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Physics Laboratory by Video Tracker and Visual Basic for Application at Home During Covid-19 Pandemic: Material Elasticity Measurement

Presented by

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Room Theater, Science Learning Center Building FMIPA UNMUL, 12th October 2021

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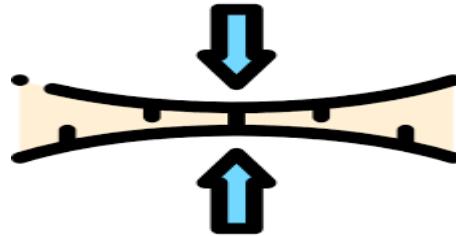
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Outline

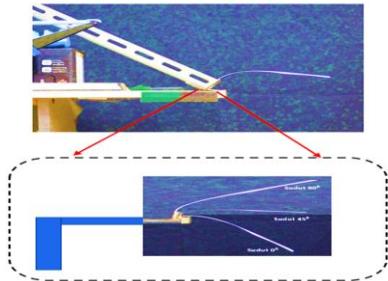
1. Introduction



2. Proposed Approach



3. Experimental



4. Results and Analysis

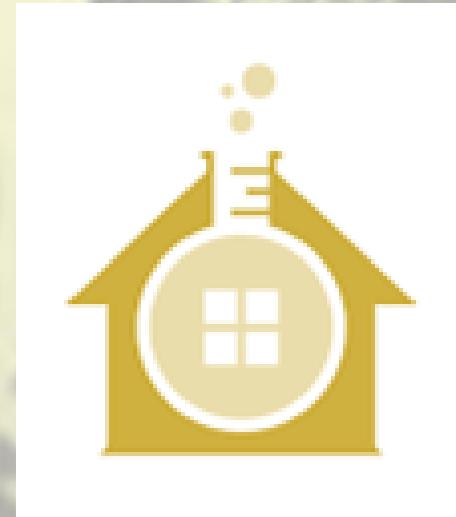
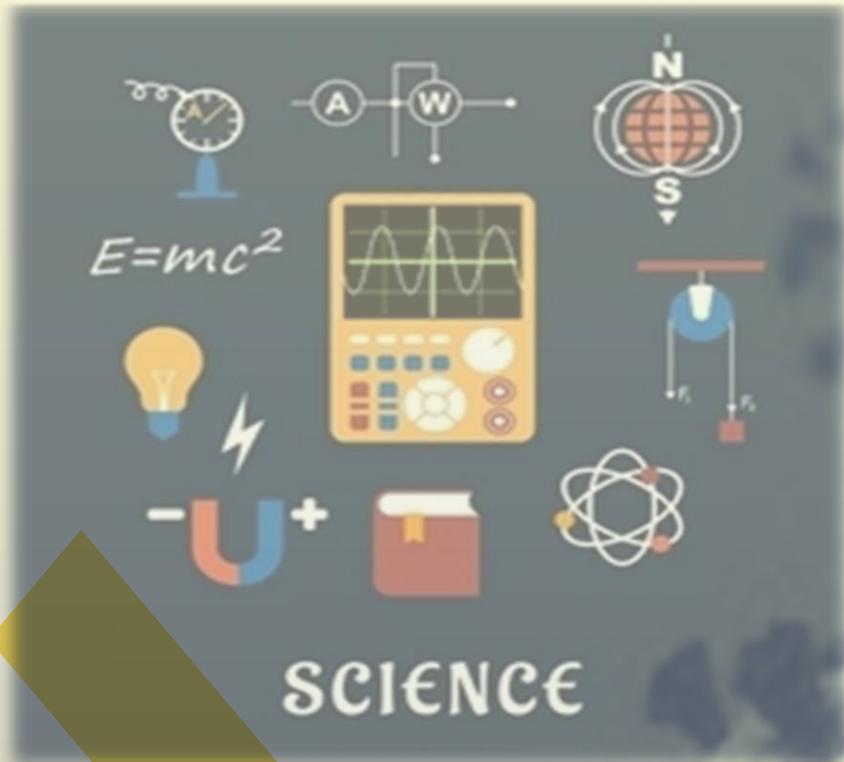


5. Conclusion



Introduction

Coronavirus (COVID-19) disease is an emerging situation that brought challenges to all sectors, including academia and research.



