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Analysis of Wireless Power Transfer Efficiency Considering Angle of IR LED Tranmission

Ibtisam Ismail[1*], Sasni Ismail[1], Juwairiyyah Abdul Rahman[1] Taufik Ridzuan[1]

[1]Department of Engineering, Faculty of Engineering and Life Sciences, Universiti Selangor, Jalan Timur Tambahan, 45600, Bestari Jaya, Selangor Darul Ehsan, Malaysia
ibtisam@unisel.edu.my

Abstract: Wireless Power Transmission (WPT) is the most advanced technology that is in usage as alternate power energy. The cost of the transmission line to transfer energy from one circuit to another circuit is higher and needs more attention to design. Unfortunately, the distance between transmitter and receiver with the appropriate circuit is the prime problem to take into consideration. Therefore, this paper based on the research to develop wirelessly transmitting power throughout a room enables users to charge electronic devices as seamlessly as they now connect to WiFi hotspots, eliminating the need for electrical cords or charging cradles. In this research, 6 IR LED transmitters with power sources transmit radiant energy to IR LED receiver which is connected to a battery. The distance between transmitter and receiver was 10 – 50 cm with varied angles of the transmitter. Based on the data analysis, the efficient distance between transmitter and receiver is 10cm until 30 cm for 0°degree angle and for other angles are 10 cm. The distance ranges of more than 30 cm for 0° angle and 10 cm for the following angles are not efficient and the voltage reading shows a drastic drop.

Keywords: radiant energy, transmitter, infrared receiver, wireless power transfer

1. Introduction

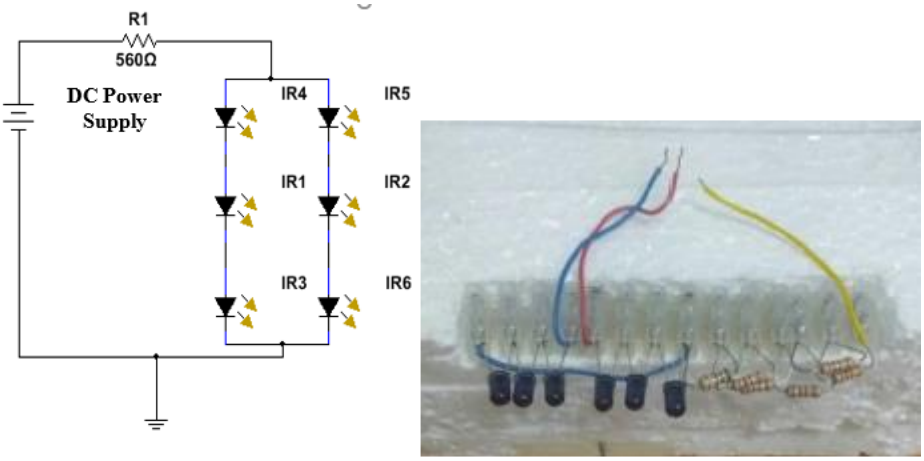
In present days, electricity is treated as one of the basic requirements of human beings. But, the cost of making electricity is risky to the environment (Barazza and Strachan 2020). To overcome this, many researchers research on alternative power generation. One sustainable technology leading this charge is Wireless Power Transmission (WPT). WPT states that the electrical power can be transferred from a source to a device without using wires (G. A. Covic and J. T. Boys, 2013).

Basically, it includes two coils which are a transmitter coil & a receiver coil where the transmitter coil is powered by AC current to create a magnetic field, which in turn induces a voltage in the receiver coil (J. Feng *et al.* 2019). Magnetic coupling mode, electric field coupling mode and electromagnetic radiation mode are the three ways to achieve wireless transfer of power (X. Luan *et al.* 2020). Wireless transmission is useful in cases where interconnecting wires are inconvenient, hazardous, or impossible. Besides that, copper cables and wires could be eliminated through this transmission.

