PUNE RESEARCH WORLD ISSN 2455-359X
AN INTERNATIONAL JOURNAL OF INTERDISCIPLINARY STUDIES VOL 8, ISSUE 2

DESIGN AND MODELLING OF AUTOMATED DIMENSIONAL CHECK CONVEYOR BELT SYSTEM FOR CATEGORIZATION OF OBJECTS

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Abstract: *To load and unload raw materials from one manufacturing stage to another, raw materials and products need to be transferred. To avoid defective products, detection or checking is necessary. We manufactured a mechatronics system (a prototype) based on ultrasonic sensors and programming. Using these sensors, we are checking three dimensions of an object in one pass i.e., simultaneously. In the end, the diverter separates the defected object and further transports it. Various design parameters like belt width, belt speed, belt pull, and motor selection are carried out as per the readings taken. The system has reached the requirement of dimensional checking and categorizing the objects.*

Key Words: Conveyor Belt, Rollers, Micro-controller, Ultrasonic sensors, Circuit Manufacturing, Arduino Sketch, Embedded C, Proteus Professional.

1] INTRODUCTION

For the completion of the tasks on a large scale, manpower and time are seen to be critical constraints nowadays. Automation helps us in reduction of human power, and human errors and increases the speed of operation. The main purpose of our system is to increase the accuracy in dimensional checking of jobs in the industry and then segregate it as accepted or rejected based on quality checking. Industrial machining and processes depend upon computers which reduce human intervention. In the existing system, only one dimension can be checked at a time and is unable to categorize objects as accepted or rejected. The system we designed is capable of overcoming the above- mentioned problem.

1.1] Current scheme

The existing system used a proximity sensor for measuring a single dimension at one pass. When the inspection is done, the separation of defected objects is done manually. This process consumes time. Also due to single dimension checking, the efficiency of a system is less as it is semi-automated.

1.2] Proposed System

This proposed system can overcome the problems of the existing system. It gives the convenient approach of automatically detecting the dimensions of the job over the conveyor system using a micro-controller for high accuracy, precision, and fast material handling without any interruption. The dimensional check conveyor system consists of six ultrasonic sensors for the measurement of three dimensions i.e., height, width, and length of an object. The system is T-shaped and consists of three conveyor belts, one primary and two secondary belts. The arrangement of the system is such that two secondary belts are connected perpendicularly to the primary belt. The primary belt consists of a checkbox that includes the above-mentioned ultrasonic sensors. Two sensors for checking one dimension each. A diverter/separator is placed on the junction point of primary and secondary belts which segregates the job as per the aspects being detected.

2] METHODOLOGY

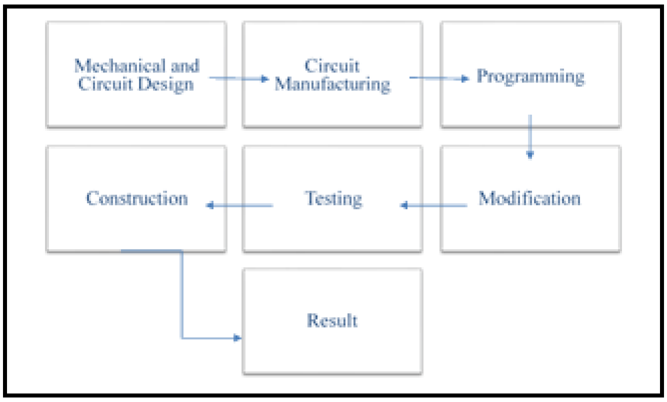


Figure 1

The mechanical design of our conveyor system is done in CAD software SOLIDWORKS. We have used Proteus Professional software for circuit design required for the working of electronic components of our system. The dimensions displayed on the LCD are programmed in Arduino Sketch software using embedded C language.

3] COMPONENTS IMPLEMENTED

The main mechanical element designed is Conveyor Belt, pulleys/wheels, and supporting frame. The different electronic components specified and implemented in the system are transformer, bridge rectifier, voltage regulator, Atmega328P microcontroller, LCD, Ultrasonic sensors, Relays, Servo motor, DC motor, motor driver, resistors, and capacitors.

