Enhancement Of Performance Parameters Of An Mp3 Player.

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Abstract:

There are many fine music players available from the likes of Sony, Samsung, Apple, Creative and Panasonic. However, it is often observed that the best players in the market are exorbitantly priced all because of the brand name of the manufacturers. Also, these music players are still lacking in many performance parameters which can be significantly improved. The performance parameters are expandable memory, frequency response, driver software requirement, Bluetooth capability, output power, signal processing abilities and most importantly, cost. A portable mp3 player has been developed which addresses the above mentioned shortcomings in today's music players. We have first designed our own prototype, included and improved existing features, added fine touches of our own and also conducted a comparative study on its performance compared to well establish products. We also hope to debunk the myth that only the best manufacturers can provide the best technology. This paper demonstrates the maximization of results and features using minimum essentials. We would also like to demonstrate the possibility of designing and executing a standalone electronics device at the graduate level, which was our main motivation. As a result of our work, we have met most of the objectives that we have initially set out to achieve and also found out innovative workarounds to certain problems that were encountered. We are proud to present the AMS mp3 player- a music player for an enhanced experience.

Introduction.

An Apple iPod or a Samsung or Sony mp3 player may be widely considered as the best portable music player around in the market. According to Karl Lagerfeld "The iPod completely changed the way people approach music." And rightly so, but even an iPod has shortcomings. There are many features that are still missing from an iPod or for that matter many of the leading music players that are currently available. One might think that with the constant innovation and new technologies on display that the portable music player industry has reached its zenith in terms of innovation and only something new and revolutionary can set of a spark just like the iPod did more than a decade ago. However, there is so much that is still lacking in today's mp3 players that leave a lot to be desired. This technical paper is the result of actual implementation of our own mp3 player and most importantly enhancing its performance parameters

The performance parameters are expandable memory, driver software, frequency response, output power and signal processing. After conducting an extensive literature survey, we found no portable music player supports expandable memory. Most of these players have fixed memory and higher the memory capacity, greater is the cost. Also, almost all music players require driver software installed in a PC to transfer music to the player. Users face many issues related to usage of driver software from compatibility to faulty functionality. It's a wonder that most manufacturers haven't done away with the use of driver software. Apart from these, quality is mostly associated by brand name and not by actual measurable parameters. So, even the best mp3 players have some shortcomings when it comes to providing the best sound quality.

The goal of this project is to address these shortcomings and enhance the above mentioned performance parameters. We also back up our work with a comparative study with available portable mp3 players. During the course of the implementation of this project, we have not only learned to make a device comparable to market standards but also realized that hardly anyone has conducted research in this area. The leading products and their manufacturers have hardly been challenged, nor has there been any study addressing shortcomings in the

product. This project aims to identify chinks in the armor of commercial mp3 players and to match or even better them at graduate engineering level. Also, most importantly to achieve all this without compromising on a low-cost requirement to compete with the price war in today's markets.

Work Done.

The first Objective was to make a working, basic mp3 player with memory card slot, as the memory element for storing audio files. The components used are Arduino Mega Board, VS 1053b mp3 decoder chip and PCD8544 graphics LCD display. Arduino Mega Board contains an At Mega 2560 microcontroller IC which runs on a 16 MHz oscillator. It has 6 hardware interrupts and 6 internal times. It is capable of SPI mode of communication which is preferred mode of communication between the Arduino and the peripheral chips. VS1053b is a powerful digital signal processing IC which is capable of decoding streamed digital mp3 files into analog form and amplifying it sufficiently for headphones or small speaker output PCD8544 is a graphics LCD display which was used in the older model Nokia phones

