# Design and Evaluation of a Solar-Powered Modular Robotic Object Maneuvering Assistance System

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## Background and Motivation

- Suitable robotic (mechatronic) devices used for maneuvering assistance and rehabilitation support may be more convenient, useful, user-friendly and effective than purely mechanical devices for sick, weak and disabled people.
- The design should be easy to use, simple, lightweight, low-cost, and modular.
- Powering the device using solar power can make the device the most suitable for users living in remote areas where electricity is not available easily.
- A comprehensive evaluation scheme is necessary to evaluate the performance and user satisfaction of the device.

## Objective

- The objective of this paper was to propose a simple, lightweight, easy to use, low-cost, anthropomorphic, solar-powered and modular object maneuvering assistance robotic device for sick, weak and disabled people and for people needing upper arm rehabilitation support.

- We here present the innovative electro-mechanical design of such an assistance device, describe its prototype and present the evaluation results for the prototype device after evaluating the device following a novel, innovative and comprehensive evaluation scheme.

## Design

- The solar-powered robotic object maneuvering assistance device was designed (Figure 1, upper).
- Adjustable modular gripping mechanisms were designed (attachments at the inner surface of the jaws for gripping rectangular objects with smooth surfaces (Figure 1, middle left) and circular objects with smooth surfaces (Figure 1, middle right).
- The groove at the back side of the device was designed to contain electronic and electric circuit components (Figure 1, lower/bottom).

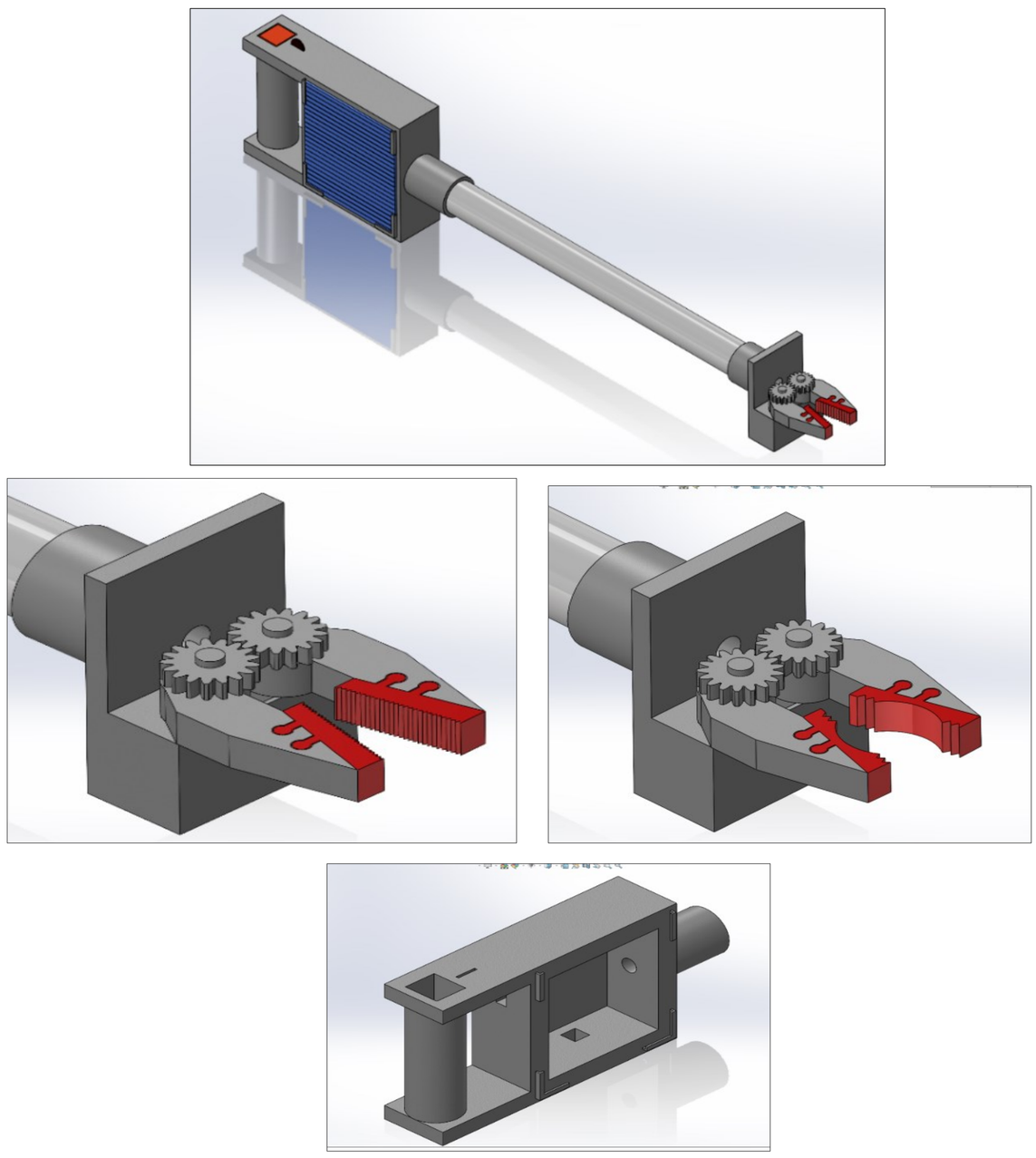


**Figure 1**- Design of the solar-powered modular robotic object maneuvering assistance system.

## Prototype Development

- Developed a simple prototype solar-powered modular robotic object maneuvering assistance system using 3D-printed structure.
- Assembled the innovative gripping mechanism and the electronics with the 3D-printed plastic structure.
- Performed mechatronics design and development.

