

Design and Fabrication of Automated Wire Cutting And Stripping Machine

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Abstract- *The aim of this project is to produce the mechanical design of programmed wire cutter and stripping machine. Our machine can consequently take care of, cut, and strip wires to a given length and amount. Our ultimate objective was to fabricate a useful machine that was to wipe out the need for an individual being to hand measure, cut, and strip huge amounts of wires. With our machine, they will include their ideal parameters through an installed HMI and let the machine do the monotonous and redundant work. This mechanized undertaking opens a labourer and takes into consideration a tremendous expansion in profitability, subsequently making it a truly significant resource in the business.*

Keywords- Reducing labour cost, reducing waste, improving quality, increasing repeatability, reducing employee injuries, and allowing uninterrupted production.

I. INTRODUCTION

In the underdeveloped small-scale businesses, these days workforce is a significant issue for industries. Multiple circumstances happen when workers for their own advantages which bring degradation in quality, corruption, and misfortune failure. Subsequently, the industry proprietors need to bear the losses and thus can't accomplish their desired benefits and profits. The arrangement of robotization in the business can take care of this issue in an exceptionally compelling manner. The automation system tackles workforce issues that save cost, increase precision, and diminishes manual errors. After studying different electronics and electrical industries we infer that these days some industries have acquainted automation in their frameworks to a degree, yet for some essential cycles such as time and labour-consuming like cutting of wire, stripping and packing and so on. On the off chance that if we introduce automation with these fundamental cycles, it will be efficient in production regarding the organizations. Certain industries discovered in which they need an answer that is proficient, quick, and affordable in cutting wires of various lengths which are needed for electrical and electronics production.

1.1. Objective

The goal of this project is to design and build up a programmed automated wire cutting machine to accomplish low expense cutting. It works quickly and decreases the cutting time. This machine isn't made by utilizing complex segments. This machine is straightforward and versatile. This machine is designed controller unit, rollers, cutter, guide tubes, and angle bars to control the whole activity of the machine. The practical target of the programmed wire stripping machine is to cut the necessary length of wire.

The goals of undertaking are to plan a framework for a programmed device to cut wire are:

1. Automated
2. Improved Efficiency
3. Consumer-friendly
4. Transported easily
5. Price-viable
6. Simplified and tedious assignment
7. Criterion on functionality of the system
8. Response to the user's input
9. User information display.

1.2 Study, Comparison and Data Analysis

At present a manual method is used to cut and quantify wire, which requires a lot of time and requires more workforce. The physical method's efficiency and precision are extremely low. The automatic wire-cutting system's main goal is to cut the necessary wire length in the appropriate quantity. In terms of user helpfulness, this device is less complicated and mobile.³

On our survey, currently today at industries the cutting and stripping process in small scale industries and some start-up units are done manually by labours which is a tedious, time consuming and tiresome. Most of these industries when observed is using this traditional method of manpower instead of commercial automated machines is due to the high price, high maintenance, and high volatility in

specific business segment. The observation on the installation cost, maintenance cost and operating cost faced by industries takes a huge hit on profit.

Most of these commercial grade machines have exorbitant maintenance and in terms of mobility to re-organise shop floor is impossible. Also, with respect to OSHA injuries report CY2019 on minor injuries for labour working on these industries have almost 28% recorded non-fatal injuries.

Also, the commercially available similar machines are high cost, high maintenance and high in non-modularity. Our initial idea was to have automation right from the feed of wire out from cable bobbins to the cutting and stripping to required length of wire fed by user.

The Existing commercial machines use DC motors which does the work but are highly inefficient and high power consumption whereas, Stepper motors give their max torque at low speeds, which makes them particularly valuable in high accuracy, applications like mechatronics and 3D printers use them predominantly. Some DC motors additionally create high torque at low speeds, however, are not better at continuous runs, as their torque is steady over their speed range. The fundamental distinction is that, while the stepper motor can push more from the rest, DC motors will in general have a more supported yield.

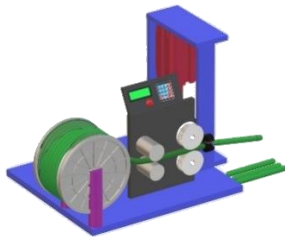


Figure 1 Initial 3D concept

II. COMPONENTS OF SETUP

We wanted to setup an effective product, fare price and gaining instant ROI with highly modular to restructure the industrial process flow and workflows. So, we had the following simple yet fancy key components in our machine,

1. Feed Rollers
2. NEMA 17 Stepper Motors
3. Nextion 3.2" Touchscreen HMI
4. Arduino Mega
5. CNC Shield and Driver attachment

In our automated cutting and stripping machine, we have a HMI interface which helps the user to feed input on the

parameters of length of wire required to be cut or stripping the top insulation and exposing the conducting core.

