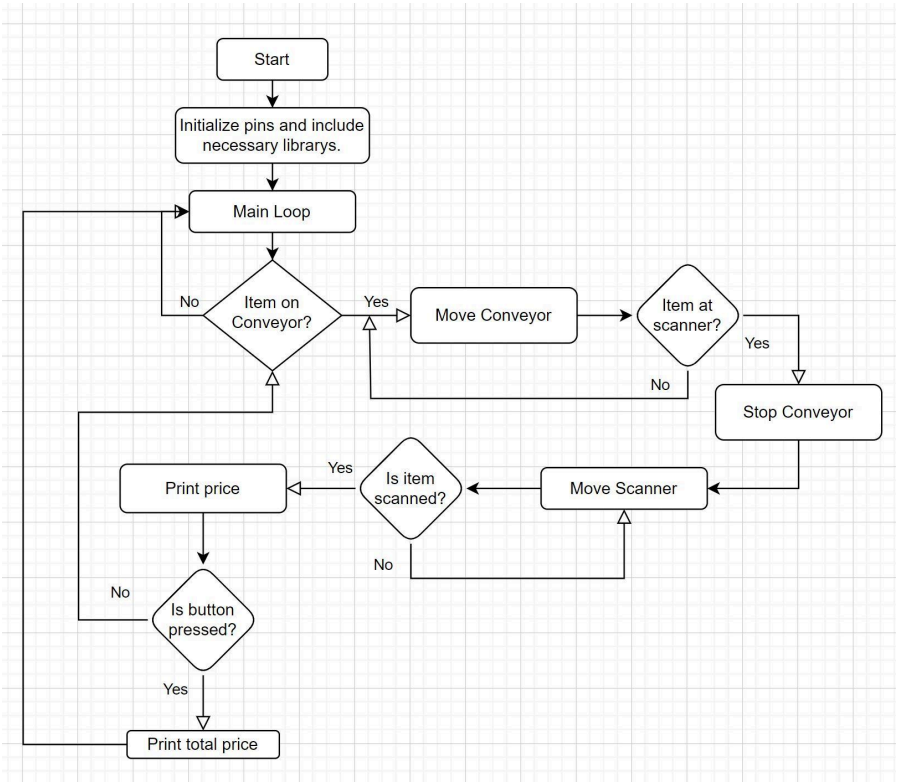
Project Overview

I, along with a team of four other students, developed a **Smart Cart prototype** for automated checkout. The system integrates key subsystems for **barcode scanning, item sensing, and transportation**, utilizing **infrared sensors**, a **rack-and-pinion system**, and **Arduino-based control** to scan and transport items efficiently. Below a program flowchart displays the logic of the system.

Program Flowchart



Challenges Encountered

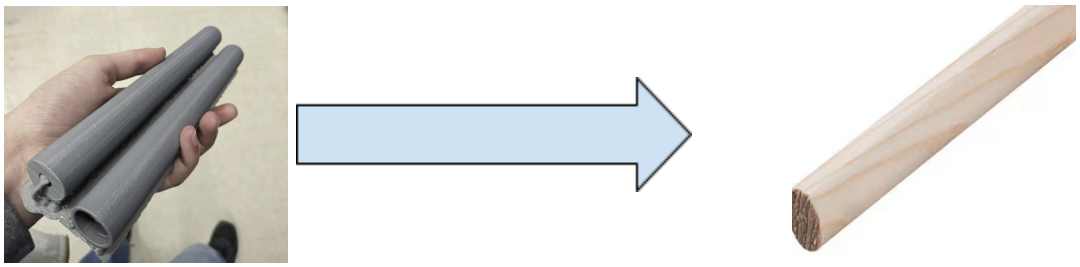
To prioritize operational efficiency, we encountered several unexpected challenges that required innovative solutions:

1. **Conveyor Belt Material**: The initial rubber belt was too heavy, causing motor stalls. We replaced it with lighter paper sheets, which helped a lot.

Before **After**

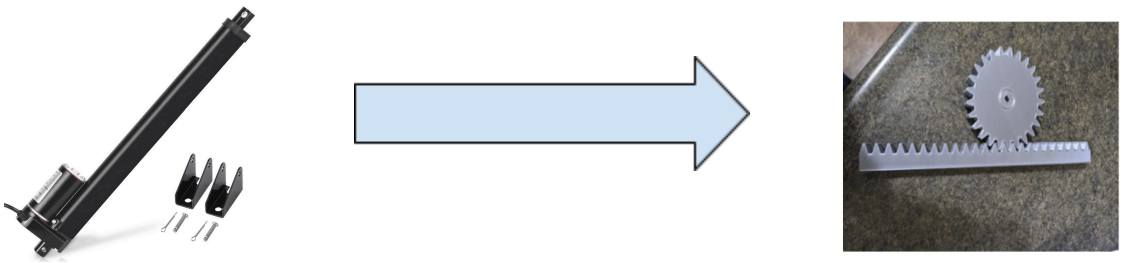
2. **Roller Support**: Thick 3d printed rollers were used to rotate the conveyor belt resulting in increased friction, hindering motion. We used one 3d printed roller connected to a DC motor and a thinner wooden dowel for the final design.

Before **After**



3. **Vertical Scanning Mechanism**: The linear actuator was too slow to meet speed requirements. We eventually decided to replace it with a rack and pinion system.

Before **After**



These issues were unique and had not been anticipated. Resolving them required iterative design adjustments that were both time-intensive and technically challenging.

My Contributions

- **Problem Solving**: I proposed replacing one of the 3d printed rollers with a **wooden dowel**, improving the roller's free motion and reducing friction.
- **Design Work**: I designed the **rack-and-pinion system** in SolidWorks, which replaced the slower linear actuator.
- **Technical Support**: I helped debug the code to ensure proper interaction between subsystems.
- **Team Collaboration**: Worked dynamically across all subsystems, complementing team members' expertise by addressing mechanical and design challenges.

Outcome and Lessons Learned

The project successfully demonstrated the feasibility of the Smart Cart concept, despite some reliability issues in the final prototype. These issues stemmed primarily from limited time spent on coding, as practical design challenges consumed the majority of our efforts.

What I Learned:

- **Time Management**: Balancing design iterations and coding earlier could have reduced last-minute troubleshooting.
- **Adaptability**: Leveraging my skills in mechanical design and problem-solving allowed me to contribute uniquely to the team, complementing rather than overlapping with other members' expertise.

What I Would Do Differently:
Allocate more time for coding earlier in the project timeline and incorporate iterative testing to ensure reliability. Initially, we underestimated the complexity of debugging and focused too heavily on hardware adjustments.