Design and Analysis of a Sound Generator for wave file format via Parallel Printer Port

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ABSTRACT

Ports in computers are used mainly for two reasons : Device control & communication. Parallel ports are mainly meant for connecting the printer to the PC. The purpose of this paper is to design and analayze a sound generator for wave file format by the use of the data and command port of the parallel printer port , the parallel printer port is being programmed to transmit the data from the wave file to the designed device.

Some of integrated circuits used in abundance in most electronic applications have been selected in order to achieve its purpose, that all the constituencies used are electronic circuits and logical circuits dependent upon in the design of this sound generator.

A digital to analog converter is being used in order to transfer the data from the digital to analog to be heard by the human ear. A program written in Visual Basic language to extract the data from the wave file and to activate the designed device.

.   :

                    .

         .   (wave)

              .

                                                    .

              (   )   .

                                        .

1. INTRODUCTION

Sound is actually vibration. Most often, the sounds we hear are passed through vibrating air. The air vibrates in a certain way, passing waves of vibration to any objects it encounters. When the vibration reaches to eardrums, it pulsates the sensitive membranes in the ear, and is interpreted by the brain as a sound. To create sound, the computer feeds electricity at a certain wavelength through a stretched membrane (the speaker), causing it to vibrate. The speaker passes along the vibration into the air, creating a sound **[8].**

To record a sound ,the microphone changes the air pressure fluctuation in to electrical voltage fluctuation ,which the sound card measures every so often and changes in to number ,called samples. When you play a sound back ,the process is reversed ,expect that the voltage fluctuations go to the speakers instead of the microphone ,and are converted back in to air pressure by the speaker cone **[3, 19].**

A sound card (also known as an audio card) is a computer expansion card that facilitates the input and output of audio signals to/from a computer under control of computer programs. Typical uses of sound cards include providing the audio component for multimedia applications such as music composition, editing video or audio, presentation/education, and entertainment (games). Many computers have sound capabilities built in, while others require additional expansion cards to provide for audio capability[14].

Parallel Ports

The Parallel Port is the most commonly used port for interfacing home made projects. This port will allow the input of up to 9 bits or the output of 12 bits at any one given time, thus requiring minimal external circuitry to implement many simpler tasks. The port is composed of 4 control lines, 5 status lines and 8 data lines. It's found commonly on the back of your PC as a D-Type 25 Pin female connector (figure 1). There may also be a D-Type 25 pin male connector. This will be a serial RS-232 port and thus, is a totally incompatible port . **[2, 6, 18]**

Parallel Printer Port had a total of 12 digital outputs and digital inputs accessed via 3 consecutive 8-bit ports in the processor's I/O space .

- 8 output pins accessed via the DATA Port .
- 5 input pins (one inverted) accessed via the STATUS Port .
- 4 output pins (three inverted) accessed via the CONTROL Port .
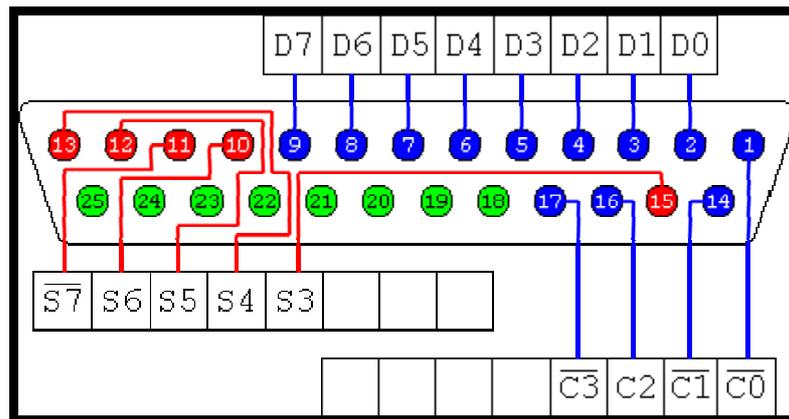- The remaining 8 pins are grounded .**[5, 13]**

Figure (1) 25-way Female D-Type Connector

Port Addresses

The Parallel Port has three commonly used base addresses. These are listed in table 1, below. The 3BCh base address was originally introduced used for Parallel Ports on early Video Cards. This address then disappeared for a while, when Parallel Ports were later removed from Video Cards. They has now reappeared as an option for Parallel Ports integrated onto motherboards, upon which their configuration can be changed using BIOS.

