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DESIGN AND DEVELOPMENT OF GEAR TESTING & SEGREGATION CONVEYOR BY USING MATLAB

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ABSTRACT :- Gears are one of the most common mechanisms for transmitting power and motion. Error in gears causes two main problems, increased acoustic noise in operation and increased wear, both of which are sufficiently troublesome to cause concern. Therefore, precision measurement of gears plays a vital role in gear measurement and inspection. The current methods of gear measurement are either time consuming or expensive. In addition, no single measurement method is available and capable of accurately measuring all gear parameters while significantly reducing the measurement time. Computer vision-based methods typically need to determine the coordinate of the centre of the gear as a benchmark, so the accuracy of centre detection directly affects the precision of the measurement of gear parameters. Among the traditional methods of image detection, the centre detection algorithm generally requires an edge detection method to determine the edge of the gear, and then uses the gravity method, the median method, and the Hough transform method to determine the centre of the gear. The first two algorithms require more evenly distributed images; otherwise, they will lead to considerable errors. The latter algorithm requires voting point-by-point and requires more time to record, yet the accuracy is not high enough for industrial standards The aim of this work is to utilize computer vision technology to develop a non-contact and rapid measurement system capable of measuring and inspecting most of spur gear parameters with appropriate accuracy. The vision system has been established in the metrology lab and it is used to capture images for gears to be measured or inspected. Software (named Gear Vision) has been especially developed in-house using Microsoft Visual C++ to analyze the captured images and to perform the measurement and inspection processes.

Keyword: Component inspection, Sagrragation, METLAB, C++, Area Calculation, Gear Diametre, Teeths.

I. INTRODUCTION

As a common power transmission device, the gear has played an essential role in the historical development of industry, and gear quality has a direct impact on the performance of mechanical products. Therefore, product quality must be tested and controlled rigorously in the manufacturing process of gears. Because of the geometric shape of the gear itself, the measurement process to find faults, such as grinding gears, missing teeth, and crooked gears, is complex. Moreover, the structure of the regular measuring equipment, such as the three-coordinate measuring machine and the gear integrated error checking instrument, is complex and the process is expensive, requiring a relatively high number of personnel for testing. The development of the modern manufacturing industry also requires a higher rate of fault detection in gear products. Therefore, there is a demand to find a way to rapidly measure and analyze gear parameters during actual production.

Computer vision technology, a new non-destructive testing means, has gradually become an effective way to achieve product quality monitoring and fault diagnosis, showing promise in gear measuring technology. When compared to the traditional means of detection, visual inspection has the advantages of not making direct contact, having fast speed, and having a strong anti-interference ability at the site. These advantages greatly reduce the work intensity required by testing personnel and reduce subjective errors in aiming, reading, and improving the efficiency and accuracy of measurement. Computer vision-based methods typically need to determine the coordinate of the centre of the gear as a benchmark, so the accuracy of centre detection directly affects the precision of the measurement of gear parameters. Among the traditional methods of image detection, the centre detection algorithm generally requires an edge detection method to determine the edge of the gear, and then uses the gravity method, the median method, and the Hough transform method to determine the centre of the gear.

1.1 WORKING PRINCIPLE

PC is the main unit of the project. I / O devices are connected to a computer's parallel port. Image processing is a signal processing in any form, with an input of an image, such as a photo or a video recorder; the image processing output may be an image or a set of attributes or parameters associated with the image. Most image processing methods include image processing as a two-dimensional signal and the use of standard signal processing methods. Matlab software process that images by using algorithm and confirm the gear geometry.

The vision system has been established in the metrology lab and it is used to capture images for gears to be measured or inspected. Software (named Gear Vision) has been especially developed in-house using Microsoft Visual C++ to analyze the captured images and to perform the measurement and inspection processes.

