Executive Summary

PHOTOGRAPH

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1. **Title of the Project**: Smart Prosthetic Arm

2. **Date of Start of the Project**: 01.10.2021

3. **Aims and Objectives**:

Aim of the project is to enable easy use of an upper limb prosthesis involving multiple motors by making some of the motors perform autonomously in a context dependent way. To achieve this, the project will use the terminal device already designed (patent pending) by the awardee and consider simplified task scenarios to demonstrate the concept. The present device has user activated grasping with manual wrist rotation. Therefore, the primary objective of the proposed work is to support autonomous wrist rotation to enable grasping of objects presented in various orientations. Subsequently attempt will be made for autonomous movement of the elbow joint of a prosthesis.

4. **Significant achievements**

Summary of Literature:

All the methods proposed in literature are highly resource intensive. They involve use of sophisticated interfaces and computation. Even then real-time performance is far from being practically useful. The systems have different functional components which are extraneous to the prosthesis; accommodating them within the prosthesis device may not be possible. Intensive neuro-muscular or AI related training involves additional hindrance towards making the system self-contained, reliable and robust.

Proposition of Present Research:
Design of a lightweight, affordable, and robust device that would enable autonomous control of an additional motion on an existing prosthetic arm thereby enhancing the user's capability without additional physical, cognitive or interaction load.

Development:
Using the in-house developed advanced trans-radial prosthesis, PURAK, there are two basic challenges to be addressed. Provision of a motor at the interface of the end-effector and socket of PUTAK for changing the orientation of the hand and development of a method to suitably control the motor. Two designs for the wrist drive with minimal additional weight have been developed and tested for their satisfactory performance. Instrumenting the palm of PURAK with a pair of time of flight (ToF) based proximity sensors, two PoC prototypes have been developed that demonstrated the feasibility of object-interactive control scheme for the first time in literature. An electronic circuit has been developed on the Arduino platform to integrate and synchronize the wrist and grasp controllers and the desired performance has been demonstrated. The application for patenting the idea and publication of the results is under progress.

The newly designed prosthesis has two motors: one for wrist rotation and one for finger movements for grasping. The palm of the prosthetic arm, when presented near any graspable object, it autonomously rotates to align itself with the object for proper palmer gasp. The grasp motor is then activated by the user to securely grasp the object.

5. **Concluding remarks**:

A comprehensive literature study revealed the need for a simple and effective method for controlling the motors in a multi-function prosthesis without active input from the user. The idea of object-interactive control of wrist rotation has been established in a basic PoC prototype using an existing trans-radial prosthesis wherein input from the sensors on hand are utilized for meaningful actuation to enable voluntary and intended grasp. The work established the possibility of the object-interactive control strategy for prosthesis and successfully demonstrated it for the autonomous wrist alignment in a transradial prosthesis. Thus, the primary objective of the project has been achieved.