1. **CONVEYOR BELT**

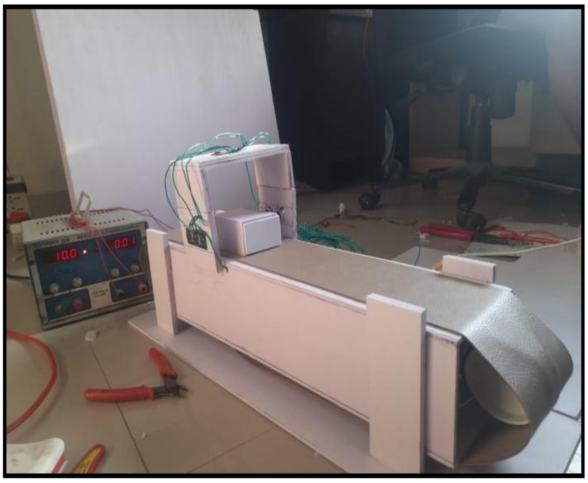
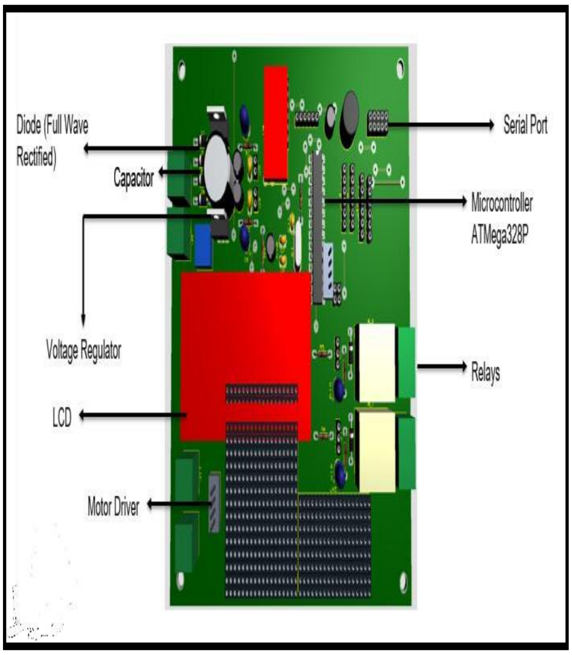


Figure 2: Conveyor system

Conveyor belts are material handling equipment that is used to move loads in factories or plants, mines, storage centers, etc. They can be in vertical, horizontal, or inclined directions for short distances of some 10 to a hundred meters as well as for thousands of kilometers. The conveyor belt system here used is a prototype of the actual system. Hence the material used for the supporting frame is PVC foam sheet and the belt material is rexine fabric.

The system consists of two cylindrical roller wheels which perform the duty of pulleys. The conveyor belt rotates over these rollers which are driven by a DC motor. The conveyor system DC motor is powered by a 230V power supply which is stepped down using a stepdown transformer.

2. CIRCUIT DESIGN



The figure above exhibits the 3D representation of the circuit designed for the system. It consists of the relays which are used for switching on and off of the conveyor belt, motor driver is for controlling the diverter movement. The final dimensions checked by the sensors are displayed on a 20*4 liquid crystal display. The coding required for working the system is carried over the Arduino Sketch, which is further given as an input to the serial ports. According to these, the Atmega328P microcontroller works and gives the desired output.

The power supply available for the operation is in the form of an AC signal. For the conversion of AC signal to DC signal, a full-wave bridge rectifier is used.

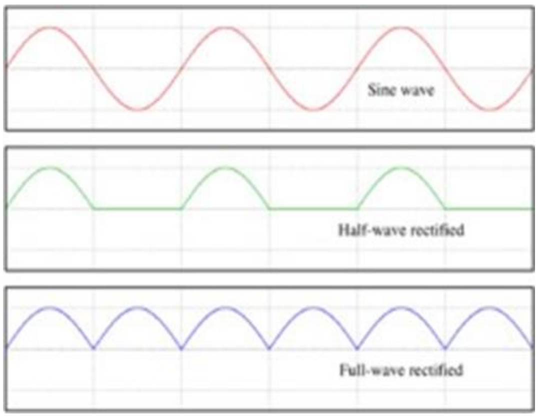


Figure 4: I/O Waveforms of Half and Full Wave Rectifier

The rectified signal passes through the capacitors for filtration. Two regulators are implemented out of which one is used for the IC and the other is used for the motor.

4] DESIGN CALCULATIONS FOR THE PROPOSED SYSTEM

1. Design of belt:

Mass of one object = 50 g

Distance between two roller/wheels (D) = 55 cm Diameter of roller 1(d1) = 68 mm

Diameter of roller 2, (d2) = 68 mm Belt Width (B) = 100 mm Thickness of belt (t) = 1 mm

2. Length of belt (L):

L = ((π/2)*d1) + ((π/2)*d2) + 2D L = 1313 mm = 131 cm

3. Mass of belt (M):

L= 1313 mm, B = 100 mm, t = 1 mm V = L*B*H

V = 1313 x 100 x 1

V = 1.31 x 105 = 0.0001313 mm3

M = ρ x V = 2500 x (0.0001313) = 0.33 kg

4. Total Belt Pull (F)

Now the total vertical force applied by gear on belt conveyor

F1= (Total mass of object) *(Acceleration due to gravity) = 0.05 x 9.81

F1 = 0.4905 N

Total weight of belt (F2) = (mass of belt * g)

F2 = 0.33 x 9.81 F2 = 3.2373 N

Total belt pull (F) = F1+(F2 * μ)

F = 0.4905 + (3.2373 x 0.4) F = 1.785 N

5. Belt Speed (v) = (3.14 x wheel diameter x motor rpm)/ (60 x 1000)

6. Power required for moving conveyor belt (P)

Total power required for moving conveyor belt = belt pull * belt speed

P = 1.785 x 0.2136

P = 0.3813 watt

Hence according to these requirements, we have selected a 12V, 60 rpm DC motor for the appropriate working of our system.

