# Mechatronics and Making
# Mid Project Report
# Exoskeleton Robotic Hand With Wolf Claw Mechanism

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# 1 Introduction

## 1.1 Project Objectives and Description

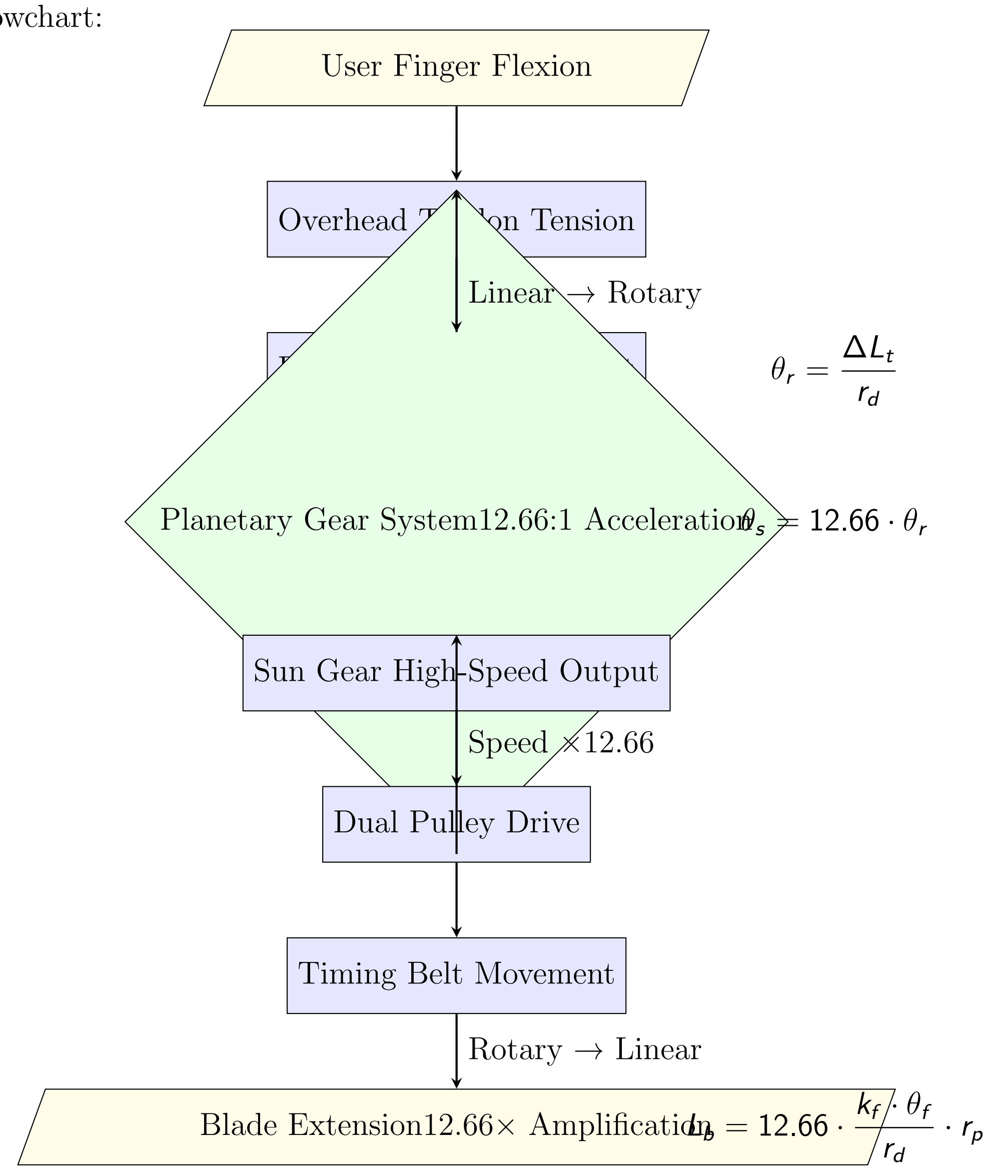
## 1.2 Similar Mechanisms

## 1.3 Industrial Applications

# 2 Mechanical and Mechanism Analysis

## 2.1 Drive Method and Transmission

The exoskeleton robotic hand employs an acceleration-based transmission system where finger movements are amplified through a planetary gear mechanism to achieve significant blade extension. Below is the detailed transmission process illustrated through a flowchart:



### 2.1.1 Transmission Process Details

1. **Biomechanical Input (Finger Flexion)**:
    - Natural finger flexion creates geometric displacement
    - Overhead tendon routing on finger dorsal side
    - Tendon displacement: $\Delta L_t = k_f \cdot \theta_f$
2. **Tendon to Rotary Conversion**:
    - Tendon wraps around drum connected to ring gear
    - Linear displacement converted to rotational input
    - Ring gear rotation: $\theta_r = \frac{\Delta L_t}{r_d}$
3. **Planetary Gear Acceleration**:
    - Ring gear serves as input (unconventional configuration)
    - Planet gears transfer motion to sun gear
    - 12.66:1 acceleration ratio: $\theta_s = 12.66 \cdot \theta_r$
    - Sun gear outputs high-speed, low-torque rotation
4. **Pulley and Belt Transmission**:
    - Sun gear shaft drives dual synchronized pulleys
    - Timing belts maintain parallel blade alignment
    - Three blades mounted perpendicular between belts
5. **Final Blade Deployment**:
    - Belt movement translates to linear blade extension
    - Total amplification: 12.66× finger movement
    - Final extension: $L_b = 12.66 \cdot \frac{k_f \cdot \theta_f}{r_d} \cdot r_p$

### 2.1.2 Key Design Advantages

- **Amplification Efficiency**: 12.66× mechanical advantage enables significant blade extension from subtle finger movements
- **Compact Design**: Planetary gear system provides high ratio in minimal space
- **Intuitive Control**: Direct relationship between finger position and blade extension
- **Safety**: Acceleration mechanism requires minimal finger force, reducing user fatigue

### 2.1.3 Kinematic Performance

The complete transmission system achieves:

$$\text{Overall Ratio} = \underbrace{\frac{k_f}{r_d}}_{\text{Tendon}} \times \underbrace{12.66}_{\text{Planetary}} \times \underbrace{r_p}_{\text{Pulley}} = 12.66 \cdot \frac{k_f \cdot r_p}{r_d} \quad (1)$$

Where small finger movements ($\theta_f$) result in proportionally larger blade extensions ($L_b$), making the system both responsive and precise for its intended applications.

This acceleration-based transmission represents an innovative approach to exoskeleton tool deployment, leveraging planetary gear mechanics to amplify natural human movements into effective tool operations.

## 2.2 Fingers and Wrist Mechanisms

## 2.3 Wolf Claw Mechanism Comparison

### 2.3.1 Version 1: Planetary Gear

### 2.3.2 Version 2: Compound Gear Train

# 3 Mathematical Modelling and Analysis

## 3.1 Fingers and Wrist Modelling

## 3.2 Wolf Claw Mechanism Version 1: Planetary Gear

## 3.3 Wolf Claw Mechanism Version 2: Compound Gear Train

# 4 Conclusion and Future Work

# References


[1] author. title. In editor, editor, *booktitle*, year.