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Abstract—**Motion tracking and object recognition often use cameras that are mounted in motion platforms like pan-tilt units, linear tables and even robots. Tracking can be automated by visually servoing the platform's degrees-of-freedom (DOF) thus keeping the camera's point-of-view directed at the target. Tracking quick moving targets often demands faster bandwidth platforms. However biology suggests a redundant approach where DOF, like the eye and head, cooperate to direct vision systems and overcome joint limits. This paper illustrates the effectiveness of this concept using a robot-mounted camera.**

Keywords: visual-servoing, tracking, biomimetic, redundancy, degrees-of-freedom

1 Introduction

Visual coverage of large areas often demands mounting cameras on motion platforms like booms, gantries, planetary rovers, industrial robots, aircraft and submersibles. Previous work in visually servoing a 5-DOF hybrid gantry robot demonstrated that a coupled coordination of redundant DOF, called *partitioning*, can track faster moving subjects [4].

Section 2 describes our tracking interests with a camera-carrying gantry along with brief highlights of previous gain-tuning results. Section 2.1 defines the tracking task and DOF coordination using a cost function to optimally tune gains and develops the necessary controller.

2 System Description

Our particular tracking interests are in visually monitoring tools, workpieces or people moving in a large ($3.6 \times 6.4 \times 1.0\ m^3$) manufacturing workcell, Figure **??**. We thus built a ceiling-mounted Cartesian gantry and attached a 2-DOF pan-tilt unit (PTU) to its end-effector. The gantry's large inertias limit camera translational velocities but allow the camera to be positioned anywhere in the workcell. By comparison, the PTU only servos a light-weight camera and thus camera orientations are quick but its joint limits constrain what fields-of-view can be obtained. The net effect is a hybrid robot characterized by DOF dynamics, kinematics and redundancy. The PTU can point the camera at the subject and the gantry can maneuver the camera to maintain a desired camera-to-subject depth or achieve line-of-sight if subject occlusion occurs.

Here, 2 copies of the same figure are included and lie side-by-side. Latex only accepts EPS or PS graphics formats. The width can be changed from 3 inches if you wish. For caption, change the text between the french braces. Lastly, give the figure a label so you can reference it later You don't have to worry about where the figure is placed. Latex does the placement for you by considering where in the text the figure is referenced.

2.1 Cost Function

Notice that whatever number the parent section is, the child subsection will be automatically numbered.

Equation numbers are automatically generated. Label allows easy referencing throughout the paper

$$\mathbf{X}[k+1] = A\mathbf{X}[k] + B\mathbf{u}[k] \tag{1}$$

You can also add an unnumbered equation as follows

$$\theta_c[k+1] = \theta_c[k] + Tu_p[k]$$

3 Conclusions and Future Work

For the reference sections, equations figures and bibliographical references consider the following. Section1 described the general problems motivating the research.

References

[1] Carpenter, R.H.S., *Movements of the Eyes*, 2nd Edition, Pion Publishing, 1988.

[2] Franklin, G.F., Powel, J.D., Workman, M.L., *Digital Control of Dynamic Systems*, Second Edition, Addison-Wesley, 1990.

[3] Oh, P.Y., Allen, P.K., "Design a Partitioned Visual Feedback Controller," *IEEE Int Conf Robotics & Automation*, Leuven, Belgium, pp. 1360-1365 5/98

*Text in here gets placed in a footnote section. Typically you thank sponsors here, and add the date of the manuscript submission and your address e.g. Drexel University Mechanical Engineering, Robotics & Machine Vision Lab, Philadelphia PA USA 19104 Tel/Fax: 215-895-6396/1478 Email: paul@coe.drexel.edu

[4] Oh, P.Y., Allen, P.K., "Visual Servoing by Partitioning Degrees of Freedom," *IEEE Trans on Robotics & Automation*, V17, N1, pp. 1-17, 2/01