# Dvhan - Data over Sound

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**Abstract -** *The need to transfer data between two electronic devices is growing exponentially with emerging domains like the Internet Of Things (IoT). The purpose of this paper is to revisit the literature on sharing data with the help of sound waves. We have studied the earlier literature available on data over sound technologies and identified the basic functionalities of it. In the architecture section of the research paper we have compared different data over sound methodologies in technical terms.*

***Key Words***: Data over sound, frequency shift keying, Modulation, Demodulation, Bits over sound, Wireless data transmission

## 1.INTRODUCTION

The order of reference in the running text should match with the list of references at the end of the paper. Demand grows for better connectivity, with the need for the most basic of smart devices to be able to process real-time audio. One emerging solution is sending data-over-sound. Data over sound enables the exchange of data between any devices with microphone and speaker through sound. Earlier data has been transferred from mobile devices using known technology like Bluetooth, Wi-Fi, etc. which does not use the internet. We can share links and other data through sound. The main aim of the project is to share data through sound between two devices (laptop/mobile) with no preceding setup and minimal hardware like microphone and speaker.

In order to transmit this data over sound, it is critical to examine the properties of audio signals and origin of its generation. Audio signals are generated by using the power of computers to process digital signals, in which the generated audio signal is transmitted over the air via sound waves. When those waves are obtained on the receiving device, they're relayed over to the demodulation unit. The acoustic signal undergoes time shifts in the technique of being recorded and demodulated. The binary code hence ought to face up to such interrupting elements while still preserving its characteristics for allowing it to be reliably recovered through the decoder. The proposed paper illustrates a method that utilizes audio signal for audio signal for conveying the data.

The methods presented in this paper can make IoT devices talk to each other via the use of a mere speaker and a microphone and stay connected over short distances without the requirement of an internet connection. This may come handy in case of internet connectivity shortage, and allow devices to talk and carry-on tasks that would rather require the devices to be connected to each other via a connection. The data-over-sound application is more beneficial to certain fields like IoT, NFC, small data sharing between devices, etc. The data-over-sound application refrains from sending data over large distances or sending huge amounts of data.

## 2. METHODOLOGY

### 2.1 System Overview

To share data via sound medium, the data is first checked for ASCII values if the data contains any other character which is not an ASCII character the system prompts the user to input ASCII data only. Each ASCII character is converted to its ASCII character code. This ASCII character code is then converted to its binary equivalent in 7-bit representation. Hamming code, a simple linear error-correcting code is then applied to the bit stream. The bit stream generated is then Frequency Modulated onto a sound wave. This modulated wave is transmitted via the speaker of the sender's device. The receiver, in receive mode, records the audio being broadcasted and then analyzes the audio to demodulate the message back to the original form. This demodulated message is then checked for any errors and are corrected, if any. Then the bit stream is split into chunks of 7-bits, a chunk is converted back to its base-10 form and then the number is mapped to it's ASCII character. Repeating this procedure for each chunk yields the original text message transmitted.

### 2.2 Implementation

The proposed prototype is tested using the Python language. An application is developed which is capable of sending as well as receiving data between true air gaps with minimal requirements of a speaker and a microphone and also the respective drivers. On implementing the above discussed strategy we were able to attain a speed of 3 bits per second. The modulation algorithm we used was the Frequency Shift Keying, which shifts the frequency of the carrier wave between predefined frequencies with respect to the fully processed bit stream which is to be transmitted. The modulated carrier wave was padded with a start bit at the beginning and a stop bit at the end, which is basically a predefined frequency to notify the start and stop of the actual data. On the receiver's end the application will record an audio for a certain period. The receiver will then analyze the audio to get the start and stop signal and will explicitly calculate the message between these signals.

The below given figures, delivers the idea that this project uses to change the form of the message so as to transmit and receive the data over short distances.

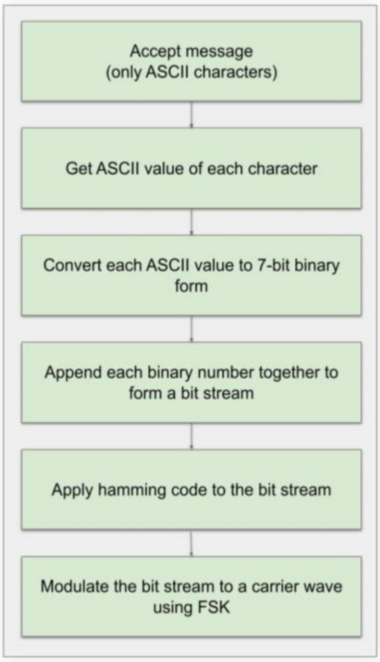


Fig A. Modulation flow of sender's end.

