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Design and Development of Automatic Weight Based Rubber Sheets Cutting Machine

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ABSTRACT
This Paper gives the detailed information about the design and development of automatic weight based rubber cutting machine for rubber industries. At present conventional method used in rubber industries are cut the rubber sheets of the desired length. There are some of the rubber industries requires cutting rubber sheets of equal and desired weight of one piece for that they use human resources to cut rubber piece to its desired weight manuallywhich is time-consuming. The accuracy obtained by the conventional method is also poor. After surveying various industries we conclude that nowadays the industries have introduced automation in their systems to some extent. The automation system solves the labour problems it saves cost, increases accuracy, decreases human errors. By using automation our objectives to achieve low-cost cutting which works fast and reduces cutting time. The practical objective of automatic weight based rubber cutting machine is to cut a rubber of required weight of one piece regardless of its length. This machine is simple, accurate and reduces time so it increases productivity.

Keywords–Autoweight rubber cutting, High accuracy, High production rate, Reduce manpower.

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I. INTRODUCTION

In the underdeveloped small-scale industries, nowadays labour is a major problem for the industries. Many time's situations happen that labourers strike for their personal benefits which result in performance degradation and loss in efficiency. As a result, company owners have to bear the great loss and hence cannot achieve their desired profit and goals. [1] The system of automation in an industry can solve this problem in a very effective way. The automation system solves labour problems which save cost, increases accuracy and decreases human errors. Automation will be fruitful regarding the company's development and profit gain as it improves the system in many ways. One such industry found out in which they need a solution that is very efficient, fast and economical for cutting rubber sheets of desired weight of one rubber piece regardless of its length.

[2]Most of the rubber industries using a conventional method that is cutting rubber sheets of the desired length which cut the rubber sheets as per the set length, but some industries requires cutting a rubber based on its weight for this they need labour for cutting a rubber according to its desired weight. This method is time-consuming, less accurate also some time industries facing labour strike.

In an automation system, we measure a thickness of rubber sheets continuously. We know that density of rubber is constant throughout the process. The major problem is the rough surface of the rubber sheets. Aswidth is constant, by calculating the length for a required weight of one piece from density and measured thickness. Distance laser sensor is used to measure the thickness of rubber sheets. CompactRIO is used for high performance and accuracy. It calculates the length of rubber for desired weight effectivelyfrom thickness and rubber density. PLC is used to control servo mechanism andthe system. This automation system is fast, reduce manpower, and give better performance. The accuracy obtained by this method is good.

II. EXISTING SYSTEM

[2]Most of the rubber industries are using conventional method for cutting the rubber of equal length. This method is time-consuming because they have to measure the weight of rubber for every piece after cutting so production rate is low. Also, unequal cutting of rubber so accuracy is less. This method requires more manpower. The major problem of the conventional method is a rough surface of rubber sheets so that there is a variation of weight for equal length of a piece. The second problem is more time

is required to measure weight after cutting each piece. Also, the company facing labour problems.

III. PROPOSED SYSTEM

The objective of this project is to design and develop an automatic weight based rubber cutting machine. It works fast and reduces the cutting time. This machine is simple and accurate. This machine is designed using distance sensor for thickness measurement, conveyer belt, Human Machine Interface, cutter and a controller unit to control the entire operation of the machine.

The purpose of the project is to design an automatic weight based rubber cutting machine which is:

1) Automatic
2) Efficient
3) User-friendly
4) Cost-effective
5) Reduce strenuous and repetitive task
6) Respond as per user's input
7) Accurate
8) Display user's input

The basic need for automatic weight based rubber cutting is to cut the rubber of required weight of pieces, without labour and efficiently. So we decided to make a title 'Automatic weight based rubber cutting machine'. For that we decided some specifications given below:

1) To cut a rubber of required weight.
2) A thickness of rubber sheets continuously measured.
3) Fast and accurate computation is required to calculate the length of rubber piece for required weight.
4) The guide is provided to keep a rubber sheet exactly below the distance sensor.

Methodology: This proposed system gives the convenient approach of automatically detecting the weight of rubber piece by measuring its thickness. The density of rubber and width is constant throughout the process, so by precisely measuring a thickness of 1 mm of rubber sheets, we get the weight of 1mm rubber piece by using following equations,

Volume of rubber (V) = length*width*thickness (1)

Density = mass / volume (2)

As rubber sheets having a rough surface, the sensor continuously measures a thickness of rubber sheets very fast and accurate which update the output per every 1mm. The density of rubber remain constant, we get the weight of 1mm rubber. The controller continuously adding this 1mm weight of rubber and when target weight is achieved controller gives the output which is a length of one rubber piece of required weight. By using this automatic system we get a perfect weight of the rubber piece.

