ENGINEERING

McMaster University

Project Three – Independent Research Summary

Ultrasonic distance sensor

ENGINEER 1P13 – Integrated Cornerstone Design Projects

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Summary of Working Principle

Ultrasonic distance sensors serve the function of measuring the distance between an object and the position of the sensor itself [1]. These sensors measure distance by transmitting an ultrasonic sound wave (ultrasonic waves have frequencies greater than 18 kHz) and then receiving the same wave after it has bounced off the detected object [1]. An ultrasonic sensor typically consists of two transducers, a transmitter, and a receiver. The distance can then be determined by a calculation involving the amount of time taken by the wave to return, and the speed of sound in air (which is dependant on the temperature and humidity of the environment), which is typically 344m/s at room temperature (20°C) [1]. Using sound to measure distance is preferred over using light because the speed of sound is much slower than the speed of light, so it can be much more precise and power-efficient [2].

Summary of Significant Material Properties

In ultrasonic sensors, the ultrasound wave is transmitted by a transducer called the transmitter, which converts electricity into sound. Typically in ultrasonic sensors, the transmitter is a piezoelectric transducer [3]. Piezoelectricity is the generation and accumulation of electric charge proportional to mechanical stress applied within a substance [3]. In the case of an ultrasonic sensor, a potential difference controlled by a clock signal generator is applied across the two electrodes of the piezoelectric transducer and a high-frequency sound wave is produced [4]. The performance of the sensor depends on the properties of the crystal material used in the transmitter such as dielectric permittivity, piezoelectric charge constant, resonant frequency, and density [4]. A well-known and commonly used crystal is lithium niobate, which has a high piezoelectric charge constant (polarization generated per unit mechanical stress) value, making it very performant and a good choice of material [4].

References

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