LPT1 is normally assigned base address 378h, while LPT2 is assigned 278h. However this may not always be the case as explained later. 378h & 278h have always been commonly used for Parallel Ports. The lower case h denotes that it is in hexadecimal. These addresses may change from machine to machine.

Table (1) : Port Addresses

Address	Notes:
3BCh - 3BFh	Used for Parallel Ports which were incorporated on to Video Cards - Doesn't support ECP addresses
378h - 37Fh	Usual Address For LPT 1
278h - 27Fh	Usual Address For LPT 2

Address 0000:040E in the BIOS Data Area may be used as the Extended BIOS Data Area in PS/2 and newer BIOS[13],[15]

Digital-to-Analog Converter

The DAC fundamentally converts finite-precision numbers (usually fixed-point binary numbers) into a physical quantity, usually an electrical voltage. Normally the output voltage is a linear function of the input number. Usually these numbers are updated at uniform sampling intervals and can be thought of as numbers obtained from a sampling process. These numbers are written to the DAC, sometimes along with a clock signal that causes each number to be latched in sequence, at which time the DAC output voltage changes rapidly from the previous value to the value represented by the currently latched number [1].

Most modern audio signals are stored in digital form (for example MP3s and CDs) and in order to be heard through speakers they must be converted into an analog signal. DACs are therefore found in CD players, digital music players, and PC sound cards**[4, 17].**

Wave File Format [19]

The Wave file format is Windows' native file format for storing digital audio data. It has become one of the most widely supported digital audio file formats on the PC due to the popularity of Windows and the huge number of programs written for the platform. Almost every modern program that can open and/or save digital audio supports this file format, making it both extremely useful and a virtual requirement for software developers to understand.

. Data Formats

Since the Wave file format is native to Windows and therefore Intel processors, all data values are stored in Little-Endian (least significant byte first) order.

❖ **Strings**

Wave files may contain strings of text for specifying cue point labels, notes, etc. Strings are stored in a format where the first byte specifies the number of following ASCII text bytes in the string. The following bytes are of course the ASCII character bytes that make up the text string[19].

. File Structure

Wave files use the standard RIFF structure which groups the files contents (sample format, digital audio samples, etc.) into separate chunks, each containing it's own header and data bytes (table 2). The chunk header specifies the type and size of the chunk data bytes. This organization method allows programs that do not use or recognize particular types of chunks to easily skip over them and continue processing following known chunks. Certain types of chunks may contain sub-chunks. For example, in the

diagram to the right, you can see that the "fmt " and "data" chunks are actually sub-chunks of the "RIFF" chunk.

One tricky thing about RIFF file chunks is that they must be word aligned. This means that their total size must be a multiple of 2 bytes (i.e. 2, 4, 6, 8, and so on). If a chunk contains an odd number of data bytes, causing it not to be word aligned, an extra padding byte with a value of zero must follow the last data byte. This extra padding byte is not counted in the chunk size, therefore a program must always word align a chunk headers size value in order to calculate the offset of the following chunk[3].

