BOLT LOOSENESS DETECTION METHOD 3: COMPUTER VISION

MScAC Internship

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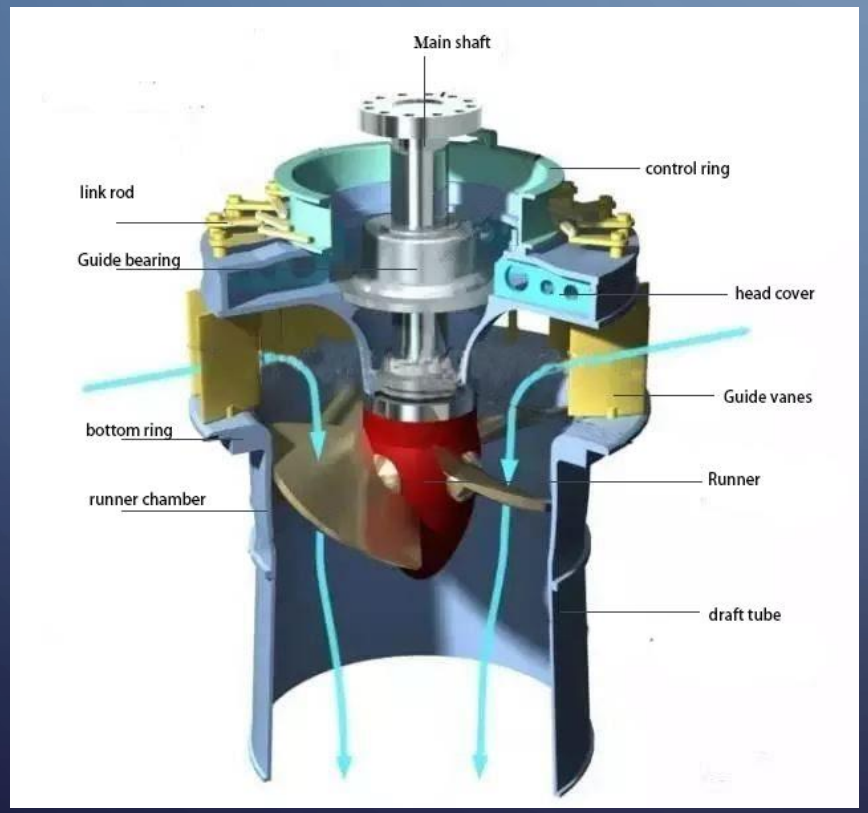
OUTLINE

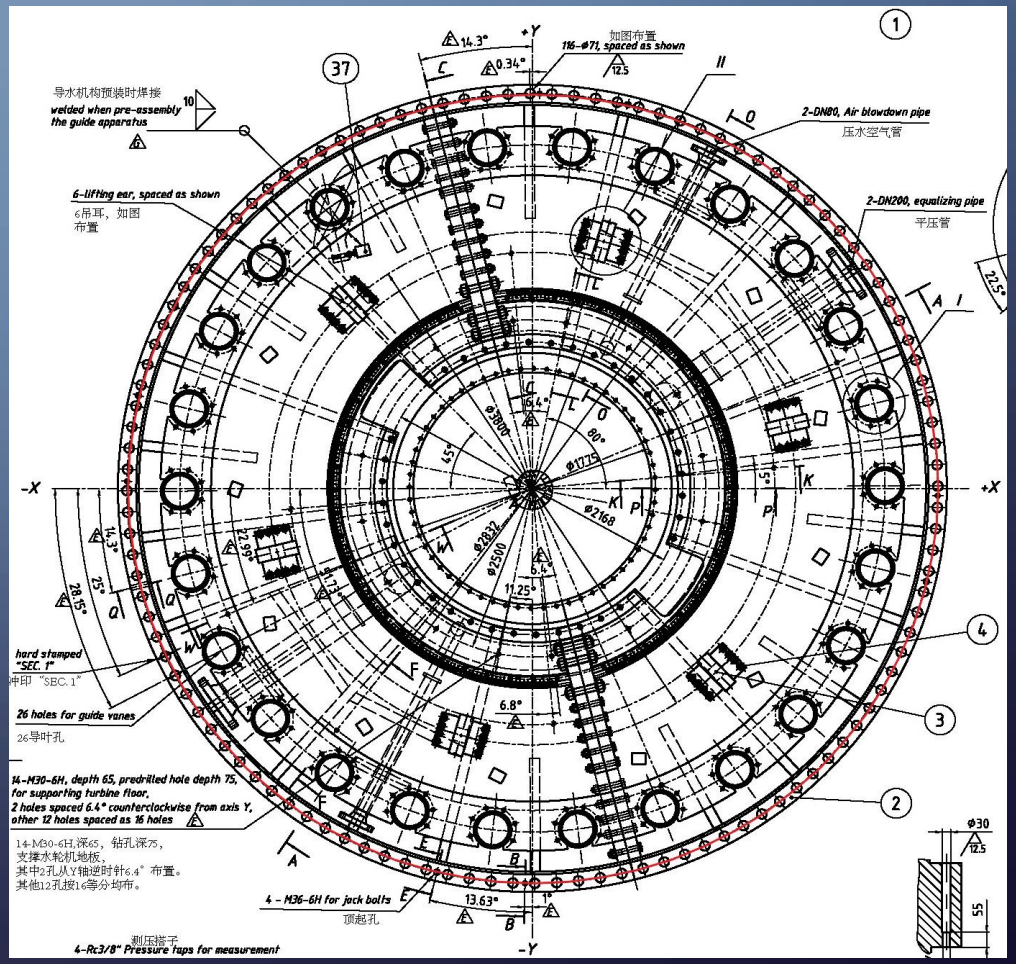
- Problem reminder
- 3 Potential solutions
  - Method 3: Computer vision