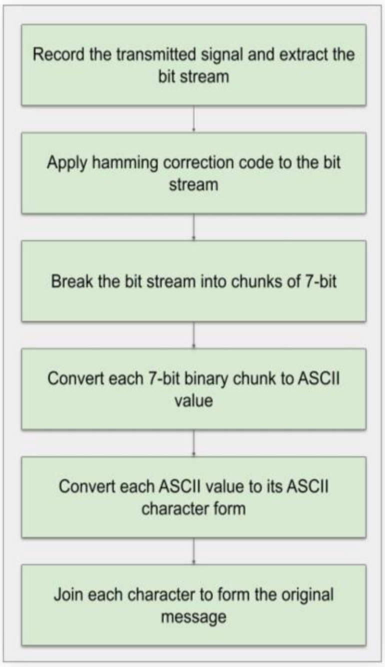


**Fig B**. Demodulation flow of receiver's end.

## 2.3 MODULATION TECHNIQUES

In our proposed model we used a variant of Frequency Shift Keying. We found that everyday devices such as laptops, cell phones are very susceptible to noise. When we used Amplitude Shift Keying as a modulation technique, the message received was with errors.

### 2.3.1 Amplitude Shift Keying

When the carrier signal's instantaneous amplitude is varied in proportion to the message signal m(t). We have the modulated carrier mtcos(ωct), where cos(ωct) is the carrier signal. As the information is an on-off signal the output is also an on-off signal where the carrier is present when information is 1 and carrier is absent when information is 0. Thus this modulation scheme is known as on-off keying (OOK) or amplitude shift key.

### 2.3.2 Frequency Shift Keying

When the carrier signal's instantaneous amplitude is varied in proportion to the message signal m(t). We have the modulated carrier mtcos(ωct), where cos(ωct) is the carrier signal. As the information is an on-off signal the output is also an on-off signal where the carrier is present when information is 1 and carrier is absent when information is 0. Thus this modulation scheme is known as on-off keying (OOK) or amplitude shift key.

### 2.3.3 Phase Shift Keying

The phase of the carrier is shifted for this modulation. If the base band signal m(t) = 1 carrier in phase is transmitted. If m(t) = 0 carrier which is out of phase is transmitted.

## 2.4 SOURCE CODE

We implemented the whole system in the Python language(3.x). The python language has various libraries which were used to build this project. Taking advantage of Python's capability to handle audio streams the function of creating and playing the sound was achieved. To generate a finite length sine wave of various frequencies we used NumPy library's sin function on a linear array of time space. To do the frequency modulation, the objects of pre generated sine waves were concatenated to a single array. This array would be played by the sound module to broadcast the data to any nearby receivers. To reduce the errors during transmission we used hamming encoding technique, which is capable of detecting 2 bits of error and reverting back one bit of error.

An application was developed which is discussed in the Results and finding section of this paper. The application is a working prototype and can be used to send and receive small bits of data over short distances.

## 2.5 Error detection

In this research project we used hamming codes for error detection. Hamming codes can detect up to two-bit errors or correct one-bit errors without detection of uncorrected errors. By contrast, the simple parity code cannot correct errors, and can detect only an odd number of bits in error. Hamming codes are perfect codes, that is, they achieve the highest possible rate for codes with their block length and minimum distance of three.

In any case where the errors are non-recoverable the sender will be notified of the same. And the sender can resend the same message to the receiver. The errors may occur due to the surrounding noises which may interfere with the sound signal. However, to overcome these errors the dvhan application can use high frequency sound but may also produce side-effects like hardware not being capable of sending/receiving high frequency sound.

## 3. RESULTS AND FINDING

### 3.1 FINDING

While experimenting with various data-over-sound techniques to transmit data between two devices, we used ASK(Amplitude Shift Keying) as our primary modulation technique. On using ASK, we varied the amplitude of the carrier wave based on the binary stream that is to be sent. But later came to realize that mobile devices like laptop/computers/cell phones are very susceptible to the environmental noise i.e. sound. On recording and analyzing the modulated carrier wave, carrying the bit stream, the magnitude of error in the received bit stream was incorrigible. And used FSK(Frequency Shift Keying) as the modulation technique.

