

3-Dimensional Optical Wireless Power Transmission Using Robotic Arm

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Introduction

With the widespread adoption of mobile devices, wireless power transmission (WPT) technology has become increasingly important and widely applied. However, traditional wireless charging methods, such as inductive power transmission, are limited by their short range. To address these limitations, laser-based wireless power transmission, known as optical wireless power transmission (OWPT), has emerged as a promising alternative [1]. In previous OWPT system designs, we utilized a camera and a Galvano mirror with a maximum rotation angle of 25 degrees for target recognition and beam steering [2]. While effective under ideal conditions, these systems faced challenges when the laser path was obstructed or required precise dynamic adjustments. To overcome these challenges, we have developed a novel OWPT system that integrates a dual-arm robotic system controlled via TCP protocol.

Experiment setup

In this study, we developed a dual-arm robotic system to evaluate its performance in optical wireless power transmission (OWPT). The system consists of two robotic arms placed 70 cm apart on the same horizontal plane. One robotic arm is controlled by an M5Stack chip and equipped with a 532 nm laser with an output power of 1 mW. The other robotic arm, controlled by a Raspberry Pi chip, is equipped with a solar panel to receive the transmitted power. The robotic arms are connected to a central computer via TCP protocol, which acts as the server, transmitting synchronized coordinate data to both arms. This approach eliminates the need for additional sensors, simplifying the hardware configuration while maintaining precise movement control. The relative positions and coordinate transformations between the robotic arms were calibrated prior to the experiment to ensure accurate synchronization during operation. During the experiment, the laser beam was directed toward the solar panel using coordinate data calculated and transmitted by the server. The robotic arms' movements were governed by their predefined relative positioning, and a homogeneous transformation matrix was used to convert coordinate data between the two robotic arms. The experimental setup was designed to test the system's ability to maintain continuous power transmission in a 3D plane under static conditions.

Results and discussions

The dual-arm robotic system successfully achieved optical wireless power transmission (OWPT) in a 2D plane. Using TCP protocol, the laser-equipped robotic arm and the solar panel-equipped robotic arm, positioned 70 cm apart, maintained precise alignment throughout the experiment.

As shown in Figure 2, the experimental setup demonstrates the system in operation, with the laser beam accurately directed toward the receiver. The results confirm the system's ability to achieve stable and effective power transmission, validating the feasibility of integrating robotic arms with OWPT technology for 2D applications.

References

- [1] A. W. S. Putra et al. IEEE Phot. Technol. Lett. **31** (2019) 157.
- [2] A. W. S. Putra et al. SPIE Photonics West 2020, LASE, 11272-50 (2020).

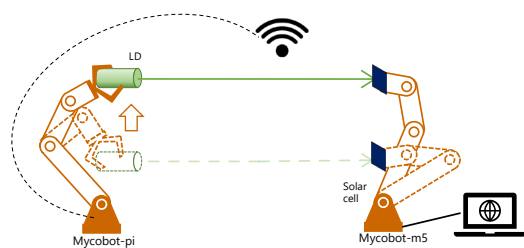


Fig. 1 Schematic of Dual-Arm Robotic Systems of OWPT

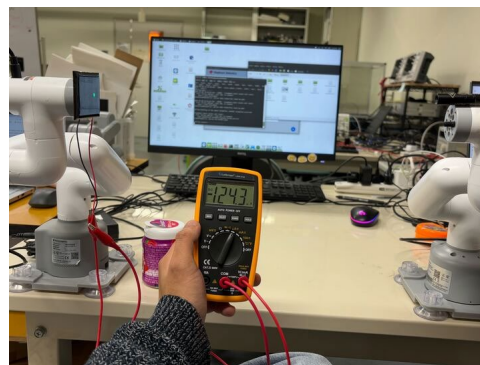


Fig. 2 Demonstration of 3D OWPT Using Robotic Arm