PROBLEM REMINDER

BOLT LOOSENESS AND FRACTURE DETECTION

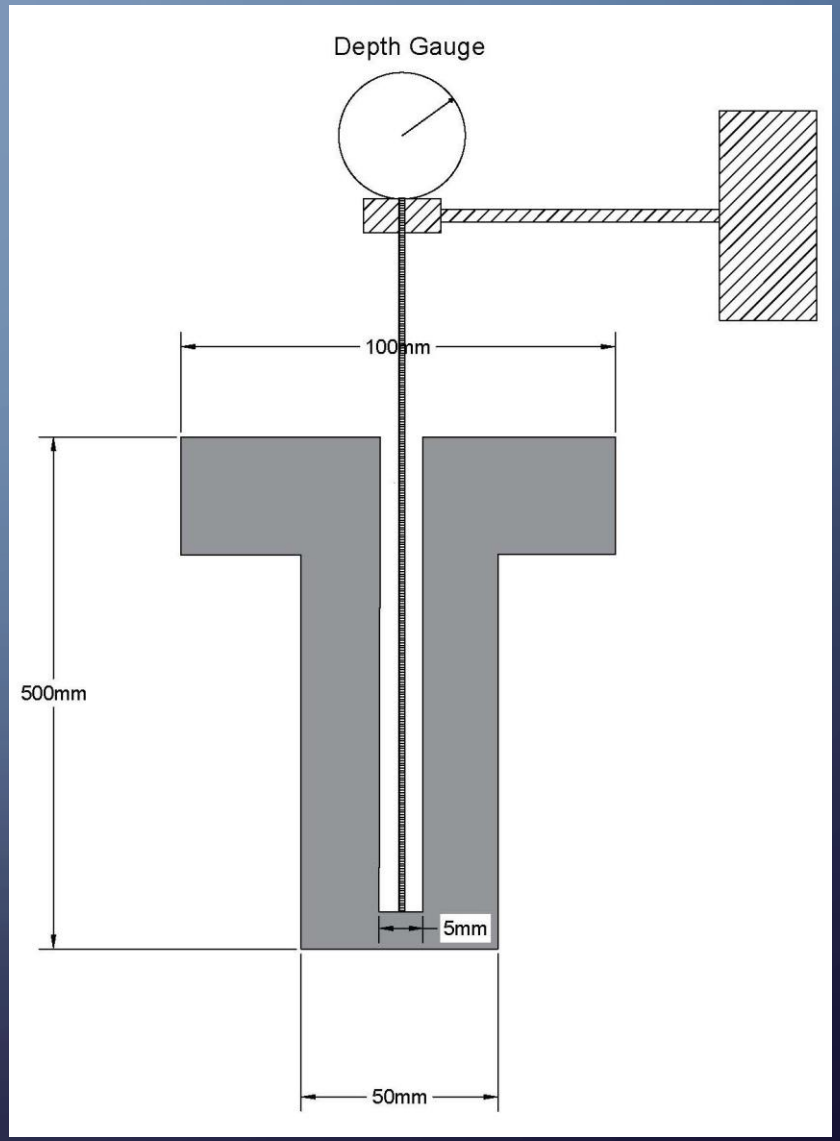
- Bolts on the pump turbine head cover





MANUAL INSPECTION

- There is a deep hole in the bolt
- A depth gauge is used to measure the strain change of the bolt



