BOLT LOOSENESS DETECTION METHOD 3: COMPUTER VISION

MScAC Internship
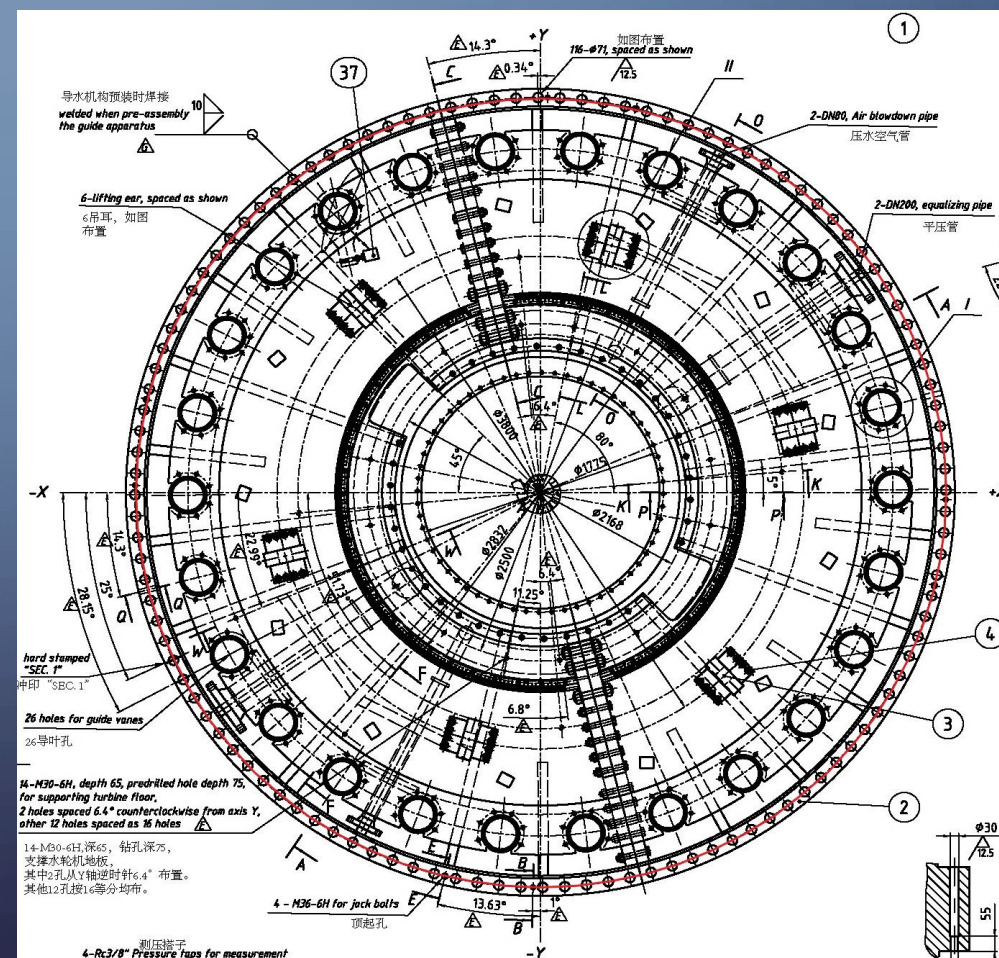
Zhimao Lin

OUTLINE

- Problem reminder

- 3 Potential solutions