Table (2) : Basic Wave File Layout

Chunk ID "RIFF"
Chunk Data Size
RIFF Type ID "WAVE"
Chunk ID "fmt "
Chunk Data Size
Sample Format Info
Chunk ID "data"
Chunk Data Size
Digital Audio Samples
Chunk Header
Chunk Data Bytes

2. Sound Generator Overview

In this work , a sound generator device has been designed .Some of an integrated circuits used in abundance in most electronic applications have been selected in order to achieve its purpose, that all the constituencies used are electronic circuits and logical circuits dependent upon in the design of this device. The sources of these circuits are private companies manufacture various types of these circuits , So as to be compatible with the requirements of any logical work. And these circuits are being used in many special applications that can be added to a PC computer through various expansion outlets. The available of these circuits have been used to achieve the goal of the paper.

Parallel Printer Port Usage

The parallel printer port has been used to connect computer with the designed device via private cable of data . Although the savior Pyramid seems to be limited at first glance but in fact it is multi-use and is composed of three ports:

1. Data port .
2. Command port .
3. status port .

The first port is called the Port Data which is Bi-direction (with address 378). It is the way data export figures eight-Pacific bilateral internal organs of computer and output devices like the printer. Although can be used to supply the same data entry from any external device into the PC. But in this designed device I use it to send a line from the matrix to the device circuit .

The second port is called Command port (with address 37A).Which is used to send orders of the printer .But in this design I use it to determine the direction of the data whether it is for the left channel or right channel .

The third port which is called status port is not used in this design .

R-2R Ladder DAC which is a binary weighted DAC that uses a repeating cascaded structure of resistor values R and 2R. This improves the precision due to the relative ease of producing equal valued matched resistors (or current sources). However, wide converters perform slowly due to increasingly large RC-constants for each added R-2R link, this type of DAC is used in this work.

Hardware Integrated Circuits

The following integrated circuits have been used in this design .

. The Integrated circuit 74LS541: OCTAL BUFFER/LINE DRIVERWITH 3-STATE OUTPUTS

The SN54/74LS541 are octal buffers and line drivers (figure 2). These device types are designed to be used as memory address drivers, Clock drivers and bus-oriented transmitters/receivers . These devices are especially useful as output ports for the microprocessors, allowing ease of layout and greater PC board density.

• Hysteresis at Inputs to Improve Noise Margin.
• PNP Inputs Reduce Loading.
• 3-State Outputs Drive Bus Lines
• Inputs and Outputs Opposite Side of Package, Allowing Easier Interface to Microprocessors.
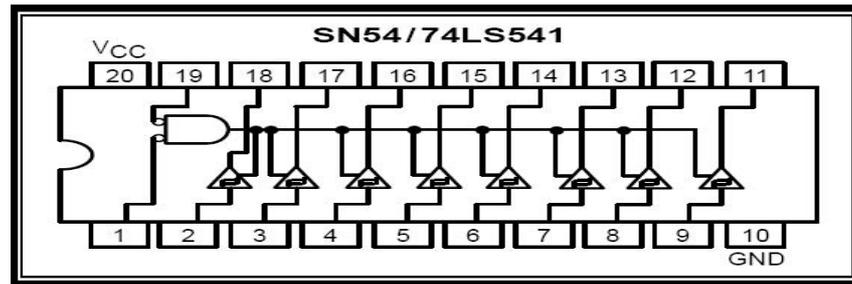• Input Clamp Diodes Limit High-Speed Termination Effects[12, 16].

Figure (2): 74LS541 Pin assignment

. The Integrated circuit 74LS541: OCTAL D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

The MC74F574 is a high-speed, low-power octal D-type flip-flop featuring separate D-type inputs for each flip-flop and 3-state outputs for bus oriented applications. A buffered clock (CP) and Output Enable (OE) are common to all flip-flops (figure 3).
• Broadside Pinout Version of F374.
• Edge-Triggered D-Type Inputs.
• Buffered Positive Edge-Triggered Clock.
• 3-State Outputs for Bus Oriented Applications.
• ESD Protection > 4000 Volts. **[10]**
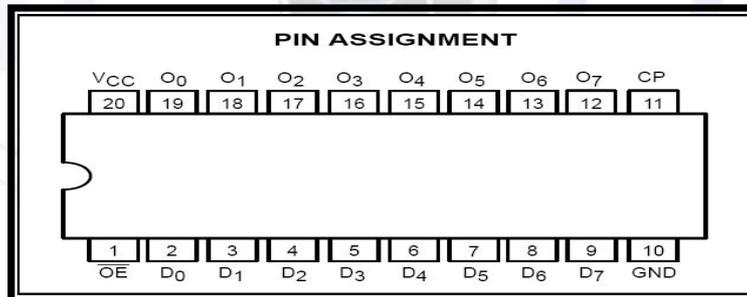
Figure (3): 74LS574 Pin assignment

