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Research Article

Direction and Distance Finding using Microphone Array of a Sound Source

Bhanu Priya R, Lavanya H*, Lavanya Ganesh, Althuru Pranathi and Girish.G.K

Dept. of ECE, Nitte Meenakshi Institute of Technology, Bengaluru, India

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Abstract

Direction finding refers to detection of sound source and estimation of it. A system of microphone array is preferred for finding Direction and distance from source to destination. Here we use three microphones of two sets to find the angle and distance of the moving vehicle. Methodology will be using correlation principles for processing digital signals. The system will be implemented using myRIO, a real-time embedded evaluation board by National Instruments. Software used is LabVIEW. The simulation results obtained are displayed on a LCD.

Keywords: *Direction and distance, microphones, myRIO, LabVIEW, vehicle*

1. Introduction

[1]The project has a two-fold approach to solving the problem. We aim to determine the direction of signal and also to calculate distance between sound source and microphone array. The direction of source is determined using averaging concept and distance using trigonometry. The objective of project is to build a microphone array of two sets separated by a known distance and each microphone array consisting of three microphones and to calculate direction of the sound source. Programming DSP Processor (myRIO) is used to calculate distance using the directions, to interface a LCD to the processor to display the calculated direction and distance.

Block diagram

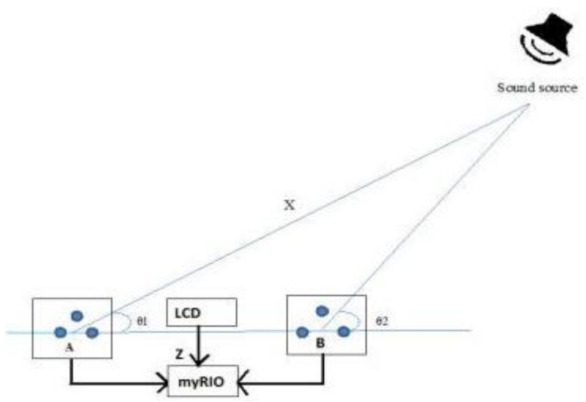

Figure 1 Block Diagram

The LCD is interfaced with the myRIO board. The sound source is captured by the microphone arrays. The myRIO board processes the data captured by the microphone array and the calculated values are displayed on the LCD.

2. Methodology

The project flow as shown in Figure 2 represents the main steps for the estimation of direction and distance of the sound source.

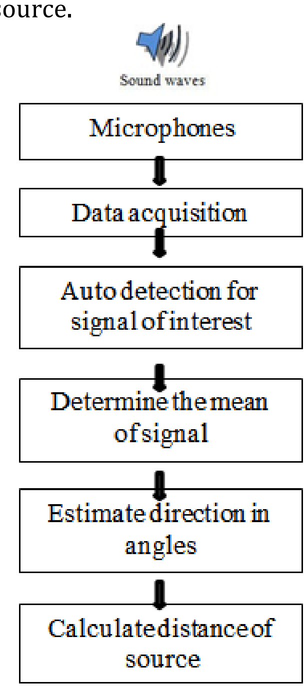

Figure 2 Project Flow

*Corresponding author's ORCID ID: 0000-0002-9128-9270

The three microphones which are arranged in a triangular form that contributes to one microphone set. After the detection of the signal, mean values are obtained and direction of source is calculated and distance from the sound sources is also calculated.

If the mean values between microphone1 and microphone 3 are compared and concludes that the signal received from microphone 1 is more compared to microphone 3 then angle is estimated to 0°.

If it's the other way then the angle estimated to be 90°.If the mean values are equal then the angle is at the middle that is 45°.The similar conditions if applied between microphone2 and microphone3 same phenomenon is followed.

To increase the precision in the angles, we can further assume more conditions and find the angles of the source. To obtain more précised angle we need to keep the microphones far apart so that the signals are properly captured and the microphones are kept at such distance from one another so that signals are captured properly.

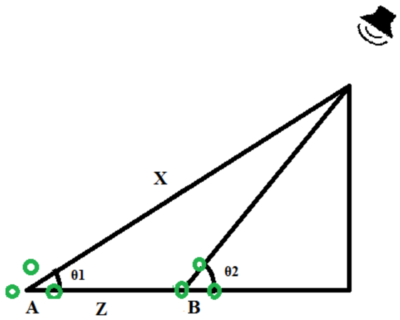

Figure 3 Microphone array system for distance finding

The figure 3 implies that it consists of two microphone sets A and B. The microphone A set consists of three microphones and set B consists of three microphones. The two microphone sets are kept at a constant distance Z which is fixed in meters. From set A one of the angle is found θ1 and from the other set another angle is found that is θ2.

The two angles obtained from the microphones and according to trigonometric function distance is calculated. The trigonometric formula used to calculate distance of source is given by X, calculated in meters.

$$X = \frac{Z*\sin(\theta 1)}{\sin(\theta 1-\theta 2)}$$

4. Implementation

Software used for implementation is LabVIEW from national instruments. The simulation results are displayed in front panel shown in figure 4.

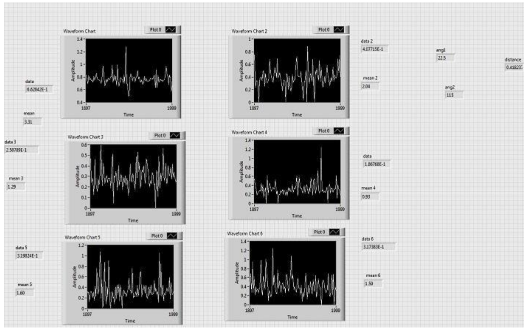

Figure 4 Simulation results

The figure 4 shows the angles θ1 and θ2 obtained after simulation. With the angles obtained the distance is determined from the sound source and the microphone set.

The θ1 and θ2 values will change according to the incoming sound source. Due to the varying angles the distance is also varied.

Conclusion

In this project, three microphones which are arranged in a triangular form contribute to one set of microphone. There are two sets of microphones and the signals are captured successfully. The distance and direction of the sound source from the microphone sets are determined. The implementation is done using a myRIO kit and labVIEW and the results are obtained.

Future scope

By using more microphones precision can be increased.

A dedicated processor can be used to reduce the cost of the system. We can implement wireless technology in future.

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