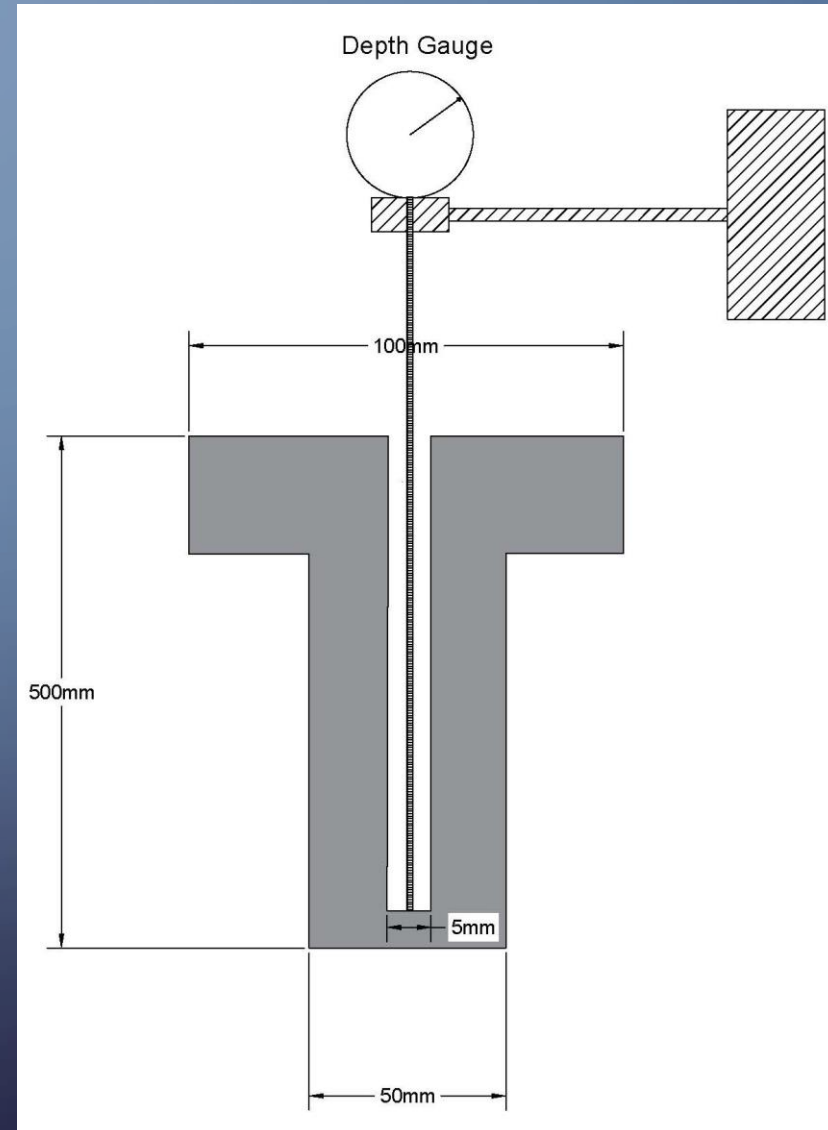 - Method 3: Computer vision

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
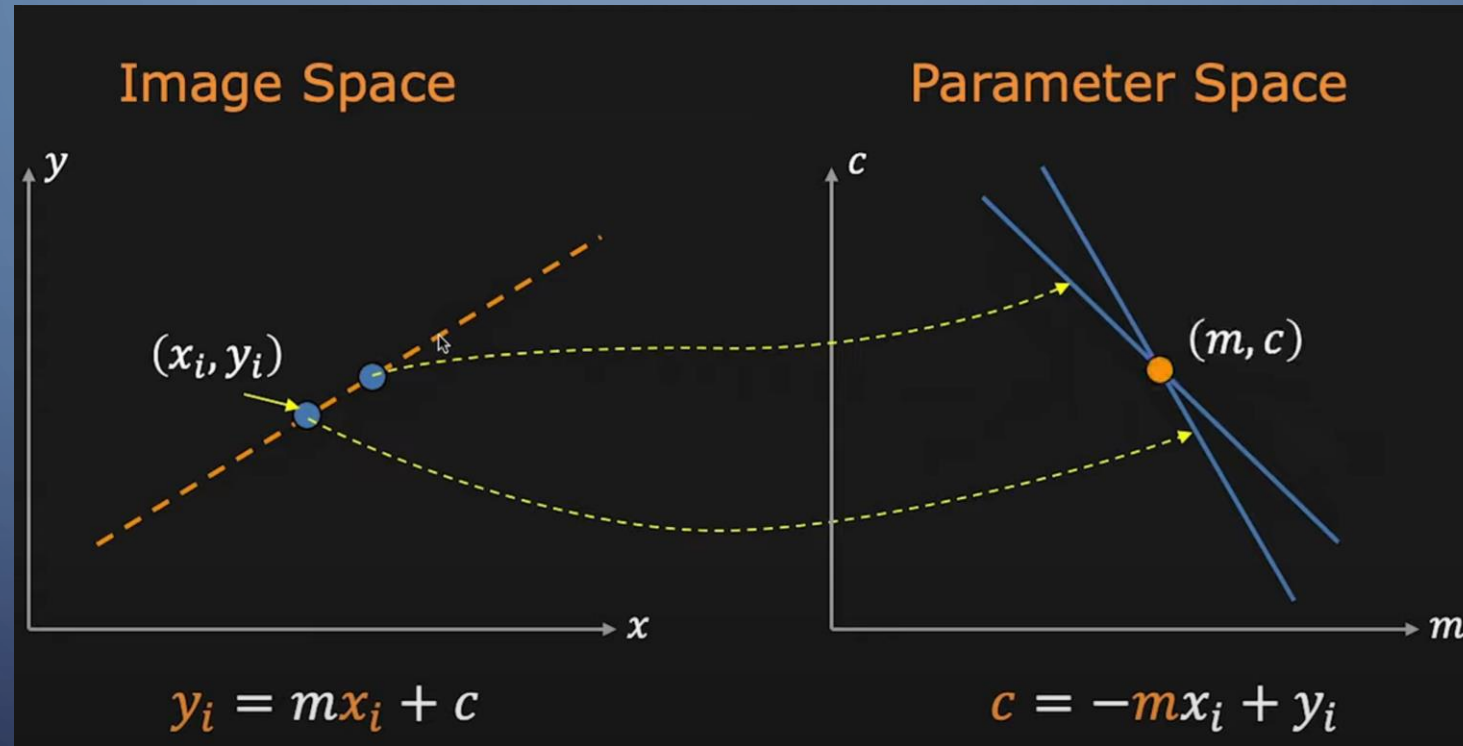
IMAGES OF THE REAL BOLT