IV. PROPOSED SYSTEM COMPONENTS

1) Baumer Distance Sensor:

[6]Baumer Sensor presents an innovative and compact sensor for measurement of demanding surfaces. The laser distance sensor provides accurate and repeatable measurement results, without elaborate conversion or external software.

Fig. 4.1 Baumer Distance Sensor

This sensor basically measures a distance. First, it gives the output of the reference distance from its base when rubber sheet is not present and once the rubber sheet passes it gives the distance from rubber, by subtracting this value with reference value we get the actual thickness of a rubber sheet.

2) Crio:

[5]The National Instruments Series CompactRIO Integrated Systems with Real-Time Controller and Reconfigurable Chassis combine an industrial real-time controller and reconfigurable field-programmable gate array (FPGA) chassis for industrial machine control and monitoring applications.

Fig. 4.2 CompactRIO

The FPGA Module may be used to implement high-performance data processing on reconfigurable fabric. Such data processing may be performed ondata streaming in from connected I/O Modules.The FPGA can be programmed separately and is connected to the real-time controller using an internal PCI bus.CompactRIO first measures the density of rubber from reference values, then during auto mode, it calculates the length of rubber for required weight.

3)PROGRAMMABLE LOGIC CONTROLLER

A programmable logic controller (PLC) is an industrial computerized control system that continuously monitors the states of input devices and makes decisions based upon a custom program to control the state of output devices. The input sensing devices is fed to the input module which acts like an optical isolation. What is connected to the main device CPU and memory data. The monitor who acts like a programming device where it displays the given. Then the entire system is connected to the output block where the outputs are connected.

Fig. 4.3 PLC

In automatic system PLC is used to control the speed of servo motor and give a command to the cutter to cut the rubber sheets.

4)HUMAN MACHINE INTERFACE

A human-machine interface (HMI) is the user interface that connects an operator to the controller for an industrial system. HMIs are usually deployed on Windows-based machines, communicating with programmable logic controllers (PLC) and other industrial controllers.It provides a graphics-based visualization of an industrial control and monitoring system.

Fig 4.4 HMI

V. WORKING PRINCIPLE

The Automatic weight based rubber sheets cutting machine having two major component,

1) CompactRIO used for fast and accurate computation
2) PLC used for controlling servomechanism and cutter.

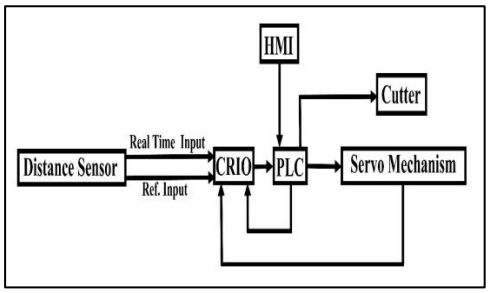

Fig 5.1 System Block Diagram

The first step of the Automatic system is to set the target weight of one piece in HMI also enters the reference value of length, thickness, and width for measurement of rubber density. The density of rubber remains constant throughout the process. HMI is connected to PLC. Distance sensor is mounted above the conveyor line and measure the reference distance from the base. The rubber sheet falling on the conveyor belt when the rubber sheet reaches below the distance sensor it measures the distance continuously from rubber sheets. The sensor gives a precise measurement as it updates output for every 1mm of a rubber sheet. The output of the sensor is given to the CompactRIO. Which calculate a thickness of rubber sheets by subtracting the real-time value from the reference value.

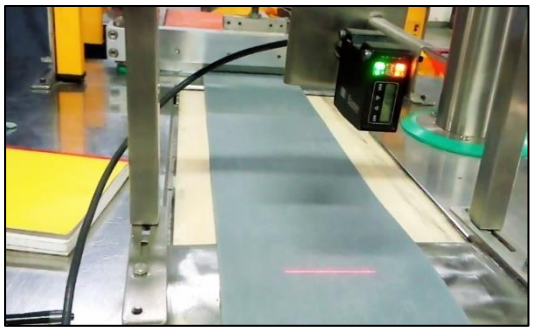

Fig. 5.2 Experimental set up for Automatic Weight based rubber cutting machine

As the density of rubber is constant, CompactRIO calculates the weight of 1mm rubber and continuously summation of 1mm rubber weight and compare it with a target weight. When target weight is achieved CompactRIO calculate the rubber's length of required weight. This calculation is done with LabVIEW programming installed in FPGA module which is connected to CompactRIO. [4]The output of the CompactRIO is given to PLC and control the travel of servo motor and cutter will cut the rubber according to the calculated length, by this method we get the perfect weight of one rubber piece.

