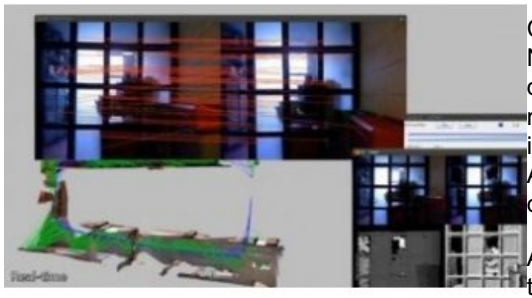
Accurate 3D Maps of Indoor and Outdoor Environments in Real Time



Computer scientists at MIT (Massachusetts Institute of Technology), USA, and the National University of Ireland (NUI) have developed a mapping algorithm that creates dense, highly detailed 3D maps of indoor and outdoor environments in real time. The researchers tested their algorithm on videos taken with a low-cost Kinect camera, including one that explores the serpentine halls and stairways of MITâ€™s Stata Center. Applying their mapping technique to these videos, the researchers created rich, three-dimensional maps as the camera explored its surroundings.

As the camera circled back to its starting point, the researchers found that, after returning to a location recognised as familiar, the algorithm was able to quickly stitch images together to effectively 'close the loop', creating a continuous, realistic 3D map in real time.

The technique solves a major problem in the robotic mapping community that is known as either “loop closure” or “drift”: as a camera pans across a room or travels down a corridor, it invariably introduces slight errors in the estimated path taken. A doorway may shift a bit to the right, or a wall may appear slightly taller than it is. Over relatively long distances, these errors can compound, resulting in a disjointed map with walls and stairways that do not exactly line up.

In contrast, the new mapping technique determines how to connect a map by tracking a camera’s pose, or position in space, throughout its route. When a camera returns to a place where it has already been, the algorithm determines which points within the 3D map to adjust, based on the camera’s previous poses.

Before the map has been corrected, it is sort of 'tangled up' in itself, explained Thomas Whelan, a PhD student at NUI. They use knowledge of where the camera has been to untangle it. The technique developed allows the map to be shifted, so it warps and bends into place. The technique may be used to guide robots through potentially hazardous or unknown environments. Whelan’s colleague John Leonard, a professor of mechanical engineering at MIT, also envisions a more benign application.

He has a dream of making a complete model of all of MIT, stated Leonard, who is also affiliated with MIT’s Computer Science and Artificial Intelligence Laboratory. With this 3D map, a potential applicant for the freshman class could virtually ‘swim’ through MIT as if it were a big aquarium. There is still more work to do, but Leonard thinks it is doable.

Leonard, Whelan and the other members of the team — Michael Kaess of MIT and John McDonald of NUI — will present their work at the 2013 International Conference on Intelligent Robots and Systems in Tokyo.

Read more on this new technique at the MIT news website.

The image shows the visualisation of the mapping process, producing dense maps at sub-centimetre resolution.