II. PROBLEM STATEMENT

Gears have a wide variety of uses in mechanical and electrical industries and need to be perfect and flawless. Different features such as number of teeth, pitch circle diameter, module, addendum, duodenum, face width define the correctness and application in sense where these gears are to be used. This task of checking and classifying gears are done by humans but have limitations of speed and accuracy. This responsibility of classification of items can be accelerated and made more accurate by the use of imaging technology and computers aided by some mechanical devices.

In this project we are detecting various parameters of spur gear from which we can compare it with standard dimensions to find the errors in gear. This is going to be done with the help of MATLAB.

2.1 OBJECTIVE

The main objective of this research is to find mechanism of automating the process of mechanical component quality assurance. The objective of this paper is to develop setup which can help us test and select spur gear with required dimensions. System also consists of arrangement which can reject spur gear. This whole process is to be made automated, accurate and fast image processing system which could identify defects of gear.

III. METHODOLOGY

We have developed MATLAB code by using image processing, read the image original gear object and converted original gear object into gray scale image, and then calculated the threshold value of gray scale image and by using threshold value we have converted the gray scale image into binary image. After this process it has removed small objects from the binary image, to overcome the holes of the object it has filled the holes of binary image object, then calculated the surface of binary image of gear object, showing the area of gear object here it is measured. The code has sequenced in this way, it has measured the properties of the image object regions, after that we have convex the polygon which are in regions, finally it is converted into regions of interest to the regions mask through which it has been highlighted the region with lines which indicates the teeth region of a gear object obviously through this. The first two algorithms require more evenly distributed images; otherwise, they will lead to considerable errors. The latter algorithm requires voting point-by-point and requires more time to record, yet the accuracy is not high enough for industrial standards. To resolve these issues, we propose a program based on the automatic analysis of gear parameters, using the mathematical morphology

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method. That is, we input a gear image into the computer and then extract gear features through an image processing algorithm. This isolates the gear from a variety of complex backgrounds, allowing automatic counting and size measurement of the gear teeth. Using this method, we achieve good results in the production application.A system for identifying surface defects on gear was designed, based on analyzing images acquired from top of the gear.

