# Design and development of an acoustic distance finder in Android SDK and MATLAB

**Arijit Mallik[1], Subhendu Das[2]**

[1] Department of Computer Sc. & Engineering    [2] Department of Information Technology
National Institute of Technology Karnataka
Surathkal, Mangalore, India

**Abstract:** *Smartphones are the latest technology trend of the 21st century. Today's social expectation of always staying connected and the need for an increase in productivity are the reasons for the increase in smartphone usage. One of the leaders of the smartphone evolution is Google's Android Operating System (OS). Our paper intends to address the problem of measuring the distance of the nearest obstacle using sound waves. The implementation has been done in Android to make it useful for daily needs, especially suitable for the situations of sudden power cut. Whereas the Android app finds the distance of the obstacle, the purpose of the MATLAB implementation was to include the use of the Butterworth signal-processing filter (a band-pass filter) to reduce the inherent noise present in the environment to make the distance calculation more effective.*

**Keywords:** Acoustic, Transmission, Recording, Echo, Band-Pass Filters.

## 1. INTRODUCTION

'Acoustic' refers to the properties of any object that are related to sound. While determining the distance of the nearest obstacle from the source, we need some mechanism to capture the echo. To be audible and clearly distinguishable from the original sound, an echo has to travel to an obstacle at least 16.6 meters apart (Consider speed of sound in air = 332 m/s). However, to capture the echo from a nearer obstacle, we need a mechanism.

Laptops, PCs and other devices with built in microphone can record the sound by own whereas the others not having built-in mic. needs an external mic. to record. In general, smartphones are equipped with microphones.

Acoustic range finding is a base for SONAR (Sound Navigation and ranging) - technique that uses sound propagation (usually underwater, as in submarine navigation) to navigate, communicate with or detect objects on or under the surface of the water. *Active* sonar emits pulses of sounds and listening for echoes. Sonar may be used as a means of acoustic location and of measurement of the echo characteristics of "targets" in the water. Acoustic location in air was used before the introduction of radar. This denotes the importance of our proposal, where the distance calculation is possible through tiny android applications also.

## 2. BACKGROUND WORK

We can find the use of such an application in nature itself. Bats are not equipped with envision capabilities, hence they use an alternate mechanism-transmit an ultrasonic sound wave. The echo received is used to detect any obstacle in their paths and hence their flying mechanism is based on inherent acoustic distance finding capability. As we have already mentioned in the introduction, a lot of research work has been already done on how to use the sound signals to measure the depth of the water, or to detect below the surface objects (such as submarines, icebergs). Some other applications are helpful for blinds.

A lot of apps are already available for Android which uses sound recording, e.g., the voice recognition apps. They use the default recorder available in the mobile phone. For MATLAB, we need to use a microphone with the PC/Laptop in order to record the sound.