Physics laboratory at home

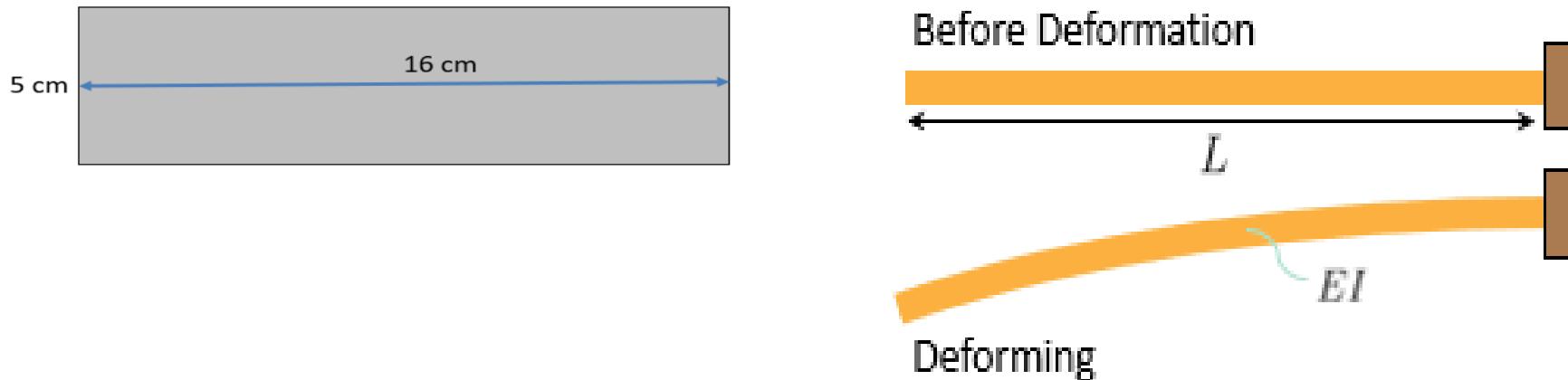
Tracker

Video Analysis and Modeling Tool



Proposed Approach

We investigated application of video tracker for Physics Laboratory: elasticity modulus measurement of sheet-shaped material



“ Proposed Approach

We present a novel approach to calculate modulus elasticity for sheet-shaped material from known image tracking using video tracker software.

The method is very potential for developing new equipment for determining elastic modulus with very simple procedures without damage the material.

