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Design and Fabrication of Involute Gear Profile Error Detector System Using Mechatronic System For Industrial Aplication: A Review

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Abstract: *The accurate measurement of the gears plays an important role in measuring and checking the gears. The tools currently in use are either time consuming or expensive. In addition, some measurement methods can not be used and this allows accurate measurements of all gear ratios, but significantly reduces the time. The purpose of this document is to use computer vision technology to develop a non-contact and rapid metering system that allows measurement and control of most gear parameters and accuracy. The vision system is created and used to measure measured or controlled gear wheels. The built-in vision device is calibrated with metrics, then verified by measuring two sample strokes and calculating the comparison of parameters with the actual values of the fishing parameters. For small gears, greater accuracy and small differences can be achieved. The objective of this paper to study the existing methods for checking the gear profile measerment.*

Keywords: *gear parameters;image Processing;MATLAB;*

I. Introduction

Gears are one of the most commonly used to transmit movements and power. For most modern industrial and transport applications, fishing gear is important and often used as a key factor. Injuries in the production of gears cause two major problems, increased acoustic noise and increased wear, which are both cumbersome to cause a worry[1]

In order to better control the accuracy of fishing gear, it is important to accurately measure gear ratios. Spur gears are the majority of all types of gear used; therefore, the gear measurement process automatically accelerates to a permanent target. The actual dental deviation design profile, profile error, can be measured in several ways. The easiest way is to measure gear rails in many places using a custom caliber. Another method is to measure with a moving probe, with a biasing signal transmitted to imitate the design profile. There are many mechanical tire testing systems available, but these systems are not suitable for smaller gears. Some tests have been designed to measure smaller mechanical elements for suitable probes. The alternatives use a coordinate measurement machine to measure the actual profile or roller discs in a stationary sample. The current gear measurement method is either time consuming or expensive. In addition, no measurement method can be used and allows accurate measurement of all gear parameters, but significantly reduces the time of the measurement. Therefore, many researchers have emphasized the measurement and control of spiral equipment. Recently, vision systems have been widely used in many applications. For the quality control, computer systems have been developed that are being used as objective -measurement and evaluation systems. Robinson et al. The design of the synchronized gearbox control system described in which measurements were made using a video camera and image analysis software. They were investigating the accuracy and possible sources of errors. They concluded that the measurement accuracy was comparable to the methods used to control the current gear's tolerance. In addition, an inexpensive and easy-to-use image analysis system is an attractive alternative. Sung et al uses wavelengths to pinpoint the position of the teeth in the ratchet system with high precision. They reported that the use of such an approach could improve the detection capability of the transmission system, especially if the defective device rotates with other gears at an angle. The purpose of this document is to use a multi-contact viewer to develop metering systems on a computer that allows you to measure most of the rhythm parameter with reasonable accuracy. This can facilitate and accelerate the process of catch measurement and control. [2]

For the present project we studied the following papers, to study the various automatic measurement techniques for gear profile error. Abdallah A. Alshennawy, and Ayman A. Aly, "Edge Detection in Digital Images Using Fuzzy Logic Technique" [1] The fuzzy technique is an operator introduced in order to simulate at

a mathematical level the compensatory behavior in process of decision making or subjective evaluation. The following paper introduces such operators on hand of computer vision application.

In this paper a novel method based on fuzzy logic reasoning strategy is proposed for edge detection in digital images without determining the threshold value. The proposed approach begins by segmenting the images into regions using floating 3x3 binary matrix. The edge pixels are mapped to a range of values distinct from each other. The robustness of the proposed method results for different captured images are compared to those obtained with the linear Sobel operator. It is gave a permanent effect in the lines smoothness and straightness for the straight lines and good roundness for the curved lines. In the same time the corners get sharper and can be defined easily.

