

Ale-HAND-ra: Design and Development of a Low-Cost, Open-Source Humanoid Robotic Hand

 Hillary Velásquez¹, Marcela Lagos¹, Fávell Núñez¹, Luis Felipe Casas²
¹Faculty of Engineering, Universidad Tecnológica Centroamericana (Unitec), Tegucigalpa, Honduras

²Department of Computer Science, University of Texas at Dallas, Richardson, TX, USA

Abstract

Ale-HAND-ra is a low-cost, open-source robotic hand with 20 degrees of freedom, designed for human-like functionality using affordable 3D printing methods. Based on biomechanical analysis, it offers precise motion and a 350g grip, making it ideal for educational, prosthetic, and robotic use. The achieved goal was to develop an affordable, open-source humanoid robotic hand, using digital fabrication tools, that accurately replicates human anatomy and functionality.

Methodology

Independent Variables

- Number of Actuators
- Manufacturing Materials
- Degrees of Freedom

Evaluation Metrics

- Motion Precision
- Design Replicability
- Grip Versality
- Grip Strength



- Digital Fabrication
- Biomechanical Modeling
- Modular Component Assembly

Design & Fabrication Process

Results

Ale-HAND-ra demonstrates the feasibility of building an affordable humanoid robotic hand that replicates human anatomy and function. Through digital fabrication and 3D printing, a modular and durable prototype with realistic movement was developed, guided by anatomical and kinematic analysis validated through simulations. Its servomotor-based non-holonomic control system enables complex, human-like motions. Balancing functionality, durability, and cost, Ale-HAND-ra supports applications in education, prosthetics, and robotics, with its open-source resources available on GitHub.



Grasp	Ale-HAND-ra	Clip Studio	Real Hand
Digito-palmar			
Cylindrical			
Spherical			
Pentadigital			
Tri-digital			