IMAGES OF THE REAL BOLT

3 POTENTIAL SOLUTIONS

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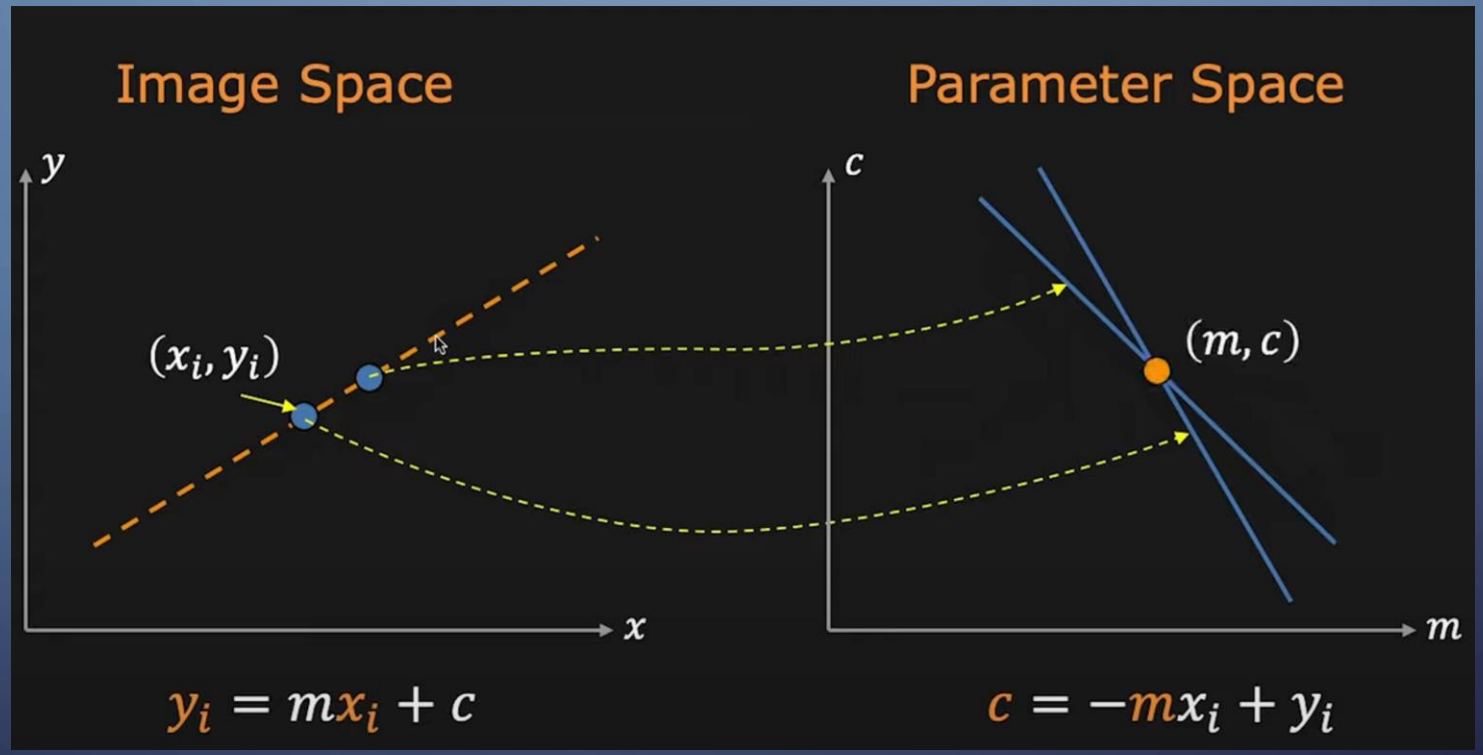
