26C8 Development of Laser-Radar to Survey the Electrical Power Lines and Vicinity Trees

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1.Introduction

The most of electrical power transmission lines are fed throuth the mountainous regions.In these regions,trees are growing under the lines,and shoud the trees grow up near the lines,power failure may be resulted in.

To avoid such an accident one should survey the distance between the electrical power lines and trees.

For this purpose Kyushu Electric Power Co.INC.and NEC Corporation developed a helicopter mounted laser-radar system that can measure the distance between the electrical power lines and trees.

See Figure 1 for schematic diagram.

2.Theory of Mesurements

In order to acquire the data, laser pulses(LD pumped Nd:YLF laser at 1.047 μm(10kHz,1kWpeak)) are radiated downward from the equipment, which is installed on the helicopter flying over the overhead electrical power lines, while scanning is made in the perpendicular direction to the longitude line of the helicopter.

The theory of measurements of the equipment is to calculate three dimensional position of each measuring point (point of reflection of laser)from the distance(the time elapsed from radiation and reflected back to the equipment)to the objects to be measured (power lines and trees) and the direction of radiation (angle) to obtain the distance between two discretionary points.

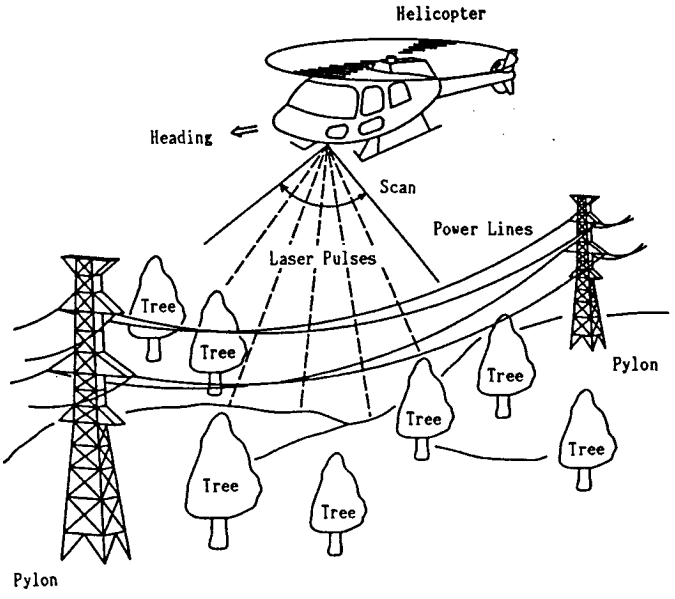

Figure 1. Schematic Diagram

3.Scanning System

Scanning direction of the equipment is perpendicular to the longitude of helicopter. However, resultant loci of laser distance measurements are zigzagged as shown in Figure 2 because the helicopter continues to move forward, and the measurement points of laser pulses are radiated onto the loci. When the angle of deflection is θ,the repetition frequency of pulse laser is f, and the number of frames per second is N, the number of data of the points of measurement per frame is :

$$D=f/N$$

And when the angular distance α of the points of measurement in 1 frame is :

$$\alpha=\theta/D$$

When the velocity of helicopter is v, then the distance d of advancement during 1 frame is :