The use of Arduino & its IDE made the software aspect quite easy. The libraries and online resources helped in the overall writing of code. The major aspect of code was interfacing the SD card with the Arduino Board. The SD Fat library was the main resource. However a detailed study of this library and underlying SD card technology was done and hence we successfully interfaced the SD card with the Arduino. Now that audio files from the memory card were easy to access, data was read from the audio file and streamed serially to the decoder chip. The datasheet of the VS1053b chip was highly informative and clear instructions were provided in its use. In this manner we were able to make the basic working prototype and in the process achieved our first objective of making a Mp3 player with an expandable memory slot. Now that we had achieved basic playback, we set out for the next objective i.e making the device driver software independent. It was required to improve the robustness of code for this purpose. After much manipulation and re-study of Sd Fat library, driver software independency was achieved. After this, the difficult task of interfacing the display was achieved, displaying the name of the current song, the volume bar and the current state of playback is displayed on the screen

Results and Discussions.

Now that our working model was complete, we set out to do an analysis on its output.

- **White Noise Test.**

A white noise mp3 file was taken which had almost flat frequency response characteristics from 0 to 10 KHz after which the characteristics tapered off to a lower level. The tests were conducted with the same mp3 file at maximum volume of respective devices. The output was analyzed by calculating the FFT using Blackman window taking 16376 points. The obtained characteristics were very much close to flat except for a slight peak at 200 Hz. The test was then conducted on an ordinary mobile phone an iPod nano and Samsung galaxy S duos Smartphone; sharp peaks were observed in higher frequency ranges indicating that even the leading manufacturers are not able to reproduce perfect frequency response. Also our result revealed significantly higher power or voltage compared to all the other music players.

- **Expandable Memory.**

The next important feature is the expandable memory. In our working prototype, as long as the file system is FAT 16 or FAT 32 and there are mp3 files in the SD card, it will play music. Hence, one can carry more than a single SD card and switch it without any hassle; also usage of expandable memory eliminates the need of driver software. A card reader can be used to directly copy the music files into the card. The significance of expandable memory is that no portable music player has this feature; the reason for this is that, leading manufacturers have fixed memory music players and price is directly proportional to memory capacity. This puts the consumers at the mercy of these brands and prices are exorbitant. The price of our own prototype will reduce in comparison

- **Open Source**

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Our mp3 player will be an open source player, it will be first of its kind, wherein the consumers will be able to work on the code and hardware and come up with their own suggestions and ideas regarding the player.

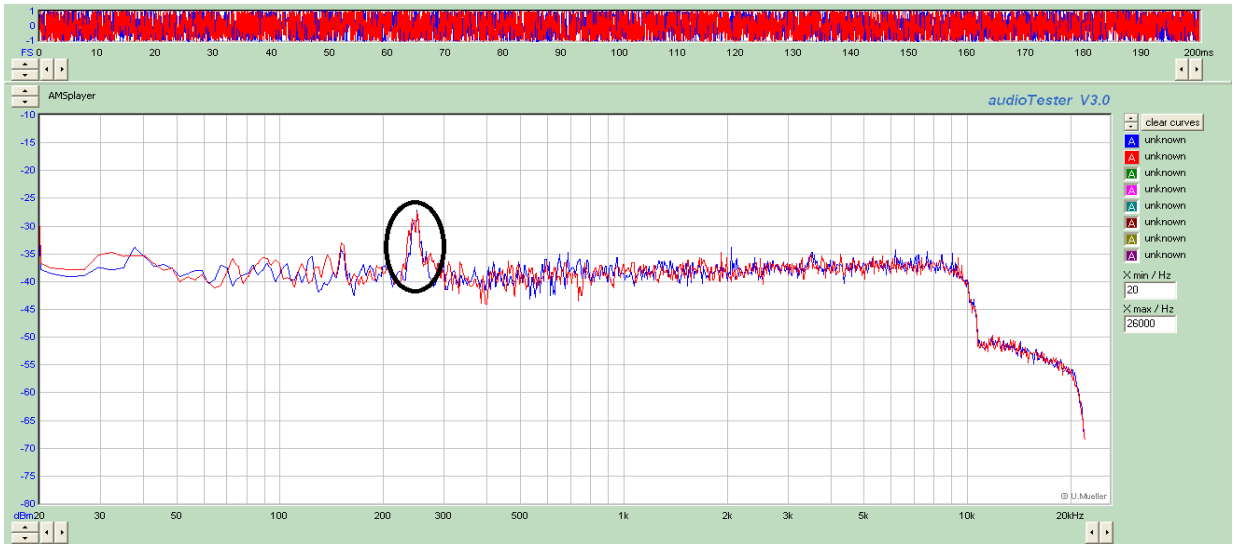

Figure 1: White Noise Test Performed on AMS Mp3 Player.

