



LASER POWER TRANSFER TO THE REAL TIME TRACKED OBJECT- A Review

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Abstract- In this paper, the concept of laser energy transfer for power a real-time tracked object is presented. It begins with introduction about the laser energy transfer and its applications and advantages. The aim of the research here to demonstrate the feasibility of laser power transfer by designing and implementing a system which uses components like arduino uno, servo motors, camera and is equipped with a laser to test the same.

Python programming with Haars Cascade object detection and image training is utilized. A camera is mounted onto 2 servo motors, both rotating in different axis and this ensures that the tracked object is always in the frame. All this happens whilst the attached laser module delivers energy onto the tracked PV cell.

This paper provides a summary of laser power transfer (LPT) and discusses various other projects and discoveries conducted encompassing LPT technology. It brings forth the challenges and the required improvements in the efficiency of transmission, highlighting the importance of currently undergoing research to improve and advance forth LPT technology for practical uses and application.

The paper compares laser power transfer to various other wireless power transfer technologies and put forward a simple and minimalistic LPT model made for transmission of higher efficiencies. It also discusses

the uses and advantages of LPT in applications such as motor drive and provides a comparison of different wireless power transfer technologies based on some important key parameters.

The paper shows the successful utilization of object tracking and laser energy transfer integrating the both, showing the potential for efficient and wireless power transmission. Research can further improve, optimize, and surely bring out new methods for the same. This technology promises a revolutionary future for different industries and hence can contribute to a sustainable and interconnected future.

Index Terms-

Laser energy transfer, Real-time tracked object, Object tracking, Wireless power transfer, Photovoltaic cell

I. INTRODUCTION

Laser power Transfer (LPT) is one of the technologies that has garnered great attention in recent years for its high potential applications in various fields such as energy transmission, modern robotics, and automation. The capability for wireless power transfer has always been a topic of great potential and utility and various studies. Therefore, laser energy transfer opens a new window to this platform [1-2].

LPT can provides a solution to the issues and drawbacks of traditional energy transfer and long-

distance wireless energy transfer methods. Traditional transmission methods like power lines, has some drawbacks such as losses due to the cable resistance and many others, which the LPT technology have advantage over. Using LPT, power can be transmitted over longer distances without much loss, making it a great alternative for applications where the power source is located far from the device that needs to be powered or charged [3-4].

To summarize, laser energy transfer has the potential to revolutionize various industries by providing a more efficient and sustainable method of power transfer. Here, we are aiming to explore the uses of laser energy transfer by powering a real-time tracked object by using an Arduino Uno, servomotors, camera, and Python programming for the object-tracking algorithm. The main objective is to show the feasibility and effectiveness of LPT designing and implementing a system that can track and power a moving object using a laser beam. This research can contribute to the development and improvement of sustainable power transmission methods. The concept of long-range wireless power transfer technology is not only exciting but also would play an important role in reducing the reliance on cables and wires, making our systems compact [5-6].

Also, the use of LPT technologies can have a great impact on our environment. Methods of power transfer, which uses the use of fossil fuels, are not only expensive but also contribute to environmental pollution. In addition to that, LPT can also have other important economic benefits. LPT can reduce the cost of transmission by eliminating the need for costly infrastructure such as power lines and cables.

This technology can be used for powering stationary devices and equipment too. Using LPT, we can significantly improve the efficiency of devices like that by removing the need for in-house batteries and cables [7].

The use of LPT technologies can also help to manage the issues of power outages in remote and rural areas. powercuts and blackouts are common. In many parts around world, because of the lack of infrastructure and many other factors in such areas, LPT can be a boon. Figure 1 depicts the flow chart of LPT.

II LASER POWER TRANSFER

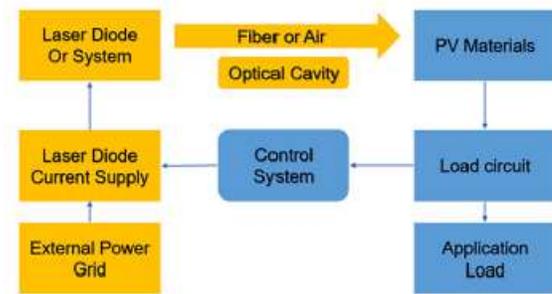


FIGURE 1 FLOW CHART OF LPT

HISTORY OF LASER POWER TRANSFER

LPT has been a subject of interest since it was first proposed by NASA in the aerospace industry. However, due to the low efficiency in both LD and PV materials, there was hesitation for the practical application of the technology. With the advent of the 21st century, there was a big improvement in the development of LD and other efficient forms of technology such as GaAs PV, LPT technology had gradually been applied in various experiments.

Various other experiments were conducted using LPT technology. For instance, in 1985, Alejnikov et al. carried out a fibre optic LPT experiment in which a power of 7 W was applied in CO laser and as for carbon dioxide laser, 15W. The European Aeronautic Defence and Space Company (EADS) Space Transportation facility conducted an experiment in the year 2002, regarding laser power transfer on land over long distances. A laser diode by the name of Nd: YAG was used by them, which produced an output power of 5 W at the wavelength of 940 nm, and had provided approximately 1 W to power a small car at the distance of 250 m [8]. First micro aircraft by LPT powered by NASA In 2003. , the aircraft had a PV material named Ga : InP₂, and it gave out 6 W of power to a 20 m high aircraft and made it fly for 14 min. However, despite the success of these experiments, the technology proved to be inefficient than hoped due to the low conversion efficiency of laser diode and the PV

Our project is a significant step towards exploring the materials used. This inefficiency has remained a major importance and potential of the LPT method, it has to be challenge for LPT technology [9]. noted that it is only a prototype.

