***Ultrasound Distance Detection on Moving Objects – A Research Project.***

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Summary/Abstract

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# Introduction:

This project aims to accurately measure objects whilst they are moving using the medium of ultrasound to do so. The main point of this is not the application itself, i.e. distance measurement, since there are many devices which can do this, using infra-red and lidar, and although ultrasound can have its advantages compared to these, such as how it is not impacted by light and so can be used just as successfully during the day or night, ultrasound typically works over shorter distances and can be disturbed by adverse weather conditions if used outside (rain drops can cause random scattering of the signal along with changing its speed of propagation an uncalculatable amount when moving through the water) and can impeded by large changes in temperature (the speed of sound ranges between 331.5m/s at 0 degrees and 362m/s at 35 degrees which although not incredibly significant would change the same readings, in for example winter and summer). Moreover an Ultrasound distance measurer can be bought for about £5 for amateur projects which interfaces with an Arduino controller and works up to 200cm and with an accuracy with 3mm (so says the spec HC-SR04: <https://www.electroschematics.com/wp-content/uploads/2013/07/HCSR04-datasheet-version-1.pdf>)\*\*. Rather the aim of this project is to use this application as a means by which the limits and something of the medium of ultrasound itself can be explored.

Ultrasound is a particularly interesting and useful medium for communication and in sensors as it is non-invasive, the technology surrounding it is fairly well understood and so ultrasound transducers are relatively inexpensive (BACK UP). It is also fairly easy to test and set up and ‘look at’ in the lab and a lot of the knowledge and practices can be transferred to higher frequencies without too great an effort which makes it a perfect medium to research and look at for this final year project. Also, since ultrasound is used extensively in medicine to give non-invasive imaging of the internal body, most scholarly articles are focused around that function and it is difficult to find article purely discussing the use of ultrasound in measuring distance and this is what this report will aim to do.

*DESIGN OF DISTANCE MEASUREMENT PROJECT*

The basic principle of using ultrasound is a fairly simple one and is governed by the equation relating speed time and distance, namely that *Speed* = (1). Since sound waves travel at a constant speed through the same medium (i.e. water or air), with fluctuations in speed arising only from the temperature, and is known to be about 343m/s at room temperature though air; if the time taken for a sound wave to travel to an object and reflect off of it and return to where it was sent is measured, then how far away that object is can be calculated by re-arranging formula (1) so that *Distance = (Speed \* Time)/2* (2)*.* The calculation is divided by two since the time measured is how long it takes to reach the object *and* get back again. All that is required, then is to measure how long it takes for an ultrasound signal to be sent by one transducer and received by another which are adjacent to each other and are pointing in the same direction.