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

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1 Introduction

1.1 Project Objectives and Description

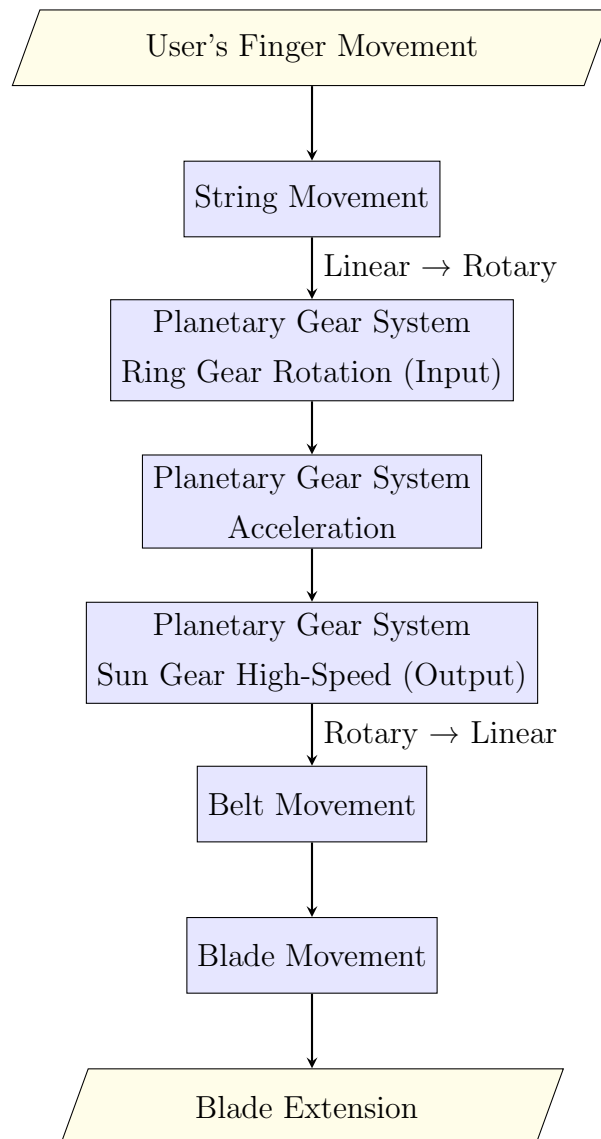## 1.2 Similar Mechanisms

1.3 Industrial Applications

2 Mechanical and Mechanism Analysis

2.1 Drive Method and Transmission

This robotic hand exoskeleton uses an acceleration-based machinery system. Therefore, the movements of the finger will be amplified by this mechanism.

This mechanism can do that through a planetary gear mechanism, whereas a belt system and a string transmission system are also needed.

Details of the transmission process shows below:

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              User's Finger Movement

                  String Movement

                Linear → Rotary
              Planetary Gear System
             Ring Gear Rotation (Input)

              Planetary Gear System
                   Acceleration

              Planetary Gear System
            Sun Gear High-Speed (Output)

                Rotary → Linear
                  Belt Movement

                  Blade Movement

                  Blade Extension
```

2.2 Hand Exoskeleton Mechanisms

2.2.1 Hand Structure

根据Heo等人（2012）的综述，人手包含19块骨骼和14个关节（不包括腕骨）。手指关节主要包括：

掌指关节（MCP）：具有2个自由度（屈曲/伸展、外展/内收）

近端指间关节（PIP）和远端指间关节（DIP）：各具1个自由度（屈曲/伸展）

拇指的腕掌关节（CMC）为鞍状关节，具有2个自由度，赋予其更大的灵活性。

在休息姿态下，MCP关节屈曲约45°，PIP屈曲30–45°，DIP屈曲10–20°。这些数据对于设计外骨骼时的运动范围和安全性至关重要。

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

User's Input (Finger Movement)

The linear movement of the string that is deployed over the finger is created by the finger's flexion.

Figure 1 has two sub-figures: Figure 1a describes the details and data when finger curved, Figure 1b describes the details and data when finger extended.
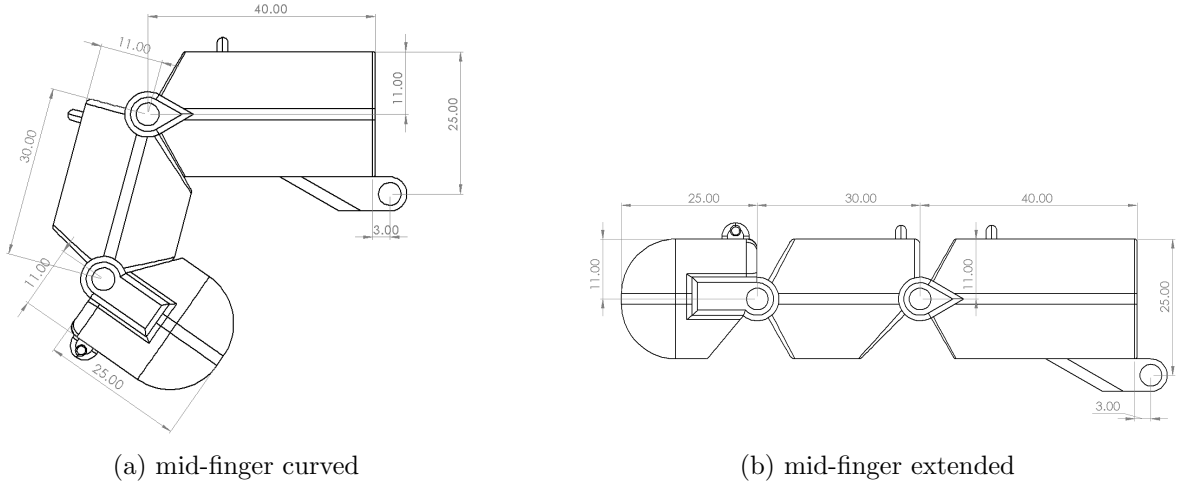

(a) mid-finger curved   (b) mid-finger extended

图 1: mid-finger exoskeleton design

Total displacement of the string overhead by calculation:[1]

$$\Delta L = L_{DIP} + L_{PIP} + L_{MCP}, \quad \text{where}$$
$$L_{DIP} = 11 \times \frac{45}{360} \times 2\pi \approx 8.64,$$
$$L_{PIP} = 11 \times \frac{60}{360} \times 2\pi \approx 11.52,$$
$$L_{MCP} = (25 - 11) \times \frac{85}{360} \times 2\pi \approx 20.77$$
$$\Rightarrow \Delta L \approx 8.64 + 11.52 + 20.77 = \boxed{40.93 \text{mm}}$$

3.2   Wolf Claw Mechanism Version 1: Planetary Gear

3.3   Wolf Claw Mechanism Version 2: Compound Gear Train

4 Conclusion and Future Work

参考文献

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

参考文献