

LASER AS A VISUALIZATION DEVICE LĀZERIS KĀ VIZUALIZĀCIJAS IERĪCE

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Abstract: As known to the prior characteristics of the laser, the new advanced technologies are based on the lasers. It can be used in different ways like scanning, displaying, engraving, cutting, drilling, marking, and many more. In this article, a discussion is made about the use of lasers as a device of visualization in climatic conditions like snow, fog and heavy rain. The existing technology "LiDAR" is one of the systems that will be discussed. LiDAR is a Light Detection and Ranging device used for driving the autonomous vehicles and are also installed on aircrafts in order to scan a vast area like forest, cities, etc. Lidar has been contributing a lot to our intelligence of the Earth's atmosphere for the past few years [2]. But with so many features, this system has its own limitations, with some conditions such as in bad weather and unable to recognize the white color. In this research two types of red-lasers are being used i.e. Diode and He-Ne Laser, of wavelength 650nm & 632.8 nm respectively. Also a green diode laser of wavelength 532nm is used. With the help of these lasers, we will be able to conclude if the laser is able to reflect back from water, snow and fog or it will pass through them without detecting. With this, we can also justify the loss of power that laser generates.

Keywords: Diode-Laser, He-Ne Laser, Laser, LiDAR, Visualizing device.

Introduction

The process of emission of light based upon the optical amplification consisting of stimulated emission of electro-magnetic radiation makes a laser. They are of different types such as: - Gas, Solid, Semi-conductor and Liquid (Dye) lasers. As with the advancement of technology, lasers are the most common devices used in the present time [4]. They are used in every field such as weaponry, industrial, medical, teaching, defensive and many more [4]. Most common usage is for scanning, cutting, engraving, marking and aiming [4]. All of these use different classes of lasers, depending upon the required wavelength. For example, in scanners the class 1 laser of wavelength 650nm is used, as they are used for scanning paper only. But if we talk about cutting, engraving, marking or medical use, the wavelength of their laser is of high energy density, ranging more than 100W of power. And if we talk about the weaponry or defensive system, class 4 lasers are used with the wavelength more than 10064 nm, which are highly dangerous. So, the safety measures are mandatory to remember. In the present era, these laser systems are more preferred, as they are a time and money saving processes [4]. And the fact of this statement can be seen with an example of the autonomous vehicles operated now a day in many countries on the basis of LiDAR system that could be observed in Figure 1. LiDAR is a method of surveying an area by calculating the distance of an object by generating pulsed lasers and receiving it back on a sensor, as shown in Figure 2 [7]. Companies owning this technology on their vehicles are saving a lot of money, as they do not have to hire any more human drivers. But still it is not possible for the autonomous cars to drive through every situation that a human driver can. These cars are designed to drive on their self, but their system does not allow them to drive in some bad climatic conditions. For example, when there is snow all around, their system does not recognize their path of driving as the white color of snow makes the system blind. It is just because of the photons. Because whenever a light strikes a surface it gets reflected back. But some of the amount is absorbed by the surface [5]. But in the case of the white color, none of the light is absorbed and the same wavelength is turned back making no difference in color [5]. But still there is much more effective system for visualizing objects in the path of the laser. This system is called "Airborne LiDAR System." In this system

a laser scanner is attached to an aircraft to make a survey of an area and visualizing it in 3D view, as shown in Figure 3. This setup is much more practical than that of autonomous cars, as it uses laser pulses to scan an area, as shown in Figure 4 [7]. With this arrangement we can obtain a 3D map of a specific scanned field, as it will calculate the time in which the pulsed lasers are reflected back from an object [7].