CompactRIO, PLC and HMI of the automatic system is connected through the Ethernet cable.[4]The system also having the proximity sensor placed before cutter for safety purpose. This automatic weight based rubber cutting machine is efficient and accurate. It increases production rate without human resources.

VI. DESIGN AND CALCULATION

A. Density Measurement:

Length: 100mm
Width: 200mm
Thickness: 5mm
Volume: 100000 mm^3 (from eq. 1)
Weight: 100gm

Density = 100 / 100000 (from eq. 2)
= 0.001 gm / mm^3 (3)

B. Weight of 1mm rubber:

For Example-
Density = 0.001 gm / mm^3 (from eq. 3)
Width of rubber = 100mm
Measured Thickness= 4.95mm

Weight= Density*volume (from eq. 2)
=0.001*(200*4.95*1)
=0.99 gm
So weight of 1mm is equal to 0.99gm,

From above calculation we get the length of rubber piece for required weight.
E.g. Set Weight = 20 gm

Sr. No.	Length (mm)	Thickness (mm)	Weight (gm)
1	1	5.01	1.002
2	1	5.04	1.008
3	1	5.07	1.014
4	1	5.1	1.02
5	1	5.13	1.026
6	1	5.16	1.032
7	1	5.19	1.038
8	1	5.22	1.044
9	1	4.95	0.99
10	1	4.98	0.996
11	1	5.01	1.002
12	1	5.04	1.008
13	1	5.07	1.014
14	1	5.1	1.02
15	1	5.13	1.026
16	1	5.16	1.032
17	1	5.19	1.038
18	1	5.22	1.044
19	1	4.95	0.99
20	1	4.98	0.996
Total Length = 20 mm		**Total Weight = 20.34 gm**	

Table-1 Experimental data

From the above table-1 we get the weight of one rubber piece equal to set value 20 gm and calculate the length of one rubber piece which is equal to 20mm. This computation is done in LabVIEW.[3] Output length is given to PLC and it gives command to servo to travel 20 mm and then cut the rubber using cutter.

VII. EXPERIMENTAL RESULTS

The following data will show real time data and analysis of three different rubber material having different density.

1) Material No. 2431 (Light Blue)
Density of rubber: 1.19 gm/ cm^3
Set Weight: 140gm
Acceptable Range: 140 ±5 gm

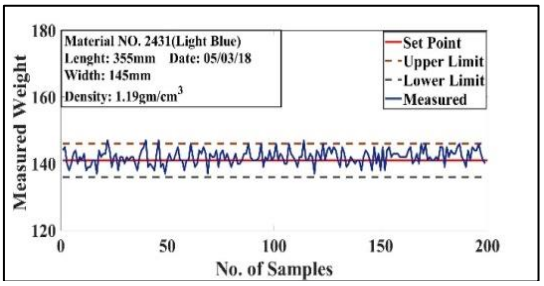

Fig.7.1 Experimental results of Autoweight system

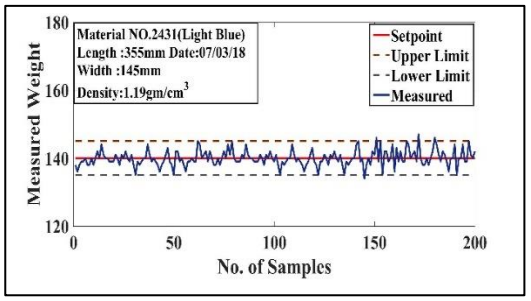

Fig.7.2 Experimental results of Autoweight system

2) Material No. 431 (Grey)
Density of rubber: 1.27 gm/ cm^3
Set Weight: 145gm
Acceptable Range: 145±5 gm

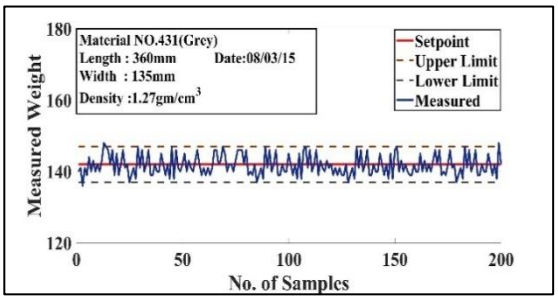

Fig.7.3 Experimental results of Autoweight system

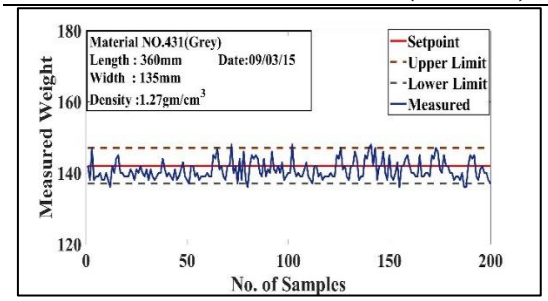

Fig.7.4 Experimental results of Autoweight system

3) Material No. 2377 (Black)
Density of rubber: 1.097 gm/ cm^3
Set Weight: 202gm
Acceptable Range: 202±5 gm