Wuyin Jin, Hongru Du, Xia Zhang and Jingping Hu, "Development on Inspection System for Gear's Dimension Based on Machine Vision" [2] A noncontact inspection system for gear based on machine vision is developed in this work, according to the mathematical model of lens distortion; the calibration of the camera was realized by the MATLAB calibration toolbox, obtained the distortion coefficients, by which the pixel is proofread. After then the key parameters of gear could be automatically acquired with proposed algorithm. In this work, the algorithm is applied to a practical case of a standard spur gear; the experimental results reported here confirm the effectiveness of the approach.

E.S. Gadelmawla, "Computer vision algorithms for measurement and inspection of spur gears" [3] 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. The aim of this paper is to utilize the computer vision technology to develop a non-contact and rapid measurement system capable of measuring and inspecting most of spur gear parameters with an appropriate accuracy. A vision system has been established and used to capture images for gears to be measured or inspected. A 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. The introduced vision system has been calibrated for metric units then it was verified by measuring two sample gears and comparing the calculated parameters with the actual values of gear parameters. The maximum differences between the calculated parameters and the design values were ±0.101 mm for a spur gear with 156 mm outside diameter. For small gears, higher accuracy could be obtained and a well as small difference.

Dr.raghu, kumar, niraj tiwari, devendra kunwar r., r vara lakshmi , mohan chhetri, "transmission error on spur gear" [4] This study is characterized by gearbox transmission, including contact data analysis, bending stress, impact strength, and transmission error. The problem of widely circulated gears in an electric mass transfer system is usually characterized by one or more high-power acoustic signals. In order to evaluate the error of the real transmission system due to the geometry of the tool due to the irregular shape of the tool, the two steps are alternately inadequate and so on. Using this gear analysis, the geometry of the tooth profile is used and their modification by the FEM method. Here, the teeth deflection is calculated using flexural pressure, shear stress and fundamental stresses. In this document, the teeth relief modification is calculated by changing the profile using the FEM.

Zhang Jie, Ma Shuyuan, Huang Jie, Long Zhenhai, "A Machine Vision System for Real-time Automated Gear Fatigue Pitting Detection" [5] The machine vision system for the detection of the gear pitting is an essential element for the mechanical fatigue test, because the whole system effectively integrates internal information of the fatigue test to classify the related data into different sort automatically. Therefore, an industrial machine vision for gear pitting detection is proposed in this paper, and an image processing algorithm which mainly consists of image segmentation algorithm and contour computation is presented.

Amandeep Mavi, Mandeep Kaur, "Identify Defects in Gears Using Digital Image Processing" [6] Gear defects are a major reason for poor quality and of embarrassment for manufacturers. 0Inspection processes done on these industries are mostly manual and time consuming. To reduce error on identifying gear defects requires more automotive and accurate inspection process. Considering this lacking, this research implements a Gear.

Defect Recognizer which uses computer vision methodology with the combination of local thresholding to identify possible defects. The recognizer identifies the gear defects within economical cost and produces less error prone inspection system in real time. In order to generate data set, primarily the recognizer captures digital gear images by image acquisition device and converts the RGB images into binary images by restoration process and local threshold techniques. Later, the outputs of the processed image are the area of the faulty portion and compute the possible defective and non –defective gear as an output.

Han Lianfu, Fu Changfeng, Wang Jun, Tang Wenyan "Outlier Detection and Correction for the Deviations of Tooth Profiles of Gears"[7] In order to reduce the effect of measuring dental profiles, this paper suggests a way to identify and correct white theoretical phenomena. After studying the properties of the discovery abnormalities in dental profiles, this paper provides a method for initial processing of modeling data

with varying value and creates a model for detecting and correcting external dentures for abnormal values of dental profiles. The simulation results showed that one and one heterogeneous variable, a separate gray model processed by the pre-treatment method proposed in this document, is more accurate than the one sequence and one variable other than the homogeneous separate gray model and OndGam is more convenient than non-binding rack features.

