9/11/22

Mechanical Engineering
IIT Bombay

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# Smartphone Goniometer

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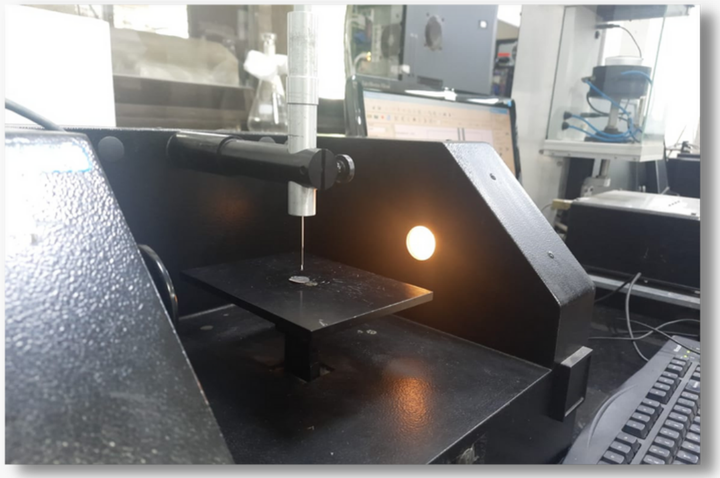
## I Research Background & Motivation

- Goniometer setups are **bulky** and **expensive**
- Our aim is to make use merely a **smartphone** to measure the interfacial contact angle

**Objectives**:

- Understanding the influence of surface tension and contact angle between interfaces in material design
- Developing the CAD model of the device
- Developing software in-house
- Comparison of results with standard equipment

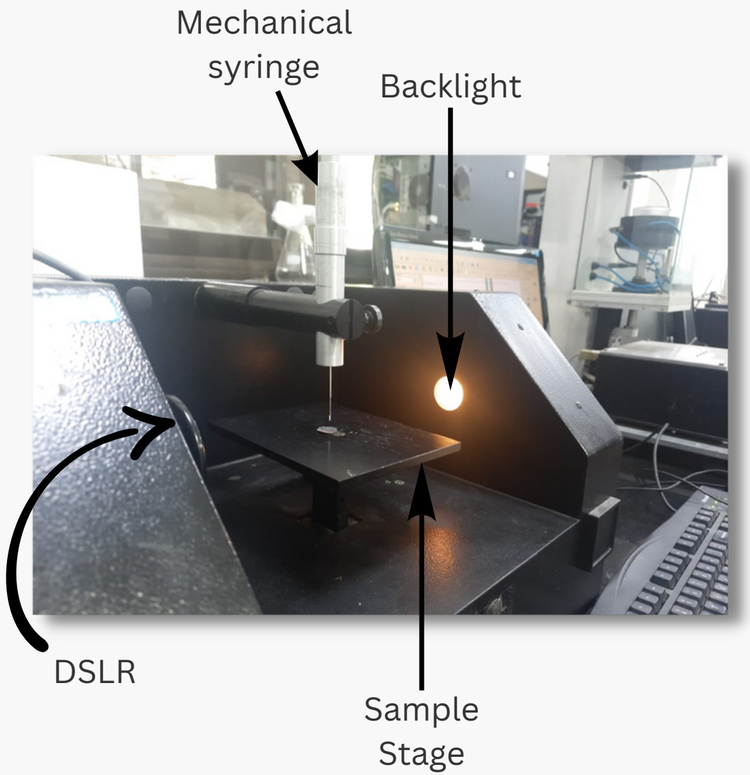
This project was the appropriate junction between our interests and area of knowledge