$$d=V/N$$

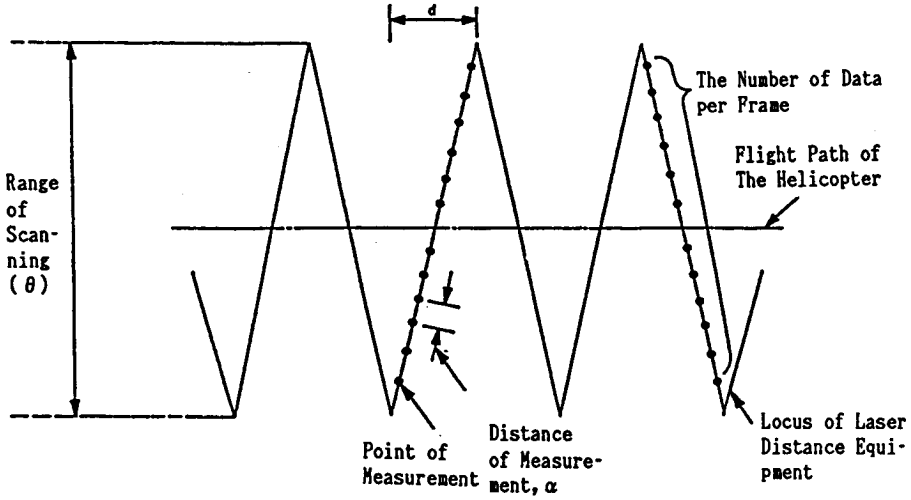

Figure 2. Method of Scanning

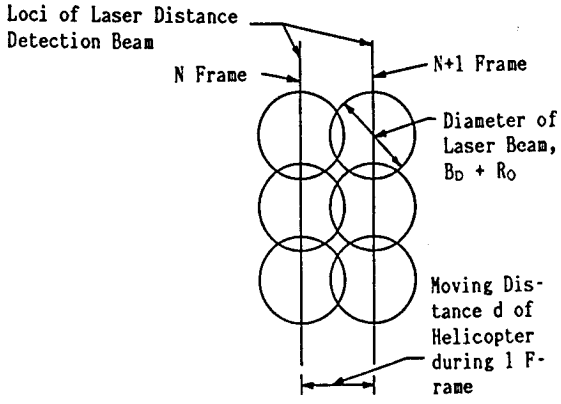

Figure 3. Relationship between Angle of Beam Spread and Frame

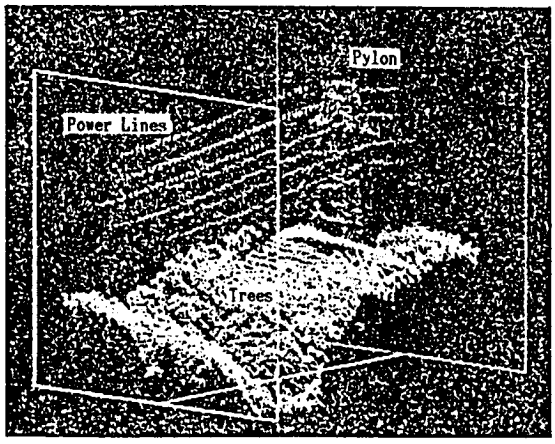

Figure 4. An Example of 3-Dinentional Analysis Inage (3-Dinentional Display)

4.Spread Angle of Laser Beam

In general, laser beam is propagated with certain spread angle. When the spread angle of laser beam is B_D, the diameter of radiated a, then the diameter of beam A at the point, whose distance from the equipment is R_O, is :

$$A=a+B_D+R_O$$

If the spread angle of laser beam, B_D, is set grater than the measuring distance, α, laser beams can be radiated on the scanning locus(zigzagged) without gap. Furthermore, when the spread angle of laser beam, B_D, the velocity of helicopter, V, the number of scanning frames, N, are set to satisfy $d < B_D \times R_O$ as shown in Figure 3, the area covered by the flight path of helicopter and the angle of scanning is able to provide dense and gapless data.

5.Composition of the Equipment

Generally speaking, the equipment consists of Data Gathering System (Airborne Equipment) that is used to acquire the data on the helicopter and the Data Processing/Analysis System (Ground Equipment) that process the data acquired by the former equipment.

6.Performance Verification Test

The system was installed on a helicopter for flight test. As the result of conversion of acquired data into orthogonal coordinates to plot the measured points, positional relationship between the electric power lines and trees (show in Figure 4) were analyzed in 3-dimensions, and it was verified that they can be displayed as the image of plane, vertical section, or cross section at the optional position.