III. MACHINE SPECIFICATION

The automatic wire cutter and stripper is to cut the wire of required length in stripping required area set by the user without labour, efficiently. So, we decided to make a project named 'Design & Fabrication of Automated wire cutting and stripping Machine'. Some specifications considered for our scope:

- a. To cut user set length of wire.
- b. The feed to cut and strip can be adjustable anytime during operation.
- c. Reduced maintenance in operation.
- d. Rollers are used to feed automatically based on HMI data without manual intervention.

IV. SELECTION AND CALCULATION

4.1. Selection of Motor

r = radius of roller = 220mm

220mm of wire length is covered in one roller revolution.

Motor speed = 30rpm

• Torque Required = $F \times r$: Where,

Spring force denoted as F .

Roller radius denoted as r

For gripping purpose, let's assume spring force as 2kg

$$\therefore T = r \times F$$

$$= 2 \times 35 \times 9.81$$

$$= 700 \text{ N-mm.}$$

Now,

• Frictional Force and the clamping force are equal Where,

Frictional force = $\mu \times R_n$

Friction coefficient is denoted as μ

Reaction force is denoted as $R_n = 20$

For the rubber material, we assumed a friction coefficient of 0.3.

Frictional force denoted as f .

$$f = R_n \times \mu$$

$$= 20 \times 0.3$$

$$= 6 \text{ N.}$$

Assume a 25% reduction of torque transferred from the motor to the drive roller caused by friction.

∴ By accounting for 25% losses, the torque of the motor is calculated.

$$\text{Torque} = 700 \times 1.25 \text{ N-mm}$$

$$T = 875 \text{ N-mm}$$

• Total Generation of power = 2.749 watt

4.2 Calculation for cutting force

Calculation for wire

$$\text{Syt} = 70 \text{ Mpa}$$

$$= 70 \times (10)^6 \text{ N-m}^2$$

$$\text{Sut} = 0.577 \text{ Syt}$$

$$= 0.577 \times (70 \times (10)^6)$$

$$= 40.39 \times (10)^6 \text{ N-m}^2$$

Force required to cut the wire

$$D = F/A$$

$$A = \pi/4 \times d^2$$

$$D = 1.2 \text{ mm} = 1.2 \times (10)^{-3} \text{ m}$$

Required amount of force for shearing the wire is,

$$40.39 \times (10)^6 = 4F/\pi \times (1.2 \times (10)^{-3})^2$$

$$F = 45.68 \text{ N}$$

Length of cutter denoted by $l1$

Applied force denoted by $p1$

Cutting length $l2$

Cutting force is denoted by $p2$

Therefore $l1.p1 = l2.p2$

$$L1 = 85 \text{ mm}$$

$$L2 = 15 \text{ mm}$$

$$P2 = 45.68 \text{ N}$$

$$\text{Therefore } 0.085 \times p1 = 45.68 \times 0.015$$

$$P1 = 8.06 \text{ N}$$

Torque required for motor

$$T = F \times r$$

$$T = 8.06 \times 0.045$$

$$T = 0.367 \text{ N-m}$$



Figure 2 Build Prototype

V. CONCLUSION

Our prototype signifies and gives an undeniable degree of precision and accuracy in cutting the wires than the current cutting machines available in the world. Consequently, because of this, the proficiency of manufacturing is improved. This device gives an accurate size of wires with necessary dimensions. The circuit intricacy is decreased in this device. As the intricacy in the circuit is diminished, it is straightforward and easy to comprehend and mobile, modular. The primary benefit of this device is that the accuracy is

improved necessary outcome is gotten achieved in little time. The time needed to strip wires is low contrasted with physical method of cutting wires. Because of straightforward equipment, and its economic feasibility and support to ergonomic working environment, it is a great and successful project for small-scale industries. To conclude, we have all learned a lot throughout this project. It was very rewarding to start with nothing but an idea and turn it into a working, automated machine all on our own. We now have a fully functional machine that can cut and strip any amount of wires that a user commands it to through an HMI. Our automated wire cutter could be a very useful machine in the industry. We feel that with the total amount we invested into this machine, the return on investment would be very high.

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