A 3D Laser Projection System Based on Laser Vision Hybrid Localization and Galvanometer Scanning

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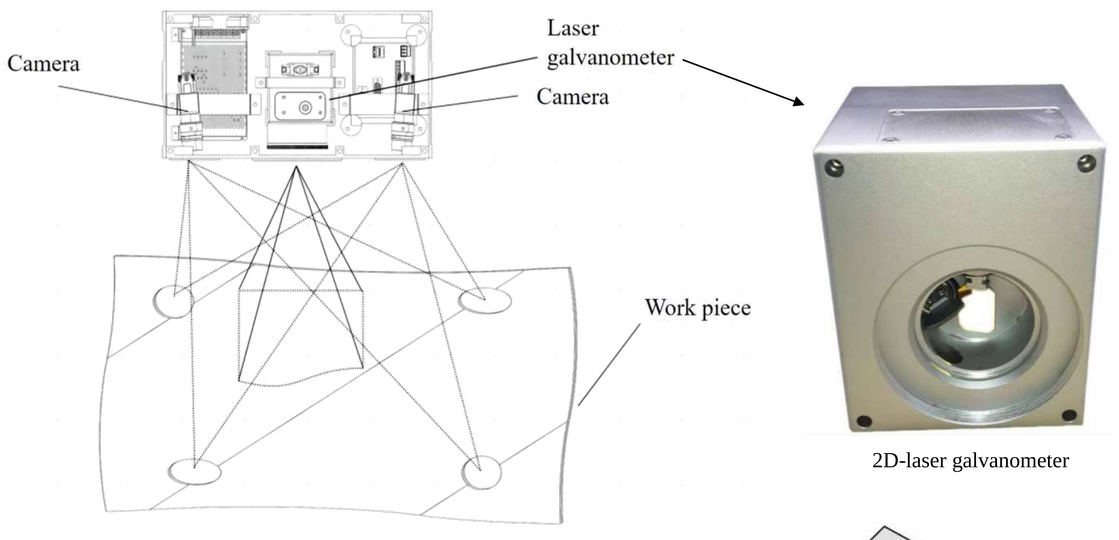
Introduction

In the manufacturing process of large workpieces, it is often necessary to use a 3D laser projection system as an auxiliary positioning device to project the required 3D Laser pattern into the workpiece. The 3D laser projection system mainly includes a positioning measurement module and a laser galvanometer scanning mechanism. The positioning measurement module is used for the positioning of the workpiece to obtain the positional relationship between the workpiece and the projection system. The 3D laser pattern is projected by scanning the laser galvanometer.

The work focus on Improve system design, achieve intelligent workpiece recognition and positioning, and be able to flexibly project based on working distance, complete system optimization calibration, and conduct experimental verification.

Principle and System design

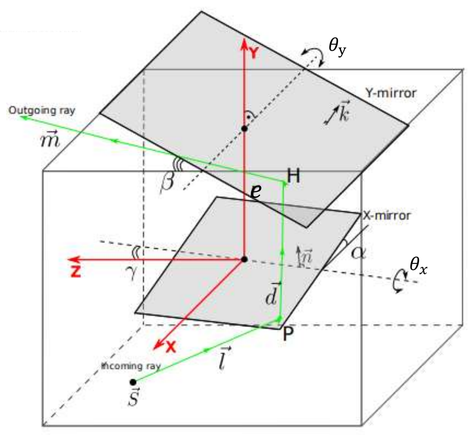
The positioning module adopts two hybrid positioning technologies, laser ranging scanning and visual recognition measurement, which can achieve recognition and positioning of workpieces with or without cooperative targets. Utilize visual measurement technology to calibrate the pose relationship between the positioning module and the laser scanning mechanism.



2D-laser galvanometer

The laser emitted from the transmitter can theoretically be projected to any position (x, y, z) in the front space after two deflections. The relationship between the deflection of the galvanometer and the outgoing coordinates can be described by a mathematical model:

$$\begin{cases} z_g = dp = -ct_c \times \cos 2\theta_x \times \cos 2\theta_y \\ y_g = dp \times \tan 2\theta_y \\ x_g = e \times \tan 2\theta_x + dp \times \tan 2\theta_x / \tan 2\theta_y \end{cases}$$



To achieve intelligent workpiece recognition and positioning, A hybrid method of laser ranging and binocular vision recognition and localization has been adopted. among which the laser scanning ranging method is used for workpiece recognition and positioning of non cooperative targets.

Automatic focusing and collimating optical systems are used to reduce the width of outgoing light and adapt to different working distances.

Positioning and projection system workflow.

