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# LIDAR TECHNOLOGY AND APPLICATIONS

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## ABSTRACT

*LiDAR (Light Detection and Ranging) is the primary method of determining the distance from an object or surface by pulsing optical lasers. LiDAR is an optical remote sensing technique that measures the properties of scattered light to find distant distance and other information. The LiDAR system basically consists of three sets of technologies, namely, inertial navigation systems (INS), lasers and GPS. LiDAR is similar to more familiar radar that can be considered laser radar. LiDAR also transmits and receives electromagnetic radiation at a higher frequency. LiDAR works in the ultraviolet, visible and infrared regions of the electromagnetic spectrum. This paper focuses on the technology used by LiDAR and how the method succeeds in establishing itself as an important data collection technique. LiDAR systems have become commercially viable alternatives to the development of the Earth's Surface Digital Elevation Model (DEM) due to today's advanced and enhanced computer functions, as well as the latest positioning and orientation systems.*

**KEYWORDS:** *Optical, INS, LASER, GPS, Electromagnetic Radiation, spectrum, DEM.*

## I. INTRODUCTION

LiDAR (Light Detection and Ranging, also LADAR) is an optical remote sensing technique that can measure the distance or other attributes of the target by illuminating the target with a pulse from the laser. LiDAR technology is applied to geography, archeology, geography, geology, geomorphology, seismology, forestry, remote sensing and atmospheric physics. Abbreviation LADAR (laser detection and ranging) is often used in military backgrounds. The term LiDAR is sometimes used even if the LiDAR does not use microwave or radio waves, and therefore is not actually associated with radar.

LiDAR uses UV, visible or near-infrared light to image objects and can be used with a wide range of targets (including non-metallic objects, rocks, rain, chemical compounds, aerosols, clouds and even single molecules). In addition, the wavelength is much smaller than the wavelength achievable with the radio system and ranges from about 10 microns to UV (about 250 nm). At such a wavelength, the wave is "well" reflected by the small object. This type of reflection is called backscatter. Different types of scattering are used for different LiDAR applications. The most common are Rayleigh scattering, Mie scattering and Raman scattering, and fluorescence. Based on different types of backscatter, LiDAR can be referred to as Rayleigh LiDAR, Mie LiDAR, Raman LiDAR and Na / Fe / K fluorescence LiDAR, respectively. These wavelengths are ideal for measuring smoke and other air particles (aerosols), clouds and air molecules. LiDAR also transmits and receives electromagnetic radiation at a higher frequency. LiDAR works in the ultraviolet, visible and infrared regions of the electromagnetic spectrum. The laser typically has a very narrow beam that allows physical features to be mapped at very high resolution compared to the radar.


**Fig.1: Electromagnetic spectrum**

## II. LIDAR SYSTEM

### A. Working Principle behind LiDAR System

LiDAR is an active remote sensing technology using laser. The LiDAR system measures the reciprocating time of the energy of the laser pulse (the energy of the stimulated emission by radiation) between the sensor and the target. The incident energy pulse interacts with the earth's characteristics and is reflected back to the target. The travel time of the pulses from start to return to the sensor is measured and it provides the distance or range from the instrument to the object (hence the term "laser height measurement", which is now commonly synonymous with LiDAR). Since the speed of light is constant, it is possible to accurately measure the time from pulse emission to pulse return (Table 1).

| Lidar echo time to measurement range conversion<br>(speed of the light *c* = 3.0E8 m/s) | | |
|---|---|---|
| 1 ns | 0.15 m | 5.9 in |
| 1 ms<br>10 m<br>100 ms<br>1000 ms (1 ms) | 150 m<br>1.5 km 15<br>km<br>150 km | 492 ft<br>0.93 statute mile (0.81 n mile)<br>9.32 statute mile (8.1 n mile) 93.2 statute mile<br>(81 n mile) |

Table 1

### B. Mechanism of LiDAR system:

A typical laser scanner can be subdivided into the following key elements: laser ranging units, optical mechanical scanners, control and processing units. The ranging unit includes a lasers and an electro-optical receiver (Figures 2 a, b). Install the transmit and receive apertures (typically 8-15 cm in diameter) so that the transmit and receive paths share the same optical path. This ensures that the surface of the object illuminated by the laser is always in the field of view (FOV) of the optical receiver. The narrow divergence of the laser beam defines the instantaneous field of view (IFOV). Normally, IFOV is in the range of 0.3mrad to 2mrad. The theoretical physical limit of IFOV is determined by the diffraction of light, which results in blurred images. Thus, IFOV is a function of the emission aperture and wavelength of light.

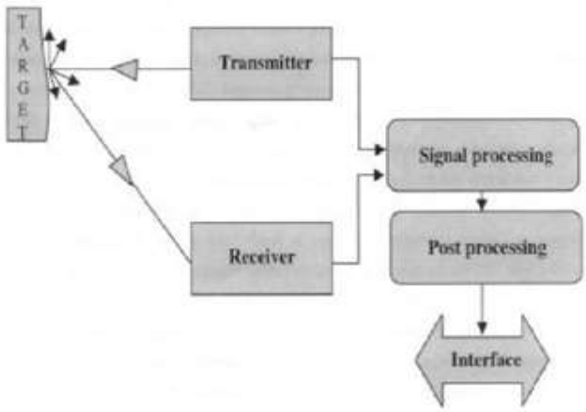


Figure.2(a)