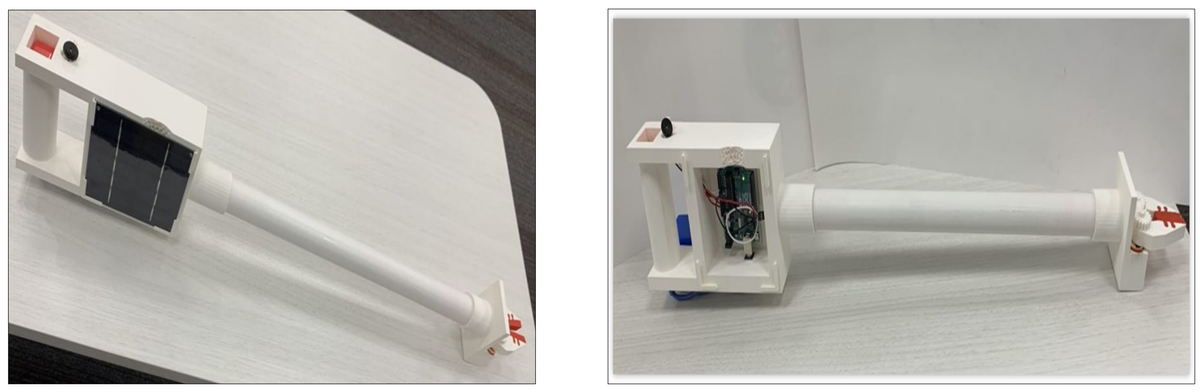
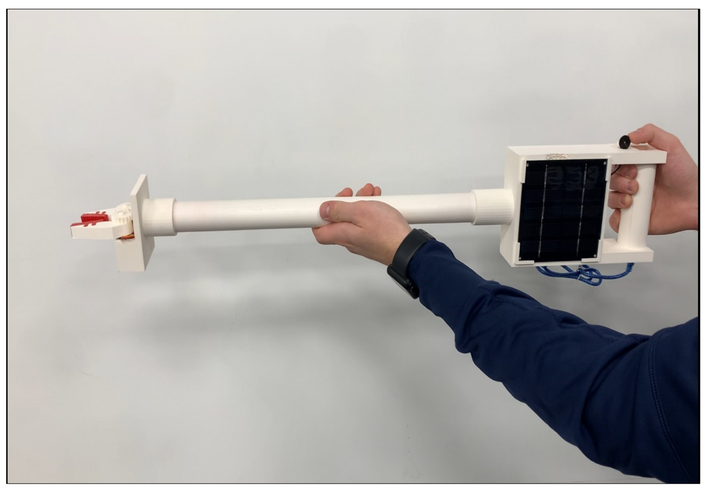



**Figure 2**- The prototype solar-powered modular robotic object maneuvering assistance system (upper), and the architecture of the mechatronics development for the system (lower).

## Evaluation Results

- Experimentally evaluated the prototype solar-powered modular robotic object maneuvering assistance system for grasping and manipulating objects of different surface conditions and shapes using healthy human subjects.
- The results met design expectations and showed satisfactory interactions with users (healthy human subjects).



| Success rates (%) at different test conditions (different objects) | | | |
|---|---|---|---|
| **Rectangular-smooth surface object** | Rectangular-rough surface object | Circular-smooth surface object | Circular-rough surface object |
| **100%** | 100% | 100% | 100% |

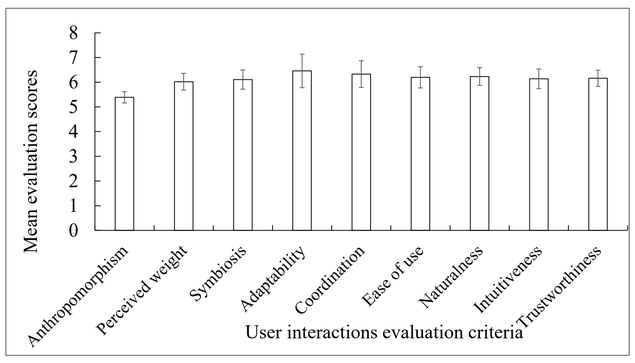



**Figure 3**- The experimental system (upper), success rates (%) in object maneuvering (lower left), and the user interactions (lower right).

## Conclusions and Future Work

- Design and prototype evaluation of a novel robotic object maneuvering assistance system powered by solar energy for assisting sick, weak and disabled people has been presented.
- The evaluation results showed that the system was able to satisfy the technical requirements in object maneuvering operations. The results also showed that the system was able to produce satisfactory and effective human-robot interactions.
- In the future, we will reduce size and weight of the device and evaluate its performance in a clinical study using weak and disabled persons.