Camera based 3D-tracking of optical Markers

Students

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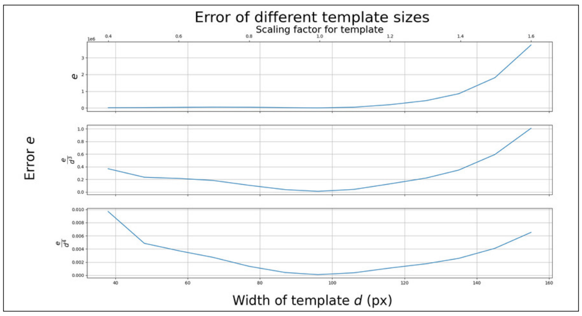
Introduction: During the development of a hydraulic drive for an excavator, it must be ensured that the velocity of the drive stays in the desired range. To be able to review the velocity of the hydraulic drives, visual markers, in our case balls, were used. The benefit of using balls as markers is that from different perspectives they look identical and so it is easier to track them. The visual markers then were tracked by multiple cameras and with the pixel coordinates of the balls the positions in world coordinates were computed by triangulation. An important requirement in this project was that the solution should be deployable anywhere, regardless of the location.

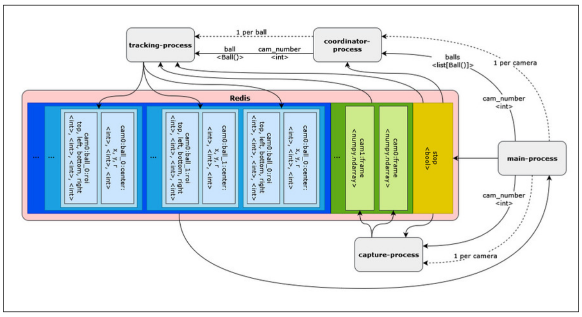
Approach: The developed solution uses template matching to track the balls and the direct linear transformation to triangulate the position. The SSQD-method (sum of squared differences) is used to match templates. The size of a marker on the image decreases with its distance to the camera. To identify the proper size, we minimize a specifically weighted sum of squared differences. To ignore the marker's background, a template consists of two parts, a template image and a template mask. To reduce the computational load, only those regions of the image are tracked, that show a ball. To get as close to real-time tracking as possible, the application is highly parallelized.
To compute positions in real world coordinates the cameras first have to be calibrated independently and afterwards a stereo-calibration takes place, which provides the rotation and translation between the cameras. Subsequently, the direct linear transform uses a singular value decomposition which determines the minimum value for the real world position.

Result: As this thesis shows, it is possible to calculate the velocity of two objects between each other using two cameras. Furthermore, a graphical user interface was implemented, so that the individual steps of the procedure can be clearly followed. The end result shows the two tracking camera streams and a 3D plot of the triangulated points of the objects.

Weighted SSQD for templates with various sizes and weighting.
Own presentment



Parallelized processes and their communication via redis.
Own presentment



Triangulated points from a stereo pair.
Own presentment

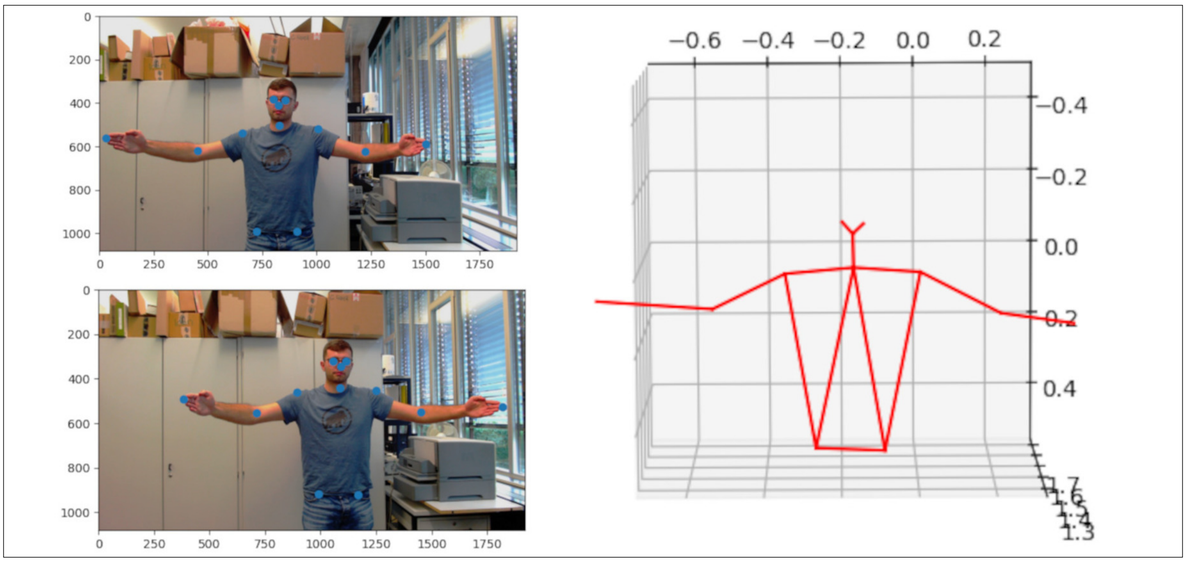


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Image Processing and Computer Vision

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