3.1 PROTO-TYPE

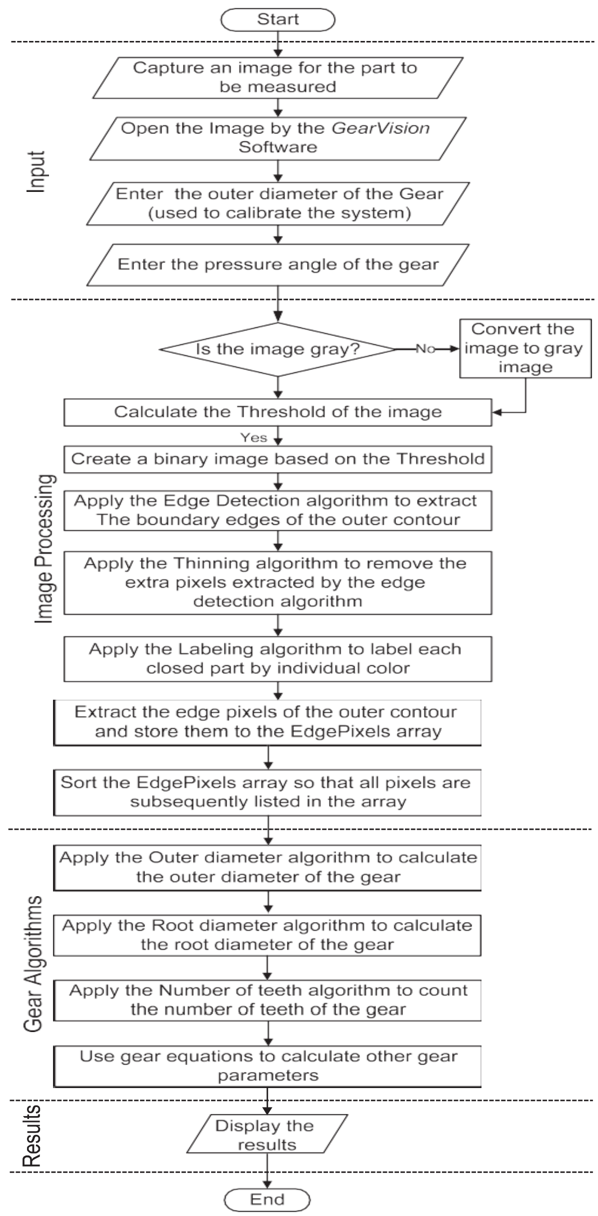

Fig.1. Flow chart

3.2 OVERALL STRUCTURE OF SYSTEM

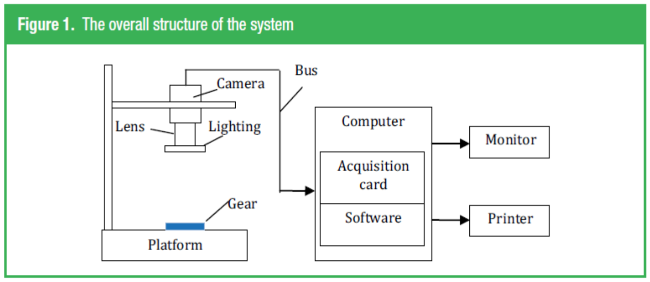

Figure 1. The overall structure of the system

Fig.2. Structure

3.3 TERMINOLOGY OF SPUR GEAR

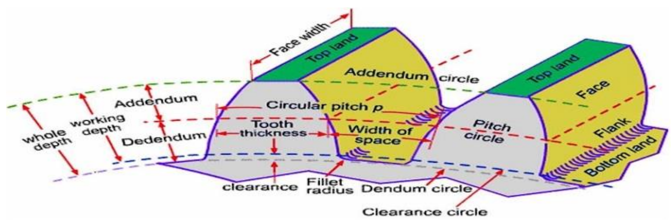

Fig.3. Terminology of Gear

The following **terms** are related to spur gears:

Addendum: The height of the tooth above the pitch circle.

Backlash: The clearance between two mating teeth of separate gears.

Base circle: A theoretical circle used to generate the involute curve when creating tooth profiles.

Center distance: The distance between the center shafts of two gears.

Table 1. Formulas for Gear Parameter Calculation

Formulas for determining some of these terms include:	
Addendum	1.0 ÷ diametral pitch
Clearance	0.157 ÷ diametral pitch
Diametral Pitch	Number of teeth ÷ pitch diameter
Number of Teeth	Pitch diameter * diametral pitch
Outside Diameter	(Number of teeth + 2) ÷ diametral pitch
Pitch Diameter	Number of teeth ÷ diametral pitch
Tooth Thickness	1.5708 ÷ diametral pitch
Whole Depth	2.157 ÷ diametral pitch
Working Depth	2÷ diametral pitch

Chordal addendum: The distance between a chord, passing through the points where the pitch circle crosses the tooth profile and the tooth top.

Chordal thickness: Tooth thickness measured along a chord passing through the points where the pitch circle crosses the tooth profile.

Circular pitch: Measurement of the pitch circle arc length from one point on a tooth to the same point on the adjacent tooth.

Circular thickness: The thickness of the tooth at the pitch circle.

Clearance: The space between one gears minor diameter and the mating gears major diameter.

Dedendum: Depth of the tooth between the pitch circle and the minor diameter.

Diametral pitch: The number of teeth per inch of pitch diameter.

Root (or dedendum) circle: The minor diameter of the tooth.

Velocity ratio: Ratio of input gear revolutions to output gear revolutions within a specified amount of time.

Whole depth: The height of the tooth from major diameter to minor diameter of a gear.

Working Depth: The depth to which a tooth extends into the space between teeth on the mating gear.