The encircled region shows that when AMS mp3 player is tested with white noise, there is a slight peak at 200Hz, this rise is of approximately +5dB and a fluctuation of +5db/-5dB under white noise test is acceptable.

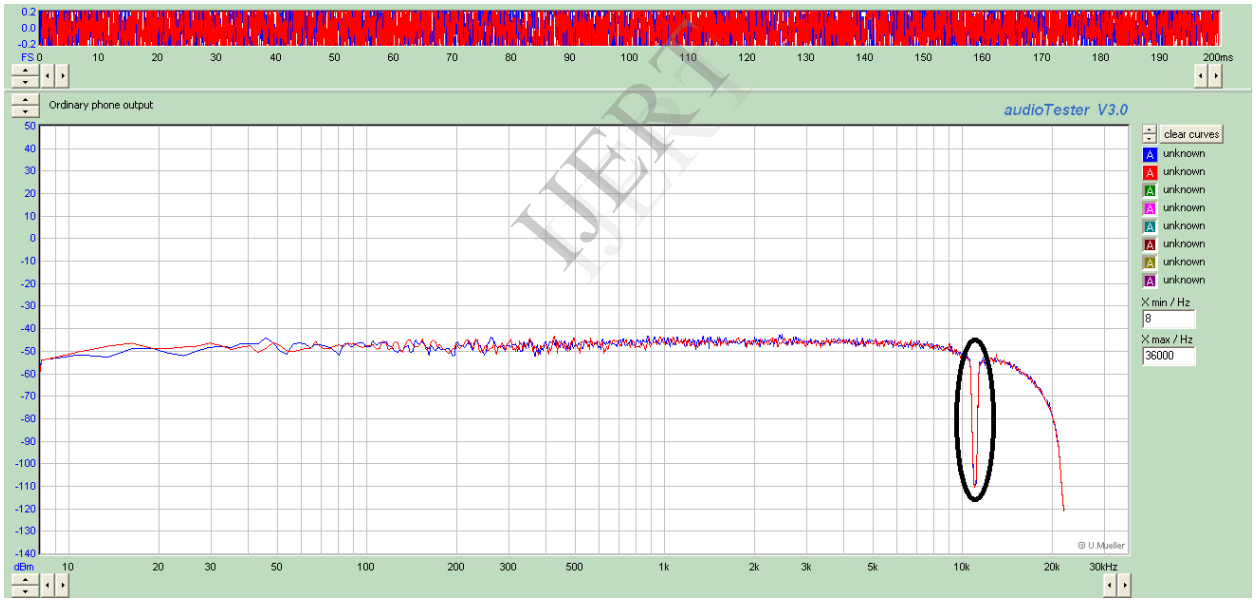

Figure 2: White Noise Test Performed on Ordinary Phone.

An ordinary phone was tested with white noise and the above figure illustrates a deviation from proper characteristics at higher frequencies. Higher frequencies are unnecessarily amplified.