. The Integrated circuit 74LS138: 1-8 DECODERDEMULTIPLEXER

The LSTTL/MSI SN54/74LS138 is a high speed 1-of-8 Decoder/ Demultiplexer (figure 4). This device is ideally suited for high speed bipolar memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three LS138 devices or to a 1-of-32 decoder using four LS138s and one inverter. The LS138 is fabricated with the Schottky barrier diode process for high speed and is completely compatible with all Motorola TTL families.
• Demultiplexing Capability.
• Multiple Input Enable for Easy Expansion.
• Typical Power Dissipation of 32 mW.
• Active Low Mutually Exclusive Outputs.

• Input Clamp Diodes Limit High Speed Termination Effects. **[11]**
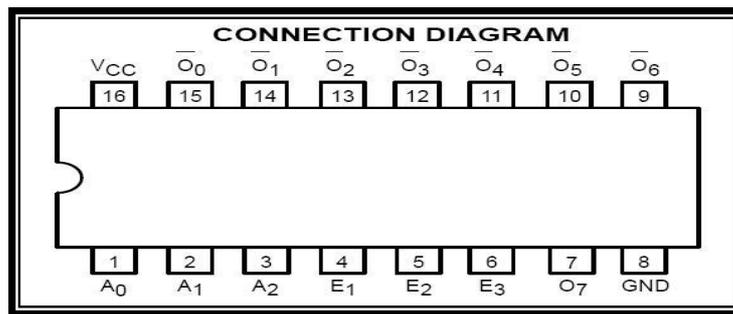
Figure (4): 74LS138 Pin assignment

. The Integrated circuit 7805: THREE–TERMINAL POSITIVE FIXED VOLTAGE REGULATOR STANDARD APPLICATION

A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0 V above the output voltage even during the low point on the input ripple voltage.

XX, these two digits of the type number indicate nominal voltage.

* Cin is required if regulator is located an appreciable distance from power supply filter.
** CO is not needed for stability; however, it does improve transient response. Values of less than 0.1 mF could cause instability. **[7, 9,** 18]
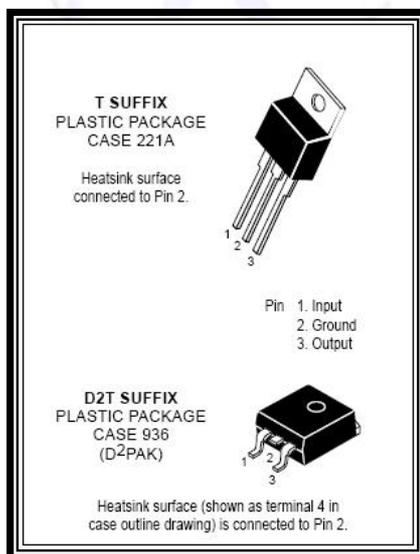
Figure (5-a): 7805 Pin
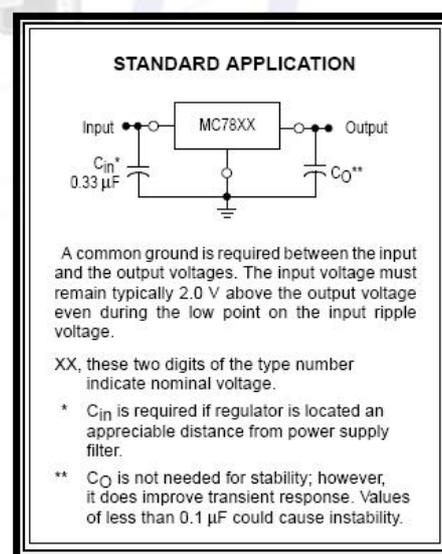
Figure (5-b): 7805 Typical

