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X-ray cone-beam computed tomography: principles, applications, challenges and solutions

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In the nineties, x-ray computed tomography, commonly referred to as CT, seemed to be on the track to become old technology, bound to be replaced by more sophisticated techniques such as magnetic resonance imaging, due in particular to the harmful effects of x-ray radiation exposure. Yet, the new century brought with it new technology that allowed a complete change in trends and re-affirmed CT as an essential tool in radiology. For instance, the popularity of CT in 2007 was such that approximately 68.7 million CT examinations were performed in the United States, which was nearly 2.5 times the number of magnetic resonance (MRI) examinations. More than that, CT has expanded beyond its conventional diagnostic role; CT is now used routinely in interventional radiology and also in radiation therapy treatment. The technology advances that allowed the revival of CT are those that made fast, accurate cone-beam data acquisition possible. Nowadays, cone-beam data acquisition allows scanning large volumes with isotropic sub-millimeter spatial resolution in a very fast time, which can be as short as 500ms for cardiac imaging. The principles of cone-beam imaging will be first reviewed. Then a discussion of its applications will be given. Old and new challenges will be presented along the way with current solutions.