Integration of 3D imaging systems in the medical field

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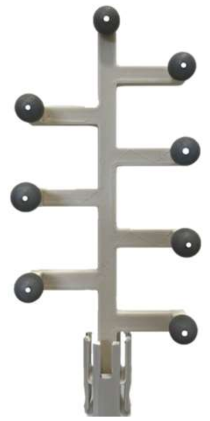
Introduction

The best known imaging systems, such as video cameras, are two-dimensional (2D) systems. In these systems, information from the real world is "squeezed" onto an array of sensors, creating the final image, but losing information about depth. Three-dimensional (3D) optical systems attempt to bridge this gap by reconstructing depth information as a *pointcloud*. In the future, robots will be increasingly used in surgery to assist and control the positioning of surgical instruments. Such systems need to be protected from possible collisions with surrounding environment. Our idea is to use such 3D systems in the surgical field to create a *collision avoidance system* that can guide the robotic arm during its positioning movements. This poster presents data from an Intel D435 3D camera: a system that can both generate a field of view (FOV) pointcloud and capture RGB images.

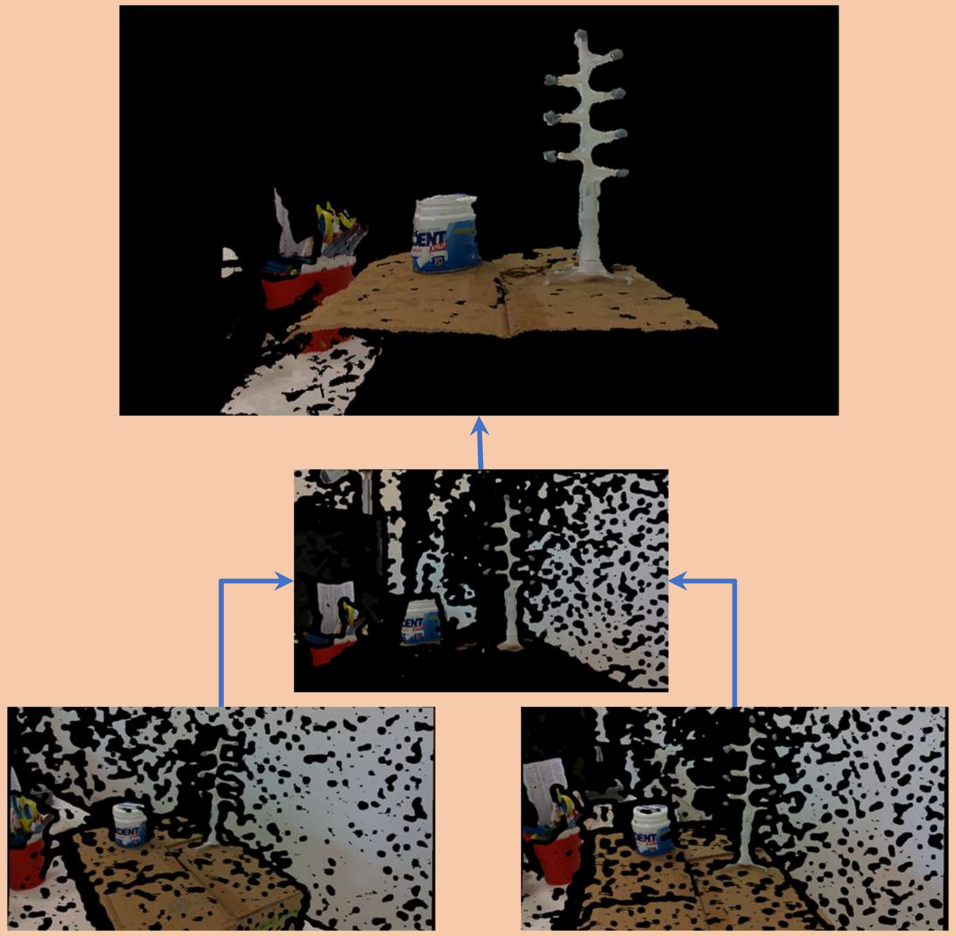
Methods

Multi-acquisition system

3D cameras, like all optical systems, are limited in recording information about visible objects in their FOV: an object that is obscured by another would therefore not be detected. This limitation can be overcome by using pointcloud registration. To evaluate the rototranslation matrix to be applied to the point cloud, we used the circle Hough transform: searching for markers with spherical shape in the RGB frames. Knowing the position of the pixels where the centres of the markers are located and the actual distance between them, it is possible to calculate the rototranslation matrix that brings the pointcloud of the second camera into the reference system of the first camera and enriches it with information. In this way, the second camera can be placed at different perspectives and distances and each of the generated pointclouds can be used to enrich the one generated by the first camera.



We are developing a system to avoid collisions during robotic surgery within **Multimodal Biomedical Imaging Platform All-in-one.**



Segmentation

After the pointcloud registration phase, we developed an algorithm for segmenting the associated objects. The algorithm is based on an iterative search for sufficiently close points within the pointcloud: by comparing the associated z-coordinate (depth), it is possible to determine whether they are close or not. Once this search is complete, points that are sufficiently close are assigned with the same identification number (label), uniquely identifying this group of points as a single object.

Oriented Bounding Box (OBB)

Since the goal is to avoid collisions with objects in the scene, after segmenting the object, we created an OBB around it to define an area in the real world that serves as information for the robot, defining a part of the space where it cannot enter.

Results

In this poster, we present a method for registering and then segmenting pointclouds generated by an Intel D435 3D camera. This method is based on the use of spherical markers with known geometry, which are detected in the RGB images by using the circle Hough transform. As future developments, we are working on adding a markerless registration algorithm and also being able to use these 3D imaging systems for texturing the reconstructed 3D volume acquired with a Cone Beam Computed Tomography (CBCT) system.

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