3 POTENTIAL SOLUTIONS

3 POTENTIAL SOLUTIONS

- Capacitive sensing

- Acoustic emission detection

  - Blind separation
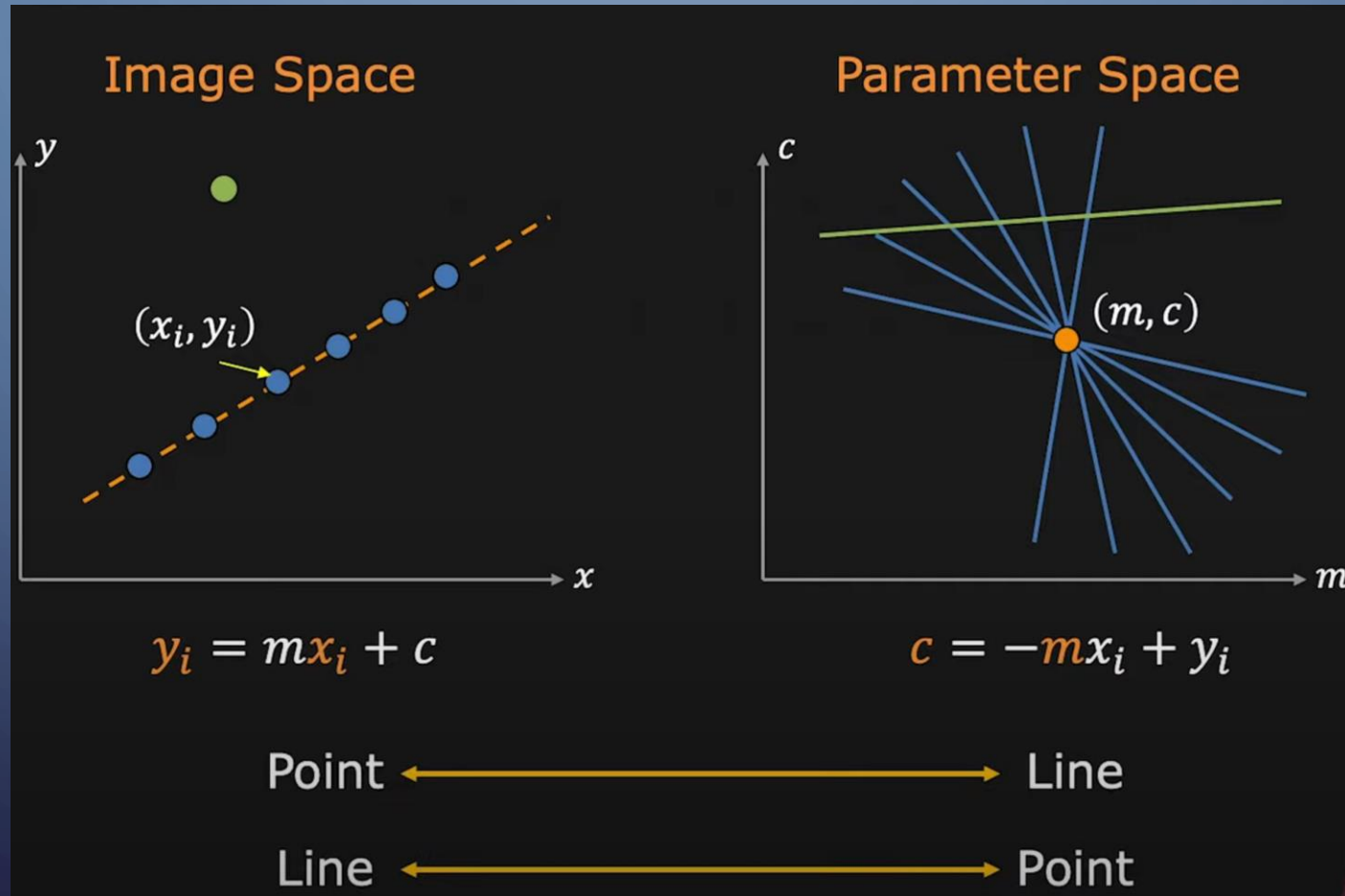
- Computer vision

  - Get the dial reading using cameras
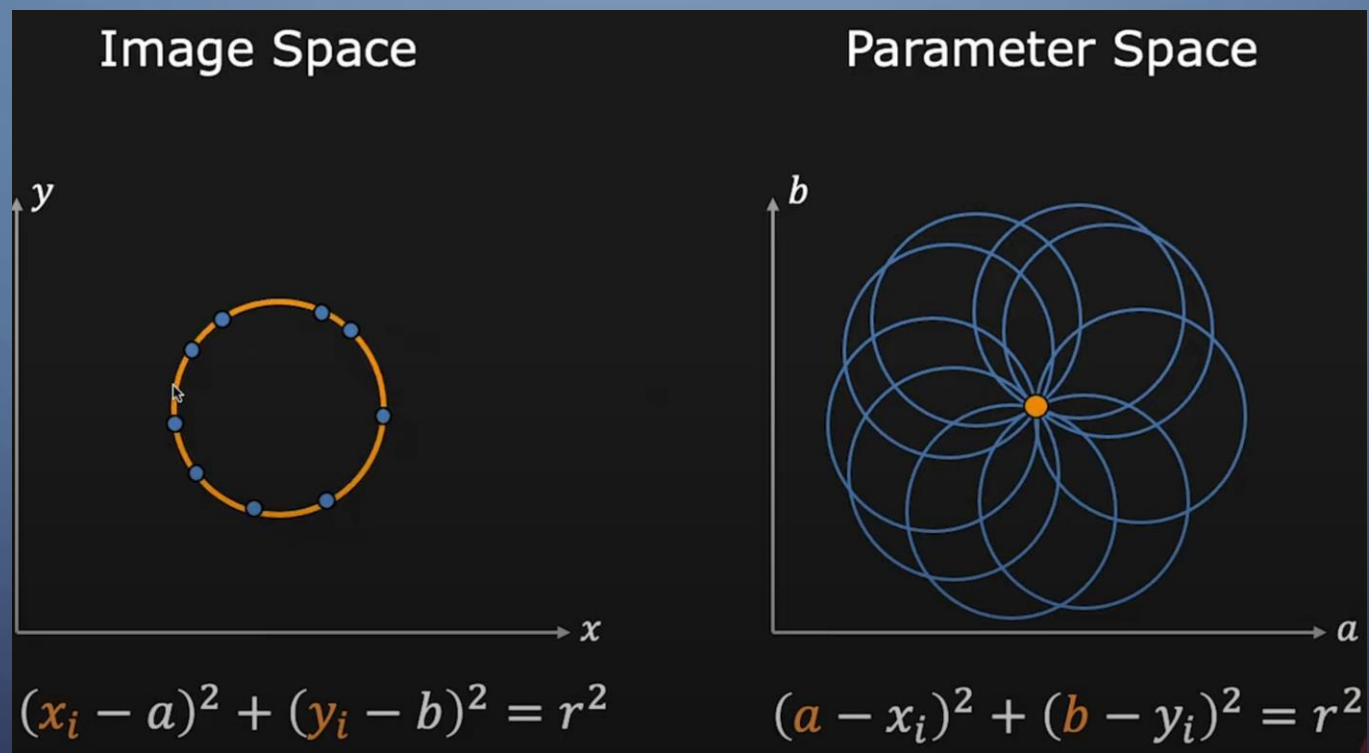