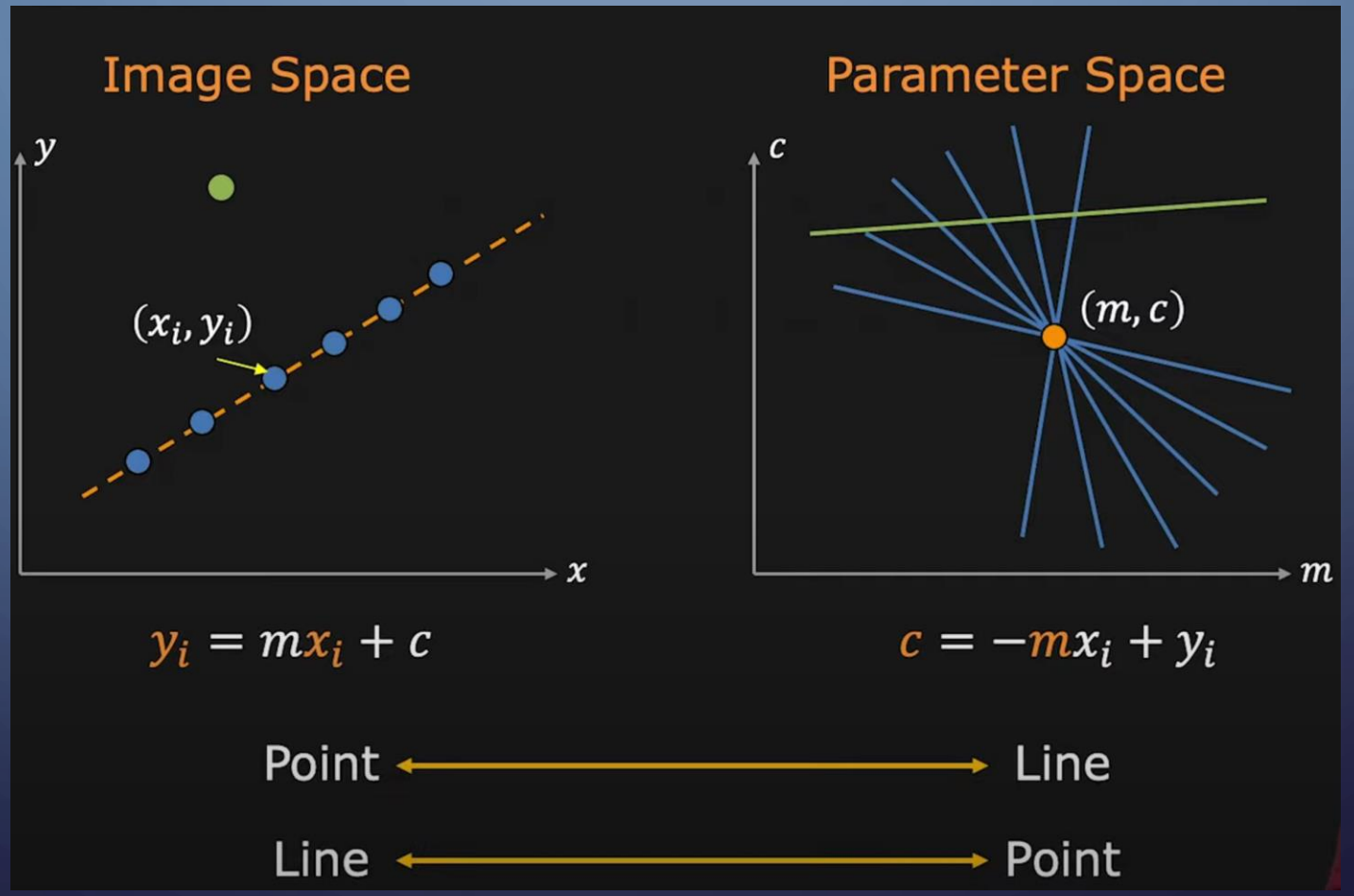
- Capacitive sensing
- Acoustic emission detection
  - Blind separation
- Computer vision
  - Get the dial reading using cameras

