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| Research paper |  |
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|  | 24 April 20xxStatistics 101 |
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|  | OVERVIEW The objective of this project is to create an automated wire bending machine that can bend thin wires with high customizability in three dimensions using simple commands.  This project uses eighteen parts, out of which seventeen were manufactured throughout lab sessions.  Considering the cost metric provided, our project has been evaluated as worth three thousand seven hundred ninety three rupees only  Improvements that could be made to the project include attaching a stepper motor to the feeder for greater precision and designing a cutting mechanism post bending. | |  |
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|  | Isometric | |  |
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|  | Design & Specifics After researching existing wire-bending solutions, We chose to use stepper motors for precision control, along with an Arduino microcontroller to facilitate custom programmability and ease of use.  By incorporating 3D-printed parts, We created a structure that is both lightweight and cost-effective. This design approach allowed us to address common limitations in wire bending, such as limited flexibility and control, while ensuring that the machine remains user-friendly and adaptable for a range of custom projects. MOTOR SELECTION  1. DC MOTOR  |  |  | | --- | --- | | Scenario | Automating z-axis rotation and feeder | | Reason for selecting motor | After rudimentary weight analysis, we found a DC motor to be sufficient | | Size |  | | Torque |  |  1. STEPPER MOTOR  |  |  | | --- | --- | | Scenario | Automating bending on XY plane | | Reason for selecting motor | Bending requires high precision, which can be controlled easily using steppers. | | Size in cm (LxWxH) | 12 x 9 x 7 | | Torque | 0.4(NM) |  1. SERVO MOTOR  |  |  | | --- | --- | | Scenario | Automating bending on XY plane | | Reason for selecting motor | Bending requires high precision, which can be controlled easily using steppers. | | Size in cm (LxWxH) | 4.05 x 2.0 x 4.4 | | Torque | 10 to 12(kg-cm) | |  | |  | |
|  | DESIGN CALCULATION  1. **Z axis Gear**: 2. **Zaxis Gear 1(Driving Gear):**   No. of teeth = 20 Module = 1.5 Indexing(40/N) = 2 O.D. = 33mm   1. **Zaxis Gear 2(Driven Gear):** No. of teeth=40 Module=1.5 Indexing(40/N)=1 O.D.=63mm   **Gear Ratio= 40/20=2**   1. **Bender Gear:** 2. **Bender Gear (Driving gear):**   No. of teeth = 12 Module = 2.5 Indexing(40/N) = 3.33 O.D. = 35mm   1. **Bender modified gear (Driven gear) (3D printed):**   No. of teeth = 30 Module = 2.5 O.D. = 80mm  **Gear Ratio= 30/12=2.5**   1. **Rack and Pinion Gear:** 2. **Pinion Gear:**   No. of teeth = 18 Module = 1 O.D. = 5mm | |  | |

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|  | Component Inventory    |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Parts Name** | **Quantity** | **Material Used** | **Manufactured/Bought** | **Manufacturing**  **Process** | | Bender Gear | 1 | Mild steel | Manufactured | Milling, Drilling, Turning | | Bender Gear Modified | 1 | Thermoplastic | Manufactured | 3-D Printing, Filing | | Rack and Pinion Gear | 1 | Thermoplastic | Manufactured | 3-D Printing | | Bender Extender | 1 | Thermoplastic | Manufactured | 3-D Printing | | Shaft Clamps | 2 | Thermoplastic | Manufactured | 3-D Printing | | Hanging Plate | 1 | Aluminium | Manufactured | Cutting, Drilling | | Z - Axis Gear 1 | 1 | Mild Steel | Manufactured | Milling, Turning | | Z - Axis Gear 2 | 1 | Mild Steel | Manufactured | Milling Turning | | L - Shaped Z- axis motor Mount | 1 | Mild Steel | Manufactured | Drilling, Cutting | | L - Shaped Shaft Holder | 2 | Mild Steel | Manufactured | Drilling, Cutting | | Shaft | 1 | Mild Steel | Bought | - | | Nozzle | 1 | Perspex | Manufactured | Turning | | Feeder | 1 | Aluminium | Manufactured | Turning, Drilling, Knurling | | Roller | 1 | Aluminium | Manufactured | Turning, Drilling | | Holder of the Roller | 1 | Mild steel | Manufactured | Cutting, Drilling | | Adjustable Knob | 1 | Mild Steel | Manufactured | Turning | | Overall Base Stand | 1 | Mild steel | Manufactured | Drilling, Taping, Threading. | | Wire Holder | 1 | Plastic, Wood | Manufactured | Cutting, Drilling | |  |  |

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| Cost Analysis Number of holes drilled: 35(small) + 4(big)  Avg. time taken to drill small hole: 5 mins  Time taken to drill big hole: 15 mins  Total **drilling** time: **3 hrs 55 mins**  Number of gears: 3  Avg. time taken to mill out one gear: 1 hour 45 mins  Total **milling** time: **5 hours 15 mins**  Total length turned: 47 cm  Avg. time taken to turn 1 cm: 5 min  Total **turning** time: **1 hr 55 mins**  Total time taken for **3D printing** (measured): **5 hours 30 mins**  Total **weight of steel** used in manufacturing: **14 kg**   |  |  |  |  | | --- | --- | --- | --- | |  | Time taken (hrs) | Rate (per hr) | Cost (in rps.) | | Drilling | 3.91 | 75 | 293.25 | | Milling | 5.25 | 250 | 1312.5 | | Turning | 1.91 | 150 | 286.5 | | 3D printing | 5.50 | 100 | 550 | | Weight | 14 (kg) | 100 | 1400 | |  |  | **Total** | **3842.25** |   Hence, the total cost of the project is evaluated as approximately 3793 rupees. |