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Design And Manufacturing of Automatic Gear Inspection Conveyor System for Quality control By Using Image Processing.

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***Abstract*— 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. 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. For small gears, higher accuracy could be obtained and as well assmall difference.**

***Keywords*— Gear Inspection, Accuracy, Spur Gears, Conveyer System, Image Processing.**

I. Introduction

Gears are one of the most common mechanisms for transmitting power and motion. For most of the modern industrial and transport applications, gears are important and are frequently used as fundamental components. Error in the manufacture of gearscauses two main problems, increased acoustic noise in operation and increased wear, both of which are sufficiently troublesometo cause concern.

For closer control over the accuracy of gears manufacture, precision measurement of gears plays a vital role. Spur gears have the majority among all types of gears in use; therefore automating the measurement process of spur gears becomes a persisting target. The deviation of an actual tooth from the design profile, the profile error, can be measured in a number of ways. The simplest way is to measure the tooth width at a number of pitches using an adapted calliper gauge, another method is to use gauging witha moving probe, with a displacement transducer attached, which traces the design profile. Many mechanical probe gear inspectionsystems are available but these systems are not suitable for inspection of smaller gears. Some attempts have been made to developsmaller probes capable of measurement of small mechanical elements Alternatives are to use a coordinate measurement machineto measure the actual profile, or rolling the gear across a stationary probe. The current methods of spur gear measurement are either time consuming or expensive. In addition, no single measurement method is available and capable of accurately measuringall gear parameters while significantly reducing the measurement time. Therefore, the measurement and inspection of spur gearshas been emphasized by many researchers.

Recently, vision systems have been widely used in many applications [12-15]. Computer vision systems have been developed for quality control and started to be used as an objective measurement and evaluation systems .Robinson et al described the designof an involute spur gear inspection system in which measurements were made using video camera and image analysis software. They investigated the possible measurement accuracy and the possible sources of error identified. They concluded that the measurement accuracy is comparable to that of current methods for tolerance inspection of spur gears. In addition, the low cost and ease of use made image analysis measurement systems an attractive alternative. Sung et al employs wavelet transform to detect the location of tooth defects in a gear system with high accuracy. They reported that utilizing this approach might improvethe ability for fault detection of a gear transmission system, especially when the faulty gear rotates in an angular speed close to those of other gears. The aim of this paper is to utilize computer vision to develop a non-contact measurement system capable ofmeasuring most of spur gear parameters rapidly with a reasonable accuracy. This can facilitate and speed up the measurement and inspection processes of spur gears.

II. Problem Statement

• When we manufacture a lot of gear at a time it is not possible to check a dimension and profile of each and every gear. At that time we used sampling process in which for a lot of 100 gears only first and last gear check and thus we concludethat the whole lot is error free. But at the customer end sometime they find an error in the gear thus the whole lot gets rejected and this results in heavy losses to the gear manufacturer.
• Sometime using these faulty gears results into the accidents of system in which they use.

III. OBJECTIVES

- The objective of the project is to collect the desired items with help of web camera and dispose the unwanted itemsusing rejection mechanism.
- The components are moved from one place to another with the help of Geneva conveyor.
- It is necessary to minimize the workers involved in it.
- To designed a conveyor with Geneva drive which is useful in industries.
- The size of the specimen is determined by the dimensions.

IV. METHODOLOGY

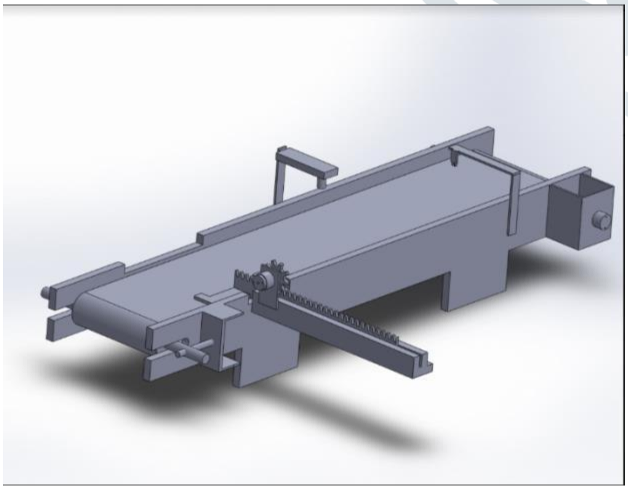
Stage 1: - First we Visit to the industry Gateej Engineering Narhe.