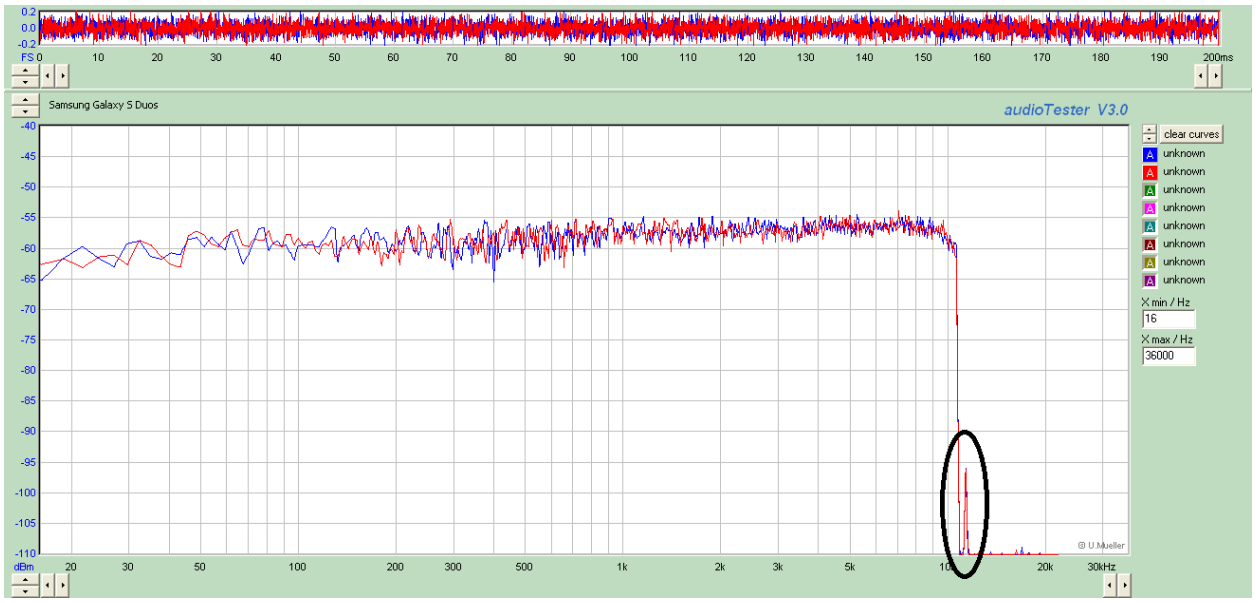

Figure 3: White Noise Test Performed on Samsung Galaxy S Duos.

The Samsung Galaxy S Duos smart phone was tested with white noise and it was seen that, there were sharp peaks at higher frequencies, the sharp peaks at higher frequencies is shown by the encircled region in the above figure.