2. Research methodology

In this research, the researcher used 6 IR LED transmitters as shown in **Figure 1**. Each IR LED transmitter light that have been chosen is in the same size which was 5 mm. The objective to choose this type of LED was to transmit a sufficient amount of radiant energy to the receiver. This IR LED transmitter was featured with high reliability, high radiant intensity and also with low forward voltage. IR LED transmitter circuit supplied with a total amount of 22 V of dc power supply for each experiment. In order to reduce the voltage, the researcher used a resistor with 560 Ω and the current flowed to the IR LEDs was 20 mA. Therefore, the IR LED transmitter can produce radiant energy which consists of peak wavelength λp = 940 nm and the IR LED receiver received the wavelength produced by the

IR LED transmitter with the same amount of energy. The distance of energy transfer was between 10 cm to 60 cm with a varied angle of the transmitter.



(a) (b)

Figure 1. IR LED Transmitter Circuit

Figure 2 shows 6 infrared receivers which are the important components in this circuit. This component needs high durability to function according to the infrared receiver. This receiver has been connected with a 12 V battery for charging the battery. Radiant energy will be converted to electrical energy. The voltage that has been received will be forwarded into the resistor and parallel with the capacitor to reduce and stabilize the voltage. In addition, the voltage that has been stabilized will move to the charging controller circuit to charge the 12 V battery that has been used for the load.

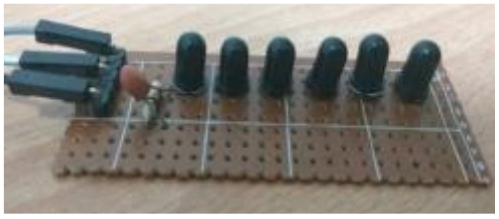


Figure 2. IR LED Receiver Circuit

The purpose of designing this Charging Controller Circuit in **Figure 3** was to boost the current for fasting charging and store the energy which received from the infrared receiver. In the circuit, the researcher used ICM 7556 as a timer to control the output of the circuit to charge and discharge the battery. The indicator LED will light up as red when the battery is low. Moreover, a 7806 voltage regulator is being used in this circuit to remain the same 6 DC voltage to the whole circuit. Green LED light will show the signal for 'ON' and it shows that the battery is supplying the voltage to the load.

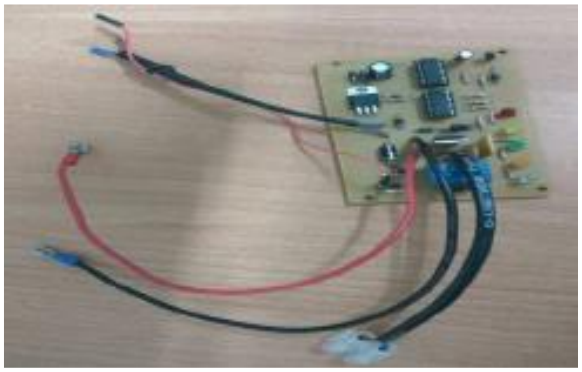


Figure 3. Charging Controller Circuit

In this research, the chosen load is an 18 watt DC 12 V light bulb and required current, 1.5 A. **Figure 4** showed an experiment has been conducted to obtain the voltage of battery which was connected to infrared receiver. The difference in the distance between transmitter and receiver is varied to obtain the optimum distance for wireless power transmission. IR LED transmits the radiant energy to the infrared receiver until a specific time for each distance.

Figure 4. The Experimental Setup

3. Results and Discussion

Table 1 shows the result of different distances at 0°, 30°, 45° and 60° angles with the voltage varied when the distance is different. The 12 V battery input source was used and the table lamp was used as a load.

Table 1. Voltage Comparison in Degree Angles

Distance (cm)	Voltage (V)			
	0 degree	30 degree	45 degree	60 degree
10	11.39	11.22	11.07	8.55
20	11.36	4.05	3.37	2.82
30	11.31	2.11	1.57	1.33
40	9.18	1.16	1.09	0.9
50	5.77	0.68	0.64	0.63
60	5.52	0.51	0.52	0.53

Figure 5 showed the DC output voltage is getting lower as the distance and degree angle are higher. From this graph, we can conclude that the wireless power transmission is higher when the distance is nearer at 0° angle.