DIAL READING USING COMPUTER VISION

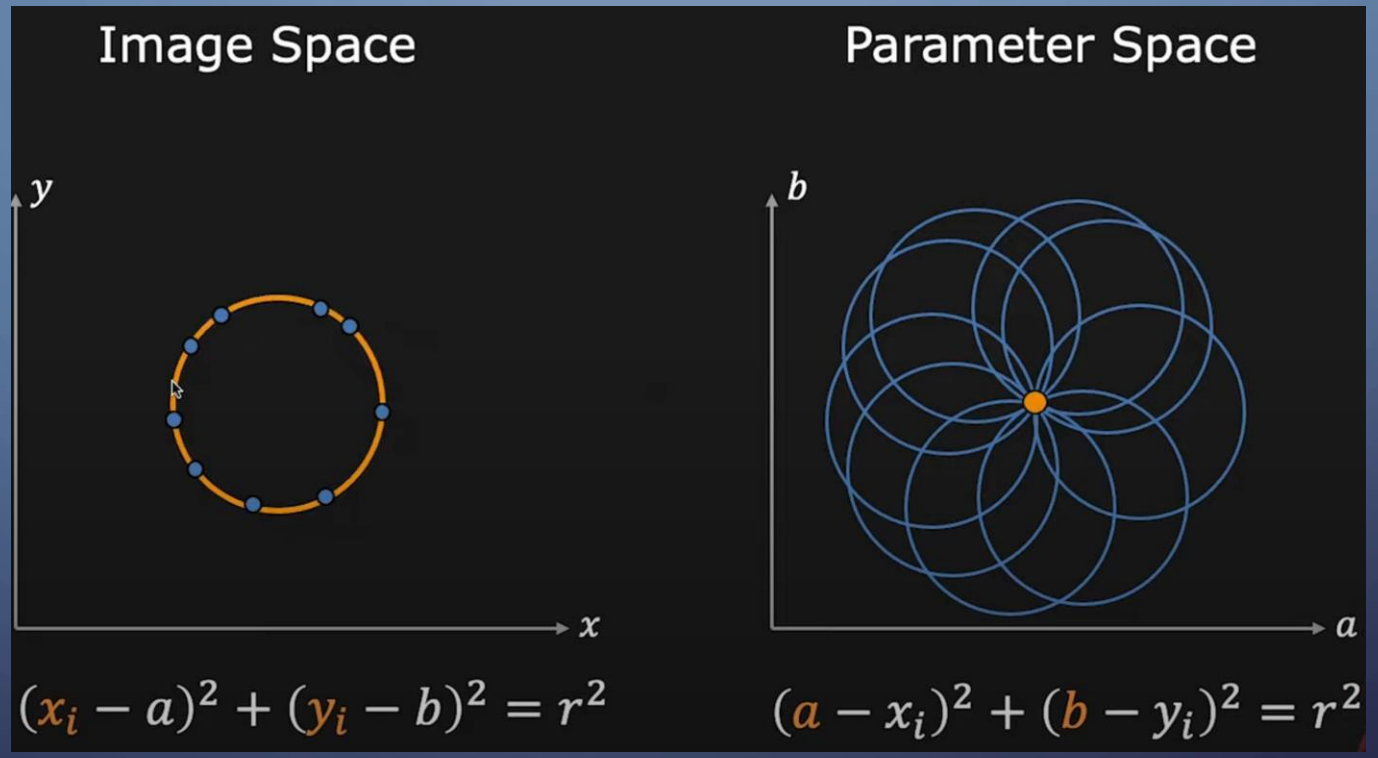
HOUGH TRANSFORM



LINE DETECTION



CIRCLE DETECTION



METHOD

- Load and pre-process the image
  - Gaussian blur
- Detect the circle of the dial
  - Average the center and radius of all detected circles
- Crop and mask the image
- Detect the line of the needle
  - Use canny edge detection to filter out irrelevant information