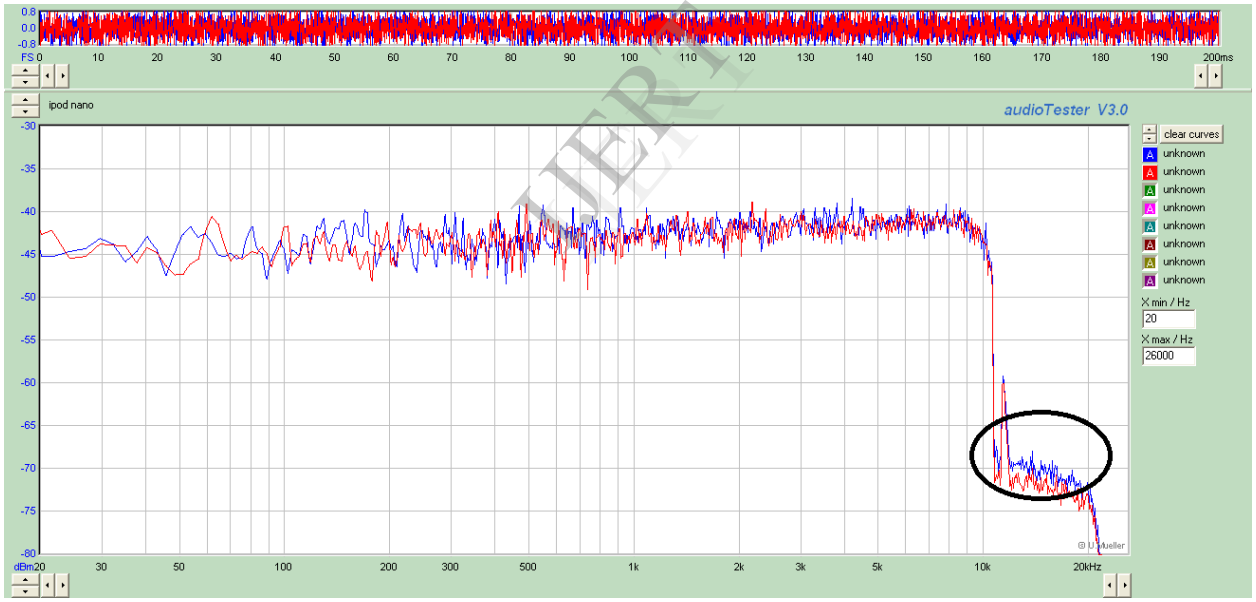

Figure 4: White Noise Test Performed on iPod Nano.

The white noise test was performed on Apple iPod Nano and it was seen that there were sharp peaks at higher frequencies (as shown in the figure above)

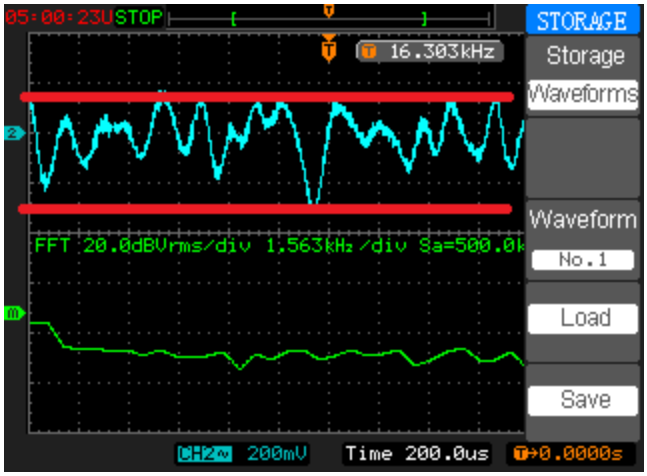

Figure 5: Output Power AMS mp3 Player.

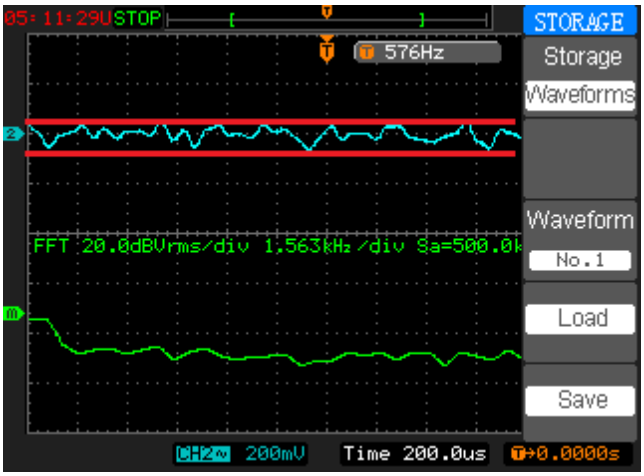

Figure 6: Output Power of iPhone 5

The above figures show the comparison between the out power of AMS mp3 player and iPhone 5. It can be seen that the peak to peak value for AMS is much higher than iPhone 5.
(This test was performed for a white noise file under identical conditions for both players at their maximum volume.)

- **Hardware Comparisons.**

This is a head-to-head hardware comparison of an iPod classic with our own AMS player.

Table 1: Comparison

Parameters	iPod Classic	AMS Mp3 Player
Memory	30 GB Toshiba 1.8 inch hard drive	Removable SD card (up to 64 GB)
Display	2.5 inch TFT LCD	PCD8544 Graphic LCD
Microprocessor	Two ARM 7TDMI-derived CPUs running	AtMega 2560 running at 16 MHz
Audio Chip	Wolfson Microelectronics WM8752 codec	VS1053b

As seen from this comparison, the hardware used by our prototype is quite inferior as far as CPU and display is concerned. Yet, we have almost comparable results. And as far as memory is concerned, removable and expandable memories have a hands-down advantage over fixed hard drives. The audio chips used by both are more or less comparable and hence not much difference in sound output is found. It is fascinating to see that we have made an mp3 player with a single CPU running at more than 5 times lesser speed than that on an iPod. This shows that with an improvement in hardware, even more multitasking can be achieved for an even better device.

