

# 3D Printed Robotic Arm Prototype

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## Abstract

The cost of technology is rising and the ability for schools to support new technologies is decreasing. Statistics show over 3 million industrial robots will be used in factories throughout the world in 2020. The goal of this project was to create a platform that could teach students basic robotic concepts. A user-friendly prototype arm was designed. This robotic arm is based on open source concepts, allowing for future expansion.

## Introduction

The arm was created with 4 degrees of freedom. Each axis is controlled using a planetary gear and NEMA 17 stepper motor. Every custom component of the arm was 3D printed using PLA filament. An Arduino Uno microcontroller was the brains of the operation. To control the stepper motors, Sure-Step drivers were installed. The entire system is powered using a 35V power source. A graphical user interface gives users the ability to control the arm from their desktop.

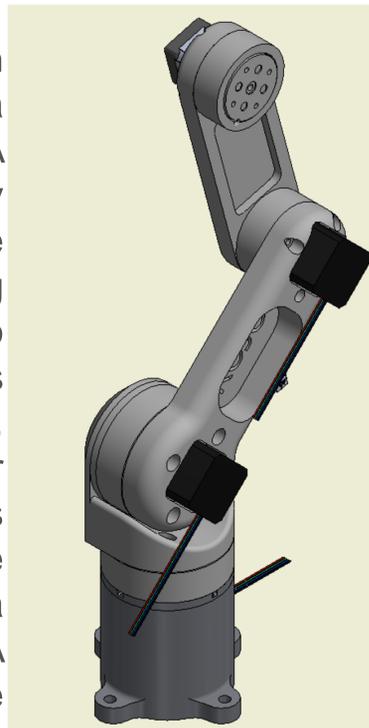


Figure 1: Robot Cad Model (Inventor by Autodesk)

## Methods and Materials

Planetary gears produce little to no backlash. Each system consists of a ring gear, sun gear, planet gears, and a carrier plate. Steels balls were used to locate the carrier plate and reduce the load on the gear itself

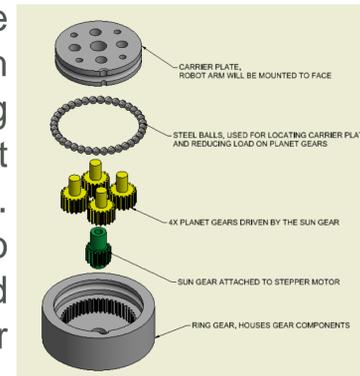


Figure 2: Exploded View of Planetary Gear (Inventor by Autodesk)

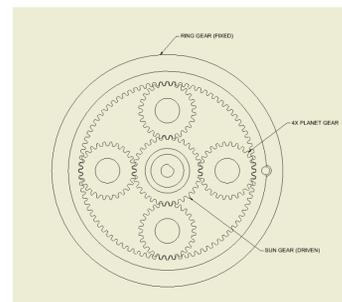


Figure 3: Detailed View of Planetary Gear (Inventor by Autodesk)

Gear ratios were calculated to ensure proper stepper motor configuration. Two sizes of gearboxes were used on the arm.

## Results



Figure 4: 3D Printed Robotic Arm (Minus Stepper Motors)

A 3D printed prototype was created. The arm is controlled using a graphical user interface. The interface was created using Python and allows the user to move individual axes. The planetary gears needed to be ran through test cycles before the motors were attached to allow for smooth movements. These cycles were done manually.

## Discussion

Where to go next? This questions can be broken into two parts: Mechanical and Controls.

### Mechanical

- Additional degrees of freedom
- Higher gear ratios to reduce motor wear
- More wear resistant material

### Controls

- Expand user interface
- Limit switches to home robot
- Upgrade to Arduino MEGA
- Addition of a teach pendant

## Conclusions

A cost-effective robotic arm platform is possible. To be successful, the arm will need to be created using more wear-resistant material and outsourced to keep costs down. The open source platform is easy to use and teach. The prototype arm shows the possibilities of having robotics systems in classrooms throughout the United States.

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