3. Designed Circuit for the Sound Generator

Figure (6) illustrates the circuit designed for the sound generator, figure (7) shows the board of the sound generator.
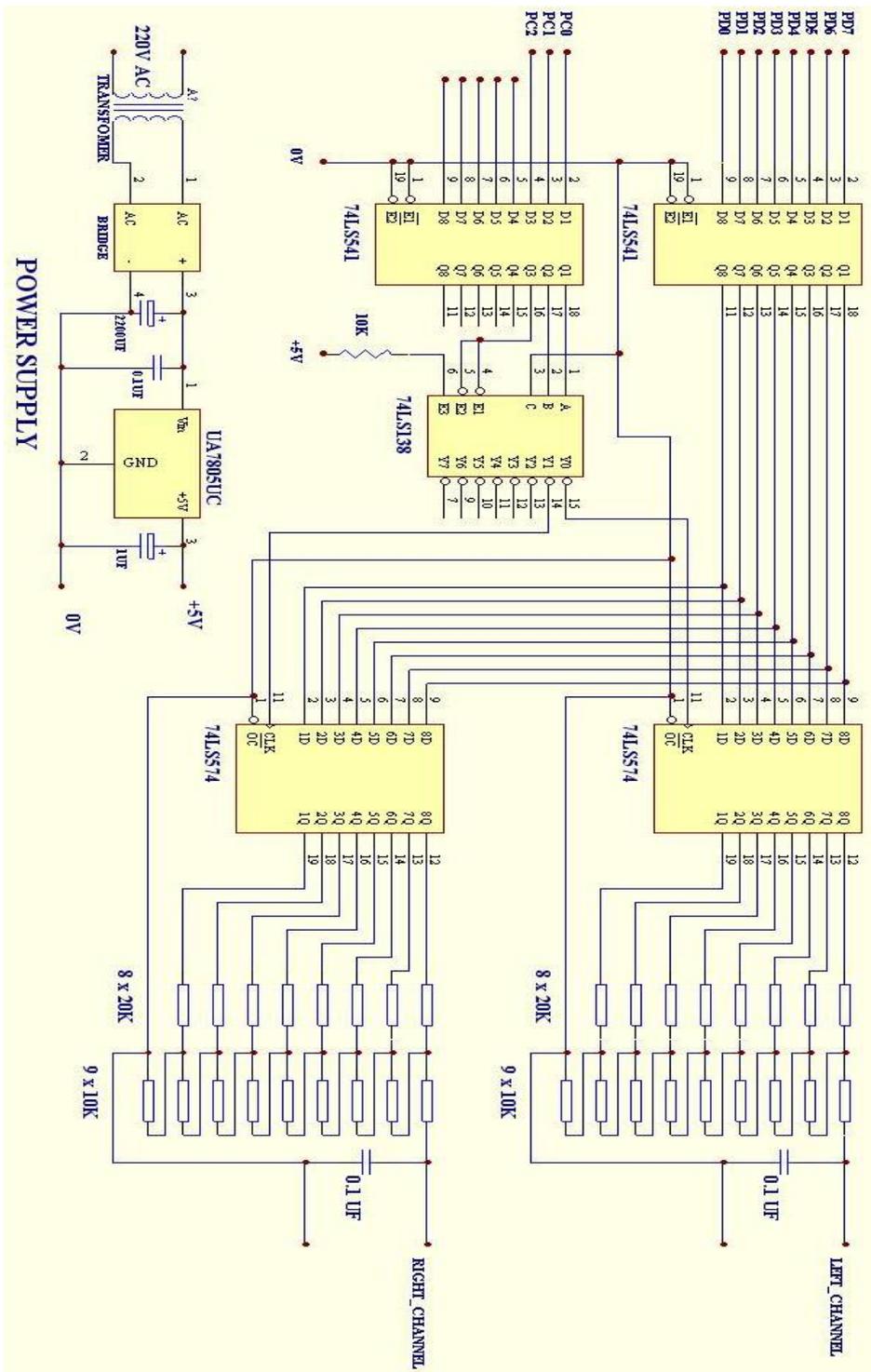
Figure (6) The Designed Circuit