For accurate measurements, introduction of noise reduction filters is necessary. The reflected sound is generally very feeble compared to the original sound. Noise from the environment can distort the echo by a considerable margin. Thus we need to use the concept of band-pass filters (i.e., it will only allow a certain range of frequencies to pass) to remove the noise. The Butterworth filter that was implemented by us is a type of signal processing filter designed to have as flat a frequency response as possible in the pass-band. Though compared to a Chebyshev Type I/Type II filter or an elliptic filter, the Butterworth filter has a slower roll-off (and thus will require a higher order to implement a particular stop-band specification), we used Butterworth filter because it has a more linear phase response in the pass-band than Chebyshev Type I/Type II and elliptic filters can achieve. Following are the images showing the gain of a discrete-time Butterworth filter next to other common filter types (all the filters are of fifth order):
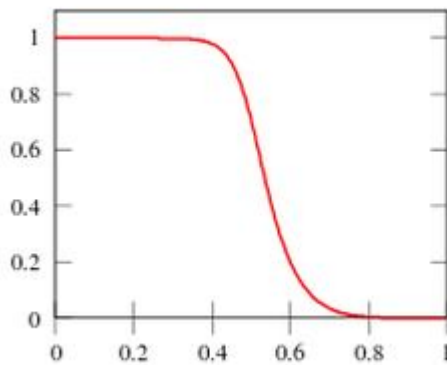
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**Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com**
**Volume 2, Issue 1, January – February 2013**                    **ISSN 2278-6856**
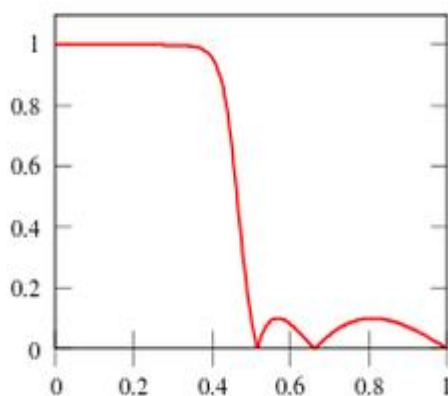
**Fig 1a**: Butterworth
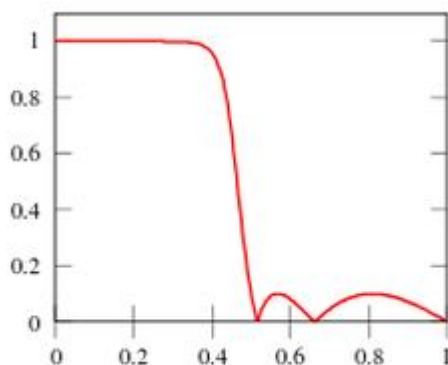


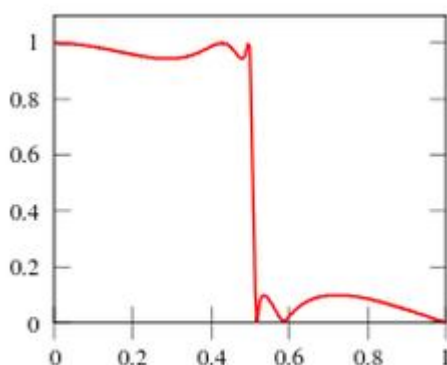**Fig 1b:** Chebyshev Type I



**Fig 1c:** Chebyshev Type II



**Fig 1d:** Elliptic

## 3. PROPOSED ALGORITHM

Our algorithm to find the distance using the echo is as follows:

```
Transmit sound.
Start the recorder.
Stop the recorder after a certain pre-
determined time.
Analyze the recorded sound to detect
the instance of time at which the echo
is received. (Using amplitude)
From this time, subtract the delay that
occurred between the transmission and
the recording of sound.
We get a time, say t sec.
Distance travelled by sound in t sec =
s = 332*t.
Distance of the source and obstacle =
s/2.
```

The above algorithm has been implemented in the android by using the MediaPlayer class to generate and transmit the sound and the MediaRecorder class to record the sound. The recorded sound has been stored in a buffer and it has been analyzed to detect the time of first reception of echo.

