Dissection Project
Dissection of a Parker Linear Actuator

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Introduction and Product Application

A linear actuator is a device used to create linear motion, contrasting the rotary motion generated by traditional electric motors. It serves as a critical component in various mechanical systems, enabling precise control over position, speed, and force.

Usage

Linear actuators play a pivotal role in various applications from industrial machinery, automotive technology, to medical devices. They facilitate movements required for automation and control processes.

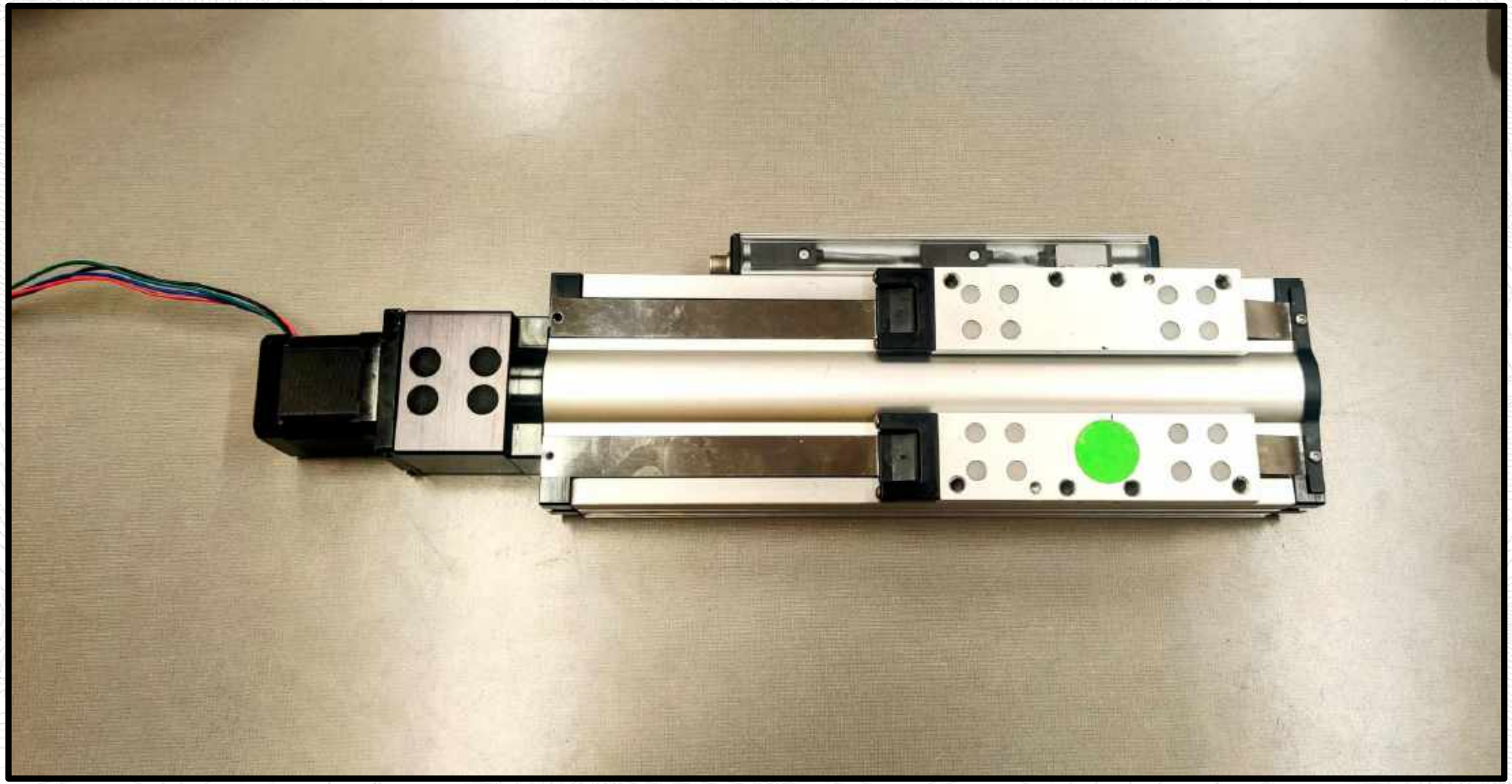
Advantages

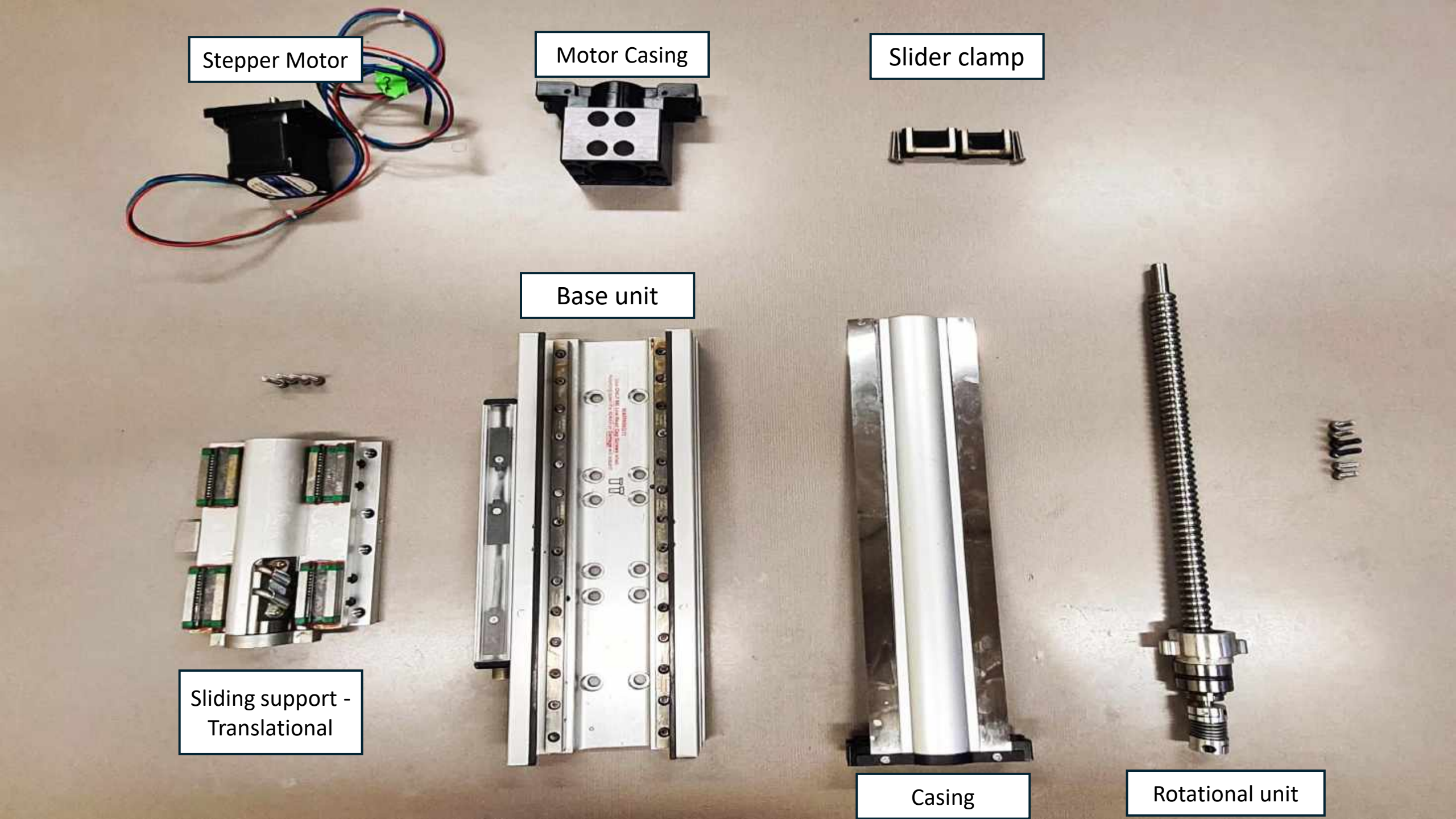
- Precision Control: Allows for exact positioning and speed control.
- Versatility: Suitable for various environments and applications.
- Efficiency: Converts energy into motion effectively, optimizing performance.

Application

In the medical field, linear actuators adjust the height of hospital beds for patient comfort and care. In automotive industries, they operate to adjust seats and windows. Industrial applications include automation processes where precise motion is required, such as in CNC machinery.

