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Gear Defect Detection Using Image and ML Process

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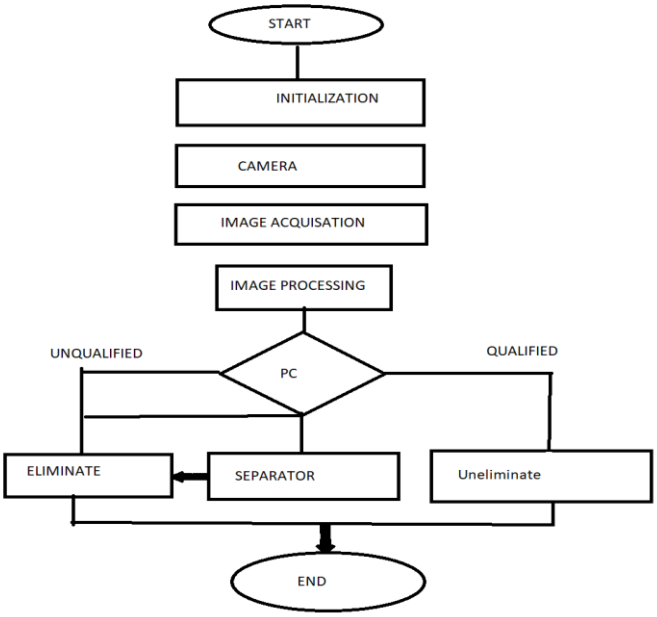
***Abstract*: The accurate measurement of the gears plays vital role in inspection of the gears. In current scenario the tools used for inspection are either expensive or time consuming. Apart from this, some methods of measurement cannot be employed for measurements of gear. The objective in context of problem statement of this project is to develop the Image Processing System for gear profile measurement. The purpose of this project is to use computer vision technology to develop a non-contact and precise system that allows measurement of gear parameters. The python language is used to generate output results in quick time with high accuracy. The different sample gears were tested by this Image Processing system and subsequent results were achieved by python programming. The output results shows that the all gears are inspected significantly in lesser period of time. It also increases the quality and productivity of gear production with reduction in the labour cost and lead time to promote the growth of industry.**

***Keywords* - gear parameters, image processing, python programming.**

I. Introduction:

Machine learning algorithms have been an effective tool for identifying gear flaws in industrial applications in recent years. The Gear is defined as toothed wheels that transmit power and motion from one shaft to another shaft by means of successive engagement of teeth. Gears can be classified as spur gear, helical gear, worm and bevel gear. In industries Fears have wide utilities ranging from daily life applications. All that gears are manufactured with different processes and with different dyes. Also, it is produced in mass quantity. Due to these conditions, it is possible that gears can be directly or indirectly manufactured with defects. These gears are used in transmission systems, so that these defects must be caught before further downstream use. A study of various defect detection techniques and their application to gears is necessary for reducing gear failure. Currently, in various gears manufacturing industries the testing of gears are done by human operation manually for all the gears on which defects are present. However, the accuracy and precision of inspection totally depends upon the operator ability of identifying defects in gear. As one gear can have different types of defects and there are many gears with different profile, different shapes and material characteristics. So the detection of defects can be challenging and time consuming. The system which we proposed is to solve this problem. In our work, we have proposed to use a machine vision-based defect detection system which uses YOLO and CNN algorithms for image processing. This network can automatically capture the required characteristics. It works in two half procedures. For image samples, first the image class is decided based on its background and then whether it contains defective parts or not is indicated. Our model works very fast and quality of inspection is also very high. As soon as defect detected the separator gets actuated and defected parts gets separated.

2.METHODOLOGY:



CALCULATIONS OF FABRICATED SYSTEM :

Conveyor
Speed of the belt:

$$U=\frac{\pi \times D \times N}{60} \text{ m/s}$$

$$U=\frac{3.14\times 0.230\times 30}{60}$$

$$U=0.361 \text{ m/s}$$

Length of belt

$$L=2.C+\frac{\pi(d\times D)}{2}+\frac{(d-D)^2}{4C}$$

C= Center to center distance C=0.85m

D=Large pully diameter

D=small pully diameter

$$L=2\times 0.85+\frac{\pi(0.230+0.230)}{2}+\frac{1}{4(\times 0.85)}(0.230-0.230)^2$$

L=1.7 m

$$T = \frac{1}{2} D\,(f + \omega\, Wg)$$

T= Torque

D= roller diameter

W= Mass of load

g= Gravity acceleration (m/s^2)

$\omega = Friction\ co\ efficient$ (0.05)

F= external force

$$T= \frac{1}{2} \times 0.230 (10 + 0.05 \times 1 \times 10$$

$$T= 0.5\times0.230 (10 + 0.05 \times 10)$$

$$= 0.5\times 0.230 (10 + 0.5)$$

$$= 0.5\times0.230 \times 10.5$$

$$T= 1.2075$$

Wiper motor

Power = 120w Speed = 30 rpm

V = 12 v dc

$$P= \frac{2 \pi nt}{60}$$

$$120 = \frac{2\times\pi\times30 .T}{60}$$

$$\frac{120\times60}{2\times\pi\times30} = T$$

$$T= 38.197 \text{ Nm}$$

So, motor selected for conveyor is justify.