In recent years as nearly as in 2021, Mohammadnia et al. had researched in the Laser power transfer technology in powering new and highly advanced next-gen drones. The laser was to power the PV materials attached to the drone. They used mainly three new types of materials, namely, GaAs, CdTe, and c-Ti. For which a power of 73.5 W, 62.6 W, and 33.2 W, respectively were received. For a 500m transmission distance, a transfer efficiency of 12.5% was received. This recent study shows that researchers are still working to improve the efficiency of LPT technology to make it more viable for practical applications [10].

IV COMPARISON WITH OTHER WIRELESS POWER TRANSFER METHODS

here we discuss different wireless power transmission (WPT) methods, focusing on, Inductive Power Transmission (IPT), Microwave Power Transmission (MPT), and Laser Power Transmission (LPT), Capacitive Power Transmission (CPT). While capacitive power transfer and inductive power transfer are commonly used in applications like bus charging and mobile phone charging, their transmission distance is limited. On the other hand, MPT and LPT are suitable for long-distance power transmission but have lower efficiencies.

III OBJECT TRACKING TECHNOLOGY USED

Our method involves using a camera attached to servo motors rotating in the x and y direction, to track the movement of the PV cell as they are hit by the laser light which is attached onto the whole module. The use of Haars Cascade image training allows for accurate tracking of PV cells which is really important of the whole procedure, ensuring that the laser light is hitting the solar panel in the most efficient way possible. The servo motors allow for precise and fast movement of the camera along with the movement of the solar cell which is being tracked, making sure that it is always in view.

Among these methods, LPT is highlighted as having outstanding advantages in motor drive applications. It offers a lower device size, ease of implementation, and medium-level reliability and stability. However, the accuracy of LPT may be affected by the bending of the laser route due to changes in air parameters. Nonetheless, it is considered that the Laser power transfer technology is highly suited for wireless energy transmission when it comes to driving a motor when parameters such as efficiency of transmission, suitability of equipment and distance of transmission is concerned.

For studying the laser power transfer, we study a model that includes a current supply, a laser diode, a PV cell, and a DC motor. We must also emphasize the role that a DC/DC convertor play for the efficiency of conversion. The comparisons of the different Wireless power transfer methods are summarized in Table 1, covering parameters such as efficiency, distance, convenience, complexity, reliability, accuracy, and stability.

We then calculate the total efficiency of the LPT method used in this system, taking into account the efficiency of the current supply when it comes to power, LD, PV cells and materials, and DC motor.

Theoretically, the total power efficiency of the system is calculated to be around 20.4%, which aptly meets the motor drive requirements. The efficiency of the laser energy transfer in different media also depends upon various specific conditions, rate of absorption and the

distance of transmission. Table 1 highlights the comparative analysis of various LPT schemes. Figure 2 depicts the basic model of LPT.

Method	CPT	IPT	MPT	LPT
Efficiency	High	High	Low	Low
Distance	Short	Medium	Long	Long
Convenience	High	Medium	Low	High
Complexity	Low	Medium	High	Low
Reliability	High	High	Low	Medium
Accuracy	High	High	Medium	Low
Stability	High	High	Medium	Medium

Table 1. Comparison of Various Methods of LPT

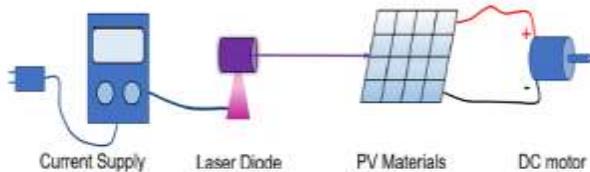


Figure 2 Basic Model of LPT

V CONCLUSION

As we come to the end, we see that our project and model has put forth results proving the success of this model and demonstrate the potential of this technology. we achieved accurate and efficient tracking capabilities. Mounting the camera on the servomotors enabled precise positioning of the camera for continuous tracking of the desired object.

our project also included the integration of a laser module mounted alongside the camera module. The light emitted by the laser had successfully hit the tracked solar cell, which enables us for the effective energy transfer.

This demonstrates to us, the feasibility of utilizing laser technology for wireless power transmission in real-world applications that we hoped to achieve.

The combination of object tracking and laser energy transfer opens up a range of possibilities for many existing and new fields such as robotics, automation, and renewable energy. This technology has a great potential and the ability to revolutionize industries by providing wireless power solutions to mobile devices, sensors, and other battery-powered devices.

Moving forward, further optimization and improvements can be looked at to improve the overall efficiency and accuracy of the system. Additionally, exploring different tracking algorithms and incorporating advanced image processing techniques

could enhance the object tracking capabilities of our system. Overall, our project showcased the ability for the successful integration of object tracking and laser energy transfer. This technology can pave the way for exciting advancements in the transmission technology and different other fields and change the landscape.

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