## Bio signal-Based Control System Enhanced by Real-Time Environmental Feedback

This study aims to develop an intelligent control system by integrating EMG signal classification with real-time environmental interaction, enabling accurate recognition of user intent and effective control of multiple hand movements.

Objective: To develop a control system using EMG and object detection for adaptive, precise, and intuitive real-time motor actuation.

**Statistic** Category Arm Amputees (Worldwide) 3 million (30% of all amputees). Vascular: 54%; Trauma: 45%; Cancer: Causes of Limb Loss 18M fractures; 2M thumb amputations; Hand Trauma (2017) 4M other digits amputated. Increased incidence, prevalence, and **Traumatic Amputation Trends** YLDs, especially in older adults. Hand and Arm Transplants 130+ patients worldwide. 35–40 million people require services **Prosthetic/Orthotic Needs** (WHO, 2017). Percentage of People Who Want Prosthesis Preferences Myoelectric Prosthesis: Among prosthetic users, 92.86% opted for myoelectric devices. Percentage of People Who Want Prosthesis: The study reports that 56% of respondents currently use prosthetic devices, implying they want and use Want Prosthesis Want Myoelectric Prosthesis

Gripper User Arm

Arduino

Image Collection

Bitalino EMG Electrodes

Camera

Griper (Servo/Motor)

Arduino

Electrode

Hand gestures are classified from EMG signals, and object detection adds environmental context to trigger adaptive motor actions in real time.

This study bridges human intention and environmental awareness, opening new paths for smarter, more responsive, and personalized control systems.

