In the field of control systems, testbeds are a pivotal step in the validation and improvement of new algorithms for different applications. They provide a safe, controlled environment typically having a significantly lower cost of failure than the final application. Vision systems provide nonintrusive methods of measurement that can be easily implemented for various setups and applications. This work presents methods for modeling, removing distortion, calibrating, and rectifying single and two camera systems, as well as, two very different applications of vision-based control system testbeds: deflection control of shape memory polymers and trajectory planning for mobile robots.

First, a testbed for the modeling and control of shape memory polymers (SMP) is designed. Red-green-blue (RGB) thresholding is used to assist in the webcam-based, 3D reconstruction of points of interest. A PID based controller is designed and shown to work with SMP samples, while state space models were identified from step input responses. Models were used to develop a linear quadratic regulator that is shown to work in simulation. Also, a simple to use graphical interface is designed for fast and simple testing of a series of samples.

Second, a robot testbed is designed to test new trajectory planning algorithms. A template-based predictive search algorithm is investigated to process the images obtained through a low-cost webcam vision system, which is used to monitor the testbed environment. Also, a user-friendly graphical interface is developed such that the functionalities of the webcam, robots, and optimizations are automated. The testbeds are used to demonstrate a wavefront-enhanced, B-spline augmented virtual motion camouflage algorithm for single or multiple robots to navigate through an obstacle dense and changing environment, while considering inter-vehicle conflicts, obstacle avoidance, nonlinear dynamics, and different constraints. In addition, it is expected that this testbed can be used to test different vehicle motion planning and control algorithms.

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The public is welcome to attend.