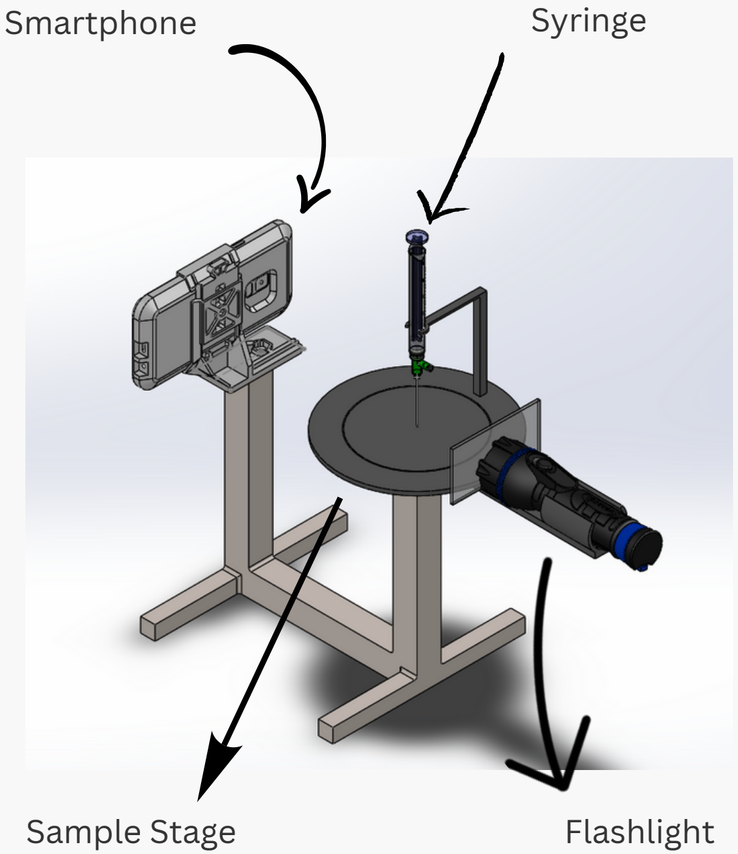
Goniometer (PG Lab, IITB)

Nike GORE-TEX

## II Methodology




Existing Setup



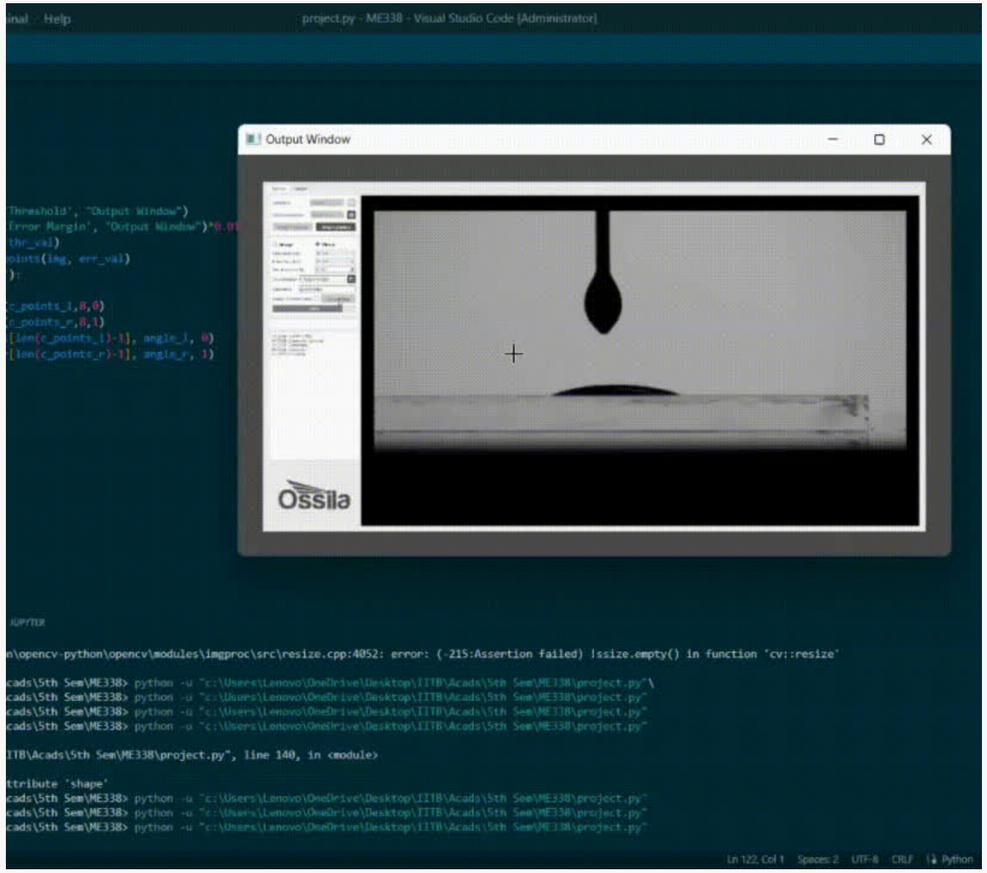

Our Prototype

| | VCA System | Our Prototype |
|---|---|---|
| Cost | $10,000 - $20,000 | $200-$500 |
| Compact | ❌ | ✅ |
| Weight | ❌ | ✅ |
| Accuracy | 1 degree | 8 degree |

