**EXPERIMENT NO. 8**

**AIM :** To study Doppler RADAR and tune it for maximum sensitivity and

best performance.

**APPARATUS :** Doppler RADAR, PC with multimedia, Doppler power supply,

Stepper motor Controller and connecting wires.

**BLOCK DIAGRAM:**

**THEORY:** A Doppler radar is a specialized radar that uses the Doppler Effect to produce velocity data about objects at a distance. It does this by bouncing a microwave signal off a desired target and analyzing how the object's motion has altered the frequency of the returned signal. This variation gives direct and highly accurate measurements of the radial component of a target's velocity relative to the radar. Doppler radars are used in aviation, sounding satellites, meteorology, police speed guns, radiology and healthcare (fall detection and risk assessment, nursing or clinic purpose), and bistatic radar (surface-to-air missile).

A radar detects the presence of objects and locates their position in space by transmitting electromagnetic energy and observing the returned echo. A pulse radar transmits a relatively short burst of electromagnetic energy, after which the receiver is turned on to listen for the echo. The echo not only indicates that a target is present, but the time that elapses between the transmission of the pulse and the reception of its echo is a measure of the distance to the target. Separation of the echo signal from the transmitted signal is made on the basis of differences in time. A feasible technique for separating the received signal from the transmitted signal, when there is relative motion between radar and target, is based on recognizing the change in the echo-signal frequency caused by what is known as the Doppler Effect. It is well known in the field of optics and acoustics that if there is relative motion between the source of a signal and the observer of the signal, along the line joining the two, then an apparent shift in frequency will result. This is the Doppler Effect and is the basis of CW (Continuous Wave) radars.

**PROCEDURE:**

1. Fix the Doppler radar and parabolic reflector antenna on a stepper motor controller.
2. Connect target Emulator to the back side of Doppler radar.
3. Connect radar output to “microphone in/Line in” of the computer.
4. Switch on radar simulator software “Zelscope” in the PC.
5. Set direction of the antenna “0” degree, step size, scanning speed and radar type using stepper motor controller.
6. Place target emulator in any direction and rotate radar antenna in 360 degree.
7. Observe maximum peak of the received echo signal and take printout.
8. Stop stepper motor controller and again set the direction of target emulator.

**CONCLUSION: ………………………………………………………………………………**

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**EXPERIMENT NO. 9**

**AIM :** To emulate the variable speeds of moving objects using CW Doppler

RADAR & observe the effect of Doppler frequency shift.

**APPARATUS :** Doppler RADAR, PC with multimedia, Doppler power supply,

Stepper motor Controller and connecting wires.

**BLOCK DIAGRAM:**

**THEORY:** A Doppler radar is a specialized radar that uses the Doppler Effect to produce velocity data about objects at a distance. It does this by bouncing a microwave signal off a desired target and analyzing how the object's motion has altered the frequency of the returned signal. This variation gives direct and highly accurate measurements of the radial component of a target's velocity relative to the radar. Doppler radars are used in aviation, sounding satellites, meteorology, police speed guns, radiology and healthcare (fall detection and risk assessment, nursing or clinic purpose), and bistatic radar (surface-to-air missile).

A radar detects the presence of objects and locates their position in space by transmitting electromagnetic energy and observing the returned echo. A pulse radar transmits a relatively short burst of electromagnetic energy, after which the receiver is turned on to listen for the echo. The echo not only indicates that a target is present, but the time that elapses between the transmission of the pulse and the reception of its echo is a measure of the distance to the target. Separation of the echo signal from the transmitted signal is made on the basis of differences in time.

A feasible technique for separating the received signal from the transmitted signal, when there is relative motion between radar and target, is based on recognizing the change in the echo-signal frequency caused by what is known as the Doppler Effect. It is well known in the field of optics and acoustics that if there is relative motion between the source of a signal and the observer of the signal, along the line joining the two, then an apparent shift in frequency will result. This is the Doppler Effect and is the basis of CW (Continuous Wave) radars.

Consider CW radar and a target are placed at a distance of R from each other. The target is moving with a speed Vr relative to the radar and along the line joining the radar and the target (also known as the line-of-sight - LOS). Note that the transmitted signal is not in the form of a train of pulses but a continuous wave with frequency fo. Let the total number of wavelengths (given by λ) contained in the to-and -fro path between the radar and the target be denoted by n. Then,

n = 2R /λ

One wavelength corresponds to an angular excursion of 2π radians. Thus, the total angular excursion φ made by the electromagnetic wave during its transit to the target and back to the radar is

φ = (2R .λ) .2π

= 4πR λ

When the target is in motion, both R and φ are changing. Now a change in φ with respect to time is equal to an angular frequency. This, in fact, is the doppler angular frequency Wd,

Wd = 2πfd

= (4π/ λ) . (dR/ dt)

= 4πVr /λ

From which we get

fd = 2Vr/ λ

= 2Vrfo/ c

Where,

fd = Doppler frequency shift, in Hz

c = velocity of propagation = 3 × 108m/s

Vr = relative velocity of the target with respect to the radar along the line-of-sight.