Basic Construction




Stepper Motor
Motor Casing
Slider clamp
Base unit
Sliding support - Translational
Casing
Rotational unit

Disassembly

Assembly

Mechatronic System

- Mechanism to transmit motion: Leadscrew mechanism
- Actuator: Stepper Motor, Power Outlet
- Sensor: (external)
- Controller: (external)

Electrical and Mechatronic Components

- **Control System**: The main component in a linear actuator is the stepper motor. The stepper motor obtains the control signal from the control unit which consists of the user interface as well as the microcontroller/processor.
- **Driver circuit**: The output of the microcontroller can be modulated with the help of the power stage modulators such as MOSFETS, power transistors, integrated driver chips, etc.
  We could not dissemble the control unit as it was soldered shut but I assume that it also consists of Micro stepping controller as well as position sensors.
- **Stepper motor**: The core mechatronic component of the linear actuator. We would not want to take the risk to open the stepper motor as the magneto components as pressure pressed. We conducted a thorough literature survey of the RoHS stepper-online stepper motor provided to us (link) and we found it consists of:

  - **Stator :** It constitutes the stationary portion of motor; the stator comprises coils of wire arranged around the rotor. When an electric current passes through these coils, they produce a magnetic field.
  - **Rotor:** The rotor serves as the movable part of the motor and typically includes a shaft along with teeth or poles. These elements interact with the magnetic field generated by the stator.
  - **Coils:** These are wire windings wound around the stator poles. By energizing these coils in a specific sequence, a rotating magnetic field is created, propelling the rotor to move in precise steps.

Mechanical Components

- **Support shaft and Bearings:** Attached to the rotor, the shaft extends from the motor, facilitating the transmission of motion. Bearings provide support to the shaft, allowing it to rotate smoothly within the motor housing. The shaft is uniformly threaded with a constant pitch and consists of a support that can be connected to the stationary component of the setup (motor casing).

- **Motor casing:** It serves as a housing component positioned between the stepper motor and the support shaft, acting as a junction to securely connect the two elements, preventing slippage and minimizing creep and friction losses.

- **Base unit (stationary unit):** It is the housing unit the helps to attach the system to a plate where the work is performed. It is a precisely machined part where all other mechanical components get mated to.

- **Casing:** It is a cover provided to protect the sliding components from dust.

- **Slider (translational):** The slider serves as the primary element responsible for transforming the rotational motion supplied by the motor and shaft into linear movement for the linear actuator. It incorporates a zero-friction bearing, assisted by ball bearings, to facilitate the upward and downward motion of the slider unit. Since the stepper motor is bidirectional, it can propel the slider along the axis in both directions.

- **Slider clamp:** It functions as a basic clamp, preventing the setup from loosening and inadvertently causing dimensional and tolerance deviations.

Challenges

We didn’t find any complicated problems when we worked on the project. Some of the inconveniences that we faced while working are:

- Ball bearing assembly: There are multiple ball bearings arranged in the shaft of the actuator, mainly to provide friction relief to the translational components. The issue we faced during the disassembly process was that these balls used to easily fall off from the various openings in the shaft casings. We faced an even bigger issue during the assembly process as we had to arrange the ball bearings evenly throughout the pitch of the transmission shaft, and it was hard to create the motion to obtain this arrangement.

- Sensor subassembly: One major issue we faced was that we could not remove the sensor casing as it was soldered shut. Though we could see that there was a position sensor from the outside, we would have loved to inspect it even more to see if there were any tachymeters, vibration sensors, pressure sensors, etc.

- Power input: We manually spun the shaft using a pin to analyze the rotation, but the issue was that we could not plug in the stepper motor to an electric supply due to the custom input pin. We thought we could plug in the Arduino board to provide inputs, but without knowing the adapter configuration, it would provide the risk of either shorting the stepper motor or the Arduino board.

- Calibration: As most of the components in the actuator are precision-based, we had a slightly harder time calibrating the setup and ensuring that we do not create any issues with damaging the threading or sliding components.

Learnings as a Team

- It was great to work on the project that involved working on components, as many of us have no professional work experience. So it was a fun learning experience.
- It was great to apply theoretical concepts to an applied component. It helped us learn the theory even better.
- Working as a multicultural team was great, as we got to learn about each other. We learned to work in and handle different working environments, which would be useful for our future professions.
- We had an opportunity to work on precision equipment that would usually not be available to us. We got to learn about the quality of components, lubrication, safety cutoffs, etc.

THANK YOU

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