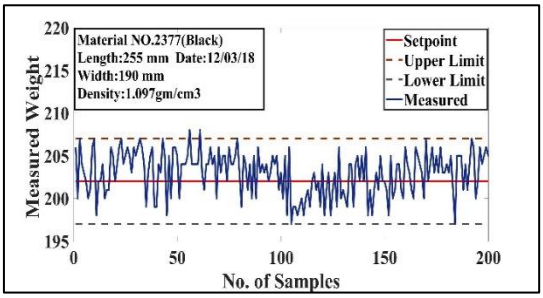

Fig.7.5 Experimental results of Autoweight system

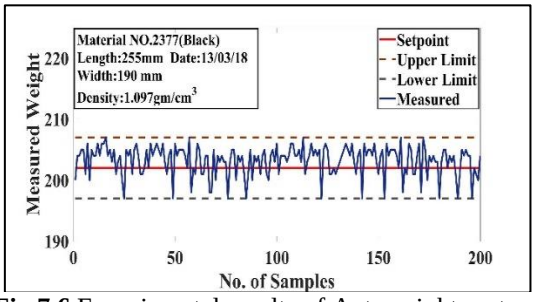

Fig.7.6 Experimental results of Autoweight system

We find out the percentage error for each material by using following equation,

$$\text{Error (\%)} = \frac{\text{Total} - \text{Acceptable}}{\text{Acceptable}} \times 100\ \%$$

Following table-2 represent the outcomes of automatic weight based rubber cutting machine for various days.It will show the error of every rubber material having different density.

MaterialNo.	**Date ofExperiment**	**Total Samples**	**Acceptable samples**	**Error (%)**
2431 (Light Blue)	05/03/2018	200	194	3.09
	07/03/2018	200	195	2.56
431 (Grey)	08/03/2018	200	196	2.04
	09/03/2018	200	192	4.01
2377 (Black)	12/03/2018	200	195	2.56
	13/03/2018	200	197	1.57

Table 2: Experimental Error Results

Fig 7.7 HMI Display of Set parameter

Fig 7.8 HMI Display of Auto Mode

From the above experimental results, the automatic weight based system has a maximum error of 4.01%. So, the accuracy of this system is better than the conventional method. Also, the production rate increases.

VIII. CONCLUSION

In the present paper, we demonstrate the solution for weight based rubber cutting system. Manually operated cutting machine can be replaced with "Automatic Weight Based Rubber Sheets Cutting Machine" which provides a high level of accuracy and automatically calculate exact weight of one rubber piece. The time required to cut rubber is less compared to the manual cutting of rubber of desired weight. Thus due to this, the efficiency of production is increased. The major advantage of this machine is to increase accuracy and to reduce the human efforts.

REFERENCES

[1] Sammed Narendra Patil1, SourabhPopatlal Karyappa,Suraj Rajendra Patil, Shubham Deepak Patil, and R. R. Joshi, "Design and Development of Automatic Wire Cutting Machine: A Case Study in Small Scale Industry," International Journal for Research in Applied Science & Engineering Technology (IJRASET) Vol. 5, no. 03, pp. 951-956, 2017.

[2] VrushaliJunnare, VrushaliDahite, Prasad Kasodekar, Hemant Chavan and Dr. L. K. Tokeb "Design and Fabrication of an Autocutter for Rubber Sheet Cutting," International Journal for Scientific Research & Development, Vol. 5, no. 03, pp. 1451-1452, 2017.

[3] S R Majumdar (1995) Pneumatic Systems: principles and maintenance, (1st ed.). Tata McGraw-Hill Education.

[4] Madhu Kumar V, Arun Kumar N, Harsha B S, Naveen Kumar K N, Nagaraja T.K. "Design and Fabrication of Pneumatic Sheet Metal Cutting and Bending Machine," International Journal of Engineering Research And Advanced Technology (IJERAT), Vol. 02, no. 01, pp.2337-2342, 2016.

[5] NI Systems (India) Private Limited (2018, March 04). About High the CompactRIO Platform. Retrieved fromhttp://www.ni.com/compactrio/

[6] Baumer Electric AG. (2018, March 04). About High-performance laser distance sensors-OM70. Retrieved from https://baumer.com/ch/en/product-overview/distance-measurement/optical-distance-sensors-/high-performance-laser-distance-sensors-/c/37027

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