Experimental Details

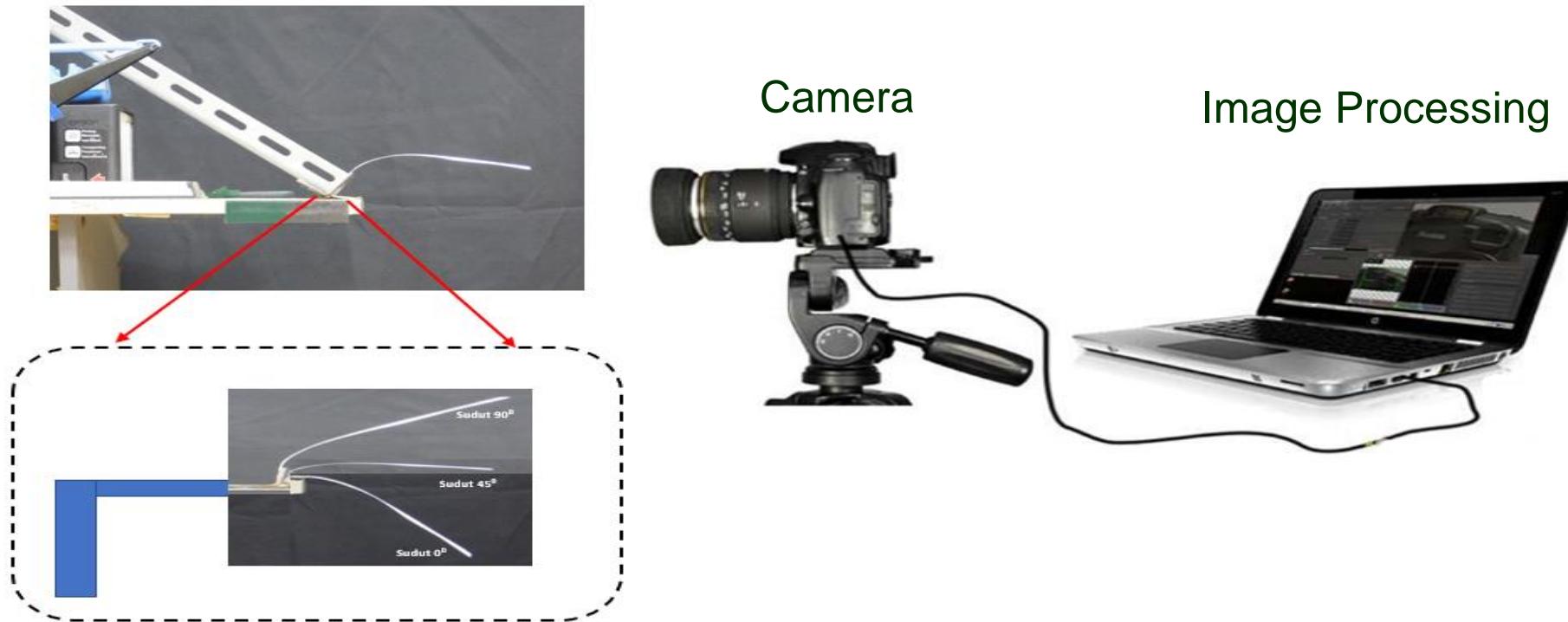


Fig.1. Illustration of a Simple Experiment Measurement Elasticity Modulus for Copy Paper 100gsm

