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VISUAL SERVOING OF AN EARTH OBSERVATION SATELLITE OF THE LION CONSTELLATION

Abstract

Satellites for observation missions, or imagery satellites, have increased drastically in number and performances since the beginning of the space age. Recent Earth observation satellites are now equipped with new instrument that allows image feedback in real-time. Problematic such as ground target tracking, moving or not, can now be addressed by controlling precisely the satellite attitude. The satellite "camera" can be used as an input sensor for real-time attitude control process. This can be addressed thanks to a closed loop control scheme that includes the images acquisition and the image processing. Real-time attitude control using such sensors will then allow the tracking of motionless and moving ground targets.

In this paper, we propose to consider this problem using a visual servoing (VS) approach. This work is thus focused on establishing a visual control law that allows to precisely control a LION satellite attitude using images provided by its starer sensor. The goal is to perform acquisition missions devoted to focus on an object of interest. The sensor is fixed wrt. the satellite and we have full control over its three rotational degrees of freedom subject to dynamic constraints, while the satellite is evolving on an orbit that only influences its position (that is not controlled by our VS scheme).

We suppose that the target is visible in the image before starting the VS. Compensating for the target motion in the image by explicitly embedding it in the control scheme becomes essential when it is significant. In our case, the satellite orbit is known, so we can determine accurately its translational motion, and compensate for it in the control law. When it comes to target motion, we propose to decompose it with known displacement caused by Earth's dynamics and residual motion due to its own motion.

The contribution of this paper is a visual servoing scheme able to control the attitude of an agile Earth observation satellite for target tracking. Three visual features are selected for controlling the 3 attitude parameters, for achieving a positioning task, and an orientation task. The control law allows for dealing with the satellite's high translational velocity induced by its orbit and other external motions including Earth's rotation and target own motion. A velocity saturation algorithm dealing with dynamic constraints that does not alter the nature of the target trajectory in the image is also proposed.

Simulations and experiments on an actual robot will be presented.