluation of measurement data — Supplement 1 to the "Guide to the expression of uncertainty in measurement" — Propagation of distributions using a Monte Carlo method.JCGM 101:2008.

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[3] Esteban, Á., De Castro, I., Delgado, L., Sáenz, M.A., Fernández, T., Peña, M.L., Sáez, A., Sánchez, C. Emerging innovations in health metrology for diagnostic imaging, Measurement: Sensors, 2024, 101649, ISSN 2665-9174.

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