DEMO

A PYTHON JUPYER NOTEBOOK DEMO

EVALUATION

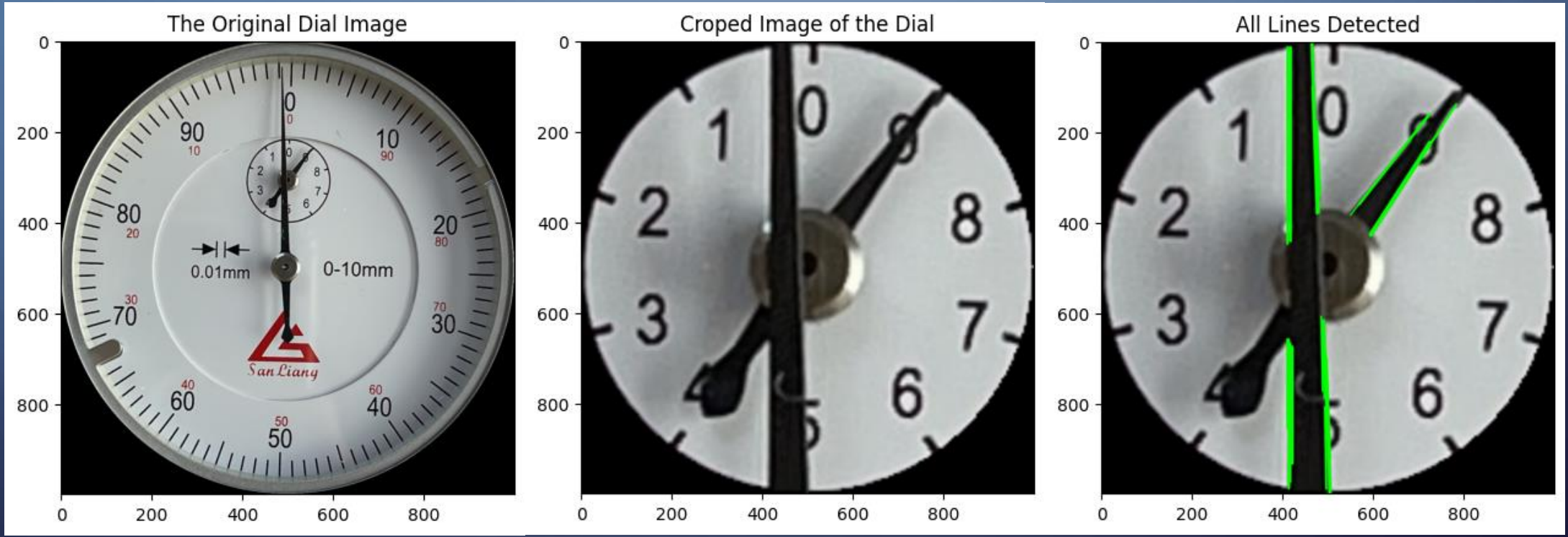
PROS

- Has the least interference of existing mechanical structure
- Lower cost: ~14 cameras to cover the whole turbine head cover

CONS

- Need to tailor the parameters for a specific dial
- Hard to read the revolution counter on the large dial
  - Low resolution
  - occlusion

OCCLUSION ISSUE



FUTURE WORK

FUTURE WORK

- Experiment with ellipsis detection using Hough Transform
- Recognize the text and numbers on the dial
  - Automatically detect the range and resolution of the dial indicator
- Try to solve the occlusion issue using a deep neural network
  - Collect data set
  - Train the neural network

PLAN FOR NEXT MONTH

PLAN FOR NEXT MONTH

- Compose the final report

FEEDBACK

FEEDBACK

- The advantage of this computer vision method is that it causes the least interference to the existing mechanical structure.
- Dr. Fae Azhari did not think a generic algorithm applicable to all different kinds of dial indicator is necessary. We can tailor our algorithm to a specific dial indicator (I think we can create a bundle sale from marketing perspective).
- This method is quite promising. Further research can be continued if time permitted.
  - Ellipsis detection
  - Text recognition to detect the zero point on the dial
  - How camera view angle affect the dial reading result
    - This paper has an algorithm of angle correction: https://ieeexplore.ieee.org/document/9298886
- If only focusing on the bolt looseness detection, the occlusion issue can be compromised.

REFERENCES

- https://www.pinterest.com/pin/84231455500355348/
- https://slmm.com.sg/industries/hydro-turbine/
- https://youtu.be/XRBc_xkZREg