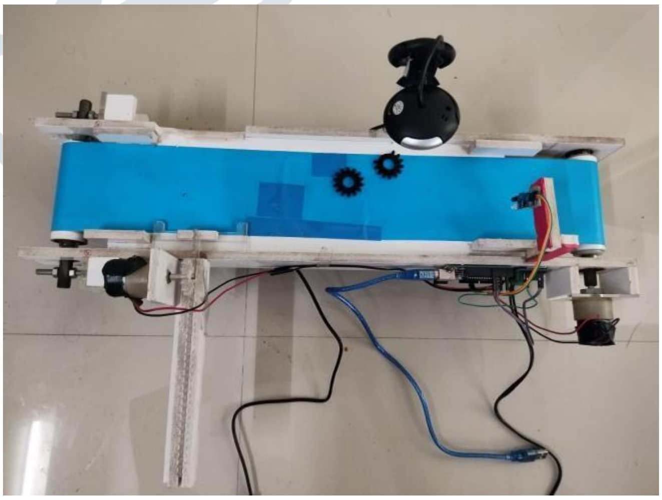
Stage 2: - Then we Identify the problem during the quality checking. and get the Idea of project.

Stage 3: - After identification of problem we done with Collection of data. And study the Literature survey of gear inspection technics currently used in industry.

Stage 4: - Design of CAD model of gear inspection. And select the material of project manufacturing.

V. EXPERIMENTAL SETUP





VI. COMPONENTS

SR. NO	COMPONENTS	SPECIFICATION
1.	Conveyor Belt	Material = Synthetic Rubber Conveying length (L) = 540mm Width of the belt (W) = 90mm Thickness of belt (t) = 1mm
2.	DC Motor	1000 RPM , 12V DC motor with gearbox, 6mm shaft diameter with internal hole, 125gm weight,Torque=0.5kgcm, No-load current = 60 mA(Max), Load current=300mA(Max)
3.	Pulley	Material = PVC pipe Diameter of pulley = 34mm
4.	Camera	Resolution = 2592*1944,2048*1536,1920*1080 5 megapixel with RGB colour filters Pixel size = 2.2 microns (H) * 2.2 microns (V)
5.	Shaft	Material = Mild Steel Shaft length = 120mm Diameter of roller d = 34mm
6.	Base	Hard foam sheet
7.	Proximity Sensor	Voltage=6.5v operated +5v 3mm Mounting hole Proximity range upto 7 cm Output pin = 2.5mm
8.	Arduino uno board	IC: Microchip ATmega328p
9.	Rack & Pinion	Material = Acrylic Rack teeth = 35 Pinion teeth = 15
10.	Control Unit	L298N Motor Driver Operating voltage = 5V Great for 2 gear motor

CALCULATIONS

Design Considerations:

1. Designing the system for continuous flow of material.
2. Going in for standard equipment which ensures low investment and flexibility.
3. Incorporating gravity flow in material flow system.
4. Ensuring that the ratio of the dead weight to the payload of material handling equipment is minimum.

Dimensions of the belt
Conveying length (L) = 540 mm
Width of the belt (W) = 90 mm
Thickness of
belt (t) = 1 mm

Typical belt speed in general use (in meter per seconds) (from handbook of conveyor belt)

Belt width	Grain or free flowing materials	Run of mine, crushed coal & earth	Hard ores & stones
100	0.015-0.018	-	-
150	0.10-0.40	-	-
200	0.50-0.90	-	-
250	1.00	-	-
300	1.25	-	-
350	1.50	-	-
400	2.0	1.5	-
450	2.5	2.25	1.75
500	3.0	2.25	1.75
600	3.0	2.5	2.25
650	3.25	2.75	2.50
750	3.5	3.0-3.5	2.75
800	3.75	3.0-3.5	2.75
900	4.0	3.0-3.5	3.0
1000	4.0	3.0-3.5	3.0
1050	4.0	3.0-3.5	3.0
1200	4.0	3.25-4.0	3.0-3.5
1350	4.5	3.25-4.0	3.0-3.5
1400	4.5	3.25-4.0	3.0-3.5
1500	4.5	3.25-4.0	3.0-3.5
1600	5.0	3.75-4.25	3.25-4.0
1800	5.0	3.75-4.25	3.25-4.0
2000	-	3.75-4.25	3.25
2200	-	3.75-4.25	

Table no.1

Conveyor belt material density

Material flexible plastic for our prototype
ρ = 0.330 x 103 kg/m3.

Design Calculations:

1) Weight carrying Capacity:
Capacity is the product of speed and belt cross sectional area. Generally, belt capacity B.C (kg/sec) is given as:
B.C =3.6 A V ρ
Where,
A= belt sectional area (m2)
ρ = material density (kg/m3)
V= belt speed (m/s).

1.1 Area of Belt:
A = Length x Width
A = 540 x90
A = 48600 mm2
A = 0.048600 m2.

1.2 Belt Speed:
From table 1 Typical belt speed in general use (in meter per seconds)
V=0.018m/s

1.3 Density of Material:
P = Density of material
Density of plastic is 0.33x 103 kg/m3.
B.C =3.6 x A x V x ρ
B.C = 3.6 x 0.04680m2 x 0.018 m/sec x 0.33 x 103
B.C = 1.03 Kg/sec.