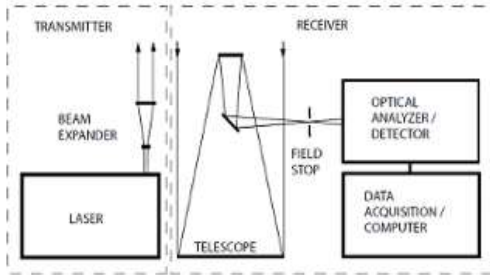


Figure 1: Principle Setup of LiDAR



Figure 2: Airborne LiDAR System

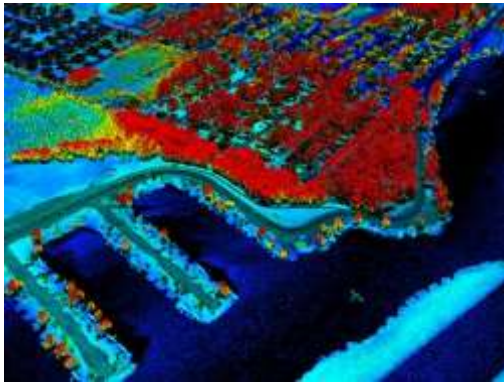


Figure 3: Airborne LiDAR System

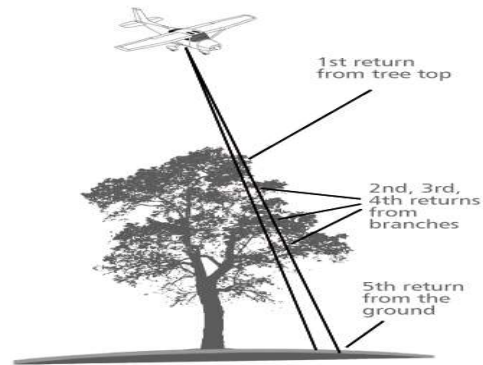


Figure 4: Pulsed Laser Schematic

Methodology

A. Materials

To obtain different climatic conditions for the experiment a transparent acrylic box has been used (can be observed in image 1), so that the walls of the container should not become a barrier for the laser beam. Lasers with wavelength lower than 1000nm has been utilized, as working with higher energy density requires a safe environment and a mentor also. Diode red laser has been used in the first part. It consisted of a transmitter, receiver, mirror, scale and a sensor. In the other part, a He-Ne laser has been placed in the setup as mentioned in the figure B. It consisted of a sensor attached to a voltmeter.



Image 1: Acrylic Box (150mm*100mm*150mm)



Image 2: Suction Pump

B. Experimental set-up

For the experiment different climatic conditions were necessary. So, these conditions were simulated inside a transparent container. For weather conditions, snow for snowy climate, water for water drops (as if of rain) and smoke for the foggy condition has been used. In order to make an unstable foggy condition (i.e. – high wind with fog) a Suction pump (image 2) was employed. Weather conditions like snow, can be explained as the ice crystals that are precipitated from the clouds and experiences the earth's climatic changes [1]. It has a density of $0.1-0.8 \text{ g/cm}^3$ [1]. Also, fog can be described as the visible clouds consisting of water droplets in air, hanging at the earth's surface [3]. And rain can be illustrated as the precipitated water drops falling from the clouds formed due to the moisture from the surroundings [6].

In the first setup, scale, oscilloscope, speed of light meter, diode laser, receiver, acrylic box, fog maker, Suction pump and a Mirror has been used, as shown in figure A. Experiment took place with the passing of laser through the empty box and the box filled with different material in order to create various climates. The readings were taken. Afterwards, the box was filled with snow, water drops and fog respectively. The readings differed from the earlier once. All of the procedure was repeated with the replacement of the mirror with sensor attached to the voltmeter, in order to make new readings for the power loss by laser, as the energy density of laser decreases due to the high density molecules of snow and fog. Whereas, in the case of water drops (used instead of rain), the laser got scattered in a very small amount which can be ignored.

In the second system, the setup consisted of a He-Ne laser, acrylic box, Sensor, voltage meter, fog maker, Suction pump, snow, water drops, pipes has been used as shown in the figure B. In this setup, once again the red laser was passed through the acrylic box and the voltage reading was taken. Then the box was filled with snow, water drops and fog respectively. Readings were taken and a difference has been recorded.