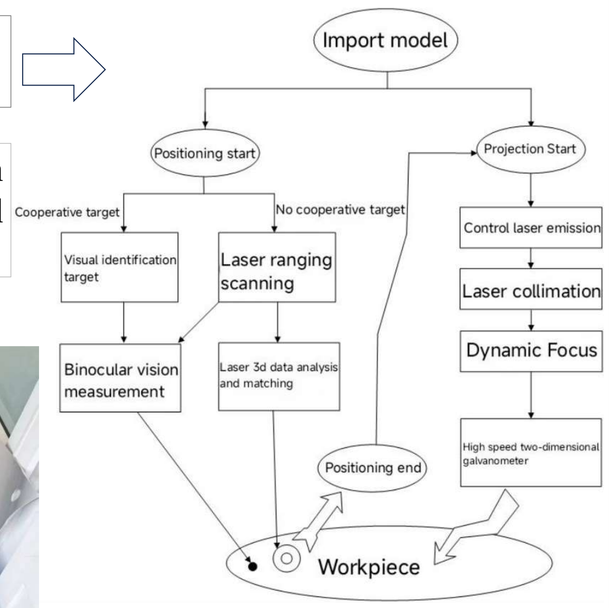
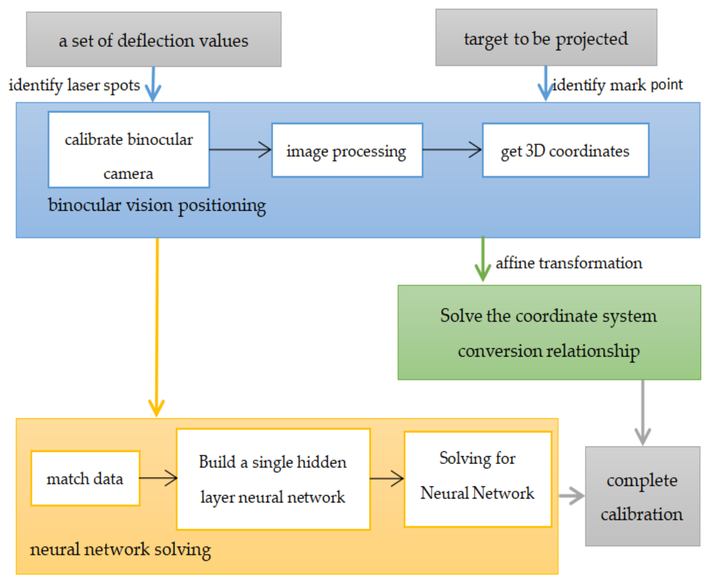


Photo of laser projection system with Laser Vision Hybrid Localization and Galvanometer Scanning.

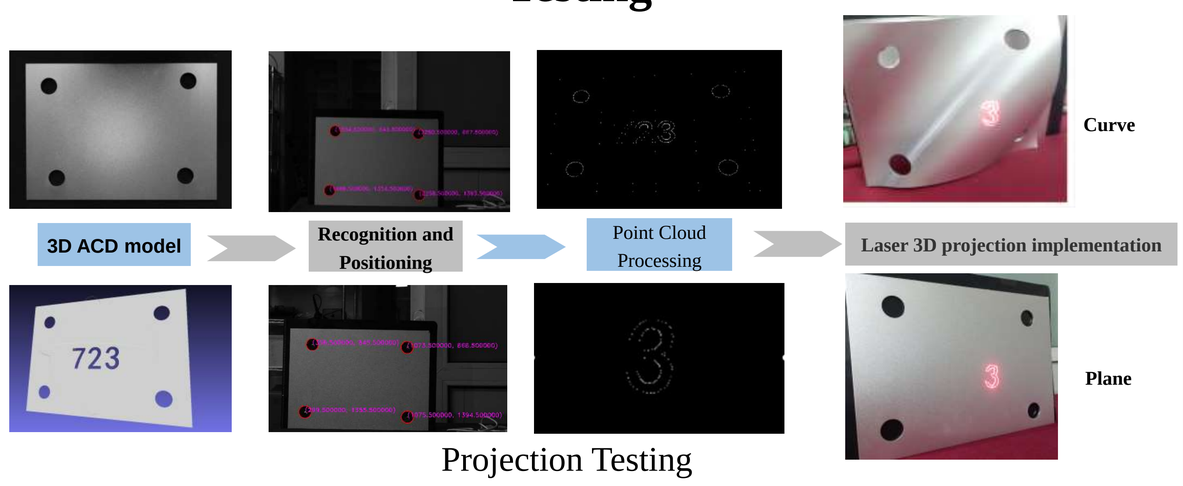
Calibration

System calibration include Binocular Vision, and relationship between Galvanometer scanner and camera coordinate system.

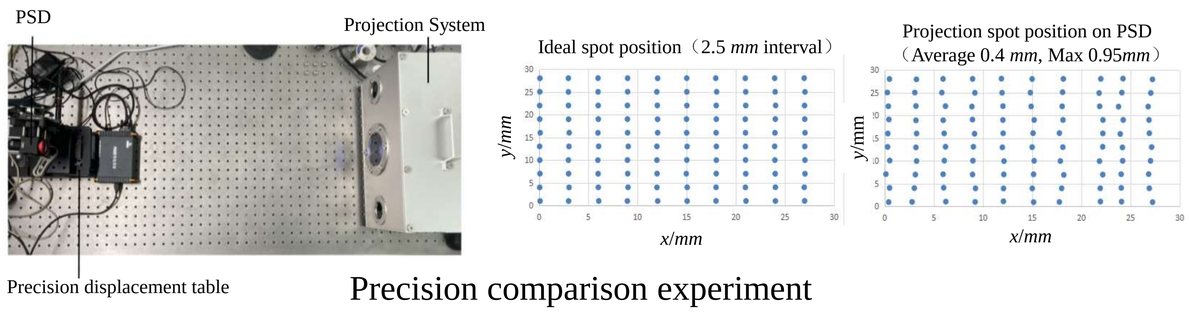
In calibrating the system using the binocular vision, the data can be directly used to solve the conversion relationship between the deflection values of galvo scanner and coordinates of the camera coordinate system, via neural network solving.



Testing



Projection Testing



Precision comparison experiment

Conclusion

A 3D Laser Projection System Based on Laser Vision Hybrid Localization and Galvanometer Scanning has been designed, calibrated, and tested. Experiments have verified the target recognition ability, and the projection accuracy can reach 1 *mm*.

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