LOW-COST RASPBERRY PI BASED IMAGING SYSTEM FOR ANALYSIS OF FIBER SPECKLEGRAM SENSORS

L.Brestovacki[1], M. Golubovic[1], J. Bajic[1], A. Joza[1], V. Rajs[1]

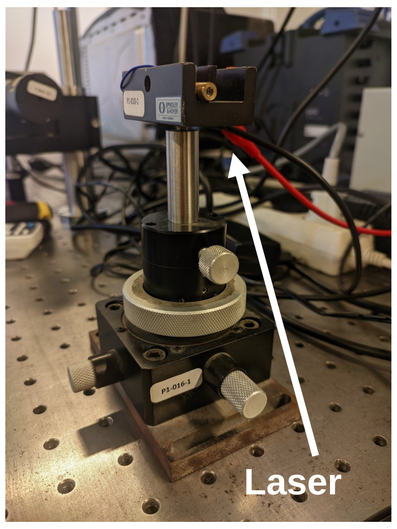
University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovica 6, 21000 Novi Sad, Serbia

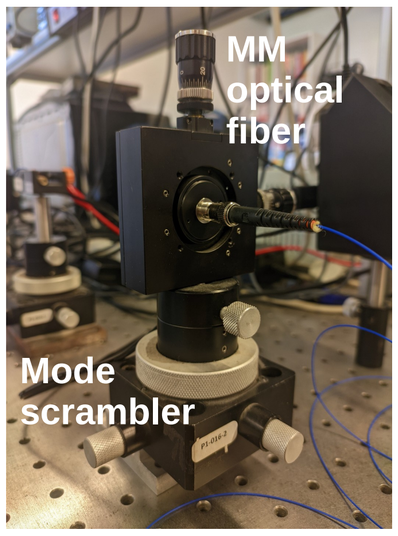
[1]Department of Power, Electronic and Telecommunication Engineering,

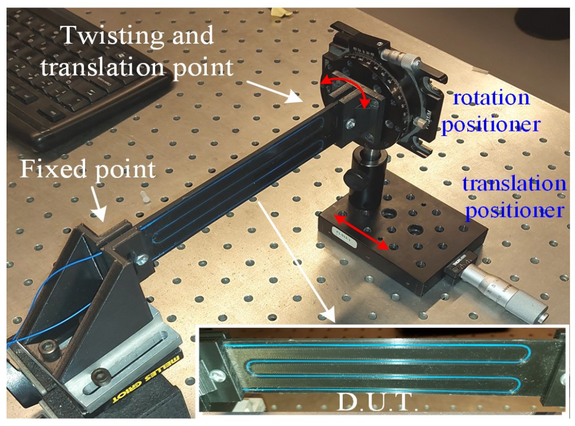
e-mail: lenkabrestovacki@uns.ac.rs

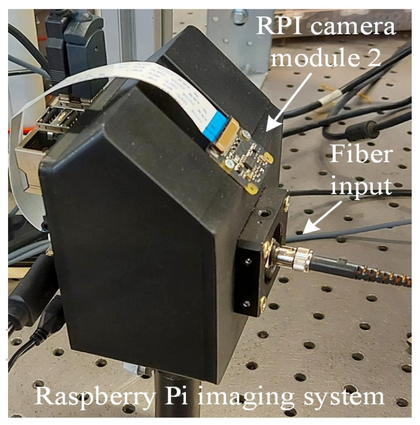
ABSTRACT: In this paper, a low-cost imaging system for Fiber Specklegram Sensors based on *Raspberry Pi* is presented. The aim of this research is to investigate the influence of mechanical deformations on specklegram by comparing referent specklegram (when the fiber is not deformed) and specklegram taken for deformed fiber. By manually making deformations, it is observed that the geometrics of speckles are different for varying deformations. Therefore, Raspberry Pi is used for image processing and machine learning techniques for classification of fiber deformation.