Experimental Details

Start

Design Experiment Method

Recording coordinates point for some points using Video Tracker

Fit the bending angles with an appropriate polynomial function

Calculate the bending angles at each point

Calculate the elastic modulus at each segment

End

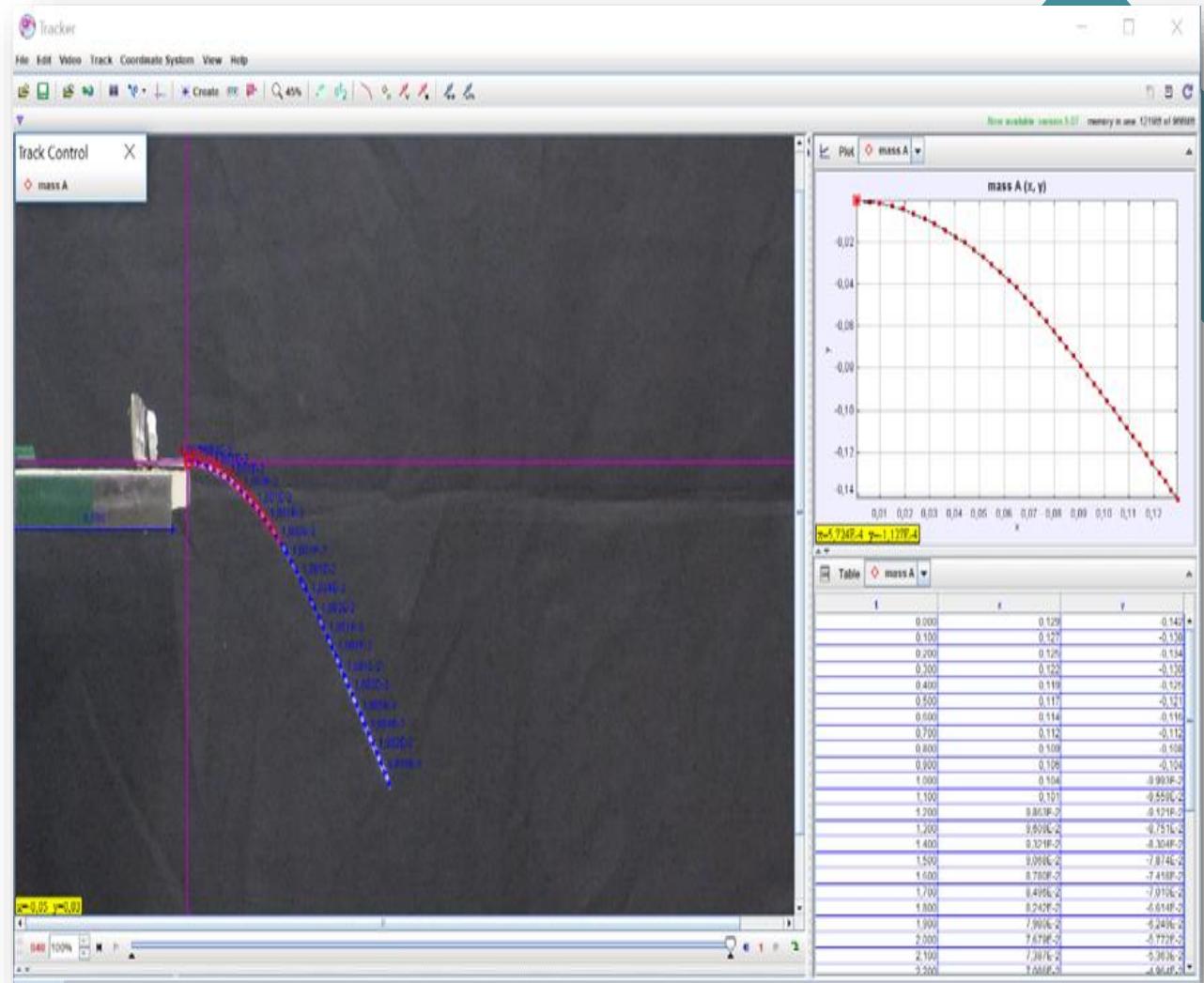


Fig. 2. Procedure for estimating the elastic modulus of the beam

Results and Analysis

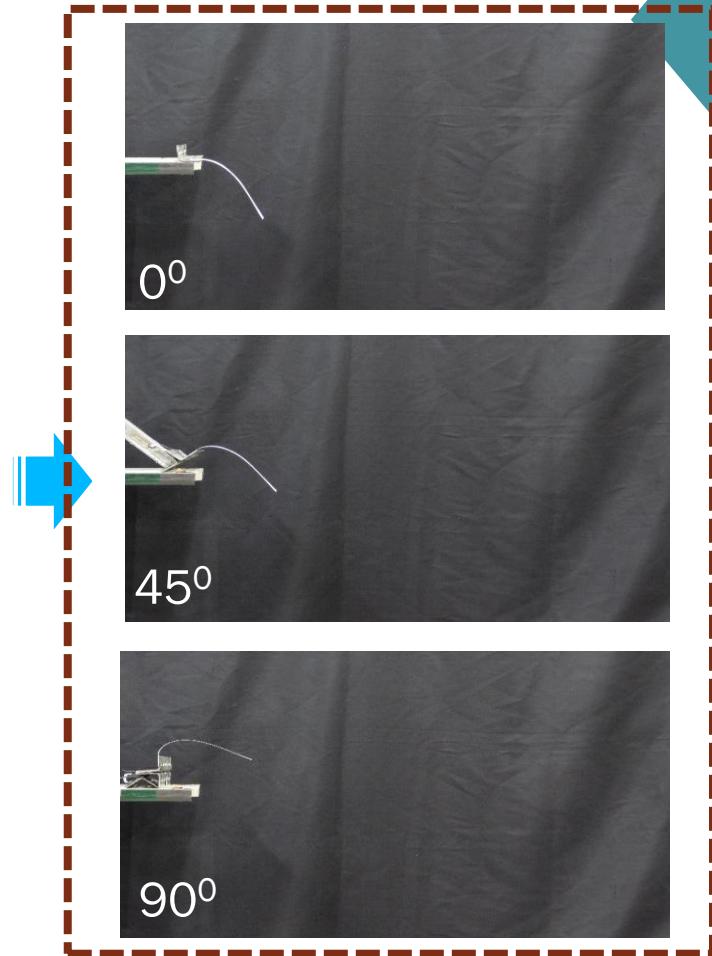
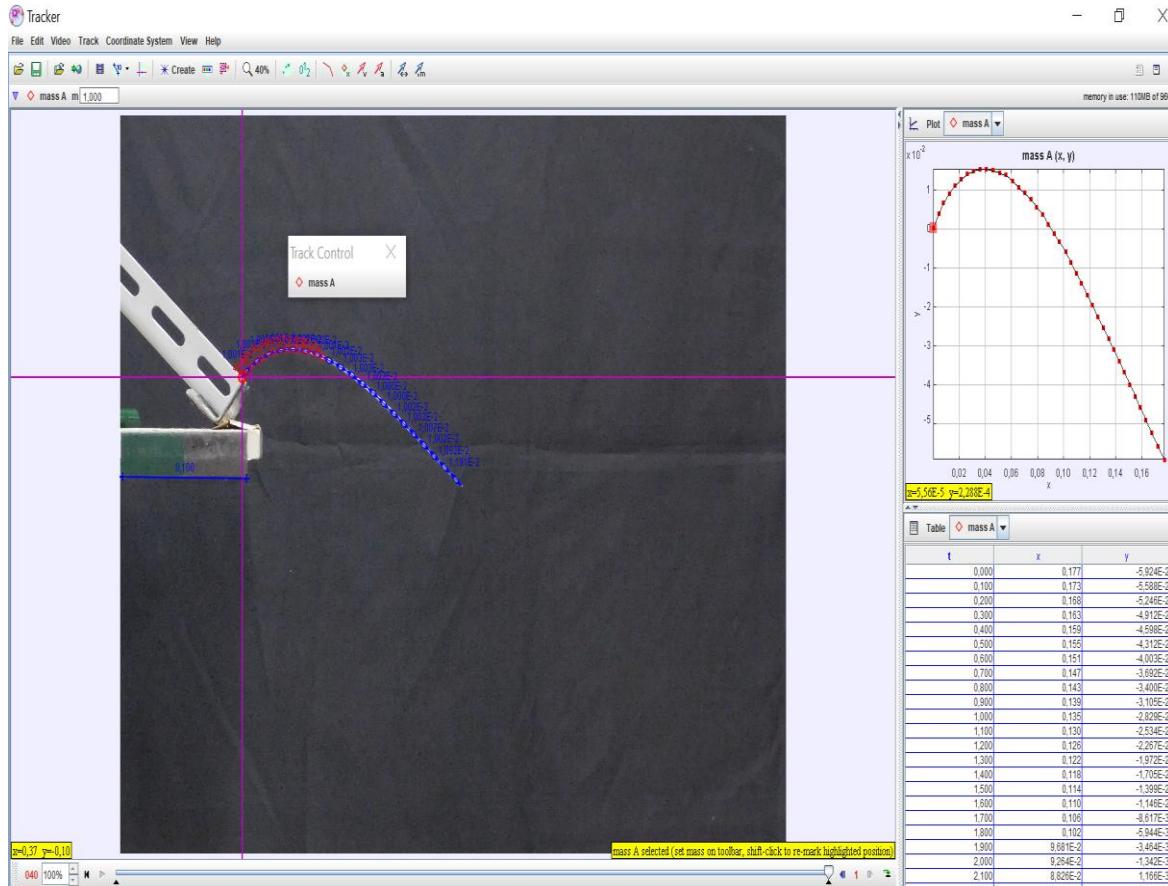


