VOCA: A Voice Activated, Multi-Articulating, and Non-Invasive Prosthetic Hand

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Introduction

Current EMG-based prosthetics are expensive, uncomfortable, and unreliable due to noisy signals and limited sensor capabilities. Many amputees are unable to afford or maintain these devices, highlighting the urgent need for an accessible, intuitive alternative that restores both function and human connection.

Novelty

VOCA is the first low-budget, voice-activated, multi-articulating, non-invasive prosthetic forearm that integrates deep learning-based grasp detection, computer vision, inverse kinematics, and haptic/audio feedback (Fig 1). Unlike traditional EMG devices, VOCA uses natural language input and intelligent prediction to perform accurate, user-intended grasps in cluttered environments.

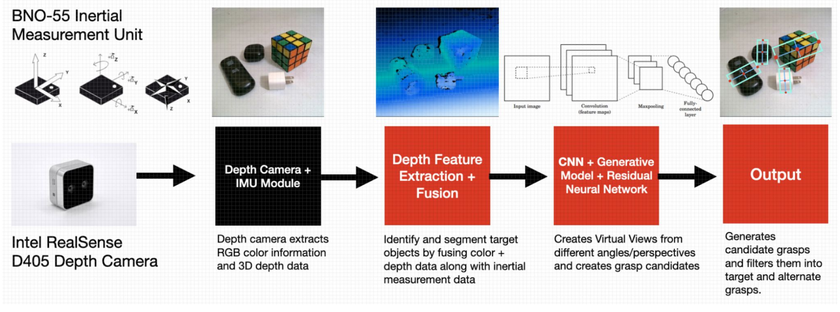

Fig. 1: AI + Voice Activation Workflow

Methods

We engineered a 3D-printed prosthetic forearm with a 4-bar mechanism and integrated it with Micro Servos for articulation (Fig 2). A deep neural network predicts grasp poses, which are converted through inverse kinematics and PID control into servo commands (Fig 3). A speech processing pipeline converts voice commands into grasp actions, supported by real-time haptic and audio feedback.

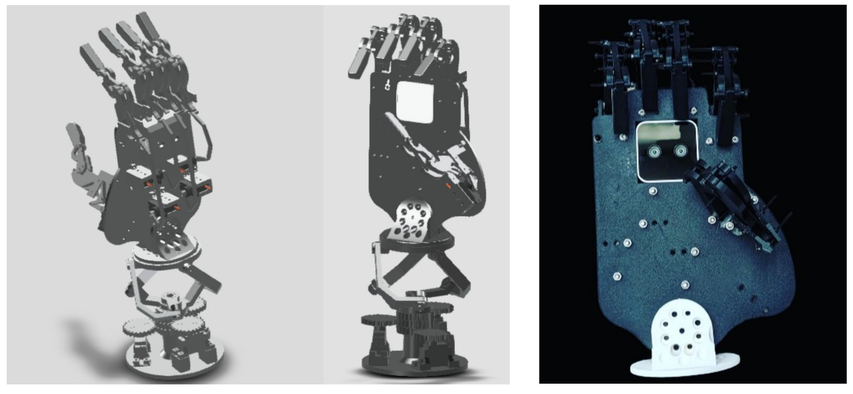

Fig. 2: CAD Design and Completed Hand

Results

VOCA successfully identified and grasped 31 out of 35 household test objects, demonstrating robust performance across diverse shapes and weights (Fig 4). The system achieved competitive accuracy, angle, and speed benchmarks compared to standard approaches, while offering an intuitive and non-invasive control interface.

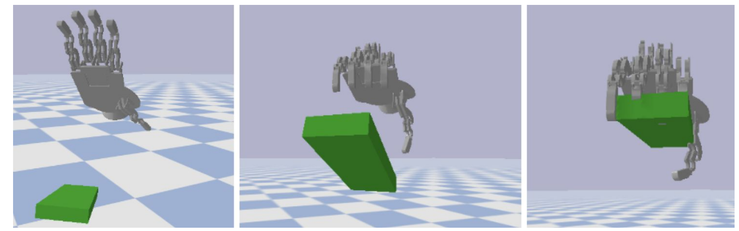

Fig. 3: Grasp Simulation

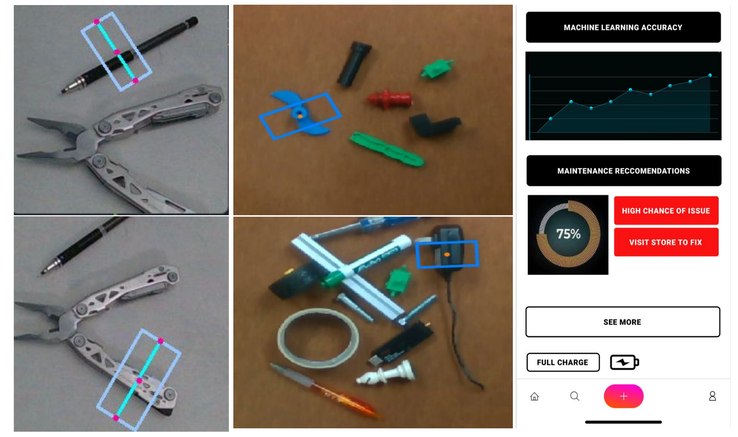

Fig. 4: Grasping in Clutter, 6D Grasp Pose

Conclusion & Future

VOCA paves the way for accessible, AI-integrated prosthetics that restore independence and dignity to amputees. Future work will focus on reducing weight, improving speed and responsiveness, expanding multi-language support, and refining hardware/software interfaces for broader adoption and commercialization.