Figure (7) : Sound Generator Board

4. Analysis of Sound File

The .wav sound file consists of two parts (header and data) parts. The header part contains information about the sound file like (file size, sample rate, no. of channels, etc) .

This file header reserves bytes   0....39 . The data part begins at offset 40 . In this work a data is begin read from offset 40 of the .wav file and store it in a matrix byte by byte . since two channels (stereo) is being used ,so the matrix will contain the bytes in the form left ,right , left ,right , etc.

L
R
L
R
.
.
.
.

The matrix

To send the data from the matrix to the designed device, first send left,then right ,and after that there is a short delay .

5. Analysis of Circuit Working

The data in the form of 8-bit from the matrix will be transmitted by the data port of the parallel printer which has an address (378). The data directed to a buffer in the designed circuit for amplifying the signal . This buffer work only if the (G) enable pin is zero. Two (G) enable have been used in this design first one (G_1) for first quid input and the second one (G_2) for the other quid input.

The command port (which has address 38A) of the parallel printer port is used to determine which channel is work (left or right).The command port is linked to the decoder in the following way : pc_0 and pc_1 (pins of the command port which are already inverted) are linked to A and B pins of the decoder. Pin pc_2 of the command port (which is not inverted) is used to enable the decoder , so it is linked to two pin enable E_1 & E_2 of the decoder . Pin E_3 of the decoder is connected to VCC .

Since pc_0 & pc_1 of the command port have an inverter, so in order to make the output of decoder (y_0) active, the value (1 1) is being written on pc_0 & pc_1 and to make the (y_1) active the value (1 0) is being written.

To send the data by the flip flop we need a complete puls to direct data from the input (D) to output (Q) of the flip flop. To make a plus (at the raising edge), the first value of pc_2 is 1 so the decoder is disabled & the output is 1 (‾‾‾) .The second value of the (pc_2) is zero, so the decoder is enabled & since   it is (active low), the output is zero (‾L__). The third value of the pc_2 pin is 1, so the decoder is disabled & the output is 1 , A complete pulse is obtained at the rising edge (‾LoΓ‾).The decoder in this designed circuit will determine the orient of the data (which is arrived from the buffer) where it is to left flip flop or right flip flop .

To send the data to the left flip flop the value (737) is being written in the command port of the parallel printer port .

VALUE	E	B	A	OUTPUT
7	1	1	1	1
3	0	1	1	0
7	1	1	1	1

To send the data by the right flip flop a value (626) is being written in the command port .

VALUE	E	B	A	OUTPUT
6	1	1	0	1
2	0	1	0	0
6	1	1	0	1

To convert the data (signal) from digital to analog , two digital to analog converter chips were being used . The type of the DAC chip used in this designed circuit is (R2R) ladder . The first chip receives the data from the left flip flop and the second chip receives the data from the right flip flop .

The ladder (R2R) need a resistances of type 20K and 10K . Resistance (20K) is not available, so I use pair of resistances of type 10K. Eight resistances of type 20K for the left and right are used, and nine of resistance of type (10K) for the left and right, the last two resistances is linked to earth. A capacitor is being used to decrease the distortion after passing the data through the DAC. Finally, the signal is transferred to analog and could be heard by the human ear.