3.Execution Plan:

Our model of gear defect detection unit consist of belt conveyor mounted on the table, and upper side there is a strip attached to if on which webcam is fixed, 12 watt dc motor is used to drive the belt conveyor and same motor is used for the separator (Rack and pinion) module to separate the defected gear from the belt conveyer. Conveyer belt is attached to the frame with the help of pedestal bearing. And the control unit Arduino is located beside it. The gear size of the gear to be tested will be up to 80 mm in outer diameter as we fed gear from one side as soon as it reaches at the down of camera will get pictures webcam will capture it images and feed to the Arduino model with the help of data bus after the image processing module will check for three defects .Measure the outside diameter Any missing teeth on gear and 3. Scratches on gear decide the gear is defected or not feed the signal to the separator if it is defected, separator will separate it otherwise it follows the same path of conveyer belt and going forward not separated, thus the module will work.

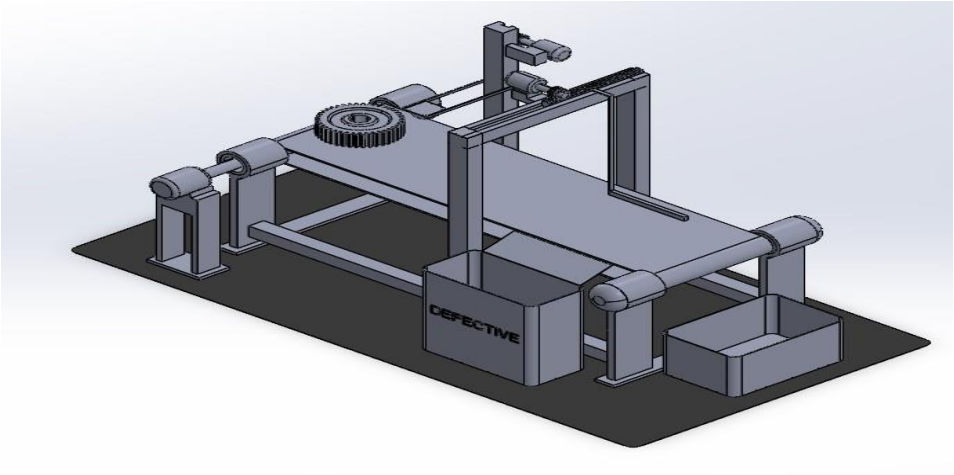


Fig .3.1 Complete assembly of the gear defect detection system with belt conveyor.

4. RESULT

Above images are collected from the module which shows Defective and Non-Defective Results. The model was trained by the gear size of outer diameter 117mm and number of teeth was 20.

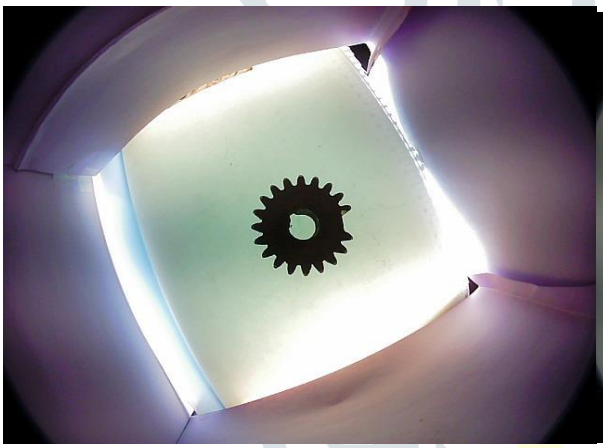


Fig.4.1 Defective gear

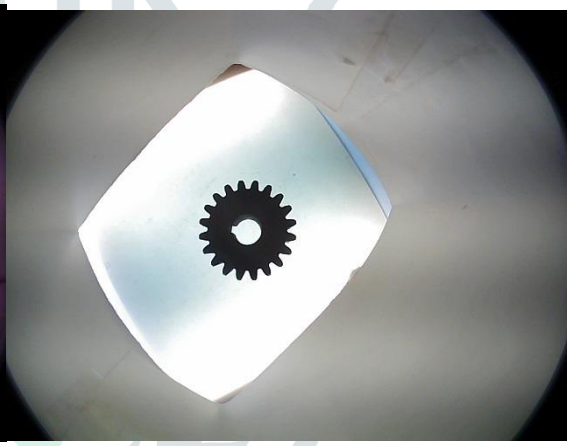


fig.4.2 Non-defective gear

In case of non-defective image, while the image was fed by the module with the help of camera, it shows outer diameter value in mm and teeth count are 117 and 20 respectively. Hence the message was shown as non-defective. In case of defective image, After its feeding it measures outer diameter in mm and number of teeth are 113 and 19 respectively. The values were not match to non-defective image values, hence it shows Defective message and separated from conveyor with the help of separator.

5.Future Scope:

Gear defect detection using machine learning and image processing is an important area of research and development, and there is a lot of potential for future growth and expansion in this field. Some potential future scope and applications of this technology include: Automation: The use of machine learning and image processing for gear defect detection can help automate the process, leading to faster and more accurate inspections. This can help increase productivity and reduce costs. Quality control: Gear defect detection using machine learning and image processing can be used for quality control in manufacturing, ensuring that all gears produced meet the required standards. Predictive maintenance: By detecting defects in gears early, machine learning and image processing can help prevent costly breakdowns and unplanned downtime. This can lead to significant cost savings for businesses. Non-destructive testing: Gear defect detection using machine learning and image processing is a non-destructive testing technique that can help identify defects without damaging the gears. This can help extend the life of gears and reduce waste.

6.Conclusion:

In conclusion, employing machine learning to detect gear defects is a potential strategy for enhancing maintenance procedures in industrial applications. Compared to conventional methods, machine learning algorithms have advantages including early defect detection and adaptability to changing operating conditions. This may result in less downtime, cheaper maintenance costs, better safety and dependability, and ultimately higher productivity and financial success.

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