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P3_6 Catch Me If You Can?

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Abstract

The objective of this paper was to investigate how the speed of the Roadrunner, in the classic Looney Tunes show, affected the infamous 'Meep Meep'. It was hypothesised that the frequency shift of the sounds that arise due to the Doppler shift would result in a sufficiently high frequency that would lie above the hearing range of Wile E. Coyote. By calculating the frequency shift by assuming a nominal speed of 67.1 ms^{-1}, the frequency of the inbound Roadrunner was found to be 54,800 Hz and that whilst outbound 36,900 Hz. Through an investigation of the literature, these frequencies were found to lie outside of the upper and lower boundaries of the hearing range of a canine, supporting the hypothesis that Wile E. Coyote would be unable to hear Roadrunner and so it would not be possible to initiate a trap. This would therefore be a significant contributing factor to the ongoing failure of Wile E. Coyote to catch the Roadrunner.

Introduction

Any waves emitted from an object travelling towards or away from an observer have an observed freqency shift. The first observations of this were made by Christian Doppler in 1842 [7] and were used to explain the apparent shift in the colour of light emitted by binary stars. The same effect is observable in sound waves where the pitch or frequency of a sound an approaching object will be higher than that of a receding one.

The Looney Tunes' Roadrunner never seems to be caught by Wile E. Coyote, even with all his elaborate traps. The hypothesis made in this work was that the observed frequency of the 'Meep Meep' made by the Roadrunner is higher than that which can be detected by Wile E. Coyote. This would mean that Wile E. Coyote could not hear the Roadrunner when it is travelling towards his traps.

Theory

The general equation for calculating the change in frequency during the Doppler shift is shown in Equation 1. However, as the motion of the Roadrunner is travelling towards and away from Wile E. Coyote's traps, when he says 'Meep Meep', this means Wile E. Coyote is a stationary observer in respect to the Roadrunner, so the equation has to be altered to take this factor into account. This is shown in Equations 2 and 3 where Equation 2 is the source, v_S, moving towards the recipient and Equation 3 is the source moving away from the recipient. In this example the Roadrunner is the source and Wile E. Coyote is the recipient. [1]

$$f' = \frac{v + v_O}{v - v_S} f \tag{1}$$

Where f' is the observed frequency, f is the actual frequency, v is the velocity of sound waves,

v_O is the velocity of the observer and v_S is the velocity of the source.

$$f' = \frac{v}{v + v_S} f \tag{2}$$

$$f' = \frac{v}{v - v_S} f \tag{3}$$

As can be observed in the Doppler shift equation, the rest frequency of the sound, the speed of the object and the speed of sound in air are required to calculate the frequency shift. Roadrunner is seen in the show to travel faster than a rocket [2] and after reseaching lift off speeds [6], typically 100-150 mph, the speed of Roadrunner was assumed to be 150 mph or 67.1 ms^{-1}. The speed of sound in air was approximated at 344 ms^{-1} [5] and the frequency of Roadrunner's 'Meep Meep' was assumed to be 44,100 Hz [3] which was determined from an analysis of an audio file.

Discussion

Using Equations 2 and 3, the inward bound frequency of the 'Meep Meep' was calculated to be 54,800 Hz and the outward bound frequency was found to be 36,900 Hz. From the literature these observed frequencies are found to be out of a Coyote's hearing range, which was assumed to be similar to that of a dog, which is in the range 67 - 45,000 Hz [4]. This would mean that that the approach of Roadrunner to Wile E. Coyote's inventions is inaudible which could lead to a higher probability of Coyote being unable to catch Roadrunner.

Conclusion

In this analysis the frequency of the 'Meep Meep' of the Roadrunner, as observed by a stationary Wile E. Coyote was found to be 54,800 Hz during an approach to a trap and 36,900 Hz when retreating. This observed frequency during an approach is above Wile E. Coyote's hearing range making it difficult to accurately time the traps to catch Roadrunner. However, further analysis could be conducted to consider the effects of:

- the actual temperature of the desert air where the show is set,
- the effect wind has on the Doppler effect,
- using the actual hearing range of a Coyote.

References

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[6] `https://www.quora.com/At-what-speed-do-planes-usually-take-off` [Accessed 10 November 2018]

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