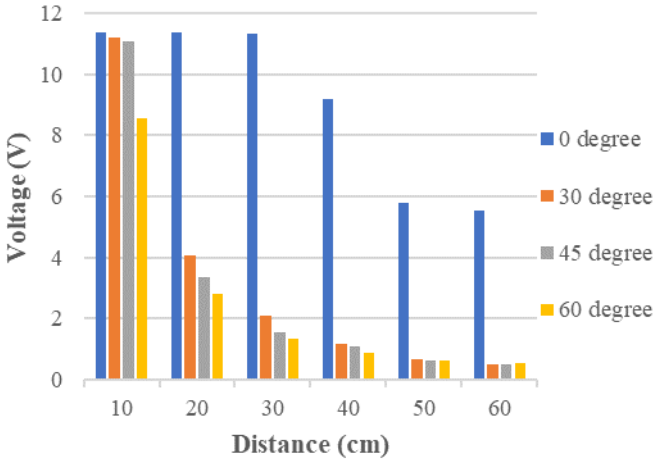


Figure 5. Voltage Comparison in Degree Angles

Table 2 shows the result of voltage efficiency at 0, 30, 45 and 60° angles when the distance is different. While **Figure 6** shows the graph of Voltage Efficiency vs Distance with different angles. The voltage efficiency is getting lower as the distance and degree angle are higher. From this graph, we can conclude that the wireless power transmission is higher when the distance is nearer at 0° angle (Panagiotis D. *et al* 2017).

Table 2. Voltage Efficiency Comparison in Degree Angles

Distance (cm)	Voltage Efficiency (%)			
	0 degree	30 degree	45 degree	60 degree
10	94.9	93.5	92.3	71.3
20	94.6	33.8	28.1	23.5
30	94.2	17.6	13.1	11.1
40	76.5	9.6	9.1	7.5
50	48.1	5.7	5.3	5.3

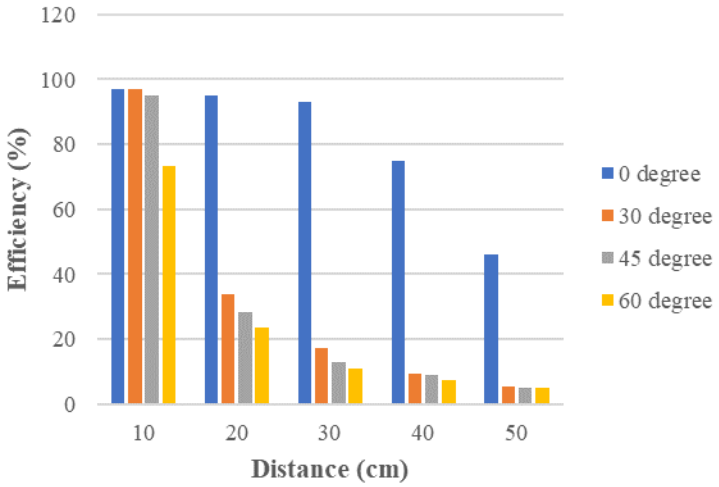


Figure 6. Voltage Efficiency Comparison in Degree Angle

4. Conclusion

The experiment proves that WPT will provide a unique solution for a wide range of applications and can be successfully used for applications like charging table lamps or mobile batteries. Based on the data analysis, the efficient distance between transmitter and receiver is 10cm until 30 cm for 0°degree angle and for other angles are 10 cm. The distance ranges of more than 30 cm for 0° angle and 10 cm for the following angles are not efficient and the voltage reading shows a drastic drop.

Instead of simple circuits, sufficient electrical power can be generated and stored on a device such as a table lamp. Furthermore, different types of IR LED bulbs had produced different efficient amounts of energy more than in various angles and distance ranges. For recommendation, design a current booster that is more efficient for fast charging and using a power bank of 10 000 mAh.

5. References

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