LINE SCAN EXTENSOMETER PROJECT

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INTRODUCTION

A line scan camera is an advanced technology used in high-strain-rate material testing to capture precise strain data. This method enables highly accurate measurements by tracking deformation in real time.

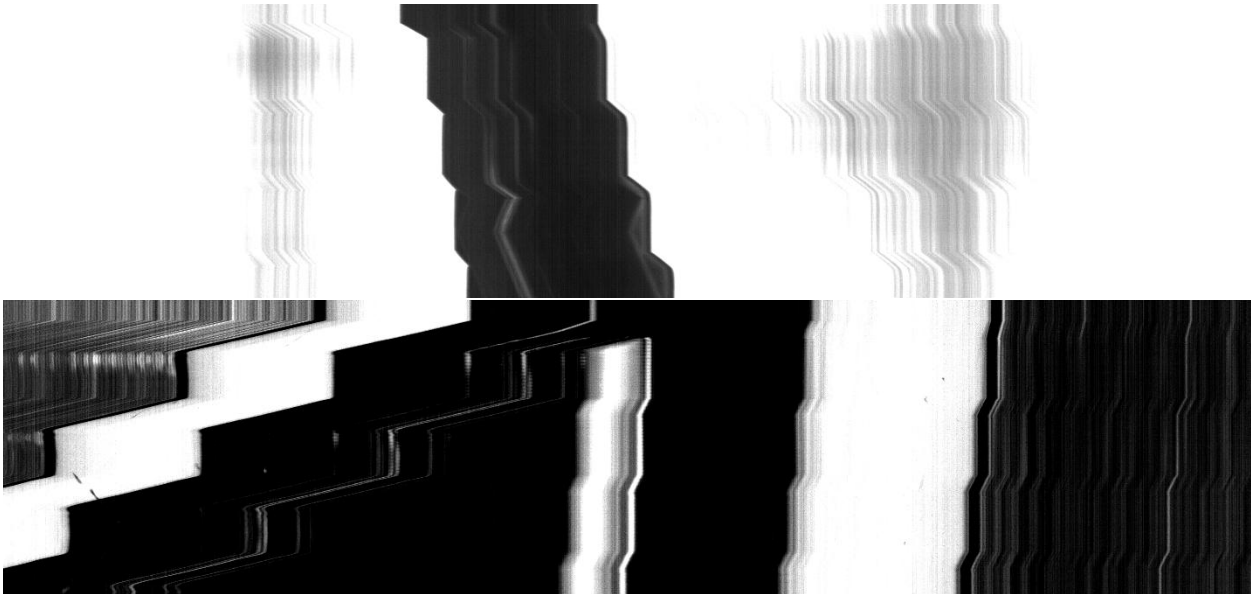
Line Scan Principle

In the image above, a black reference mark is drawn on the specimen, while the grey line represents the scanning area. The line scan camera operates by continuously capturing changes in the length of the black mark at a known rate. Strain is calculated by measuring the change in pixel count relative to the original pixel measurement. If precise displacement tracking is needed, a pixel-to-distance ratio can be established to convert pixel shifts into physical distances.

PROBLEM DESCRIPTION

The primary challenge this project addresses is the tedious post-processing of line scan images, specifically determining the starting and ending points of the scanned line. Currently, this process requires manual input for initial guess values in the solver, making it time-consuming and prone to human error. By implementing a machine learning algorithm, we aim to automate this process.

The dataset for this project consists of numerous line scan images captured during material tests (exact dataset size to be determined). These images include outputs from compression and tensile tests, as shown below.



Compression Test (Top) and Tensile Test (Bottom)

To effectively analyze these images, the machine learning model must include the following capabilities:

- Edge Detection & Thresholding – Automatically identify edges and recommend threshold values. The model should also determine whether an edge is transitioning from white to black or black to white. It should also detect whether it is a tensile or compression test, and if the gauge color is black or white as sometimes a white mark is preferred.
- Group Detection – Identify multiple line patterns, such as barcode-like markings on specimens.
- Fracture Detection – Determine when the fracture occurs to mark the end of the test.

MACHINE LEARNING APPROACH

To solve this problem, we propose using a combination of computer vision techniques and supervised learning models trained on labeled line scan images. Convolutional Neural Networks (CNNs) or traditional feature-based methods (such as Canny edge detection and Hough transforms) could be explored for edge detection and pattern recognition. A recurrent neural network (RNN) or temporal model may be beneficial for tracking changes over time. Multiple models might need to be considered for identifying different features (i.e. tension/compression classifier or classifying the gauge section color).