2) Diameter of Roller (Drive Pulley):
The roller support belt and facilitates easy as well as free rotation of the belt conveyor in all direction. The correct choice of roller diameter must take into consideration the belt width. The relationship between the maximum belt speed, roller diameter and the relative revolution per minute is given as

N = $\boldsymbol{V\ x\ 1000\ x\ 60 D\ x\ \pi}$

Where,
N = RPM of Belt
V = Speed of Belt
D = Dia. Of Roller

10 = $\boldsymbol{0.018\ x\ 1000\ x\ 60 D\ x\ \pi}$

D = 33.32 mm
D = 34 mm.

3) Power at Drive Pulley:
Pp. = 2πNT60
Where,
T = Torque of Drive motor
T = 2 kg. m
T = 19.61 N. m
Pp. = 2 x π x 10 x 19.6160
Pp. = 20 Watt.
Pp. = 0.02 Kw.

4) Material Flow rate:
Q = $\boldsymbol{W\ x\ VL}$
Where,
Q = Material flow rate
W = weight of Material on section of length (1.03Kg)
V = Conveyor speed
L = Length of weighing platform
Q = 1.03 $\boldsymbol{x}$ **0.0180.540**
Q = 0.0343 kg/sec.

5) Belt Tension at Steady State:
Tss= 1.37 x f x L x g (2 x Mi+ (2 x Mb+Mm) x cosθ) + H x g x Mm
Where,
Tss= Belt tension at steady state (N).
f = Coefficient of friction (0.2).
L=Conveyor length (m). (Conveyor belt is approximately half of the total belt length). = 540mm= 0.540m.
g = Acceleration due to gravity (9.81 m/sec2).
Mi.=Load due to the idlers (Considering no load).
Mb = Load due to belt (0.032 kg).
Mm=Load due to conveyed materials (Considering no load).
θ = Inclination angle of the conveyor.=0
H=Vertical height of the conveyor.
Tss = 1.37 x 0.2 x 0.540 x 9.81 x cos0° x 0.032076
Tss = 0.08621 N.

Shaft design
Material of shaft is **Mild steel**

Material properties of mild steel

Yield strength	Syt	150MPa , N/mm2
Factor of safety	FS	2
Poisons ratio	μ	0.303
θ		180°

Table no. 2

Permissible shear stress
$r = Sys/FS = 0.5{*}Syt\ /FS$
$r = 0.5 * 1502$
$r = 37.5 N/mm2$
The length of the shaft is considered as distance between two channel plates
D= diameter of the shaft
d= diameter of roller
The distance between channel plate is more than width of roller= 100mm shaft length = 120mm
Diameter of roller d=34 mm

Forces

1) The total load carrying capacity of the belt is act radically on the shaft & the total pulley load is considered as uniformly distributed on the pulley as shown in fig a.
F = capacity of belt* g
= 1.03*9.81
=10.1043 N
2) Belt is rotating tangentially to the pulley. so tension in belt act tangential force.
Tss= 0.08621KN=47N
3) There are two supports at the both end of shaft. The supports are bearing supports.

4) Neglecting weight of the pulley.

1) Pulley torque = tension in the belt * radius of roller
T=86.21*17
=1465.57N.mm
2) Reactions of all points
Ra+ Rd=F...................1
Ma=F*60+Rd*120=0… 2
From eq. 1 & 2
Ra=5.052N
Rd=5.052N

3) Bending moment at each point
Bending moment at pt A = Ra*0=0
Bending moment at pt B= Ra*10=5.052*10=50.52N.mm
Bending moment at pt E= Ra*60-10.43*50/2=3.762*60-7.524*25=50.52.mm
Bending Moment at pt C=Ra*110-7.524*100/2=3.762*110-7.524*50=50.52N.mm
Bending moment at pt D=Rb*0=0 (by LHS method)
Max bending moment is 50.52N.mm
Shaft diameter =
$rmax=16\pi d3\surd(M)2+(T)2$
$37.5=16\pi d3*\surd(50.52)2+(1465.57)2$
D=5.83 mm
As per shaft available in market are we selecting the shaft of diameter of 6mm

VII. CONCLUSION

The proposed methodology of modelling the sorting machine in this work can be adopted and extended to evaluate and model other types of sensors that could be applicable for sustainable sorting of different objects. This work is a fundamental approach to modelling manufacturing and automated machines. It is observed that irrespective of the type of sensors used, the proximity distances of the sorting sensors plays a vital role in determining the Table 1 Phase detection of capacitive proximity switch. Distance arm detection of individual specimen. could be adjusted to a suitable distance between object sensor detection distance.

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