Fabrication Of Paper Cutting Machine Using Eye Mark Sensor

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Abstract The paper cutting machine using eye-mark sensor is used to cut the papers in equal and accurate dimensions. The main principle of this method is used to reduce the human power and time consumption by eliminating the wastage of the raw materials. Eye-mark sensor is used to sense the colour present on the paper and make the machine to cut on the place where the paper is marked. It has a transmitter and the receiver which the sends the light signal through transmitter and it senses the colour. The sensed signal is received through the receiver. When the signal is received the roller motor is stopped and the cutter motor is started. The cutter motor completes its rotation and again the paper roll is feed. This system can be applicable for paper cutting industry and it is a low cost solution which increases the production process

Keywords: Paper roller; Eye-mark sensor, Accurate dimensions; Low cost system

INTRODUCTION

Nowadays there are lot of competition in the paper industry. For effective functioning of the paper industry there is a need for development of automated systems. That automated system should increase the production and the accuracy and quality of the product. This proposed system is used to cut the paper accurately in the industry. In the paper industry for cutting the paper in the large numbers we use this method. This machine is manufactured using low cost and efficient method. This machine aims to reduce the labour power and saves time in industries by eliminating the paper marking time. Here the paper is sensed and marked using eye mark sensor. The paper which is said to be cut is marked and the accurate position is detected with the color using eye-mark sensor and color sensor. An eye-mark is a small rectangular printed area located near the edge of the printed flexible packaging
material. The eye-mark sensor reads the eye-mark to indicate when to cut the individual units which is marked in the paper. Color sensor detects the color of the colored position the paper to cut the paper in the accurate manner. The sensor categorizes the color as red, blue or green. There may be some wastage of the paper. The paper is first fed through the roller for Color is the result of interaction between a light source an object and an observer.

1.1 Advantages of the paper cutting machine using eye-mark sensor:
1. Reduced wastage of raw materials.
2. Increase in quality, accuracy and Productivity.
3. Increased reliability.
4. Less manual power.
5. Production rate is high.

The above stated points are the major advantages of proposed paper cutting machine using eye-mark sensor. Most commonly used guidance technologies in paper cutting machine are Manual paper cutting method, Hydraulic paper cutting and automatic paper cutting using adjustment.

Literature collection also reveals that paper cutting machine using I mark sensor and geneva mechanism is a better low cost solution in paper processing industries. Vijay Kumar et al. says that the design and analysis of paper cutting machine using eye-mark is very useful for small scale industry. Sagar R. Patil et al investigated geneva mechanism for cutting paper and proved to be an effective mechanism. Ajay S. Parmar designed an intermittent paper cutting machine that gives feed using geneva wheel. The result is uniform length of feed at uniform interval of time.

2 METHODS AND MATERIALS

2.1 Design of paper cutting machine

The system design consists of the mechanical and the electrical components. The mechanical components comprises of the upper frame for the cutter blade, paper feed, rollers etc. where the lower frame consists of the motor support for the feeder and the blade cutter. The electrical component comprises of the eye-mark sensor, contactor, relays and switches.

The motor is placed at the bottom of the frame. The motor is coupled to the shaft which is connected to the blade. The blade is moved in the up down movement. The blade is used the bunch of the paper at a time so the production rate is high. The sensor is placed parallel to the blade in front the roller. The blade is operated only if the sensed feedback is given to the
drive. The another three phase motor is coupled to the paper roller once the motor completes one cycle or the blade is moved once then the motor stops which in turn the another motor starts for paper supply. The two motors runs parallel to each other. 3Dimensional model of the machine is shown in Figure 1.

![3D model of paper cutting machine](image)

**Figure 1: 3D model of paper cutting machine**

### 2.2 Calculation:

#### 2.2.1 Motor calculation:

Motor is selected based on the following dimensions and the formula. The motor calculation is as follows

*Blade material = carbon steel*

*Length of the blade = 780mm (or) 78cm*

*Thickness of the blade = 1.58mm*

*Breath of the blade = 20mm (or) 2cm*

*Volume = length * breath * thickness*

\[
\text{Volume} = 78 \times 0.158 \times 2 = 24.648
\]

*Volume of blade = 24.648 cm}^3*

*Density = mass/volume*

*Density of the material = 7.85/cm}^3*
Mass of the blade = density * volume
= 7.85 * 24.648

Mass of the blade = 194 g

Power = 1hp
= 745.7 W

Speed (N) = 1440rpm

\[ \omega = \frac{(2 \times \pi \times N)}{60} \]

\[ = 150.8 \text{ rad/s} \]

Power = torque * angular velocity

\[ \text{torque} = \frac{\text{power}}{\text{Angular velocity}} \]

\[ = \frac{745.7}{150.8} \]

Torque = 4.99

Torque for the blade = 5N.m

2.2.2 Paper roll:

The following are the specifications of paper roll that is used for the fabrication of paper cutting machine.

Material selection = mild steel

Tensile strength = 370mpa

Allowable stress = 200mpa

Modulus of elasticity = 205gpa
Shear modulus = 80 gpa
Density = 7.87 g/cm²
Bulk modulus = 140 gpa
Roller weight = 100 × 9.81
Roller weight of paper = 981 N

Shear force diagram:
\[ S_{Fa} = 981 \times 0.78 / 2 \]
\[ = 382.59 \]
\[ S_{Fb} = 0 \]
\[ S_{Fc} = -382.59 \]

Bending Moment Diagram:
\[ M_a = 0 \]
\[ M_b = 981 \times (0.22)^2 \]
\[ = 47.48 \text{Nm}² \]
\[ M_c = 0 \]

To find maximum bending stress \( \sigma / \gamma = E / R = M_b / I \) (DDB 7.1)
\[ \sigma_b = M_b \times y / I \]
\[ I = (a_1^4 - a_2^4) / 12 \]
\[ = (0.20^4 - 0.15^4) / 12 \]
\[ = 0.0016 - 0.000056 / 12 \]
\[ I = 0.000086 \text{mm}^4 \]
\[ \sigma_b = M_b \times y / I = 0.0296 \times 0.0025 / 0.000086 \]
\[ \sigma_b = 8.6 \text{MPa} \]
6allow = 200Mpa
6b < 6allow
So the design of column is safe. Figure 2 shows the bending moment diagram.