6. Software Description

Program is being written in visual basic language to extract the data from the wav file format. The program also is responsible of operating & activating the designed circuit for this sound generator. The flowchart of this program is illustrated in figure (8).

```
                          ┌─────────────┐
                          │    start    │
                          └──────┬──────┘
                                 │
                                 ▼
                    ┌────────────────────────┐
                    │   Read sound file      │
                    │  (Header & data port ) │
                    └────────────┬───────────┘
                                 │
                                 ▼
                         ◇ If file type =        No
                         ◇     .wav      ◇──────────────────┐
                                 │                          │
                                 │ yes                      │
                                 ▼                          ▼
                    ┌────────────────────────┐        ┌──────────┐
                    │  Call delay function   │        │   Exit   │
                    └────────────┬───────────┘        └──────────┘
                                 │
                                 ▼
                    ┌────────────────────────┐
                    │  Read the data from the│
                    │         matrix         │
                    └────────────┬───────────┘
                                 │
                                 ▼
                    ┌────────────────────────┐
                    │  Call Lchannel function│
                    └────────────┬───────────┘
                                 │
                                 ▼
                    ┌────────────────────────┐
                    │  Call Rchannel function│
                    └────────────┬───────────┘
                                 │
                                 ▼
    ┌──────────────────┐   No    ◇  End of  ◇
    │ Increment matrix │◄────────◇  matrix  ◇
    │      index       │         ◇          ◇
    └──────────────────┘              │
                                      │ yes
                                      ▼
                                 ┌─────────┐
                                 │   End   │
                                 └─────────┘
```
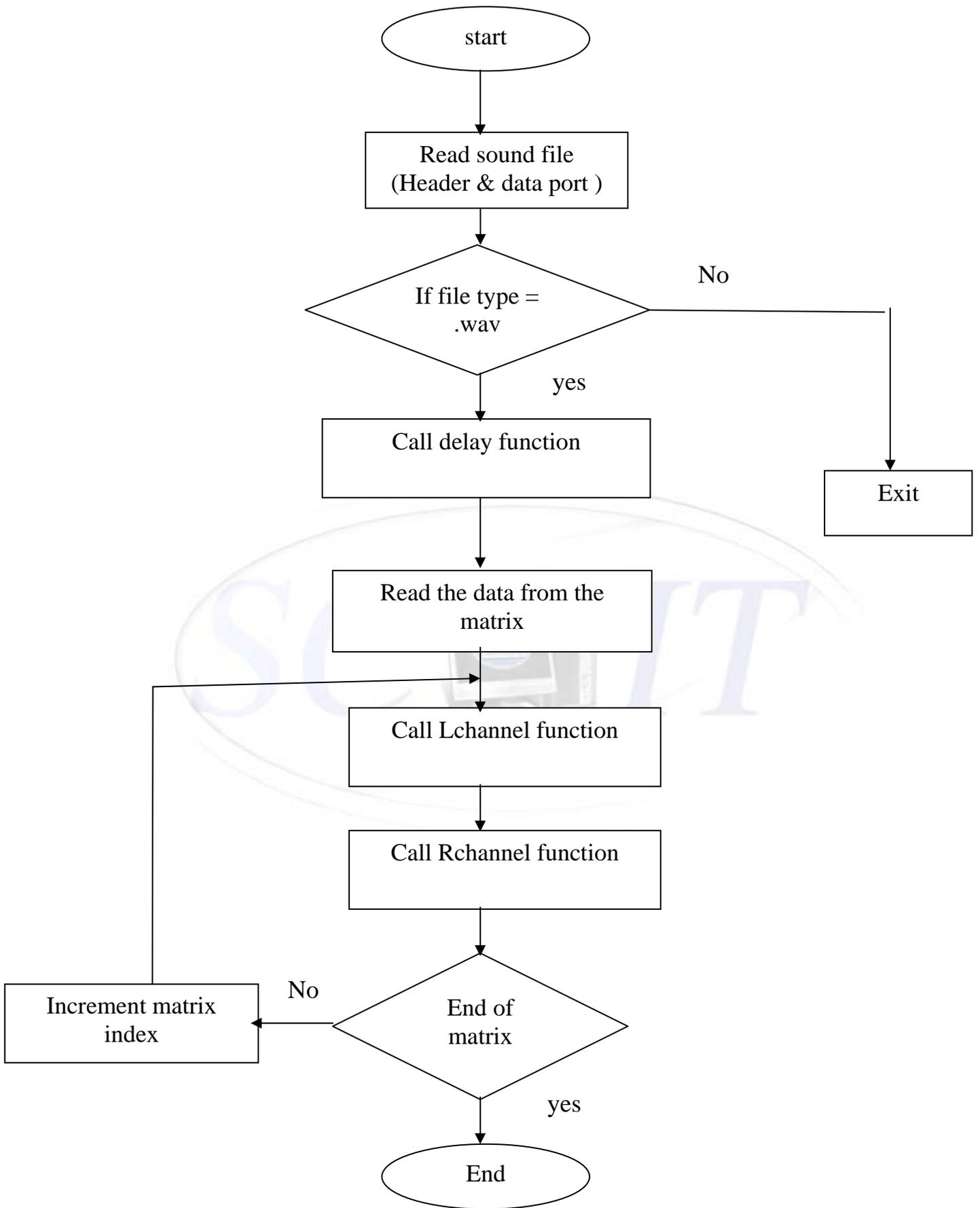
Figure(8) : Program Outline

