УДК 681.5.015

COMPUTER VISION SYSTEM TO TRACK A MOVING OBJECT

Шаккуф А. (университет ИТМО), **Попов А. С.** (университет ИТМО)
Научный руководитель – к.т.н. Громов В. С.
(университет ИТМО)

Annotation: Camera calibration process is used to connect the 3D world with 2D image by a mathematical model. This is enough to estimate the position of some object after detecting it in the image. There are many options for that, either to use one camera, two cameras, or one camera with depth sensor. Once we took enough information about object position in 3D world in different moments, DREM[1] algorithm is used to find the object moving function. The delay in processing is not a problem for DREM.

Introduction. The traditional methods for tracking moving objects usually assume that moving objects have linear motion patterns. This severely limits their applicability, since in practice movement is usually free and uncertain. In this research we assume that motion pattern is a combination of some periodic signals with different frequencies. And our task is to find those frequencies using vision and DREM algorithms.

Main part. Our object is a ball moves on an LCD screen according to some periodic pattern with unknow frequencies. The camera is fixed on the last link of KUKA youBot arm robot. The arm is placed at some unknown distance from the screen. The orientation of the screen is also unknown. In order to achieve the tracking process, we have to solve four sub tasks:

1. **Forward and inverse kinematic**. The forward kinematic task is performed using Denavit–Hartenberg representation. The inverse kinematic is needed to find the object coordinates in the robot coordinate system.
2. **Camera Calibration**. The "camera calibrator" terminal from MATLAB is used to perform the calibration. The chessboard pattern is shown on the screen and it doesn't change its position. The arm robot is moves and with it the camera moves and takes enough number of images for the calibration process. The outputs of this subtask are the camera matrix P, rotation matrices and translation vectors.
3. **Mathematical model**. There are four different coordinate systems in our system; Robot-base, End-Effector, Camera and screen coordinate systems. We should find out a relation between those systems (three homogeneous transformations). Calibration gives us the third one. Forward kinematic gives us the first. The second one is selected approximately, then a series of measurements improves that approximation and gives more accurate transformation.
4. **DREM algorithm**. The camera provides object position on the screen. An observation of the object for about 6-9 seconds is enough to estimate the frequencies. In other words, DREM takes object position as an input and it gives us the frequencies as an output. It is important to keep in mind that DREM doesn't require persistency of excitation of the regressor.

Conclusion. This research provides a new modern study for tracking objects that moves with arbitrary but periodic pattern. However, the experimental results could be improved by adding some optimization to camera calibration process.

Шаккуф А. (автор) Подпись

Громов В. С. (научный руководитель) Подпись

[1] DREM (Dynamic Regressor Extension and Mixing): an approach, which allows to increase performance of multiple frequency estimation and is capable to operate under presence of computational or transmission delays.