**PROCEDURE:**

1. Fix the Doppler radar and parabolic reflector antenna on a stepper motor controller.
2. Connect target Emulator to the back side of Doppler radar.
3. Connect radar output to “microphone in/Line in” of the computer.
4. Switch on radar simulator software “Zelscope” in the PC.
5. Set direction of the antenna “0” degree, step size, scanning speed and radar type using stepper motor controller.
6. Place target emulator in any direction and rotate radar antenna in 360 degree.
7. Observe maximum peak of the received echo signal and note down related angle and Doppler shift.
8. Repeat step 5 to 7 and take at least five readings.
9. Take printout of maximum peak of the received echo signal.
10. Stop stepper motor controller and again set the direction of target emulator.

**OBSERVATION TABLE:**

Step size = 05 Frequency = 10.5 GHz

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No** | **Angle (φ)** | **Doppler shift (fd)** | **Relative velocity (Vr)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |
| **4** |  |  |  |
| **5** |  |  |  |

**CALCULATION:**

**CONCLUSION: ………………………………………………………………………………**

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**EXPERIMENT NO. 10**

**AIM :** To find out the speed of the moving Pendulum for different lengths

using CW Doppler RADAR.

**APPARATUS :** Doppler RADAR, PC with multimedia, Doppler power supply,

Stepper motor Controller, Pendulum and connecting wires.

**BLOCK DIAGRAM:**

**THEORY:** A radar detects the presence of objects and locates their position in space by transmitting electromagnetic energy and observing the returned echo. A pulse radar transmits a relatively short burst of electromagnetic energy, after which the receiver is turned on to listen for the echo. The echo not only indicates that a target is present, but the time that elapses between the transmission of the pulse and the reception of its echo is a measure of the distance to the target. Separation of the echo signal from the transmitted signal is made on the basis of differences in time.

A feasible technique for separating the received signal from the transmitted signal, when there is relative motion between radar and target, is based on recognizing the change in the echo-signal frequency caused by what is known as the Doppler Effect. It is well known in the field of optics and acoustics that if there is relative motion between the source of a signal and the observer of the signal, along the line joining the two, then an apparent shift in frequency will result. This is the Doppler Effect and is the basis of CW (Continuous Wave) radars.

Consider CW radar and a target are placed at a distance of R from each other. The target is moving with a speed Vr relative to the radar and along the line joining the radar and the target (also known as the line-of-sight - LOS). Note that the transmitted signal is not in the form of a train of pulses but a continuous wave with frequency fo. When the target is in motion, both R and φ are changing. Now a change in φ with respect to time is equal to an angular frequency. This, in fact, is the doppler angular frequency Wd,

Wd = 2πfd

= (4π/ λ) . (dR/ dt)

= 4πVr /λ

From which we get

fd = 2Vr/ λ

= 2Vrfo/ c

Where,

fd = Doppler frequency shift, in Hz

c = velocity of propagation = 3 × 108m/s

Vr = relative velocity of the target with respect to the radar along the line-of-sight.

**PROCEDURE:**

1. Fix the Doppler radar and parabolic reflector antenna on a stepper motor controller.
2. Connect target Emulator to the back side of Doppler radar.
3. Connect radar output to “microphone in/Line in” of the computer.
4. Switch on radar simulator software “Zelscope” in the PC.
5. Set direction of the antenna “0” degree, step size, scanning speed and radar type using stepper motor controller.
6. Adjust the length of the pendulum and move the pendulum in front of RADAR.
7. Observe maximum peak of the received echo signal and note down related length and Doppler shift.
8. Repeat step 5 to 7 and take at least five readings.
9. Calculate the speed of the moving pendulum.
10. Take printout of maximum peak of the received echo signal in time domain/frequency domain.
11. Stop stepper motor controller and again set the direction of target emulator.

**OBSERVATION TABLE:**

Step size = 05 Frequency = 10.5 GHz

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No** | **Length (L)** | **Doppler shift (fd)** | **Relative velocity (Vr)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |
| **4** |  |  |  |
| **5** |  |  |  |

**CALCULATION:**

**CONCLUSION: ………………………………………………………………………………**

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