The following functions have been used in this program :

• *Delay Function:* read the sample rate from header to use (Sample rate /
slack number) to calculate the delay time among the samples .

• *Lchannel Function:*
1- Send Lchannel information into parallel printer port that address   no is
378A

<center>Out & H378, Lchannel _data</center>

2- Send the value 03 to parallel printer port that address   no is 378A

<center>Out & H37A,03</center>

3- Send the value 07 to parallel printer port that address   no is 378A

<center>Out & H37A,07</center>

4- Send the value 03 to parallel printer port that address   no is 378A

<center>Out & H37A,03</center>

The steps (2 , 3 & 4) make the Lchannel data saved in it's own Register

• *Rchannel Function:*

1- Send Rchannel information into parallel printer port that address   no is
378A.

<center>Out & H378, Rchannel _data</center>

2- Send the value 02 to parallel printer port that address   no is 378A

<center>Out & H37A,02</center>

3- Send the value 06 to parallel printer port that address   no is 378A

<center>Out & H37A,06</center>

4- Send the value 02 to parallel printer port that address   no is 378A

<center>Out & H37A,02</center>

The steps (2 , 3 & 4) make the Rchannel data saved in it's own Register

7. Conclusions

In this work a sound generator device which act as sound card for
.wav file format has been designed and analyzed by the use of parallel
printer port. This sound generator could be used for providing the audio
component for multimedia applications such as music composition,
editing video or audio.

I conclude that when converting the digital sound file to the analog
signals we must use converting circuits which is called "Digital to
Analog Converter " there are many types of this converter like (R-2R-
4R-8R) and (R-2R) but the second is more spreading and more exactness
and efficient so I use (R-2R) converter which have high features,

clearness, and high efficient to convert from digital system to analog system.

Also I conclude that there are many types of sound files and each file may contain special information of sound through one channel (mono) or tow channel (stereo) and each channel may contain (8-bit) or (16-bit)and when the sample contains the large number of binary digits the sound will be more clearness and noise will be less.

8. Further Works

As future actions I recommend to develop the designing card to work with sound files with tow channel (stereo) and each of them contains of (16-bit) instead of (8-bit).

Also I recommend to add the primary amplifier to enlarge the outside signal from converter (DAC) to increase the stress of sound because of the outside sound from converter is not in demand stress.

Finally, it possible to add filter to filtrating the undesired frequencies which effect on the stress, clearness, and pureness of sound through the converter (DAC).

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