Fig. 3. Display video tracker when tracking mass points for curvature angle 0° , 45° dan 90° .

Results and Analysis

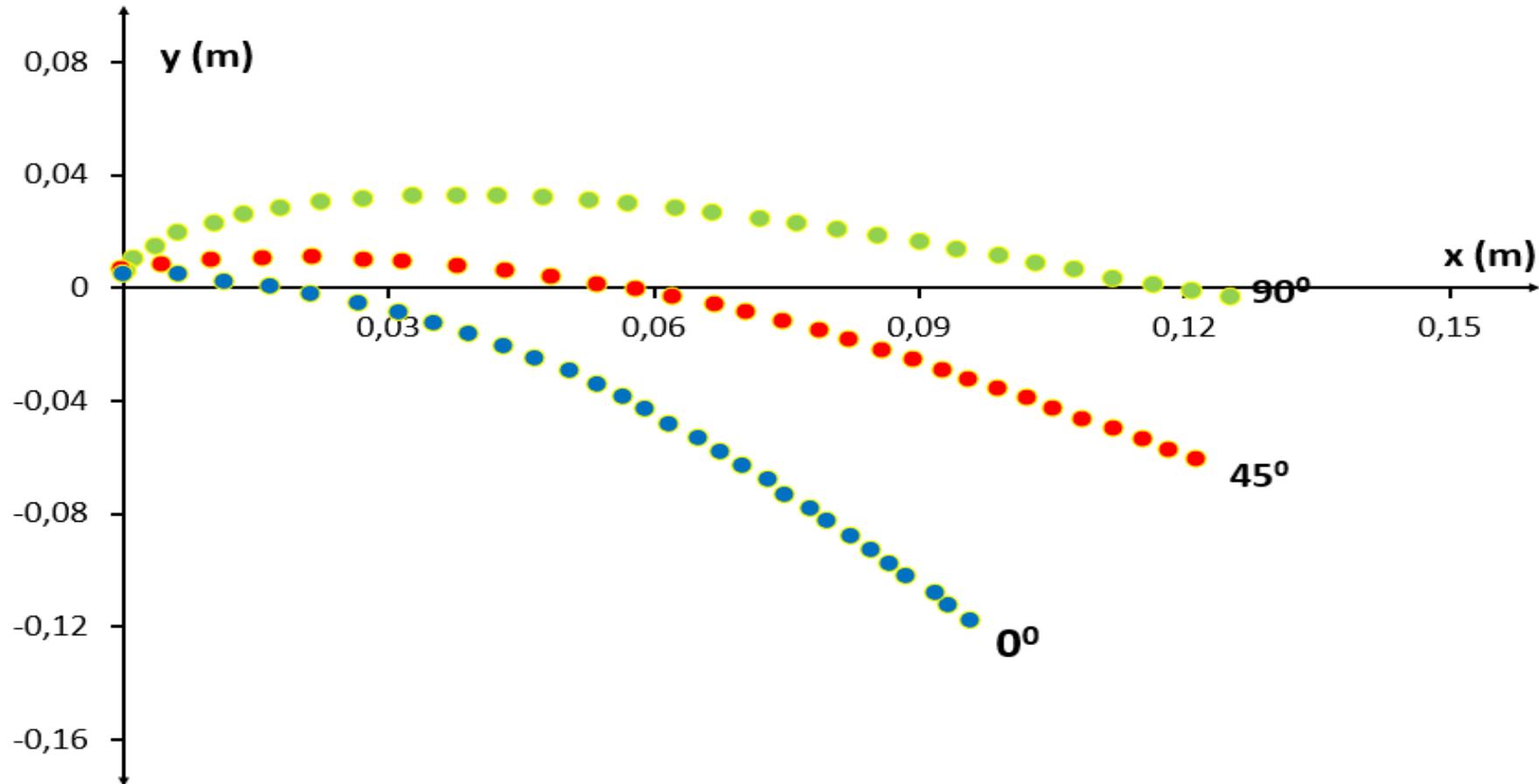


Fig. 4. The deflection profile of the results of the image through image tracking using a video tracker for sheet-shaped samples.

How to Calculate?

The image displays a complex software environment for data analysis and automation. It features three main windows:

- Tracker:** A video tracking application showing a 'calibration tape' with a blue trajectory line and a 'PP_45.trk' file. A control bar at the bottom shows '000 100%' and playback buttons.
- Excel (PP45_Polos.xlsx):** An Excel spreadsheet with a grid of numerical data. A chart titled 'measured teta' is visible, showing a series of green circles. The status bar indicates 'Ready'.
- Microsoft Visual Basic for Applications (VBA):** A code editor window showing VBA code for a 'Module1' project. The code defines variables for polynomial order and segment length, and includes loops to calculate coefficients and angles.

```
'N = 6 'highest order in the polynomial
'O = 540 'divide angle
'dang = 3.14159 / O
'M = Cells(17, 10).Value
'segmen = Cells(16, 10).Value
segmen = samlength / M 'length of segment in simulation
Cells(16, 12) = segmen
ord0 = Cells(36, 2).Value 'coefficient of the term of 0th degree
ord1 = Cells(37, 2).Value 'coefficient of the term of 1th degree
ord2 = Cells(38, 2).Value 'coefficient of the term of 2th degree
ord3 = Cells(39, 2).Value 'coefficient of the term of 3th degree
ord4 = Cells(40, 2).Value 'coefficient of the term of 4th degree
ord5 = Cells(41, 2).Value 'coefficient of the term of 5th degree
ord6 = Cells(42, 2).Value 'coefficient of the term of 6th degree

'Calculate s with smoother segmentation
For i = 1 To M + 1
    vars(i) = (i - 1) * segmen 'value of s
    Cells(i + 1, 7) = vars(i)
Next i

'Calculate teta with the polynomial equation
For i = 1 To M + 1
    angs(i) = ord0 + ord1 * vars(i) + ord2 * vars(i) ^ 2 + ord3 * vars(i) ^ 3 +
    'Cells(i, 8) = ang0(i)
    Cells(i + 1, 8) = angs(i)
Next i

End Sub
```

“ How to Calculate?