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DIAL READING USING COMPUTER VISION

HOUGH TRANSFORM

Image Space — Parameter Space

$$y_i = mx_i + c$$

$$c = -mx_i + y_i$$

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
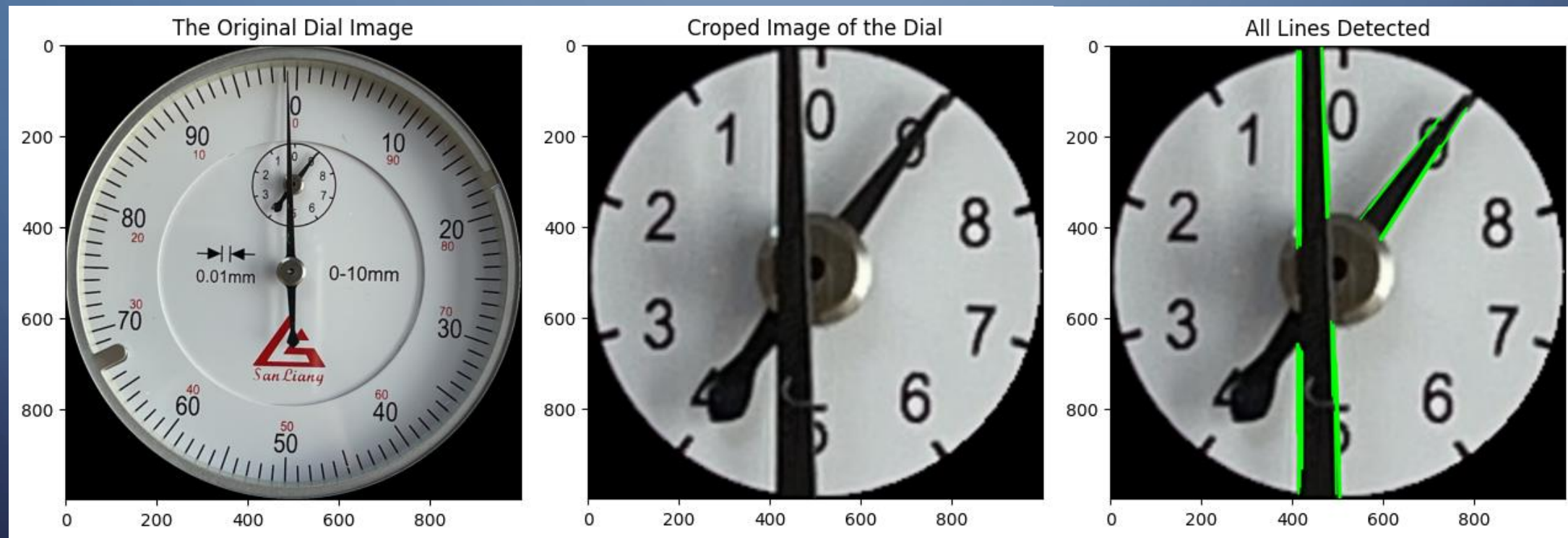
EVALUATION

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

- PhD application

FEEDBACK

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- The advantage of this computer vision method is that it causes the least interference to the existing mechanical structure.

- Dr. Fae 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