IIIT-H

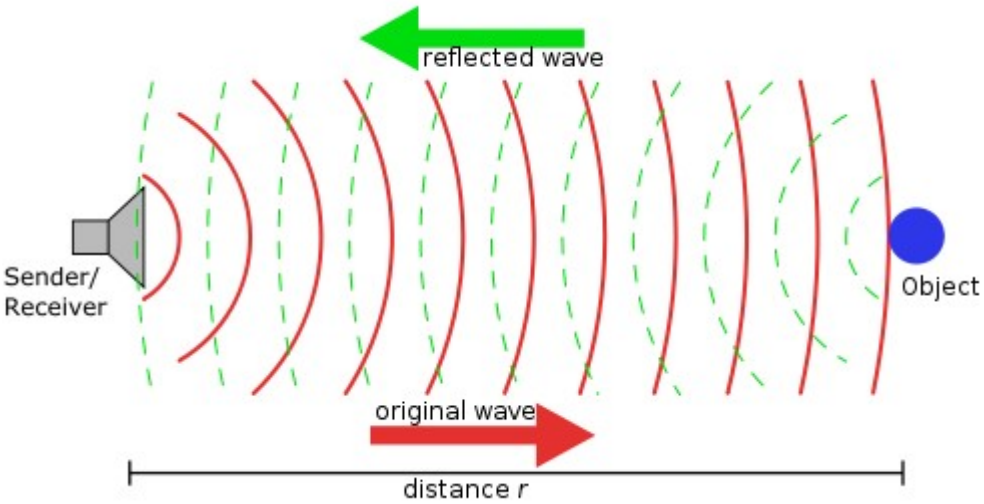
VIRTUAL LABS

Manual for Distance and Altitude Measurement

Introduction:

As by now, we have holistic understanding of the electromagnetic waves, materials, boundary condition, waveguides etc. In this, we will discuss on one of the widely used practical application of electromagnetic waves i.e to calculate the distance of between two flying planes and to measure the height of the plane from the ground level.

Electromagnetic wave propagate in a direction with electric and magnetic field in perpendicular direction. The speed of waves depends on the type of medium and its features. Depending upon certain properties of waves, the distance between the flying object or the ground can be calculated.



It has ample application i.e RADAR. Radar is an object-detection system which uses electromagnetic waves - specifically radio waves - to determine the range, altitude, direction, or speed of both moving and fixed objects such as aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. In aviation, aircraft are equipped with radar devices that warn of obstacles in or approaching their path and give accurate altitude reading.

Objectives:

The main objectives of this experiment are the following:

1. To determine the distance between two flying objects i.e planes by sending and recieveing the waves from one planes
2. To determine the altitude of the plane from the ground.

Theory:

To measure the distance to an object, a short pulse of radio signal (electromagnetic radiation) is transmitted, and the time taken for the wave to return is measured. The distance is one-half the product of the round trip time

(because the signal has to travel to the target and then back to the receiver) and the speed of the signal. Since radio waves travel at the speed of light (186,000Â milesÂ per second or 300,000,000 meters per second), accurate distance measurement requires high-performance electronics.

In most cases, the receiver does not detect the return while the signal is being transmitted. Through the use of a device called aÂ duplexer, the radar switches between transmitting and receiving at a predetermined rate. The minimum range is calculated by measuring the length of the pulse multiplied by the speed of light, divided by two. In order to detect closer targets one must use a shorter pulse length

Let suppose the distance between two plans be s m.
T be the time taken to get the reflected wave and v be the velocity of wave.

So , s=(T*v)/2.

Doppler Effects :

Doppler effect is a phenomena is the change in frequency of aÂ wave for an observer moving relative to the source of the wav. The apparent frequency (f) of the wave changes with the relative position of the target. The doppler equation is stated as follows for v_{obs} (the radial speed of the observer) and v_sÂ (the radial speed of the target) and f_0 frequency of wave :

$$f = \frac{v + v_{obs}}{v - v_s} f_0$$

However, the change in phase of the return signal is often used instead of the change in frequency. It is to be noted that only the radial component of the speed is available. Hence when a target is moving at right angle to the radar beam, it has no velocity while one parallel to it has maximum recorded speed even if both might have the same real absolute motion.

Procedure:

This experiment consists of three stages and each stage will teach you a new concept.

The experiment was designed in a way, so that you can quickly change the parameters and observe the results. This makes you to have a more clear picture of the concepts.

Start the experiment by pressing *start* button

- **STAGE 1**:
    1. In this stage you are going to determine the distance between two flying objects i.e planes by sending and recieveing the

waves from one plane.

2. Adjust the distance between two planes using the slider.
3. Now measure the distance by pressing the button "Calculate Distance". Now, note down the values of distance and time.
4. Do this with various values of parameters and write a report of your observations. After completing this, move on to the next stage by clicking on "Next" button provided at the top of the experiment window.

- **STAGE 2**:
    1. This stage is not different from previous stage. Previously you measured distance between two planes. Now, you measure the height of a plane from the ground.
    2. You can adjust the height of plane using the keyboard by pressing the keys "W" and "S".
    3. Now measure the height by pressing the button "Calculate Distance".
    4. Note down the values of height and time. Do this with various values of parameters and write a report of your observations.
    5. At any point of time, you can move on to the previous stage by clicking on "Back" button provided at the top of the experiment window.