Chordal addendum: The distance between a chord, passing through the points where the pitch circle crosses the tooth profile and the tooth top.

Chordal thickness: Tooth thickness measured along a chord passing through the points where the pitch circle crosses the tooth profile.

Circular pitch: Measurement of the pitch circle arc length from one point on a tooth to the same point on the adjacent tooth

3.4 PROTO TYPE DETAILS

The image processing algorithms shown in figure 2 were discussed in details in a previous work. In short, the process starts by opening the image of the gear to be measured. If the opened image is colored, then it will be converted into gray scale image. The gray image is converted into binary image based on a calculated threshold. After creating the binary image, an edge detection algorithm is applied to the binary image to extract the edge pixels, which represent the boundaries of the gear elements.

A thinning algorithm is then applied to the edge pixels in order to remove extra pixels obtained by the edge detection algorithm. Next, a labeling algorithm is applied to the thinned image in order to mark each set of connected pixels by a unique label. As a result, the outer contour, which represents the profile of the gear teeth, can be distinguished from other contours such as the gear's hole or the internal slots. Once the outer contour is labeled, its pixels are extracted and a sorting algorithm is applied to sort the pixels sequentially according to the distances between each two successive pixels. At this point, the coordinates of the pixels constituting the outer

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profile of the gear (teeth profile) are known and it is required to develop some computer vision algorithms capable of utilizing these data to measure the spur gear parameters.

It is well known that many of the gear parameters are correlated to each other by known equations. For example, the pitch circle diameter (*D*) is correlated to the number of teeth and the dimensional pitch while the module (*m*) is correlated to the pitch circle diameter and the number of teeth. In this situation, three computer vision algorithms were developed to calculate the outer diameter, the root diameter and the number of teeth of the gear to be measured, then other gear parameters are calculated using their equations based on these parameters.

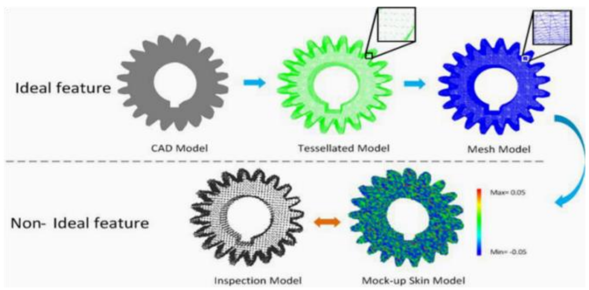

Fig.4 Features In Gear

IV. EXPERIMENTAL SETUP

4.1 EXPERIMENTAL SET UP

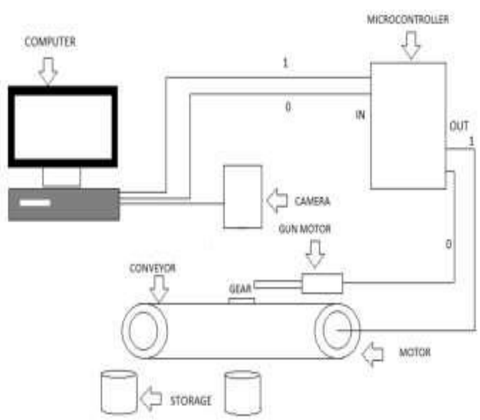

Fig 5. Experimental Setup

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SPECIFICATION

4.1.1 CAMERA FOR PROCESSING-

Fig 6. Camera for Image Captured

Model Name –FSB2KU7GES-F
Brand - Omron
Video Capture Resolution - 2048p
Connector Type – SERIAL/ETHERNET
Shooting Modes - Automatic
Item Weight - 250 Grams
Optical Sensor Technology - CMOS

4.1.2 MICRO-CONTROLLER USE –ARDUINO UNO (ATMEGA 320P)-

This kind of set up use for Image Processing to gear verification.
In ARDUNIO UNO we using ATMEGA 320 P Micro-controller programming with CAD Model Setup.

