DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 34TH CYCLE

Title of the research activity:	**An EmbeddedSystem forβ Radiological-Guided Surgery** *Research Fields*: Sensors and Electronic Systems, Real time Embedded Systems and Medical applications. *Collaboration*:*INFN* (Istituto Nazionale di Fisica Nucleare, Italy).
State of the Art:	**Embedded systems** are a combination of computer hardware and software which together form a component of an electrical device that we use in our daily life. They are limited to a particular task and serve a particular function and they are a great help in real time system because they are very quick in performing their operations. Embedded systems include not only safety-critical applications such as automotive devices and controls, railways, aircraft, aerospace and medical devices [1,2] but also communications, "mobile worlds" and "e-worlds", the "smart" home, clothes, factories etc. These applications have an enormous impact on our society, including security, privacy, and modes of working, living and health. The **radiological-guided surgery** commonly called radio-guided surgery (RGS) [3] represents a significant surgical adjunct to intraoperatively detect millimetric tumor residues by administering to the patient a radio-marked tracer that is preferentially taken up by the tumor. It is crucial for those tumors where the surgical mass removal is the only possible therapy. It has been demonstrated, in fact, that a radical resection, intended as whole enhancing mass removal, is positive both for a recurrence-free survival and the overall survival of the patients. The innovation of the RGS exploiting pure β^-emitters [4] is the higher tumor-to-non-tumor ratio (TNR) compared to the established techniques using γ or β^+ radiation [5-10]. However, a low background from healthy tissue around the lesioncan only be obtained by using a probe operating in the interior of the patient body. Low background implies both a smaller radiopharmaceutical absorbed dose to detect cancerous remnants and the possibility of extending the technique also tocases with a large uptake of surrounding healthy organs (e.g. abdominal or brain tumors). A **CMOS imager**, originally designed for visible light imaging, has already been demonstrated to be capable of ionizing radiation detection, especially regarding the charged type. In particular, the sensitivity and spatial resolution of the sensor was investigated [2,8], in the presence of a localized ionization source of variable size. Results show that it is possible to use this detector, naturally almost blind to photons, due to the reduced thickness of the sensitive volume (few micrometers), while it is close to 100% detection efficiency for electrons.
Short description and objectives of the research activity:	The purpose of the present research is to develop an innovative embeddedsystemin Radiological-Guided Surgery. The proposed development relies on these key elements: - participation toa scientific collaboration devoted to the**design and test of a real time system** to process the data and giving to the surgeon an indication of the presence of tumor residuals with dimensions of the orders of few millimeters; - building a system by using a **smart hardware and software platform** available in the market and enabling Real Time Software Execution; - capability to store the acquired information for **post-**

	processingelaboration; - getting acquainted with electronics operating in **harsh environment**.
Bibliography:	[1]Costantini, G., … Scorzoni, A., Placidi, P. et al, "Integrated Sensor System for DNA Amplification and Separation Based on Thin Film Technology," IEEE Transactions on Components, Packaging and Manufacturing Technology, 1-8, 2018. [2]Magalotti,D.,Placidi, P., Dionigi, M., Scorzoni, A.,Servoli, L., "Experimental characterization of a personal wireless sensor network for the medical X-ray dosimetry," IEEE Transactions on Instrumentation and Measurement 65 (9), 2002-2011. [3] Mariani, G., Giuliano, A. E., Strauss, H. W. (eds), "Radioguided Surgery: A Comprehensive Team Approach. Springer", New York, (2006). [4] Patent PCT/IT2014/000025 entitled Intraoperative detection of tumor residues using beta- radiation and corresponding beta- probes has been deposited by Universitàdeglistudi di Roma La Sapienza, Istituto Nazionale di FisicaNucleare and Museo storicodellafisica e centrostudi e ricerche E. Fermi. [5] Tsuchimochi, M., Hayamaand, K.,"Intraoperative gamma cameras for radioguided surgery: Technical characteristics, performance parameters, and clinical application", Phys. Med. 29, 12638 (2013). [6] Hickernell, T. S. et al.,"Dual detector Probe for surgical Tumor Staging", J. Nucl. Med. 29, 1101 (1988). [7] Daghighian, F. et al.,"Intraoperative beta probe: A device for detecting tissue labeled with positron or electron emitting isotopes during surgery", Med. Phys. 21, 153 (1994). [8] Raylman, R. R., Wahl, R. L., "A fiber-optically coupled positronsensitive surgical probe", J. Nucl. Med. 35, 909 (1994). [9] Bonzom, S.,"An Intraoperative Beta Probe Dedicated to Glioma Surgery: Design and Feasibility Study", IEEE Trans. Nucl. Sci. 54, 1 (2007). [10] AlunniSolestiziL. et al., "Use of a CMOS image sensor for beta-emitting radionuclide measurements",Journal of Instrumentation, vol.13, n.o.07, 2018.
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