Calculate angle of each segment

$$\theta_j = \theta_{j-1} - \frac{a^3 g}{E_j I_j} \sum_{i=1}^{j-1} \left(\sum_{k=1}^i \cos \theta_i \right)$$

Calculate coordinates of each segment

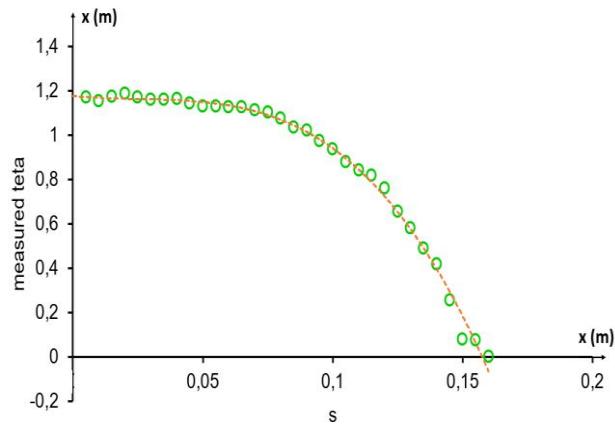
$$x_j = x_{j-1} + a \cos \theta_j \quad y_j = y_{j-1} + a \cos \theta_j$$

Calculate Young's modulus of each segment

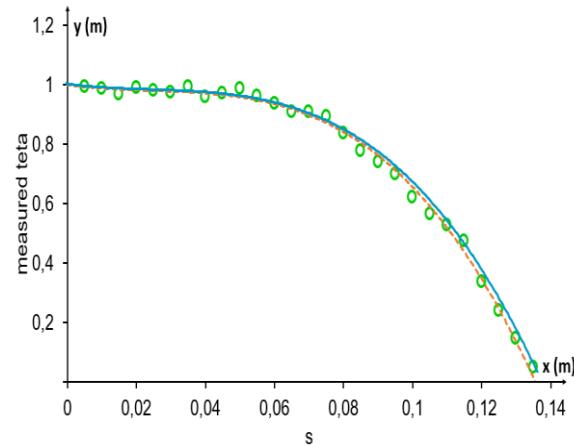
$$E_j \approx - \frac{a^3 g}{I_j (\Theta_j - \Theta_{j-1})} \sum_{i=1}^{j-1} \left(\sum_{k=1}^i \lambda_k \right) \cos \Theta_i$$

Results

Curvature angle 0°



Curvature angle 45°



Curvature angle 90°

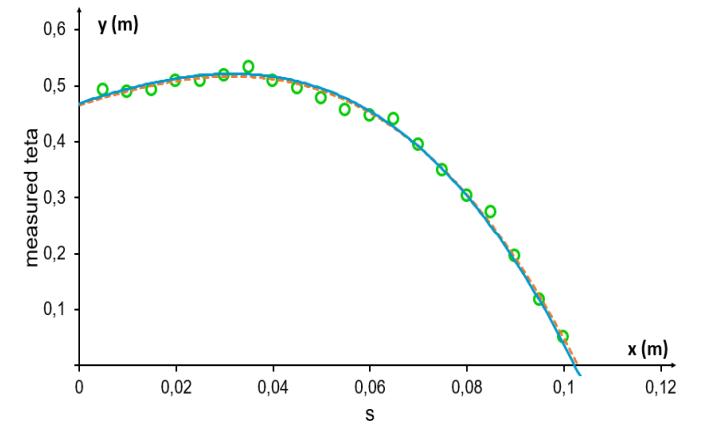


Fig.5 Experimental data fitting graph (green colored round shape), theory (orange dashed line) and simulation (blue line) on rectangular sample for Curvature angles 0° , 45° and 90°

Results

Tabel 1. The average values of elastic modulus obtained from calculation and direct measurement for sheet-shaped material (copy papper 100 gsm)

Angle	Sheet-shaped material (Copy paper 100 gsm)	Elasticity Modulus (Gpa)	
		Averaged Calculated	Averaged Measurement
0 ⁰		2.42	1.4-2.1
45 ⁰		2.18	1.4-2.1
90 ⁰		2.32	1.4-2.1

Conclusion

We have shown video tracker & VBA for elasticity modulus measurement of sheet-shaped material (copy paper 100 gsm).

This method a series of procedures:

- ❖ Tracking images using Video Tracker Software
- ❖ Calculating bending angles using cantilever beam equation
- ❖ These procedures can be conducted at home

We can accurately estimate modulus material elasticity without tensile strength equipment.