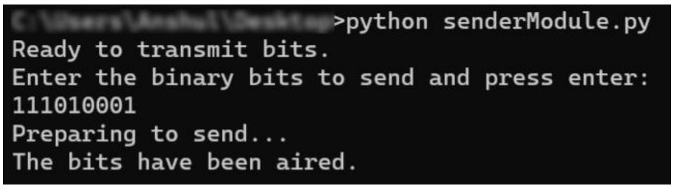


fig C. Sending data using ASK modulation

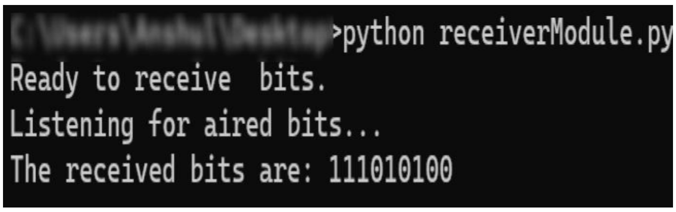


fig D. Receiving data using ASK demodulation

The above figures(fig. C and fig. D) shows the error bits received when using ASK as modulation and demodulation technique. The final modulation technique we used is Frequency shift keying. Under this modulation scheme we are varying the frequency of the carrier wave depending on the bit symbol. The bit stream when generates the sound wave which will carry the bits, before playing the audio file(i.e. transmitting the signal) the sound wave is padded with a start stop signal of predefined frequency, which notify the user about the beginning and end of the message to avoid resource wastage and possibility of any error which may crawl in.

On the receiver's end, we apply a windowing technique to correctly identify the bits that are encoded in the message signal. The signal is first recorded and then all processes follow as given in the implementation section.

### 3.2 RESULTS

We have created a prototype model of our system in the Python language using appropriate libraries and tools.

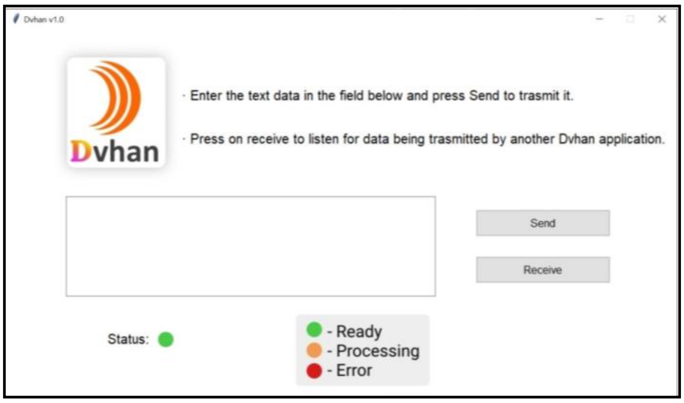


fig E. Interface of Dvhan application

In the current state of the application, the user can input test data that is to be transmitted. When the send button is clicked the data is processed and transmitted through the speaker in the form of audio waves. Another Dhvan application can click on receive to get the transmitted data by recording and analyzing the audio wave.

The error retention was reduced by using the FSK(Frequency Shift Keying) modulation. The zenith of perfect bit transmission and receiving was recorded as 4 bits per second. Higher Rates of transmission can be achieved by lossless text compression techniques.

## 4. CONCLUSIONS

In this paper we made an effort to understand and explain the concepts of Digital modulation. We studied the literature of existing data-over-sound technologies and analyzed the different models which explains the basic functionalities of any Modulation.

## 5. REFERENCES


[1] In 2014,"ultrasonic wireless communication in air using OFDM-OOK Modulation" by Wentao Jiang and William M.D .Wright.

[2] Data Transmission for Proximity Devices Using Ultrasonic Sound Waves

[3] B.Yogalakshmi 1,A.Nithya 2,R.Likhitha Chowdary 3,M.Preethi 4, Volume: 06 Issue: 03 | Mar 2019

[4] V. N. P. Rajalakshmi Nandakumar, Krishna Kant Chintalapudi and R. Venkatesan, "Dhwani : Secure peer-to-peer acoustic nfc," in Proceedings of ACM SIGCOMM 2013, Sigcomm '13, (New York, NY, USA), ACM, 2013.

[5] J. Krautkr¨amer and H. Krautkr¨amer, Ultrasonic testing of materials. Springer-Verlag, 1990.

[6] H. Carr and C. Wykes, "Diagnostic measurements in capacitive transducers," Ultrasonics, vol. 31, no. 1, pp. 13 – 20, 1993.

[7] V. Gerasimov and W. Bender, "Things that talk: using sound for device-to- device and device-to-human communication," IBM Syst. J., vol. 39, pp. 530–546, July 2000.

[8] S. Mathur, N.M., C. Ye, and A. Reznik. Radio-telepathy: extracting a secret key from an unauthenticated wireless channel. In Mobicom,2008.