The above scheme has been modified and improved in MATLAB to obtain a better result. We have provided the scheme for comparing the waveforms of the transmitted and the received signal apart from the distance calculation capability. The modified algorithm for the MATLAB application is as follows:

```
Transmit   sound   using   user-defined
amplitude,  frequency,  volume,  sample
rate,  delay,  transmission  time  and
recording time. (This is done in order
to analyze the waveforms easily).
Start the recorder.
Stop the recorder after a certain pre-
determined/user-determined time.
Use BUTTORD and BUTTER functions in
MATLAB   to   apply   the   band-pass
Butterworth  filter  on  the  received
sound.
Analyze the recorded sound to detect
the instance of time at which the echo
is received. (Using amplitude)
From this time, subtract the delay that
occurred between the transmission and
the recording of sound.
We get a time, say t sec.
Distance travelled by sound in t sec =
s = 332*t.
Distance of the source and obstacle =
s/2.
```
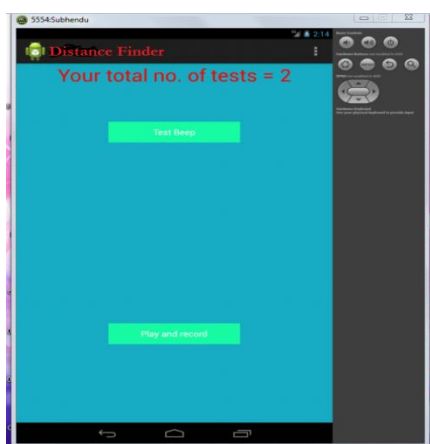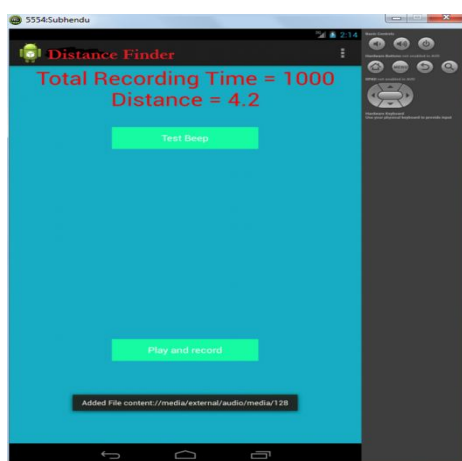
## 4. EXPERIMENTAL RESULTS

**Fig 2a:** The Test Beep button (above) is used to check whether the sound is properly transmitted or not.



**Fig 2b:** The Play and record button (above) is used to find out the distance. For experimental purpose, we are displaying the total time of recording (in ms) and we have added the recorded file in sdcard to listen to it and decide how much it is affected by noise.

Next, we show the results for the MATLAB application:
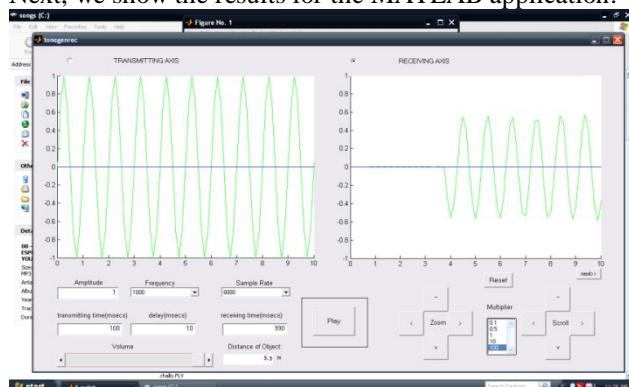


Fig 2c: The MATLAB application has two axes for transmission and receiving of sound. Each axis has Zoom and Scroll options (with a multiplier of 0.1, 0.5, 1, 10 and 100 - that determines the levels of zoom and scroll). For enlarged image, please check
http://www.mediafire.com/view/?i0fw4n0h33uu869

## 5. CONCLUSION

The MATLAB implementation shows that the pass-band Butterworth filter can remove the noise in a very efficient manner (from the waveform). For better results, we will try to equip the future versions of our app with noise reduction filters. This app can be as useful to the blinds as to the researchers concerned with acoustic range finders which can determine the range upto which the sound can travel and   reflect back to the source. They are also specifically useful in situations such as measuring the distances between mountains.

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## AUTHORS

**Arijit Mallik** is currently pursuing M.Tech in Computer Science and Engineering at National Institute of Technology Karnataka, Surathkal. He completed his B.Tech in Computer Science and Engineering from West Bengal University of Technology in 2012.

**Subhendu Das** is currently pursuing M.Tech in Information Technology at National Institute of Technology Karnataka, Surathkal. He completed his B.Tech in Computer Science and Engineering from West Bengal University of Technology in 2012.