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Introduce the Real-Life Example and Physics Concept

Introduction

The real-life example that is going to be discussed in this assignment is the RADAR. RADAR is the abbreviation of Radio Detecting and Ranging which is a method used for detecting distant objects and also determining their exact position as well as velocity. The physics concept that is used behind this example is Doppler effect. Doppler effect is a phenomena that can be defined as energy waves that travel between two objects such that theie wavelength change as one either or both of the objects are moving. Generally, in Doppler effect, when an observer moves closer to the source, energy shift is upward and the energy shift is downward when an observer moves away from the source.

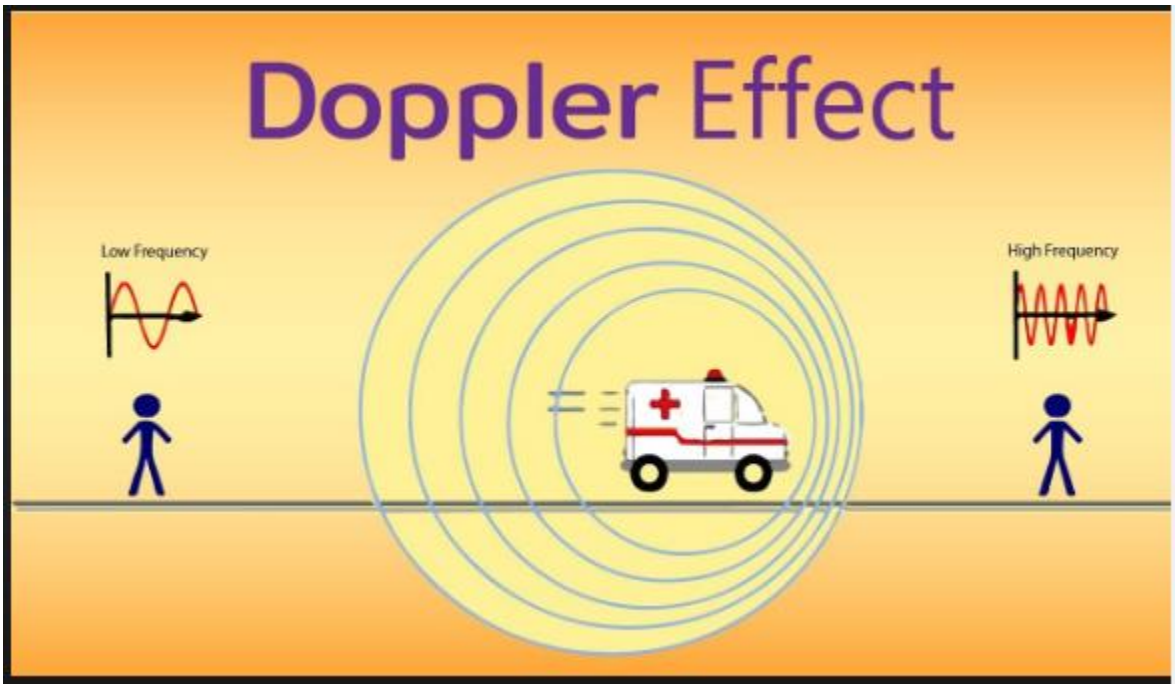
Background

The idea of Doppler effect was first introduced in 1842 by Christian Doppler. Christian Doppler was a famous mathematician from Austria and lived between 1803 to 1853. He proposed his principle of Doppler effect when he published his studies related to colored light of double stars. His hypothesis was based on the fact that if sound's source is mobile/moving, the pitch of the sound would change. The effect is also relatable to light as if we consider that there nothing between an observer and light source. To reach the observer, the successive waves need to cover a larger distance than that of previous waves. As a consequence, time taken to reach the observer by the waves will also increase and will result in frequency change of the wave.

The general formula for the Doppler effect is

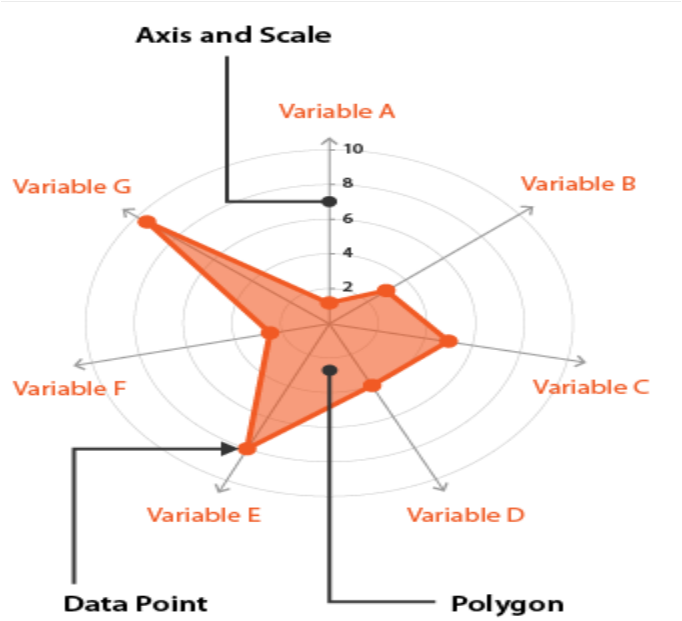
$$f = \left(\frac{c \pm v_r}{c \pm v_s}\right) f_0$$

In this formula, f_0 is the emitted frequency, f is the observed frequency, v_r and v_s are the velocity of the source and the receiver relative to the medium. Velocity of the waves inside the medium is given by 'c' in this equation.



Application

Radar is one of the most utilized and famous application of the Doppler effect. Fundamentally, the method of radar id based upon sending radio waves over a suspected medium and then calculate the time it takes when it returns back to the original position of emission after hitting the target obstacle. The timing of the wave depends upon the position of the target. If the target is moving towards the source, the calculated time will be lesser as compared to the original calculated time from empirical formulas. If the object is moving farther, the wave will take more time to return back. From electromagnetic spectrum, mainly radio waves are used whose wavelength ranges from 10 to 13m. The data calculated from the radar is displayed in a graphical method called graph chart(De Maio &Antonio). A typical graph chart is shown below.



Radar charts are useful to observe which variables are scoring low or high within the dataset to show an ideal display of the objects and their movements relative to the movement. Each variable starts from the center and is provided an axis to make it easy to configure which variable is outlier or which of the variables have similar values. The use of this technology has made it easy to measure the distances of inaccessible entities when human beings with ordinary equipment could not reach. Radio waves can however travel and propagate with speed and hence are useful in determining depth of the sea, to determine the distance of approaching air traffic or to measure the speed of any vehicle.

Conclusion

The Doppler effect has brought revolution in the field of physics regarding estimation and measurements of different objects and distances. Apart from Radars, some of the important applications and fields of Doppler effects are Sirens, astronomy, vibration measurement, audio, satellite communication, medical imaging and Blood flow measurement. Weather radars are also used to predict the atmospheric changes using the Doppler principles. In short, there are countless applications of Doppler effect that are used in the field of physics to solve complex problems

Cited By:

De Maio, Antonio, and Sabrina Greco. *Modern radar detection theory*. The Institution of Engineering and Technology, 2016.