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A miniaturized gamma camera allowing real time radiation visualization

Our goal is to develop break-through technologies and ingrate them in a wearable system that will effectively assist operators during planned and emergency maintenance in radioactive environments (nuclear installations, nuclear power plants, research laboratories, emergency responses, CBRNe accidents,⋯). Those operations require a stringent monitoring program in order to: 1) Secure the protection of the environment and the workers, and 2) allow the optimization of the operational scenarios that are most relevant to the technical.

The aim is to technically advance and combine several technologies and integrate them as integral part of a personnel safety system to improve safety, maintain availability, reduce errors and decrease the time needed for scheduled or sudden interventions. The research challenges lie in the development of real-time (time-lags less than human interaction speed) data-transmission, high resolution 3D gamma imaging, instantaneous analysis of data coming from different inputs (vision, sound, touch, buttons), interaction with multiple on-site users, complex interfaces, portability and wearability, wear/tear. The breakthrough innovation will be a next generation gamma imager with improved characteristics in terms of portability, sensitivity and angular resolution. The camera is able to produce automatically panoramic and 3D gamma images superimposed on panoramic visible images using only one single pixellated detector. The gamma camera is based on a portable high resolution-resolution gamma-ray detector based on state-of-the-art Cadmium Zinc Telluride (CZT) sensors.

The advances for the gamma camera sensor will address: 1) Higher detection efficiency, which results in lower integration times and sensitivity to very low activity sources, 2) Radiation source localization with high spatial resolution and imaging over a wide field of view, 3) Ability to reconstruct 3D images, based on the intrinsic stereo detection capability, 4) Spectroscopy capability with good energy resolution, 5) Implementation of a calibration procedure between gamma sensor and depth sensor. The main goal from an application standpoint is to estimate the distance of a radioactive source (if present) automatically and with no knowledge of the environment a priori, 6) Registration between gamma sensor and optical sensor. This allows to have a gamma image automatically superimposed on the optical image, without any parallax adjustment needed. Even for complex surfaces that are not orthogonal to the camera head, the superimposition will automatically performed with an average of one pixel accuracy. 7) Design and implementation of an algorithm for gamma 3d reconstruction, 8) develop point cloud gamma information with 3d point cloud data model regarding radioactive surfaces/objects, 9) develop a volumetric integration dynamically merged with the textured 3D mesh and the information of the radioactive source.
The gamma images and 3D dose rates will be displayed on Head Mounted Display utilizing the latest AR and VR technologies. These developed technologies, integrated in a wearable and low power system, will enable the operator to virtually visualize the dose rates in 3D and in real time with a very high accuracy. We propose to develop radically new CZT pixelated gamma camera and techniques on the field of computer vision to analyze in real time Gamma 3D models and depth sensors.

Summary

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