Haque Nawaz Lashari, Himat Ali Ranjha, "Gear Measurement Using Image Processing in MATLAB" [8] In this paper gear Measurement has been carried out by focusing two features of gear image object. The problems are to measure the gear features of gear image object, in t he sense the measurement of the Area of the gear image object and as well the teeth of the gear will be counted. We have used MATLAB tool and development code which overcome these problems and measured the area as well as teeth of the gear image object counted. To accomplish this task we have measured five different gear image objects area and counted the teeth by using image processing. The experimental results and statistics have been shown in this paper.

Renata Klein, Eyal Masad, Eduard Rudyk, Itai Winkler, "Bearing diagnostics using image processing methods" [9] In complex machines, the failure signs of an early bearing damage are weak compared to other sources of excitations (e.g. gears, shafts, rotors, etc.). The task of emphasizing the failure signs is complicated by the fact that changes in operating conditions influence vibrations sources and change the frequency and amplitude characteristics of the signal, making it non-stationary. As a result, a joint time-frequency representation is required. Previous vibration based diagnostic techniques focused on either the time domain or the frequency domain.

The proposed method suggests a different solution that applies image processing techniques to time-frequency or RPM-order representations (TFR) of the vibration signals in the orders-RPM domain. In the first stage, TFRs of healthy machines are used to create a baseline. The TFRs can be obtained using various methods (Wigner-Ville, wavelets, STFT, etc). In the next stage, the distance TFR between the inspected recording and the baseline is computed. In the third stage, the distance TFR is analyzed using ridge tracking and other image processing algorithms. In the fourth stage, the relations between the detected ridges are compared to the characteristic patterns of the bearing failure modes and the matching ridges are selected. The different stages of analysis: baselines, distance TFR, ridges detection and selection, are illustrated with actual data of damaged bearings

Hariprakash sr "involute gear profile error detector" [10] The purpose of the project is to verify the implementation of the inclusive principle of detecting the error. Usually, if the gears have defects, it will cause more vibration. In order to improve the vibration, we plan to design and fabricate a defective sensor for the profile of the set of gears. The main part of the tractor error profiles fault is the base curtain in which the gear is mounted. The gear is locked with a locking system that has a shaft and is connected to the bearings. The entire locking device is connected to a locking screw device, called locking wheels, which can be rotated manually. It consists of a rod located between the bottom plate and the locking system. The function of the actuator is to keep the base plate in tight hold. Gears are used in many applications.

Digambar S. kale, Ajinkya V. maknikar, "Automatic Material Handling and Sorting of Defective Gear Using Image Processing" [11] Gear is a widely used mechanical component whose primary use is to transmit power from one shaft to other. Gears are of many types namely spur gear, helical gears, worm gears etc. Gear drives are used in various kinds of machines like automobiles, metal cutting tools, material handling equipment's, rolling mills, marine power plants etc. MATLAB is extensively used for scientific & research purposes. It is accurate & also has a number of built in functions which makes it versatile. Gear Measurement has been carried out by focusing two features of gear image object. The problems are to measure the gear features of gear image object, in the sense the measurement of the area of the gear image object and as well the teeth of the gear will be counted. MATLAB tool is used to develop a code which overcomes these problems and measures the area as well as teeth of the gear image object counted.

Seema B Hegde, "Quality Management of Mechanical Parts using Image Processing" [12] Computer vision systems are widely implemented in automatic inspection systems. The quality management of mechanical parts in industries is vital for proper functioning of machineries. Defect detection should be done in pre-production stage ensuring quality control. Real time inspection using manual labor is inadequate, time consuming and non-consistent. Hence there is a need for a system which is built for automatic defect detection, such that it avoids human errors and is comparatively accurate. The system builds a computer vision system which detects the defective objects and segregates it. This paper makes use of an overhead camera mounted at specified height over a conveyor belt, which sends recorded images to the Raspberry Pi. Pattern recognition is performed using Open CV to identify the defective objects moving over a conveyor belt. It identifies defective number of teeth in gears and surface abrasions in metal sheets and thereby helps in quality management.

