AUTOMATED SHOE TYING MACHINE

UCDAVIS COLLEGE OF ENGINEERING

Department of Mechanical Engineering

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COMPETITION PARAMETERS

- Speed
- Success Rate
- Energy Consumption

COMPETITION RESTRICTIONS

- 2 Motors Only
- $600 Budget
- Wall Outlet Powered

CIRCUIT DIAGRAM

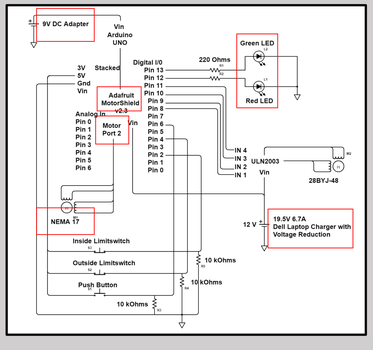


Figure 6. *Circuit diagram of electronics for machine where the red boxes highlight important components.*

INTRODUCTION

Our project is based on a competition inspired by the desires of the elderly and/or the disabled to be able to wear laced footwear instead of having to settle for velcro or slip-ons or requiring the assistance of a care provider. Although there exists hobbyist machines that demonstrate knot tying capabilities, none are fully automated and require the user to place the laces in preset locations. As a result, Team Tightens has designed a fully automated shoe tying machine capable of tying a safe and lasting shoelace knot, through an initial and final knot as shown in Figure 1, without human assistance in order to help users gain more independence, impacting their esteem and confidence.

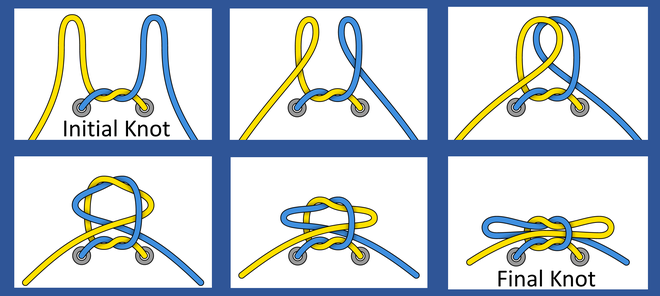


Figure 1. *Examples of the initial knot and final standard shoelace knot. (Diagrams provided by Ian Fieggen with permission).*

CONCEPT DESIGN

Figure 2. *Initial prototype of automated shoe tying machine.*

Originally, we constructed a small prototype made of cardboard and balsawood to simulate the motions of tying a shoe. We decided to base our shoe tying algorithm on the Ian knot method because it is the fastest shoe tying method and it allows for symmetrical repeated motions to successfully tie an initial and final knot. One of the first iterations of our design can be seen in Figure 2 on the left.

TESTING

STAGE ONE

- Reducing friction in bevel gears
- Perfecting clutch mechanism
- Refining hook rod design

STAGE TWO

- Test functionality of algorithm
- Time each run
- Record amount of kilowatts used

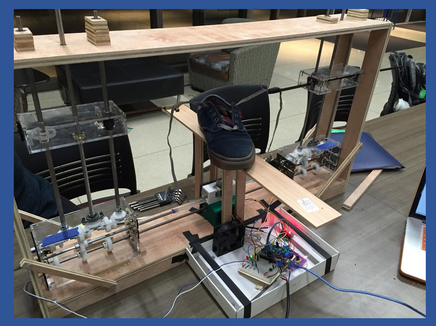


Figure 3. *Testing shoe tying algorithm.*

FINAL PRODUCT

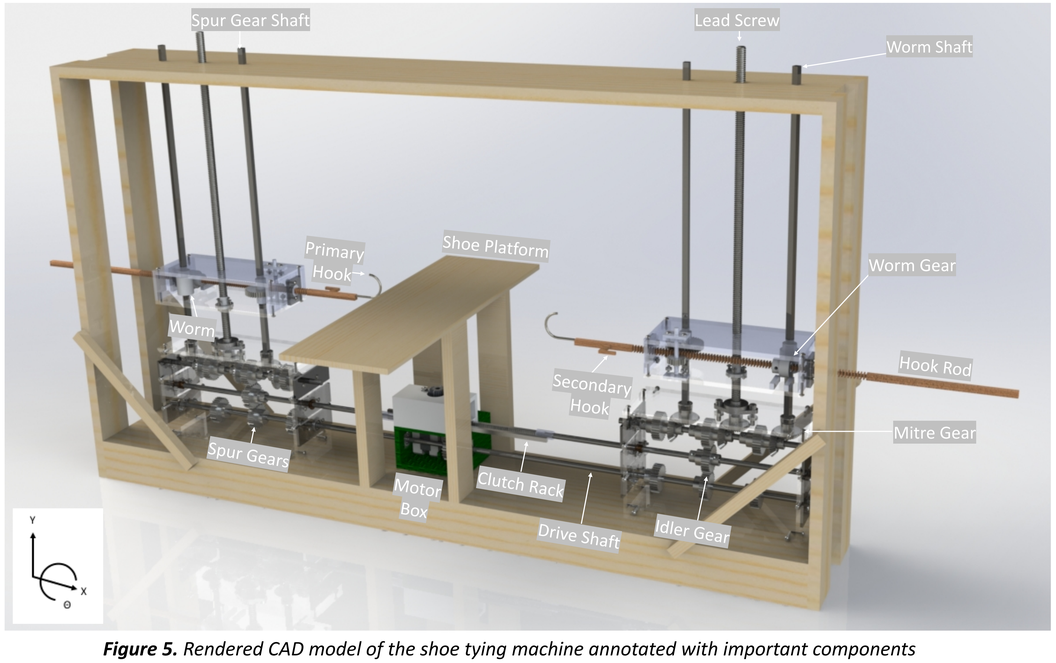


Figure 5. *Rendered CAD model of the shoe tying machine annotated with important components*

HOOK ROD MOVEMENTS:

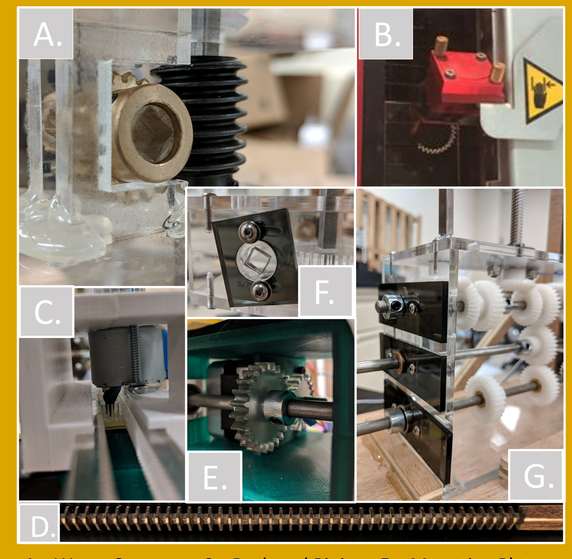
- Worm Gear → X – Axis Rotation
- Spur Gear → X – Axis Translation
- Lead Screw → Y – Axis Translation

POWER TRANSMISSION:

- Rack and Pinion → Clutch Mechanism
- Mitre Gears → Translates horizontal to vertical motion

MANUFACTURING

The laser cutter in the ESDC made our machine possible. From acrylic spur gears and racks to a custom hook rod, we cut anything we could think of.



A. Worm Gear Acrylic Insert
B. Laser Cutting Gear
C. Rack and Pinion
D. Hook Rod
E. Motor Box Spur Gears
F. Mounting Plate Bearing
G. Frame & Mounting Plates