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Design and Development of Computer Controlled Gear Cutting Machine

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Abstract: *The design, development, and performance evaluation of a low-cost, portable, and affordable gear cutting machine. The machine is specifically designed to cater to the needs of small-scale manufacturing units, provide with a cost-effective solution for gear production. The research focuses on addressing the gap in the market for accessible gear cutting machinery, aiming to enhance local industry growth and manufacturing capabilities. The thesis outlines the design process, key features, construction, and performance evaluation of the gear cutting machine, demonstrating its potential to facilitate gear production in small-scale manufacturing setups. The findings of this research contribute to the advancement of affordable manufacturing solutions, enabling small-scale manufacturers to compete effectively in the industry.*

Keywords: automatic gear cutting, mechanical System, Automation, industries

I. INTRODUCTION

Outfitting is perhaps of the most basic part in mechanical power transmission frameworks. The exchange of force between gears happens at the contact between the mating teeth. During activity, fit gears teeth flanks are submitted to high contact pressure and because of the rehashed anxieties, harm on the teeth flanks, notwithstanding tooth breakage at the foundation of the tooth are one of the most successive reasons for gear disappointment. This happens on account of unfortunate getting done and deburring process [1]. The motivation behind this paper is to take out those issues.

The reasonable stuff slicing machine to effectively assist with building those mechanical Framework more. Gears are a vital piece of the power transmission framework as they are utilized for moving hat or power from central player to the place where it is required or will be utilized. Gear cutting machines are utilized to create gears by moving a stuff clear with a pivoting shaper known as hob. Processing machines are by and large utilized in limited scope enterprises for playing out this activity. Mechanization of stuff cutting activity is accomplished by utilizing machines yet it is generally utilized in enormous scope enterprises as it were. By taking into account the way that limited scale businesses couldn't bear to purchase separate machines for performing various undertakings [2]. From the plan perspective, exhaustion strength and wear are the main rules in light of the fact that each stuff tooth might encounter billions of burden cycles [1]. Miniature gears of light materials such as aluminium, brass, bronze, copper, and polymers possess specific characteristics, i.e., light in weight, compact size, good performance and low operating power requirement [3]. The Arduino microcontrollers can be programmed easily using the C or C++ language in the Arduino IDE [4].

II. LITERATURE SURVEY

Balaji An et al [5] 2017 has mentioned that Pinion wheels can be delivered utilizing different strategies like projecting, machining, manufacturing, expulsion, powder metallurgy, and blanking. One normal technique for making spike gears is by utilizing a processing gear shaper in a general processing machine. This study presents a separable arrangement in a current penetrating machine for creating spike gears and furthermore takes out the requirement for manual dealing.

M.V.N Srujan Manohar et al [6] 2012 has mentioned that A shaper is utilized to machine a solitary occupation by utilizing a solitary point cutting instrument and consequently it can not be utilized for high creation rates. Sutar Rajendra Sidharam et al [7] 2012 has mentioned that, I made an endeavor to plan and manufacture a connection for a

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stuff cutting for a medium obligation machine. This endeavor will lessen the speculation for medium and limited scope businesses, sub sequent diminish the assembling cost of pinion wheels. Ms. Priyanka Barde et al [8] 2015 has mentioned that, The stuff cutting machine connection is append able to a current stuff slicing machine to take out the requirement for an administrator claiming both a stuff cutting machine and a machine. This sort of cutting is preposterous on a machine with ensured exactness.

H. S. Cheng, [9] 2000 As the population of our world is growing day by day, the market for various goods has risen. This has contributed to a growth in the number of different enterprises, most of which are small-scale industries that produce small parts for different large-scale industries. Cost saving is one of the key factors considered in small-scale manufacturing.

Data Flow Diagram:

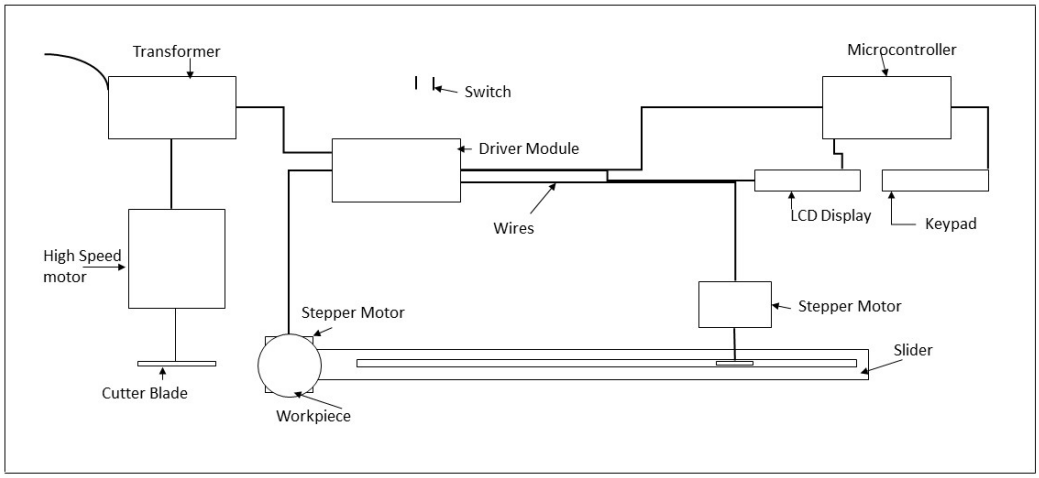

Figure 1: System Design

The mini gear cutting machine addresses this gap by offering an automated solution at a fraction of the cost, suitable for small-scale industrial applications. By eliminating the need for separate, expensive milling machines, this innovative setup makes gear manufacturing more affordable and practical for smaller enterprises. The mini gear cutting machine exemplifies the advancement of automation technology in simplifying complex manufacturing processes, driving productivity, and fostering innovation in resource-constrained settings. This development ensures that even small-scale operations can achieve high precision and efficiency in gear production, thereby enhancing their overall competitiveness and capability in the market.

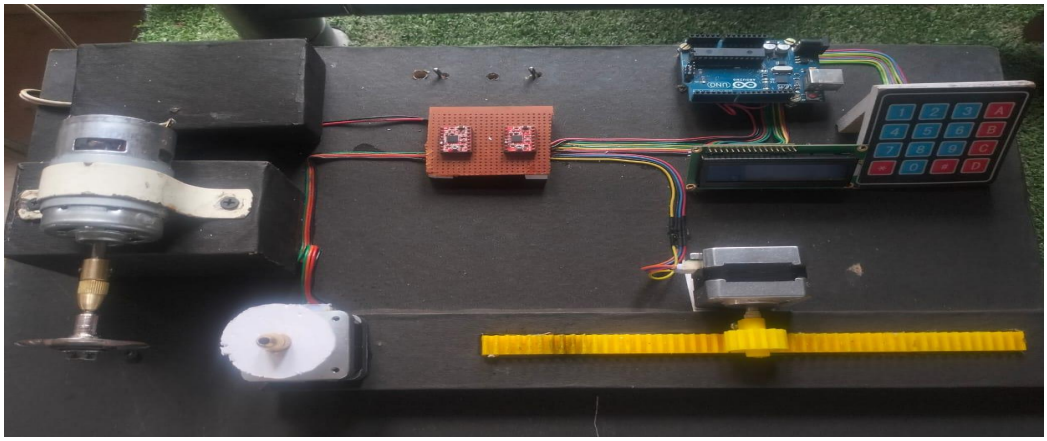

Figure 2: Project Model

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Components:

Arduino:

Microcontroller: ATmega328P ,
Operating Voltage: 5V ,
Input Voltage : 12V ,
In-out Voltage (limit): 6-20V

Stepper Motor:

Torque : 3kg -cm ,
Voltage: 12V ,
Current : 1.3 A ,
Power : 6.6 W

High Speed Motor:

Speed : 1200 rpm ,
Phase : 3 Phase ,
Frequency : 60 Hz ,
Horsepower: 40 HP

Cutting Blade:

Figure 3: Cutting Blade

Material: High Speed Steel,
Module: 2.25 mm,
Bore Diameter: 20 mm,
Pitch Circle Diameter: 50mm,
Addendum Circle Diameter: 60mm

4x4 Keypad:

Key layout: 4 rows by 4 columns,
Key type: Membrane,
Operating voltage: 3–5 V DC,
Interface: 8 digital pins, 4 for rows and 4 for columns

LCD Display:

LCD Type : TFT rows by 4 columns,
Operating voltage: 5.3 V,
Operating Current: 1 mA

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Circuit Diagram:

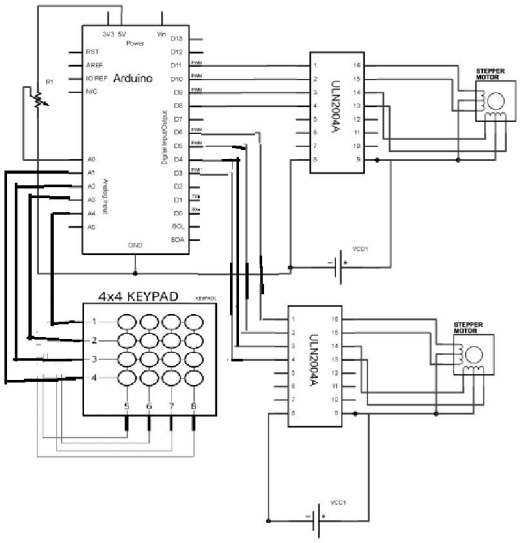

Figure 4: Circuit Diagram

Explaining Circuit:

The integration of arduino microcontrollers and stepper motors presents a versatile and cost-effective approach to developing automated machinery. One such application is the automatic gear cutting machine, which leverages arduino's flexibility and the precise control offered by stepper motors to achieve accurate and efficient gear cutting operations**.** When a value from key pad is enter it go to controller then controller program sends a command to the stepper motor which drives the it to the cutting blade were the gear are cut. The machine will be capable of performing a range of gear cutting operations, including hobbing, milling, and shaping, with high precision and efficiency. Through this endeavor, we seek to demonstrate the potential of Arduino-based automation in revolutionizing manufacturing processes and driving industry innovation.

Experiment:

The experiment was conducted on “Development of gear cutting machine” by using Arduino and stepper motors.

Calculation:

To calculate the time taken for cutting each gear, we'll need to consider several factors:
Gear cutting speed (feed rate): This depends on the material of the workpieces and the cutting tool, but for simplicity, let's assume a standard cutting speed.
Number of teeth: If not specified, we'll consider it standard.
Depth of cut: Assumed as standard for each pass.
RPM of the cutting tool: 1200 RPM.
Diameter of the workpieces: 50mm, 60mm, 70mm.
Calculate the circumference of each workpiece (C):
Without Thickness , $C = \pi \times D$
C = Circumference , D = Diameter of workpiece
With Thickness, $C = \pi \times (D + T)$
C = Circumference, D = Diameter of workpiece, T = Thickness of workpiece
Calculate the spindle speed (N) in RPM: The spindle speed is fixed as 1200 RPM.
Calculate the feed rate (F): F = Feed per tooth x Number of teeth x Speed
Calculate the time taken to cut each gear (T): T = c/f

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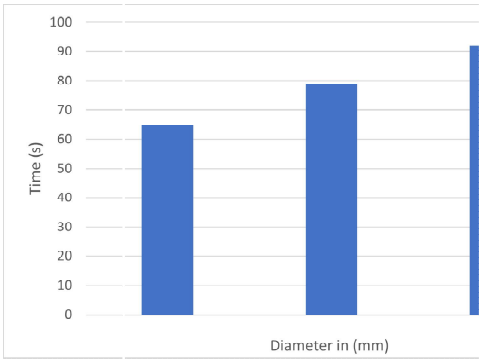

Figure 5: Relationship between the time taken to cut the diameter of the workpiece

Reading 2:

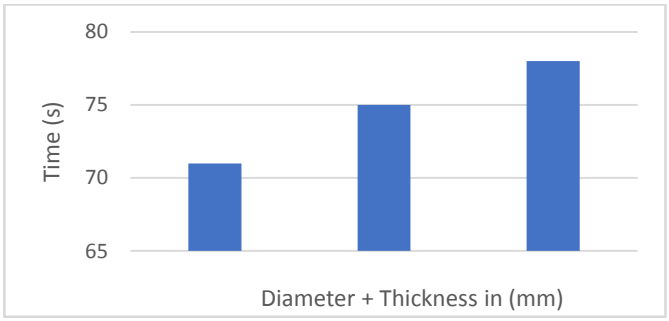

Figure 6: Relationship between the time taken to cut the diameter of the workpiece

III. RESULT AND DISCUSSION

This might be able to handle very soft metals, but it is really meant for cutting nylon and other plastics, we are using foam sheet of 5mm. The mini gear cutting machine achieved high precision, with gear teeth dimensions closely adhering to industry standards and minimal deviation, ensuring reliable power transmission. The gears had a smooth surface finish, comparable to those made by traditional milling machines, thanks to a high-speed steel milling cutter. The automated process was about 50% faster than manual methods, crucial for small-scale industries.

The mini gear cutting machine achieves precision and quality with the help of DC stepper motor and Arduino UNO ensuring uniform gear teeth spacing and high accuracy. The reduction in production time is a significant benefit, allowing small-scale industries to boost production rates without compromising quality. This efficiency is vital in competitive markets requiring timely delivery. The cost-effective detachable setup, leveraging existing drilling machines, minimizes initial and ongoing costs, making it accessible for small-scale industries. Positive feedback highlights the machine's ease of use, operational flexibility, and simplified automation with Arduino UNO, reducing the need for extensive training.

IV. CONCLUSION

The separable arrangement for gear cutting in penetrating machine has been planned and manufactured. This arrangement when executed in limited scope ventures would be savvy and would require less works as the activity is robotized and controlled through Arduino. The significant benefit of this machine is intercession of work is diminished to most extreme level.

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