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Adaptive Collision Avoidance System for Contemporary Therapy Suites

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A contemporary therapy suite is a collaborative working space, where image-guided surgery and intervention procedures are carried out. It refers to operating rooms, intervention rooms, and hybrid operating rooms together. The suite is densely populated with people and devices during the treatment of a patient. It is dynamic by its nature; people and devices are required to move for accomplishing their tasks.
Movement of a device or object in the dynamic and populated environment introduces safety threats. The devices are stand-alone and unaware of their vicinity; therefore, they can collide with surrounding people and devices. Such collisions can cause not only injury to people or economic damage but also can interrupt the treatment.
The purpose of this work is to introduce an adaptive and comprehensive collision avoidance system for the contemporary therapy suite, which ensures safety of people and devices without restricting the agile essence of the procedures.
A comprehensive and generic collision avoidance system for therapy suites has not been found in the literature. This work investigates components, observes their mutual interactions during procedures, analyzes the dynamics of the suite, and derives requirements for the collision avoidance system. No evaluation methodology has been reported in the literature which could assess the performance of the system, therefore describing performance evaluation criteria is part of this work. It implements a solution, based on the real-time swept volume and distance computation for self-collision detection method by Täubig, Bäuml, and Frese. The work extends this solution in order to represent the components of the therapy suite, take clinical requirements into account, distinguish between the cooperative and destructive interactions between components, identify safety threats, and act to prevent collisions between components.
The implemented solution is evaluated in an experimental intervention room. The experiments show that the solution adapts to instantaneous velocity, use-case, and update-rate of the components. It distinguishes the desired and undesired proximities of components, avoids all undesired interactions between components, and achieves human comfort.
The collision avoidance system ensures safety and human comfort while improving agility in the contemporary suite. The implemented solution is generic so that it can be extended to further and future components and interactions.