In the third case, with the help of the green diode laser several similar procedures were done. But, the results were not up to the mark as they were somehow clones of the previous outcomes. The concluded digits differed just because of the varied wavelength of the laser.

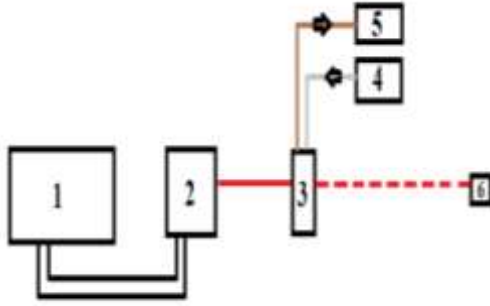


Fig. A. Setup of Speed of Light

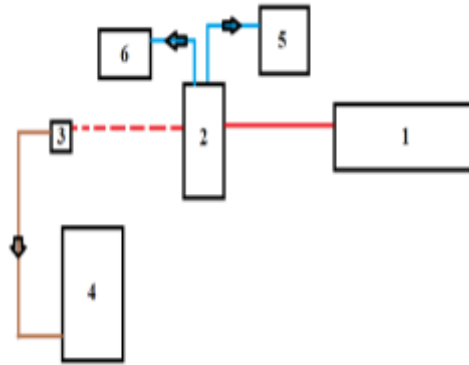


Fig. B. Setup of He-Ne Laser

Table A

No.	Description (Figure A)
1	Oscilloscope
2	Speed of Light Meter/ Diode Laser / Receiver
3	Acrylic box
4	Fog Maker
5	Suction Pump
6	Mirror

Table B

No.	Description (Figure B)
1	He-Ne Laser
2	Acrylic Box
3	Sensor
4	Voltmeter
5	Fog Maker
6	Suction Pump

Results and discussion

This research will be helpful for the sake of humanity, as it will save many lives that are lost in the accidents due to the bad weather situations. Most of the mishaps take place when there is no clear visual to the human eyes. By acquiring more knowledge and good results in the future with this research will be able to see through the climatic conditions like heavy rain, snow and fog. Most of the researchers have been researching about the things which relate to this, but it has been hard to find any article corresponding to my research. For the future I would like to continue my research and more publications.

Conclusion

In the carried out experiments, it has been concluded that red-diode laser with wavelength lower than 1000nm were able to go through the fog but was not reflected back from the mirror, due to the loss of energy density in laser. This loss of energy was determined with the help of the sensor connected to the voltmeter. In the case of water drops the laser changed its direction. When experimented with snow, the laser was totally blocked and was not able to go through, letting no reading for the voltmeter. All the respective results can be seen in the given table 1. Even the He-Ne laser had shown the same results as shown in the table 2. The results were as assumed i.e. decrease in the voltage of laser, as the climatic conditions had a high density of molecules and produced a barrier for the receiver. But in the case of snow, laser didn't go through attaining snow as a barrier. So, for snow, to be predicted by the laser and receive an outlay of it, laser with another wavelength is to be used which can be reflected back from the snow.

According, to the experiments carried out, it is necessary that a laser should be used which should not go through the objects but should be reflected back from them, so that we can get an outlined map in climatic conditions where human eyes are not able to see or taking an example

of the airborne LIDAR, a laser generating a number of pulses can also be used in order to receive a 2D/3D view of the path.

Speed of Light Meter

Table 1

Material	Water Drops		Fog		Snow	
With Empty Container						
Distance(mm)	30	30cm	30	30	30	30
Calibration	356	0	None	1	None	None
Voltage(V)	27		0.2		0.2	
With Filled Container						
Distance(mm)	30	30	30	30	30	30
Calibration	0	2	0	None	0	348
Voltage(V)	None		0.1		0.0	

He-Ne Red Laser

Table 2

Material	Water drops	Fog	Snow
With Empty Container			
Voltage(V)	38	0.3	0.3
With Filled Container			
Voltage(V)	None	0.2	0.0

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