5] EXPERIMENTAL WORK

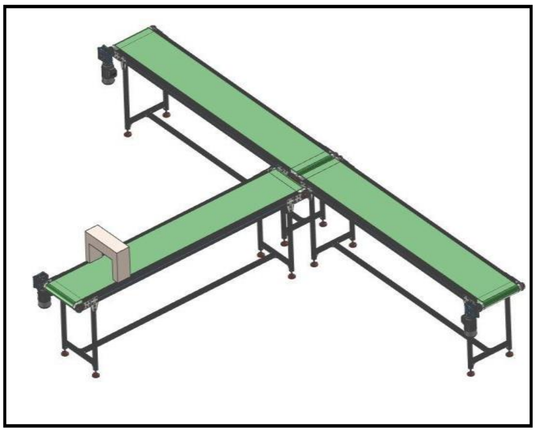


Figure 5: 3D representation of conveyor belt system

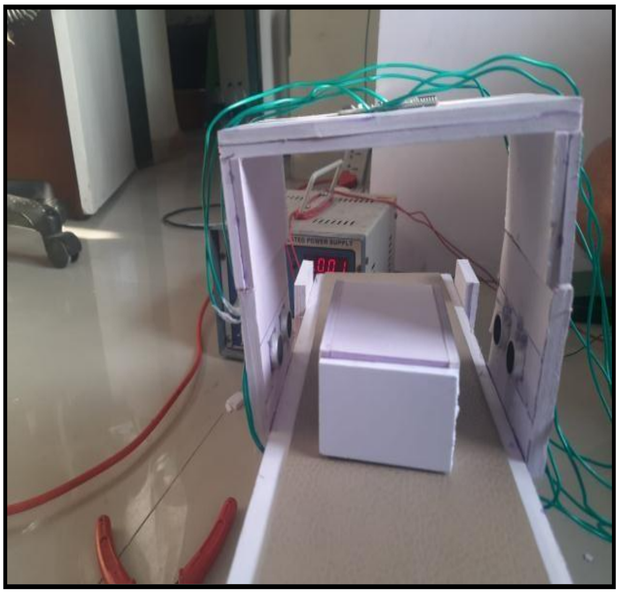


Figure 6.1: Specimen passing through the check box

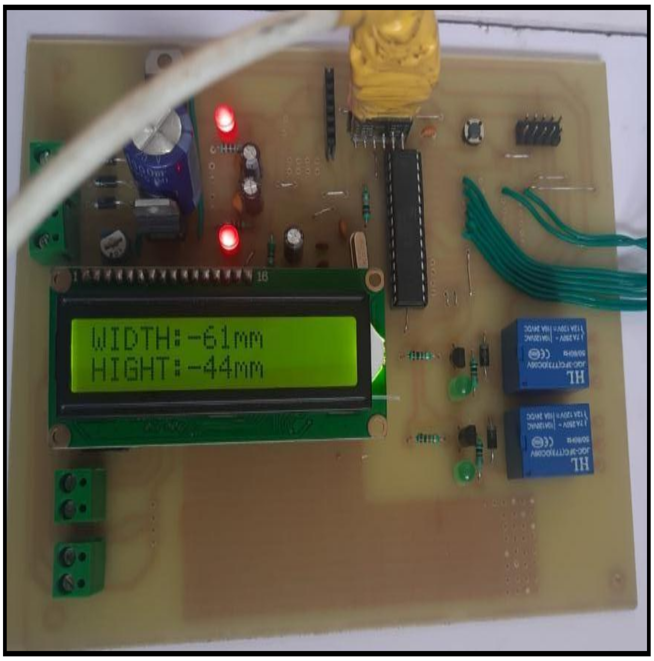


Figure 6.2: LCD showing measured output dimensions

Figure 6.3: Representation of system fabrication

6] OBSERVATIONS

Reading no.	Height (cm)	Width (cm)	Time taken for check (sec)
1	4.1	5.9	3.1
2	4.4	6.1	3.0
3	4.3	6.0	3.3
4	4.1	6.1	3.2

7] EXPERIMENTAL RESULTS

The system is capable of successfully measuring the dimensions of the specimen. If in case the measured values of the job do not match the specified dimensions, then the diverter/separator segregates the job as rejected and vice versa. This prototype requires an average time of 3.15 sec for precisely measuring 2 dimensions of the object i.e., height and width. The prototype is capable of inspecting the dimensions of various lightweight objects.

8] CONCLUSIONS

For the reduction of inspection time and segregation of products precisely, our proposed system can be implemented. Two dimensions i.e., height and width of the specimen can be measured in a single pass. Hence, overall time consumption is reduced and human intervention is minimized.

9] ACKNOWLEDGEMENT

I would like to express our gratitude to my guide Prof. J. D. Nanaware whose contribution in stimulating suggestions and encouragement, helped me to coordinate our report.

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