Use of Metrology 4.0 Technologies for Intercomparison of Activimeters in Nuclear Medicine

Monaliza Almeida[1], Gabriel Ferrari[2], Charlles Barclei[2], Paulo Assumpção[1], Carlos Henrique Sousa[3], José Peixoto[2], Wilson Melo Jr[1]

1 –INMETRO, 2- IRD, 3 – I'DOR

INTRODUCTION

Nuclear medicine uses unsealed radioactive sources for diagnosis and treatment, employing radiopharmaceuticals that accumulate in specific organs and enable the production of medical images, such as in scintigraphy. The accuracy of radiological measurements is crucial to ensure the safety of patients and professionals, and is essential for the location of activimeters, equipment responsible for measuring the activity of radionuclides. These devices work through the interaction of ionizing radiation with the gas in the ionization chamber, generating an electric current proportional to the activity of the sample. However, challenges such as the short half-life of radiopharmaceuticals and limitations in traditional intercomparison methods can compromise the reliability of accuracy, making it essential to improve deficiency and quality control procedures.

In this context, Metrology 4.0 emerges as an innovative alternative to modernize measurement processes in nuclear medicine. The use of smart sensors, computer vision and blockchain can ensure greater accuracy and traceability in the intercomparison of activimeters, reducing errors and optimizing diagnoses and treatments. The project proposes to develop methods based on these technologies to improve complexity and depth analysis, ensuring that activimeters operate within acceptable limits and provide greater safety and reliability in nuclear medicine procedures.

METHODOLOGY AND EXPERIMENT

Detection of non-conformities in instrument operation (Activimeter)

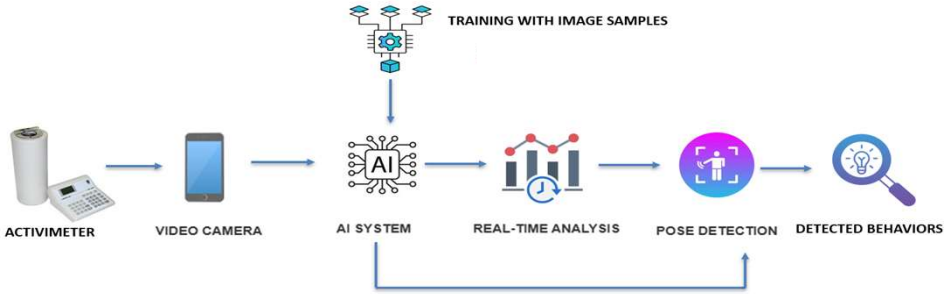


Fig. 1: Computer Vision Strategy for Intercomparison of Activometers

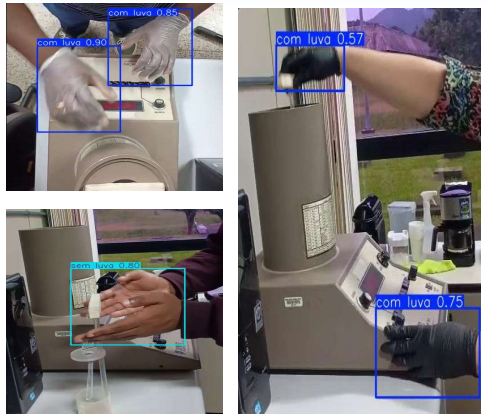
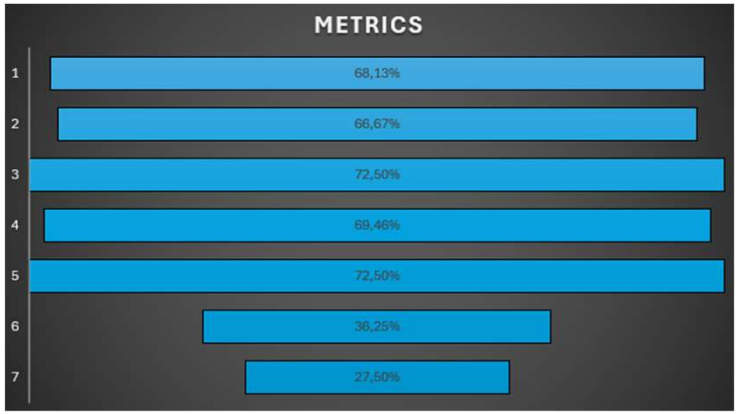


Fig. 2: Hands in different positions and conditions

RESULTS



1- ACURACY, 2- PRECISION, 3- REACALL, 4- F1, 5- DETECTION RATE, 6- TYPE 1 ERROR, 7- TYPE 2 ERROR

CONCLUSION

The results obtained to date demonstrate significant advances in the implementation of Computer Vision and Artificial Intelligence technologies for the intercomparison of activimeters in Nuclear Medicine. Participation in CBMRI 2024, with the presentation of an article, reinforces the relevance of research in the scientific scenario. In addition, the approval of two Scientific Initiation projects funded by PIBIC/CNPq represents an important step towards the development of computational models aimed at optimizing radiological measurements. The first tests of the intelligent monitoring system based on the YOLO v8 model indicate promising performance, reaching a detection rate of 72.50%. However, challenges such as reducing false positives and false negatives highlight the need for adjustments to the algorithms and expanding the database to improve the reliability of detections.

The application of Metrology 4.0 concepts in nuclear medicine proves feasible and has great potential to modernize quality control processes, minimizing human errors and improving radiological safety. The integration of advanced technologies enables the automation of operational compliance verification, laying the foundation for a continuous, real-time monitoring system. Despite the challenges still present, the solutions developed so far indicate that the proposed methodology can significantly contribute to improving the accuracy and traceability of measurements in activimeters. With the implementation of improvements, this system is expected to become an essential tool for raising quality and safety standards in nuclear medicine.

REFERENCES

ACKNOWLEDGE

This study was partially supported by the Federal Agency for Support and Evaluation of Graduate Education (CAPES) in Brazil – Finance Code 001; and by the National Council for Scientific and Technological Development (CNPq), grant 303373/2023-7.