Smooth surface image stitching with use of laser illumination

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Panoramic images constructing algorithms are being used for creating photo-mosaics, environment maps, producing satellite photos and in many other applications. These algorithms utilize either pixel intensity information by counting every pixel contribution, or distinctive features extracted from the image in order to establish correspondence between images to be stitched. There is a whole framework developed to date, and the problem of image stitching has been addressed from different points of view.

However, existing methods for image alignment experience difficulties when applied to smooth surfaces (such as steel, paper, rubber, stone, cardboard etc), where is no features can be extracted, or image intensity varies insignificantly across overlap area.

The current project presents an interesting mixture of computer science and physics, it is intersection of computer vision in part of creating panoramas and optics in part of utilizing techniques from laser speckle interferometry. Speckle phenomenon has been efficiently used to analyze optically rough surfaces, now it is employed to address the problem of finding overlaps and point correspondence in smooth surfaces.

Stitching images with use of laser speckle requires experimental apparatus, where laser illumination system, camera and pan-tilt unit are put together onto optical bench. Dedicated stitching application is developed to account particular properties of smooth surface images to form a panorama.

Experiments demonstrated that laser speckle contains necessary information for creating composite image. Speckle pattern is persistent to surface movement, i.e. it is determined by surface's roughness and moves together with surface. Template matching technique and normalized cross-correlation formula were used to calculate matching points responsible for correspondence between images.