Fig 6. Micro-controller ATMEGA 320 P

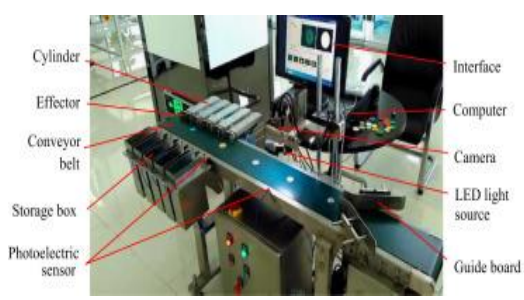

Fig 7. Photograph of the proposed vision system

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V. DESIGN OF PROJECT

5.1 3-D CAD MODEL

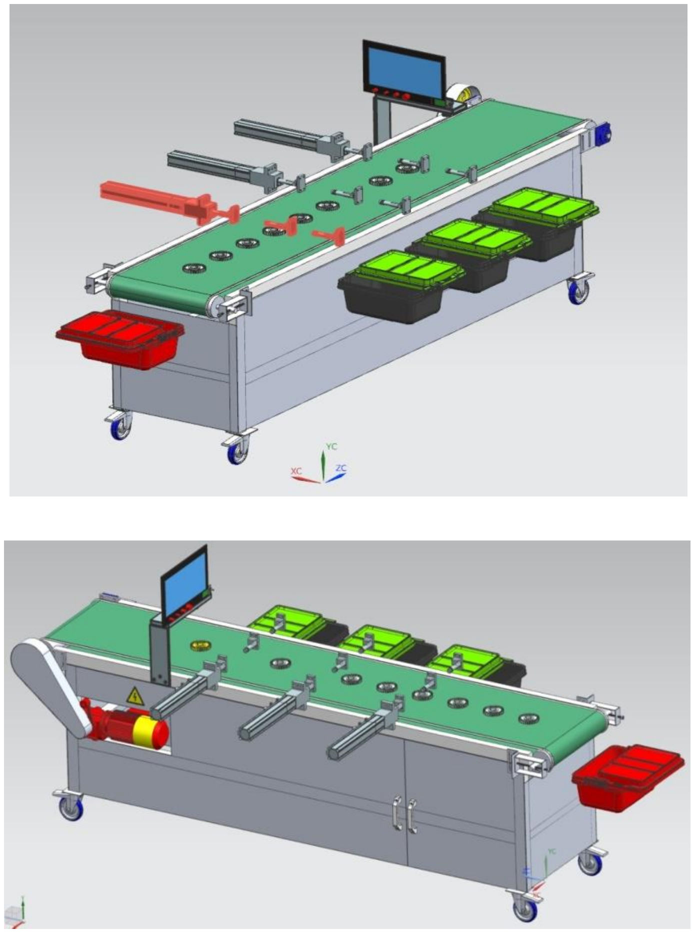
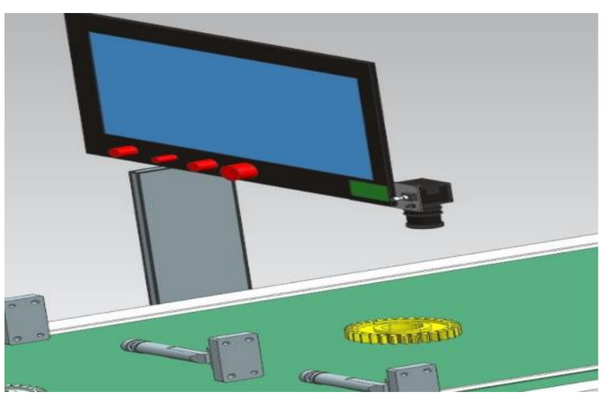