Naresh K. Raghuwanshi, Anand Parey, "Experimental measurement of spur gear mesh stiffness using digital image correlation technique" [13] Mesh stiffness is the main cause of gearbox vibration. A crack in the tooth of gear reduces the mesh stiffness. Researchers are trying to evaluate the mesh stiffness of healthy and faulty gears by different techniques and modifying the existing techniques for the purpose of vibration based fault detection in gearboxes. Generally, the mesh stiffness is evaluated statically for full mesh cycle and it is used for vibration analysis of the gearboxes. In this paper, a new experimental technique of mesh stiffness measurement by using digital image correlation (DIC) technique has been proposed. The experiments were performed on healthy as well as cracked gears. The obtained results were compared with finite element method (FEM) and analytical method (AM) and showed a good match. The results show that the DIC technique can be used to measure the mesh stiffness.

Sangeet Saha, Chandrajit pal, Rourab paul, Satyabrata Maity , Suman Sau, "A brief experience on journey through hardware developments for image processing and it's applications on Cryptography" [14] The importance of hidden applications in image and video processing, communication and cryptography has more space in the current research period. Improvement of image information for the perceived human perception of vision, such as image removal, movement of memory cards in various areas, such as satellite imagery, medical imaging, etc. Innovative research is a driving force. Specifically, we would like to develop our experience of the importance of computer viruses in one area where hardware loggers work much better than those implemented through software. Integrated Circuits (ASICs) and / or digital signal processors (DSPs) have so far successfully implemented their applications, but the development of VLTS technology is a very powerful hardware, namely, Field Programmable Gates (FPGA), which combines ASICs and DSPs. The core of the program is reprogrammable, which makes them very attractive for creating a fast prototype.

MD. Hazrat ALI, Syuhei KUROKAWA, Kensuke UESUGI, "Vision Based Measurement System for Gear Profile" [15] This research focuses on vision based gear profile measurement system in precision engineering. It mainly discusses the camera system integrated to the measurement apparatus. The system can record the video as well as is able to save the image frames in JPEG format during measurement. Vision based measurement is very useful to increase the performance of the measurement. It can help to analyze the measurement result later on whenever it's necessary to investigate. The system records video and saves image frames in real–time and also it's possible to open the video file in offline mode. In this paper, a vision based inspection system has been proposed mainly for the surface error measurement of various types of gears.

Summary of Review

Now in the measurement technique for gear inspections there are many techniques have been used. In this paper we studied the all techniques used. In most of small scale industries quality checking is done by manually. But it had many problems so we have to atomized the quality checking process

In 2009, Abdallah A. ea al. used the 'Fuzzy Logic Technique' to detect the edge of the component. Then In 2011 Wuyin Jin ea al., Hongru Du ea al., Xia Zhang ea al. and Jingping Hu ea al., inspect the dimensions of a gear with the help of machine vision technique. Again in the same year E.S. Gadelmawla ea al. used the computer vision algorithms to inspect the spur gear. In April-June, 2012 Dr.Raghu, Kumarea al. find out the transmission on spur gear by using FEM Method. Zhang Jieea al. in 2012 again use the machine vision System for Real-time Automated Gear Fatigue Pitting Detection.

In June 2012 Amandeep Mavi ea al. invent the digital image processing technique to detect the effect in the gear profile. Then in 2014 Haque Nawaz Lashari ea al. use the MATLAB for the image processing. Then Renata Klein ea al. use this method for the bearing diagnosis.

So from this review we are using the image processing technique with the help of MATLAB software & mechatronics system for the checking of quality of the gear in the gear manufacturing company.

Problem statement

In the gear manufacturing industries, final gears are going under quality checking process. Nowadays in small scale industry the process of quality checking is done manually. As it check manually there are lots of human errors, like no much accuracy, precession, and other factors like fatigue concentration. & other problem in such industry is for mass production more workers are required to check all the final gears. & it needs more labor cost. Our project can inspect all the gear one by one.

