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Introduction

One of the most critical element of any laser system is the alignment of the laser beam throughout the whole beam path until the desired target. Once the alignment has been achieved, the system is naturally subject to a number of perturbations which can cause deviations from desired path (for example temperature oscillations). To re-establish the correct operation of the laser system a re-alignment is necessary. This could be manually operated, but the process is time consuming and not efficient. The alternative is to automatically operate the alignment via motorized mirror mounts, typically located at key points of the beam path.

To this end we have developed an algorithm program, written in Matlab code, which perform a closed loop process via RS232 protocol. It combines three subsystems: the source is a He-Ne laser [1], the actuator is a motorized ultrasonic mirror mount [2] and the sensor is a Color Camera [3]. The signal of the position of the beam is detected on a XY Cartesian plane; this information processed by the algorithm which will activate the compensation motion of the actuators. The accuracy could reach sub millimeters level.

Before doing any experiments, it's critical to thoroughly understand laser safety procedures and have the necessary safety eyewear. The red tracking and motion control of mirror mount are important topics in robotics and automation that are currently being explored [4].

The algorithm controlling mirror mount was written in Matlab script. The own Gui-interface and program are developed for OptoSigma's Motorized mirror mounts, this program permit to connect to a device through RS232 serial and sending a string commands. A camera attached to a PC takes continuous snapshots of particular object (a red object in this case), detects the presence and position of red object using color detection, and tracks the movement of the object in subsequent snapshots[2]. The red object is quantified and used to determine the position of laser's point in target.

Controlling mirror mount

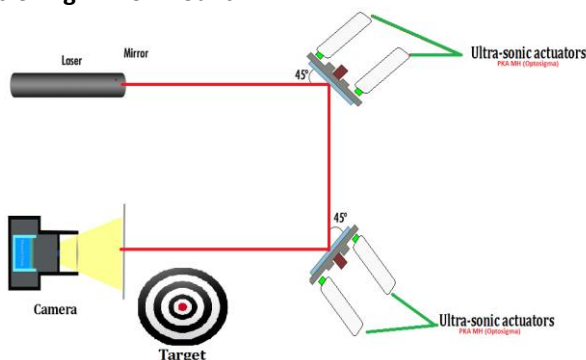


Figure 1. Setup of auto-alignment system

To align a laser beam, a several configurations for laser alignment system has been done until now such Parallel (Z-FOLD) and Perpendicular Configuration[5], we used (Z-FOLD) configuration with two mirrors oriented 45 degree which reflects the laser beam to the target as shown in figure.1

The distance between 1st and 2nd mirror is fixed at 20cm, thus implies the 1st mirror has a moving ability of $\pm 3^\circ$ degree to not exit the loop

The mirror mount is equipped with two ultrasonic motors, the upper actuator move the mirror mount in Y direction and lower actuator move the mirror mount in X direction. We have set the position reference in x-600 and 300-y, To control a mirror mount, the algorithm take in account the reference position and move the mirror to the desired target when the point laser ride out from the interval set position.

Red Laser-tracking system

The algorithm of Matlab is presented in figure.2. The Images were acquired using the getsnapshot () command. A detection object and acquisition is repeated to get a the position of red laser in X, Y plane and in real time with resolution 1280x720 pixel of camera.

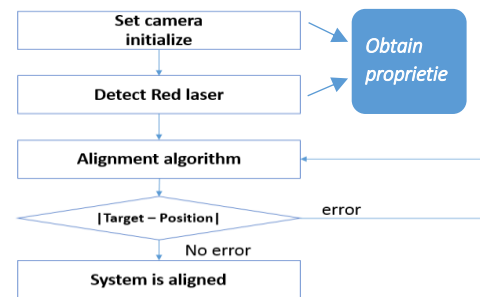


Figure 2. Scheme of the algorithm for the laser detection, tracking and control of the motion of the mirror mount.

Conclusion and perspective

The Matlab algorithm was able to successfully detect the red laser object and track its movement in subsequently acquired video and move the orienting mirror to reach the setting desired target compensate the error in order of 2mm with max-speed of an ultrasonic actuators. The future works will concern the control with two mirror mounts with resolving beam error degree via Matlab.

References

- [1]: https://www.global-optosigma.com/en/page_pdf/OSK.pdf
- [2]: https://www.global-optosigma.com/en/page_pdf/PKA-MH.pdf
- [3]: Detection and Tracking of RED color in Video Streaming Matlab, Engr. Shakeel Acadamia-2015.
- [4]: Red Color Recognition based Arduino control (Using MATLAB and Arduino).
- [5]: Simplifying Laser Alignment Edmund optics worldwide Art No-03