- **SPI Mode.**

Another important feature is the method of access of SD card. In this we are handicapped by the usage of slower SPI mode [1]. Serial Data Interface (SDI) mode provides a faster access of data in SD card. However its use is licensed and needs to be purchased on a yearly basis. However, no problem with playback was found at any time in our player.

Innovation.

During the implementation, we came across a peculiar problem; usually hardware interrupts are used to interface external buttons to a micro-controller. However in our case, we had many buttons and fewer external hardware interrupt pins; as a workaround we connected these buttons to normal

digital pins, just as an interrupt pin is internally continuously polled, these digital pins were also continuously polled using timer interrupts. When the internal time, which is pre-scaled to a predefined value, overflows and generates an interrupt. In the ISR (Interrupt Service Routine), we used polling technique at digital pins to check if a button has been pressed, if yes then a variable is initialized. We had to take care that any event of a button being pressed is not missed, and neither the button should be pressed so fast that it registers twice. In such a scenario continuous poling becomes difficult, also another matter of switch debouncing had to be taken into consideration. So for the button interface board we connected the output of the buttons to a RC circuit which smoothens out the switch debounce and this output was converted into a square wave by inverting Schmitt trigger. The use of RC circuits in the buttons interface board meant that we had to calculate the time constant of charging and discharging so that we could adjust best possible time lag between two presses of a button.

Important Results.

- The AMS mp3 player has an expandable memory slot up to 64 GB, which is more than the maximum fixed capacity provided by the leading manufacturers.
- The AMS mp3 player requires no driver software, where as the leading mp3 players in the market require a driver software (iPod's require iTunes).
- The AMS player has a better frequency response in comparison to some of the leading mp3 players manufactured today.
- The AMS mp3 player has better output power in comparison to the output power of iPhone 5, which is well known for its output power.
- The AMS mp3 player is an open source mp3 player, first of its kind as none of the leading mp3 players are open source
- The AMS mp3 player requires minimum essentials in comparison to the leading mp3 players manufactured today, due to which the overall cost of the player is low.
- The AMS mp3 player has made use SPI mode instead of SDI mode and is capable of performing the same functions comfortably.

Conclusion.

Portable music players are constantly evolving as technology evolves. Since music forms an integral part of the society, constant effort is being made to make a more enjoyable, interactive and visceral experience. However, in this bid to keep adding to the new features, there is still a lot of simple fixes that can be employed in the current marketed products to benefit the user.

As explained in this paper, a successful attempt has been made to enhance certain parameters of portable mp3 players. As far as music and audio quality is concerned, our results have shown that we are able to match and even better the audio quality provided by leading brands. When it comes to usability, our device -which does not need driver software-, comes up trumps against the competition. Expandable memory and removable SD card slot gives an added advantage fixed memory devices and it will liberate the consumers from the need to pay more for higher memory capacities.

We would like to conclude by saying that even though one might hardly consider there being any scope for improvement in portable music player, we have identified and enhanced it in certain aspects. Also, the fact that we were able to make a superior device at graduate engineering level, will help in debunking the myth that only leading brands produce best quality products. This will not only empower young entrepreneurs but also promote research at graduate engineering level to challenge established brands.

Acknowledgement.

We would like to thank our guide, Professor K.G Sawarkar , who helped us throughout the making of our project, his guidance was very important for us in achieving our goals and completing our project and research.

References.

[1] Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller" McGraw Hill, 2000 Indian Reprint Edition
[2] Martin Ruckert,"Understanding Mp3-Syntax,Semantics and Algorithms" GWV Vieweg Publications 01 May 2005.