Improvement of Position Prediction for Optical Wireless Power Transmission System using Machine Learning

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Introduction

Wireless power transmission (WPT) is an advanced technique to transmit electric power without any cable. Optical wireless power transmission (OWPT) can transmit the electric power to longer distance (>100m) with high power density and control direction more accurate [1]. In the design of OWPT system as can be seen from Fig. 1, aberration of irradiation direction due to the delay which is caused by the processing time for target recognition by the camera and PC occurs. In this case, the method to accurately irradiate the moving target by predicting its position on the next frame is needed.

In the past research, the linear uniform acceleration methods of position prediction had been used for and 85% reduction of position error of laser irradiation compared with the system without any prediction method was observed [2]. In the experiment, steering error could be reduced to 1° in the system with linear prediction method which translated into 13 pixels position error for 640 x 480 pixels camera system. However, for longer distance and random movement target, this method could not be used. In ref. [3], Machine learning can label some of the correct answers as valid in cases where vast numbers of potential answers exist. In OWPT system, an accurate position prediction of moving target by machine learning from the passed position.

Position Prediction Method

Artificial neural network (ANN) and long-short term memory (LSTM) models are used to predict the position of random moving target in the system. For random target movement simulation, the position error between the predicted position and real position of the target can be suppressed to less than 3 pixels using ANN and LSTM method for 1280 x 720 pixels captured image random target movement simulation which is more than 75% improvement of prediction error compared with the experimental results in ref. [2] and 50% improvement of linear prediction method in the simulation.

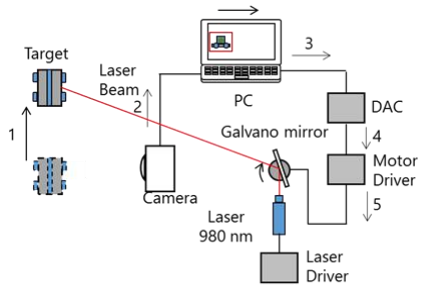

Fig. 1. Object Recognition and Beam Steering System.

Table 1. Prediction Error by Different Methods.

Average of Prediction Error[pixel]	
Uniform Acceleration	4.7
ANN	2.3
LSTM	2.4

Summary

Machine learning have been used in OWPT system to improve the target recognition by predicting the position of the target on the next frame of captured image. Using machine learning methods, position error in target recognition of OWPT system can be reduced to less than 3 pixels position error which is more than 75% improvement compared with previous experimental results.

References

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