EXPERIMENTAL SETUP









Types of deformations:
- Bending (translation positioner)
- Torsion/twisting (rotational positioner)

What should be classificate:
- Direction of deformation
- Intensity of deformation

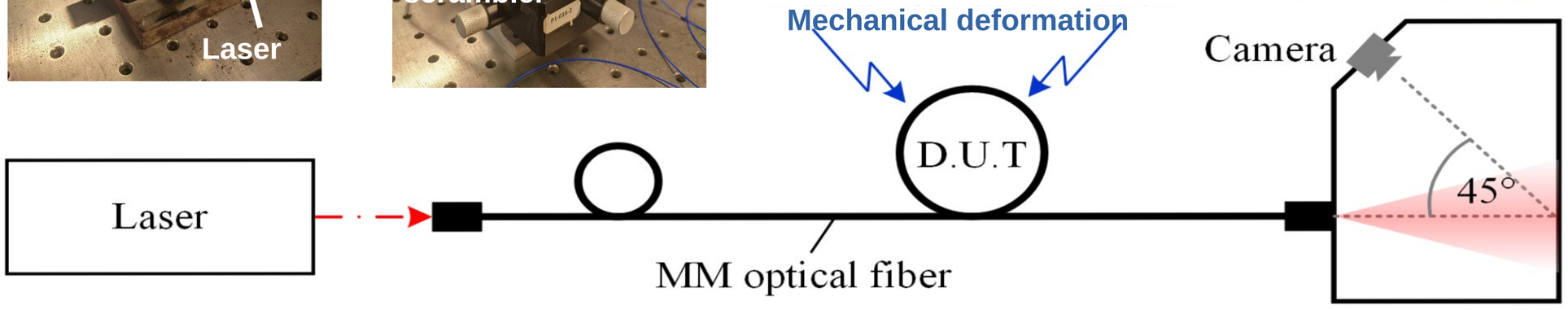


Fig.1. Experimental setup

ANALYSIS

Preprocessing

- Region-of-Interest detection (*Fig. 2. a*)
- Normalization (max) (*Fig. 2. c*)
- Filter (Gaussian) (*Fig. 2. c*)
- Color map (*Fig. 2. d*)
- Binarization (*Fig. 2. e*)

Correlation

- Referent images – edge cases
- Types of correlation methods:
  - Zero normalized cross-correlation – ZNCC
  - Structural similarity – SM
  - Normalized mutual info score - NMIS

Machine Learning

- Regression
- GaussianMixture Model (*Fig. 3*)
- PCA algorithm (*Fig. 4*)
- Deep learning neural network model

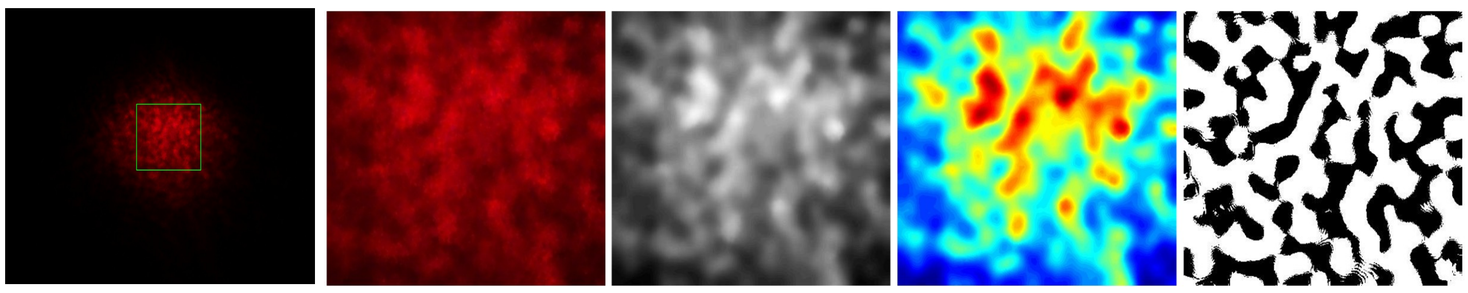


Fig.2. image preprocessing: a) raw image with marked ROI, b) extracted ROI, c) filter (Gaussian) and normalization d) color map, e) binarization

