In-situ Photometric Stereo-based 3D Reconstruction and Process Control of Incremental Sheet Forming

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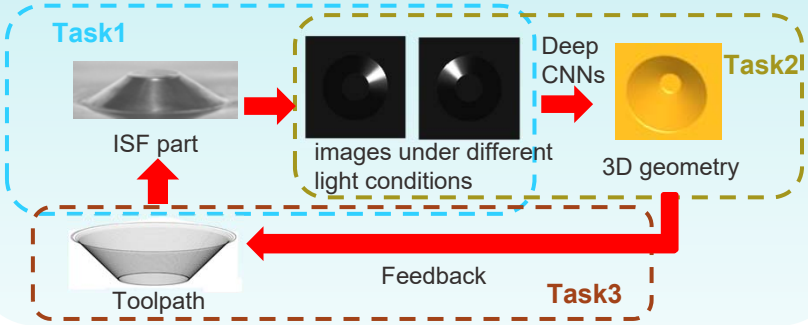
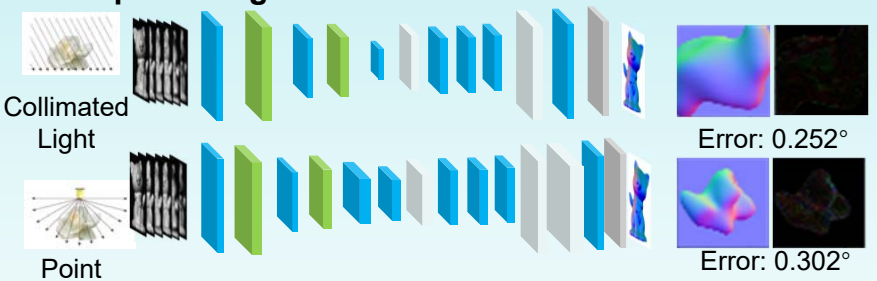
RESEARCH OBJECTIVE

Incremental sheet forming (ISF) is a flexible metal forming process that allows users to form sheet metal parts with various geometries without using any geometric-specific tools. One critical consideration in ISF is to compensate for the springback error. This project focusing on using the photometric stereo-based 3D reconstruction of the geometry being formed to guide the real-time springback compensation.

•Proposed Framework



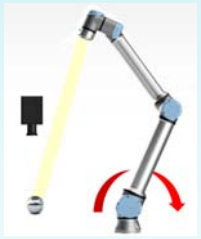
•Deep-learning Based Photometric stereo

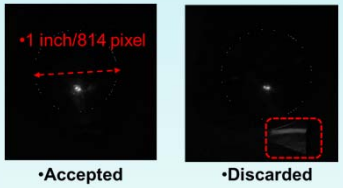


Input: 128*128*n (no. of images), output: 128*128*3

•Data-driven Reflectance Model of Aluminum

Experimental setup



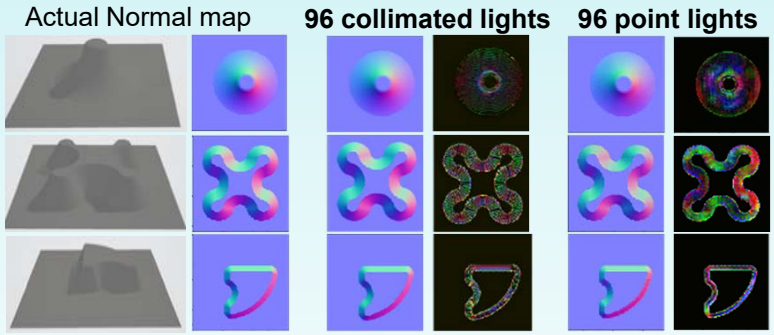


$$I = f(\theta_0, \theta_i, |\phi_0 - \phi_i|)$$

A neural network trained with **18,632,095** experimental data

•Validation Result

Actual normal maps VS predicted normal maps by DNN

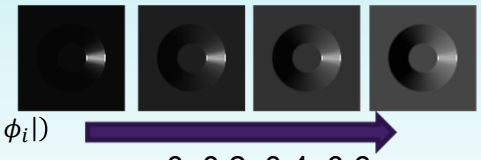


Average error: 1.462° 1.890°

•Synthetic Image Rendering

Roughness model
Assumption:

$$I = (1-\alpha) * f(\theta_0, \theta_i, |\phi_0 - \phi_i|) + \alpha * K * \boldsymbol{L} * \boldsymbol{N}$$



α = 0, 0.2, 0.4, 0.6

•Future Work

1. Reflectance model from experiment considering roughness
2. Implementation on ISF machine and forming experiment

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