Fig 8. 3D CAD Model



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Belt scraper- It is a blade or brush caused to bear against the moving conveyor belt for the purpose of removing material sticking to the conveyor belt.
Crowned pulley- It is a pulley which tapers equally from both ends towards the canter, the diameter being the greatest at the Centre
Feeder- It is a conveyor adapted to control the rate of delivery of packages or objects.
Flat face pulley- It is a pulley on which the face is a straight cylindrical drum i.e. uncrowned.
Flow- it is a device positioned across the path of a conveyor at the correct angle to discharge or deflect objects.
Return idler- It is a roller which supports the Return run of the belt.
Roller- It is a round part free to revolve about its outer surface.
Snub pulley- It is a roller or pulley used to increase the arc of contact between a belt and drive pulley.
Speed reducer- It is a power transmission mechanism designed to provide a speed for the driven equipment less than that of the prime-mover. Generally, they are totally enclosed to retain lubricant and prevent the entry of foreign particle.
Take-up or tensioning device- It is the assembly of the necessary structural and mechanical parts which provide the means to adjust the length of belt and chain to compensate for stretch, shrinkage or wear and to maintain proper tension.
Angle of surcharge- It is the angle measured with respect to the horizontal plane of the surface of material being conveyed by moving a belt. It is normally between 5 to 20. It is always less than the angle of repose because of the tendency of the material to slump as it is conveyed. It mainly depends upon the belt speed and type of material to be conveyed.
Angle of repose- It is the angle which the surface of a normal freely formed pile of the material makes with the horizontal. It is important to find the profile of a stock pile.
Bend pulleys- These are used to increase the angle of wrap of belt and overall for all the necessary changes in belt direction in the areas of counterweight tensioner, mobile unload.

Table 2 -Comparison between design and calculated values of the different parameters of two sample spur gears.

No.	Parameter	Symbol	Test gear 1 (/ = 20)			Test gear 2 (/ = 14.5)		
			Design	Calculated	Difference	Design	Calculated	Difference
1	Outside diameter	D_o	108.000	108.003	0.003	156.000	156.004	0.004
2	Root diameter	D_R	81.000	81.074	0.074	129.000	129.101	0.101
3	Number of teeth	N	16.000	16.000	0.000	24.000	24.000	0.000
4	Diametral pitch	P	0.167	0.167	0.000	0.167	0.167	0.000
5	Pitch circle diameter	D	96.000	96.000	0.000	144.000	144.000	0.000
6	Module	m	6.000	6.000	0.000	6.000	6.000	0.000
8	Circular pitch	P	18.850	18.850	0.000	18.850	18.850	0.000
9	Addendum	A	6.000	6.002	0.002	6.000	6.002	0.002

VI. CONCLUSION

This paper proposes a pre-processing method for the original deviations of tooth profiles according to the characteristics of the outliers from the tooth profiles and the features of the involute gear profile error detector model and establishes a model of outlier detection and correction for the deviations of tooth profiles.

The Conclusions are as follows.

The inner and outer diameter of the gear and also tooth profile have been checked.

The involute gear profile error detector model automatically detects the outliers of the deviations obtained from tooth profiles, so it improves the measurement precision of the tooth profiles. The analytical outputs and the tooth profile for the Spur Gear were obtained by using MATLAB software and the given outputs also suggest that the designed Spur Gear was either safe or unsafe. In fabricating this project, involute profile error checking machine. The project has been properly preplanned and cost estimated to be completed within the time limits, with less cost to an efficient working condition. Finally, we have this paper completed successfully at a lower cost using available materials. This machine serves all small-scale gear manufacturing industries that have so far been deprived of getting the benefit of the conventional involute checkers due to its high cost and complexity. By measuring the involute profile error and making corrective measures, the gear manufacturers can deliver precision gears, which render good power and torque transmission at constant velocities. It is a real boon for all of them who strived to achieve perfection in manufacturing high precision spur gear at an unimaginable cheaper cost without any compromise for accuracy.

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