Fig2 Bending moment diagram

2.2.3 Column Calculation:

Slenderness ratio = L/K
Length of the column = 400mm (or) 40cm
K = \sqrt{(1/A)}
I = \frac{d^4}{12}

K = \sqrt{(\frac{d^4}{12})/d^2}
=d^2/12

Using FOS = 2.5
Pcr = 2.5 * (Weight of the roller + tensile load)/2
= 2.5 * (0.5 + 67.14/2)
\[ P_{cr} = 84.55N \]

Clipping load by Euler’s equation

\[ P_{cr} = n \times \left[ \pi \times E \times A \right] / \left( L/k \right)^2 \]

\[ 84.55 = (0.25 \times 3.14^2 \times 205 \times 10^3 \times B^2) / \left( 100 / (L/A) \right)^2 \]
\[ 84.55 = (0.25 \times 3.14^2 \times 205 \times 10^3 \times B^2) / (10000 \times 12) / (b \times 2) \]
\[ 84.55 = 0.25 \times 12.86 \times 205 \times 10^3 \times b^4 \]

\[ 84.55 \times 12 = 505.32 \times 10 \times b^4 \]
\[ 84.55 \times 12 = 50.5 \times b^4 \]
\[ b^4 = 84.55 \times 12/50.5 \]
\[ B_{min} = 2.117mm \]

**Slenderness ratio = L/K**

\[ K = \sqrt{I/A} \]
\[ I = (2.117)^4/12 \]
\[ I = 1.67 \]
\[ K = (1.67/1.20) \]
\[ K = 1.17 \]

**Slenderness ratio = L/K**

\[ = 100/1.17 \]

\[ Slenderness ratio = 85.47 \]

The boundary line between Euler’s and Johnson equation

\[ S_y/2 = n \times \left[ \pi^2 \times E \right] / \left( L/k \right)^2 \]
\[ Sy = 200 \times 10^6 N/mm^2 \text{ for mild steel} \]
\[ E = 205 \times 10^3 N/mm^2 \]

\[
205 \times 10^6 = (0.25 \times (3.14)^2) \times 205 \times 10^3 \times 10^6) / (L/k)^2
\]

\[
\left(\frac{l}{k}\right)^2 = (0.25 \times (3.14)^2 \times 205 \times 10^9) / 125 \times 10^6
\]

\[
\left(\frac{l}{k}\right)^2 = 505.30 \times 10^3 / 125
\]

\[
= 40.42 \times 10^3
\]

\[
\left(\frac{l}{k}\right)^2 = 4092
\]

\[
\left(\frac{l}{k}\right) = 63.92
\]

Since the slenderness ratio is above the boundary line, it is long column.

Breath of the column = 2.117 mm.

The motors are selected by using the calculated torque, speed and power. The three phase dc motor is used to cut the paper. The motor is coupled to the shaft by the use of belt and to the blade. For one single rotation the blade makes a one up right moment. The another three phase motor is used to run the paper roll. Since the paper roll weighs more than 800kgs so the one horse power motor is used for heavy load. The blade is made up of carbon steel material. It can cut many papers at a time. The blade is operated by running the motor. The blade is moved in the vertical manner. The Eye-mark sensor is used to detect the mark of the colour on the paper by using the transmitter and the receiver. The transmitter sends the light signal and detects the colour mark on the paper and later received when the colour is detected. This process is done continously.

### 3 WORKING:
The design of the paper cutting machine using eye-mark sensor has the paper roller in which the raw material of the paper is loaded. The raw material paper is first loaded in the blade and the stiffness of the paper. In some cases there may be some bunch of the paper which should be cut. In such situation the addition of rollers is needed so some additional rollers are added. The paper roll raw material have the mark which is marked at the particular distances. The eye-mark sensor has the transmitter and the receiver which sends the signal an receives the signal. The sensor and the motor was linked.

The motor is used to cut the paper. The motor is used to convert the rotary motion into the linear up right motion. The blade is moved in the vertical manner. The motor is controlled by the drive. The drive is used to control the speed of motor. The variable frequency drive is used to control the speed of the motor.

4. RESULT AND DISCUSSION

The proposed model is used to cut the paper in which the paper wastage is less. The paper cutting machine starts from the paper roll and cuts the paper on sensing the mark on the paper using sensor. After entire paper roll is over the next paper roll is loaded on the roller and the process in continued. There is also available of the addition of the paper roll. Multiple paper roll can also be added and cut under the process. There addition of the counter is also added in which the counter counts the number of the paper it cuts. The followings are the main features of the machine which is designed.

1. Increased speed of paper delivery
2. Machine speed can be adjusted
3. Path flexibility
4. Adaptive to different factory layouts
5. Collision control
6. Reduction in man power cost
7. Reduced running cost compared to other systems
8. Sensors can be added to detect the payload conditions

5. CONCLUSION
This proposed paper cutting machine using eye-mark sensor is an optimized low cost model. It optimizes the heavy frame design. The advantages of this proposed system are precision machining, stable performance, high durability and uses high integrated high stability component. The paper cutting machine cuts accurately on the marked position. The cutting machine is used in the industries for the large scale.

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