Therefore it is require to atomized the existing method of quality checking with mechatronics system. Our project is the solution of above problem.

Objectives

The clear objectives of this system are to ensure:

- The purpose of the project is to collect the objects desired using a webcam and use unwanted items using a rejection mechanism.
- The conveyor is transported by genetically transferring components from one place to another.
- Minimizing the accompanying staff is necessary.
- Sample size is determined by dimension.

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. When the key is pressed, the Geneva conveyor starts to start. The two rollers are installed according to the required distance when the strap is mounted on the rollers on which the materials are located. The roller shaft is connected to the Geneva drive.

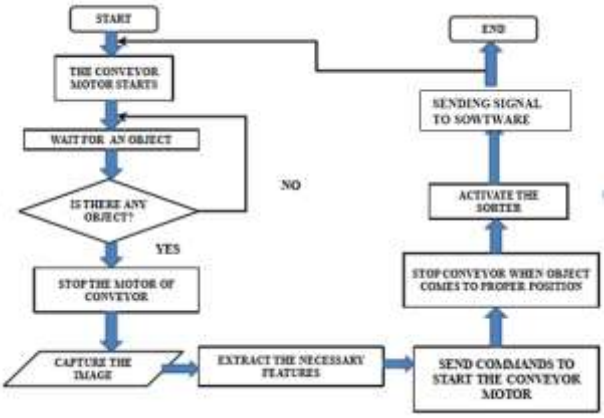

Fig 1 Flowchart of Working Principle

When power is supplied to motor, the motor-driven shaft moves to Gene with some temporary delay and the strap moves along the roller. Therefore material handling takes place. Geneva's drive can help to delay the time. The proximity sensor is used to calculate the rotation of Gene, and it can stop after a specific rotation. Once detected, the Gene conveyor stops and the material is measured at the top of the set with a fixed camera. The measured dimensions are sent to the computer and the selected piece is collected in a separate tray and the rejected piece is collected using a second dc with a pistol. The tensioning plate is fitted to the dc piston using a hinge and a spring coupler. When the dc pistol expands, by pushing the plate, the workpiece to be treated and collected on the tray is also processed. When the DC-gun is pulled back, the disc rotates with its own chain in its position.

CAD model of the system

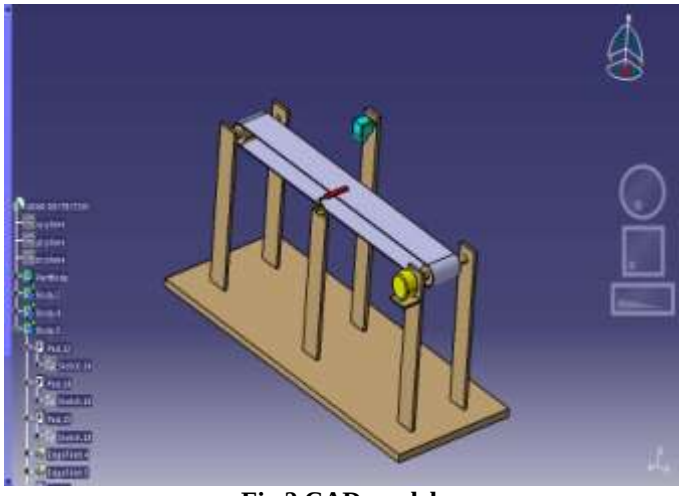

Fig 2 CAD model

II. CONCLUSION

From the review of this paper we study all the techniques used in the inspection of the gear profile. Like fuzzy logic technique, machine vision technique, computer vision technique, image processing technique, with MATLAB etc.

And we decide that in our system for the detection of error in the gear profile for quality checking the image processing. In this technique the computer unit is interface with the mechanical system. The standard comparing parameters are saved in the MATLAB software.

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