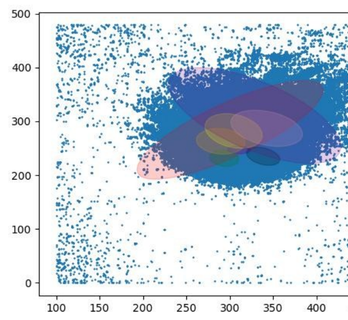


Fig.3. Gaussian Mixture Model

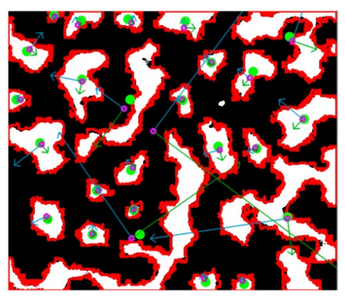


Fig.4. PCA algorithm

RESULTS

- Dataset – twisting [-4°, 4°], 10 images per position
- Regression – 94%
- At Fig. 5. results of correlation are presented.
  - A) referent image is taken at position -4°
  - B) referent image is taken at position 4°
- Three methods for correlation
- Linear correlation that is presented on diagrams for ZNCC and SM methods are good basis for usage of machine learning
- Small sensitivity

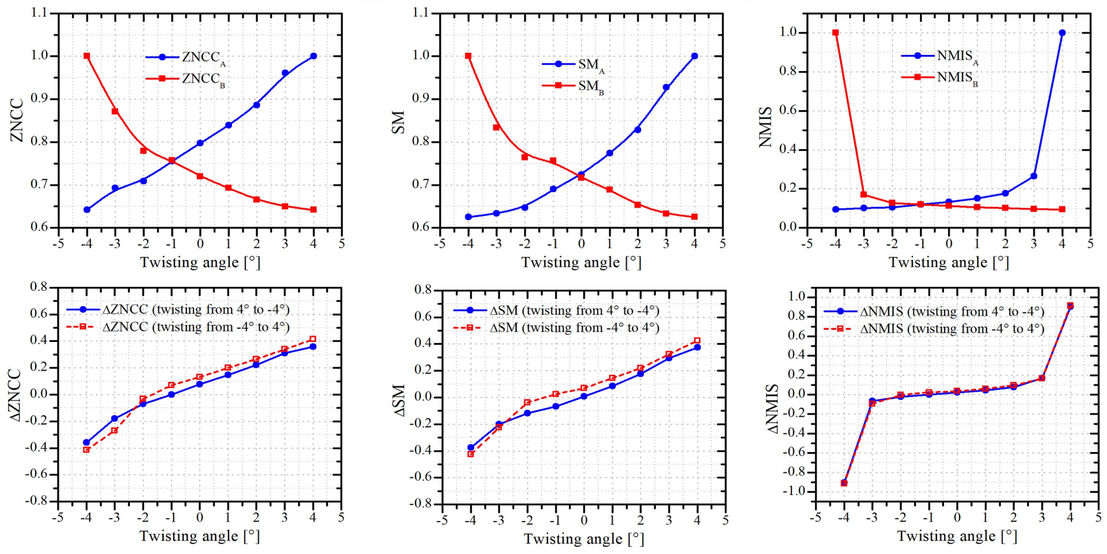


Fig.5. Correlation results

CONCLUSION: Several implementation of Imaging System for Analysis of Fiber Specklegram Sensors are tested. Analysis of the results shows that by correlation between images it is possible to detect type and intensity of deformation, therefore strong basis for finding out more reliable methods for detecting type and intensity of deformation presents itself. A statistical approach is empolyed to extract information of pattern of light intensity distribution. The useage of machine learning methods such as Gaussian Mixture Model and CNN for tracking feature changes becomes well considered selection.

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