Comparison

## Software Development

### GUI

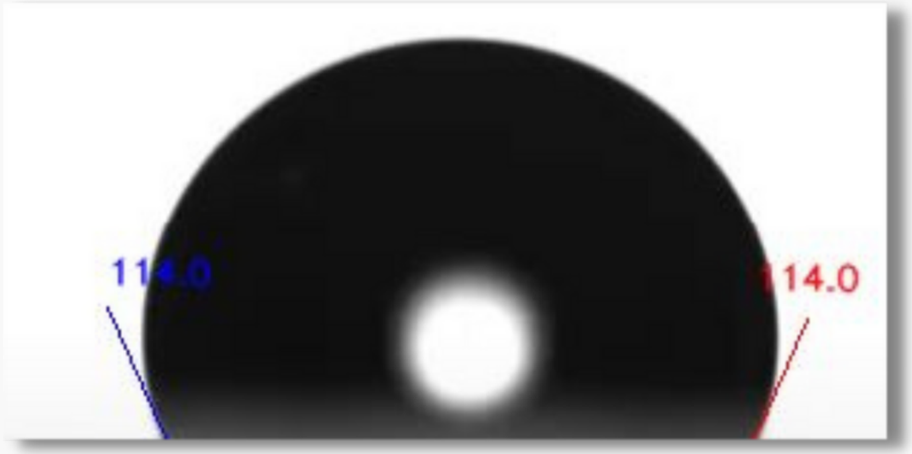



### Algorithm

- We first take the raw image or video as input
- Then we select our reference frame and crop out the required area
- We need to select the threshold parameters
- Then we select corresponding black pixels by scanning the image laterally and using the slope to determine the contact angle

# Software Implementation on different images

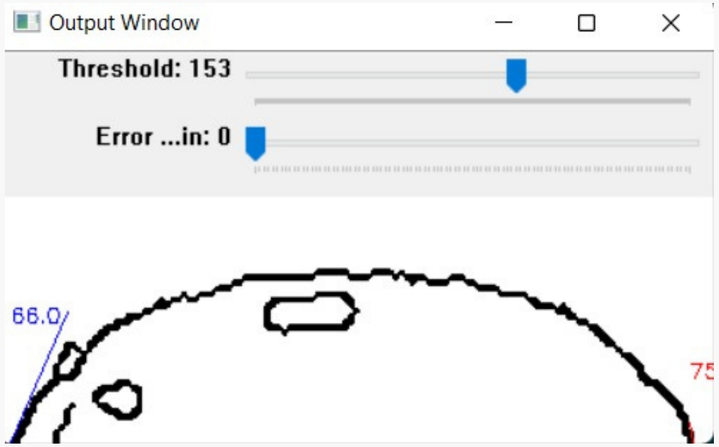
## Standard goniometer





## Smartphone camera

Raw image (shot on iPhone 13)




Processed image

# V Observations & Analysis

## Observations

| From Standard Goniometer | | From our Goniometer | | |
|---|---|---|---|---|
| Contact angle (left) | Contact angle (right) | Contact angle (left) | Contact angle (right) | Error % |
| Material1: | | | | |
| 61.2 | 67.3 | 45 | 47 | 28.40466926 |
| 61.4 | 63.05 | 42 | 47 | 28.48533548 |
| Material2: | | | | |
| 120.7 | 121.4 | 120 | 147 | 10.2850062 |
| 120.2 | 120.85 | 135 | 142 | 14.91391827 |
| | | | Mean: | 20.5222323 |

Source: Standard Images

| From Standard Goniometer | | From our Goniometer | | | |
|---|---|---|---|---|---|
| Contact angle (left) | Contact angle (right) | Contact angle (left) | Contact angle (right) | Error % | Source |
| Material1: | | | | | |
| 111.95 | 111.46 | 114 | 114 | 2.054518598 | YT |
| 111.86 | 111.36 | 109 | 109 | 2.338500134 | YT |
| Material2: | | | | | YT |
| 23 | 20 | 16 | 23 | 9.302325581 | YT |
| Material3: | | | | | YT |
| 41.56 | 41.4 | 45 | 45 | 8.486017358 | YT |
| 47 | 48 | 45 | 45 | 5.263157895 | YT |

Source: YouTube

# V Conclusion & Discussions

## Error in standard images

We obtained a 5.48 percent error in measurement

## Error in smartphone images

We obtained a 12.9 per cent error in measurement

- We can improve image clarity using lenses which provide appropriate focus
- As standarad images have better resolution and clarity we have lower error percentage
- We can improve by using better thresholding techniques

# VI Future work & development prospects

## Adjustable Lens

- We do not need to manually adjust the phone itself to adjust the focus
- Different types of lenses would provide high functionality at minimal cost (₹250-₹3000)

## Software improvements

- Usage of neural networks for cropping, thresholding and predictions

## Smartphone app

- Since the code is light, it can easily be ported to a smartphone
- The need for a PC can be completely eliminated

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# Thank you for listening!