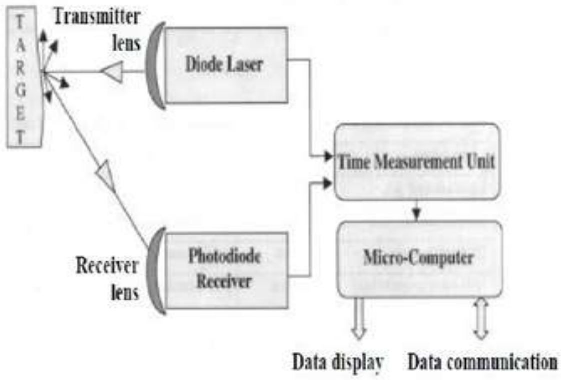


Figure.2(b)

## III. COMPONENTS

The four major components of LiDAR:

1. **Aircraft**. LiDAR data were collected using a rotor (helicopter) and fixed wing (aircraft) aircraft. The laser scanner is precisely installed at the bottom of the airplane. Usually, at least two crew members (pilots and operators) are required.
2. **GPS.** LiDAR requires precise real-time location. The main part of the location solution is provided by using GPS technology in differential motion mode. This includes finding or building a well-measured GPS base station and co-initializing with airborne GPS. GPS provides the XYZ position of the aircraft, but this is only part of the required location solution.
3. **INS**. The inertial navigation system (INS) provides another key part of the position solution. INS records the pitch, roll and yaw of the aircraft (ie, the angle at which the principal of the LiDAR sensor points). Thus, the INS position and the GPS position give the position of the sensor and the angle of the orientation.
4. **Laser Scanner System**. The laser scanner system is the core of the LiDAR system, which includes laser sources, laser detectors, scanning mechanisms, electronic devices for timing pulses and returns, and computational power for real-time processing and recording of data.

## IV. APPLICATION

### *1) Agriculture*

Agricultural research service scientists have developed a way to combine LIDAR with agricultural production. This technology will help farmers to improve the yield which they produce from the field. LiDAR can also be used to help farmers determine which areas of their field can be used for applying expensive fertilizers. LIDAR can create a map of the fields and to help the farmers by revealing the slope of the farm land and the sun.

### *2) Geology and soil science*

The high-resolution digital elevation maps produced by airborne and fixed LiDARs have led to significant advances in geomorphology, and the branches of Earth science have involved the origin and evolution of the Earth's surface topography. LIDAR is able to detect subtle terrain features such as river terraces and river canals, measure land surface elevation under vegetation canopy, better solve elevational spatial derivatives, and detect elevation changes between repeated measurements, making many of the physical and chemical The process of forming the landscape.

### *3) Hydrology*

LIDAR provides a wealth of information for aquatic science. The high-resolution digital elevation maps produced by airborne and fixed LiDAR's have led to significant advances in the field of hydrology.

### *4) Military and law enforcement*

LIDAR has a significant non-scientific application of the situation in the implementation of traffic speed, for vehicle speed measurement, as a radar gun alternative technology. The technique for this application is small enough to be installed in a hand-held camera & quot; gun & quot; and to allow the speed of a particular vehicle to be determined from the traffic flow. Unlike RADARs that rely on Doppler frequency to measure the speed directly, the police LiDAR relies on the flight time principle to calculate the speed.

**Fig.3. Police officer using a hand-held LIDAR speed gun**

### *5) Transportation*

LIDAR has been used in automotive adaptive cruise control (ACC) systems. The system uses a LiDAR device (such as a bumper) installed in the front of the vehicle to monitor the distance between the vehicle and any vehicle in front of it. In the case of deceleration or too close to the front vehicle, the ACC applies the brake to slow down the vehicle. When the front road is clear, the ACC allows the vehicle to accelerate to the driver's preset speed.

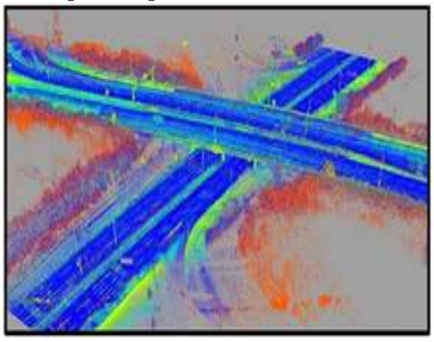

**Fig.4. Mobile LiDAR collected from a vehicle**

## V. CONCLUSION

Obviously, LiDAR is an accurate, fast and versatile measurement technology that can complement or partially replace other geographic data acquisition technologies and open up new and exciting applications. Laser technology may prove that the most useful is to detect changes in the carbon stocks in the tropics, which are expected to show the most rapid and significant climate and vegetation changes over the next few decades. These measurements will enhance our understanding of the impact of these factors on land degradation and hydrological and biological systems. The combination of LiDAR data and satellite remote sensing data can also be used to describe biodiversity and monitor changes in biodiversity. If you can collect laser data and image data at the same time, it has great potential for saving. With the maturity of technology, with the development of new data processing technology, and as a standard development, it can be said that LIDAR will become an important data collection method available to user groups.

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## REFERENCES

1. *M. D. Behera and P. S. Roy, "LiDAR remote sensing for forestry applications: The Indian context." published in - CURRENT SCIENCE, VOL. 83, NO. 11, 10 DECEMBER 2002.*
2. *Champion, H. G. and Seth, S. K., "A Revised Survey of Forest Types of India", Manager of Publications, Government of India, New Delhi, 1968.*
3. *Wehr, A. and Lohr, U., ISPRS J. Photogramm. Remote Sensing, 1999, 54, 68–82.*
4. *Experimental Advanced Research LiDAR', NASA.org. Retrieved 8 August 2007.*
5. *Mikkelsen, Torben & Hansen, Kasper Hjorth et al. LiDAR wind speed measurements from a rotating spinner Danish Research Database & Danish Technical University, 20 April 2010. Retrieved: 25 April 2010.*
6. *http://en.wikipedia.org/wiki/LIDAR*

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