# GR-0X: "Growbot" Humanoid Robot that Grows

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## Abstract

**GrowBot (GR-0X)** is a humanoid robot with variable-length limbs using prismatic actuation for dynamic height adjustment and extended reach. Each limb uses three lead screws machined for high axial loads within a 3D-printed frame reinforced at structural interfaces. FEA in SolidWorks validated lower-body integrity. Over the course of four years, the mission of GR-0X is to become a fully modular humanoid robotic platform, utilizing the extendable limbs to adapt its workspace to tasks in a way other humanoids traditionally struggle with.

## Objectives

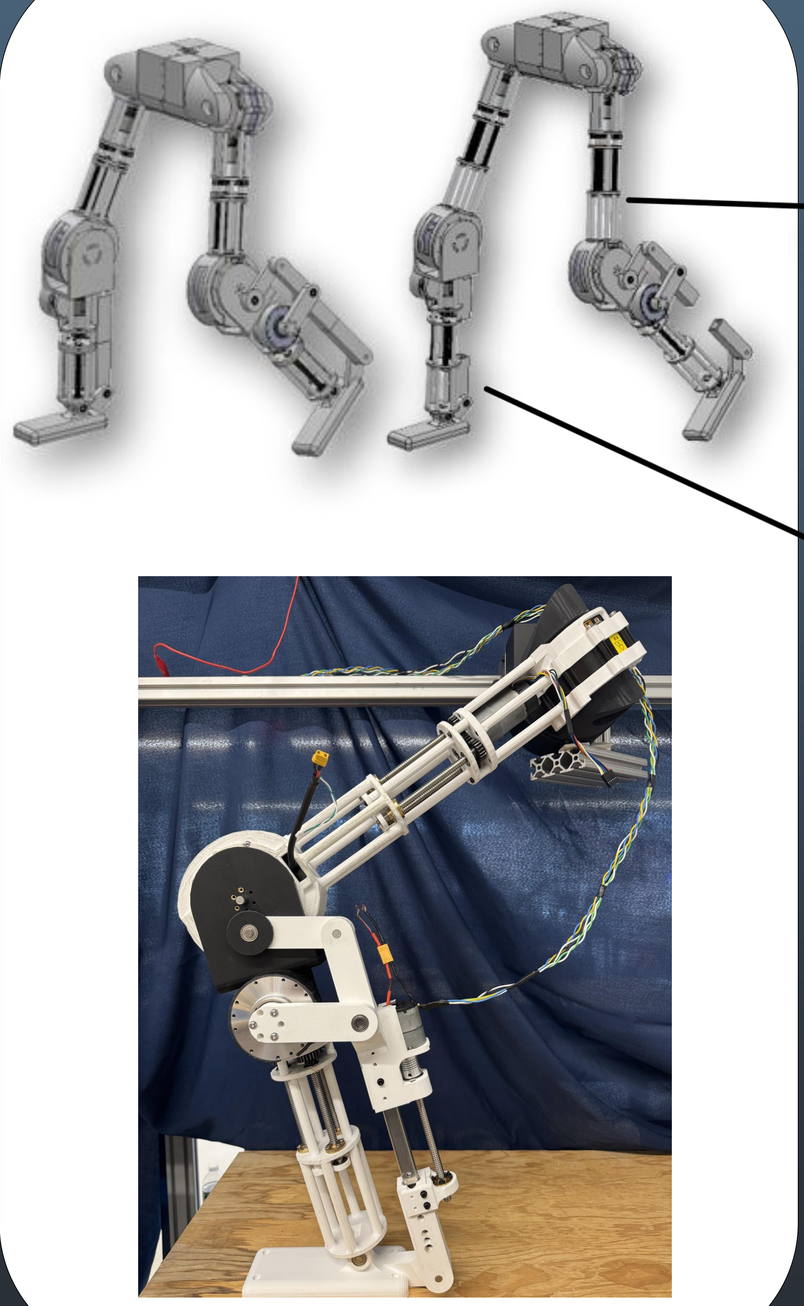
Current humanoid robots operate with fixed morphology, limiting their adaptability to environments designed for humans of varying heights and reach. This constrains task versatility a robot optimized for countertop work cannot easily access high shelves or ground-level tasks without full-body repositioning.

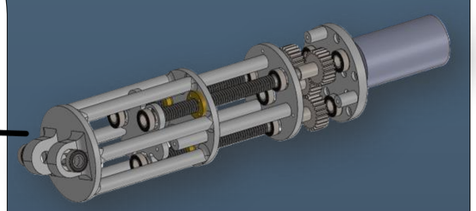
**GR-0X is a platform for exploring how variable Height Limbs can be used**

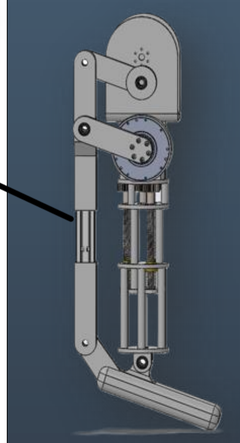
- Expand operational workspace without repositioning
- Enable a single platform to handle multi-height tasks
- Dynamically adjust center of mass for improved stability
- Reduce reliance on complex whole-body motion planning

## Motivation:

- Current Designs are typically designed with fixed morphologies, leaving them struggling to adapt.
- For a standard fixed length robot basic motions with height differentials require large full body motions to achieve
- Typical engineering solutions to increasing a robots workspace require significant increases to robot size
- Expandable limbs open up new frontiers for locomotion and obstacle avoidance.







## Linear Mechanism

**Leadscrew design:** To achieve high precision and strength a leadscrew design was chosen to extend the actuator

**Planetary gearbox:** Splits the load between three leadscrews to stabilize the foundation and distribute weight

## Leg Design: Four-Bar Ankle

**Motor Placement:** To reduce complexity, we put the motor in line with the knee motor

**Extendable Four-Bar:** Ankle needs to remain consistent even with the length of the leg increasing. The "Tendon" is a metal rail that can extend to match the growth of the limbs

## Structural Design

**3D-Printed Structure:** We needed to have both flexibility and low cost.

**Material:** High Strength Carbon Fiber-PLA was used for superior structural strength

**Metal Usage:** we used metal for bearings, Rails, and Leadscrews.

## Next Steps:

- **Upper Body Integration:** Design and fabricate torso, arms, and head with matching prismatic actuation
- **ML-Based Control:** Migrate to NVIDIA Isaac Sim for reinforcement learning of gait and manipulation policies
- **Design and Material improvements:** Create multiple linear designs, move to metal parts to enable greater load bearing capabilities.