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PAPER AS DATA STORAGE

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ABSTRACT

Paper as data storage is basically storing data like audio, video, text, image etc. On a piece of paper instead of using CD's & DVD's. With the advent in the techniques of compression and encryption it will become possible to store data equivalent to CD's or DVD's on a piece of paper in near future. After reading data we need to scale down their sampling values between 0 and 1. We will construct gray scale image from this values. So now data in the form of image can be distributed using measures like printouts. The paper can then be read through a normal scanning and the contents are decoded from matrix to reconstruct the sampled values which can be viewed or played. Though we are not able completely reconstruct noise free original data, we firmly believe that this will be important for future advancement of this idea. This extremely low cost technology will drastically reduce the cost of the storage and will provide high-speed storage as well. There are many advantages of storing data on paper such as biodegradability, cost, duplication, data transfer, speed, size, and security.

KEYWORDS: Biodegradability Compression, Encryption, Gray Scale

INTRODUCTION

When entire world is busy in inventing how to store more and more data on small size of silicon chips, idea to store data on paper has opened new directions in the horizon of data storage. Here we are implementing this idea on audio file and text file. let us discuss about why to use it and how to use it?

Why to Use Paper?

- **Biodegradable:** The biggest advantage of this technology would be the biodegradable nature of this storage device which would do away with the e-waste pollution.
- **Cost:** This is also one of the big advantages since cost of paper is very low compared to current data storage devices.
- **Duplication:** It is not quite as easy to copy an optical disk. This draw back can be resolved by paper storage which can easily duplicate data using Xeroxes etc.
- **Data Transfer:** Data stored on paper can be send to remote places easily via fax.
- **Speed:** These devices are faster than current storage devices.
- **Size:** Size is smaller than that of actual data.
- **Security:** Security of signal can be increased.

"Rainbow Technology"

It is found out that 90 GB to 450 GB of data can be stored on A4 sheet. To store such a large amount of data on paper set of techniques called 'Rainbow Technology' is used. Rainbow Storage is not a method to store data on paper but it

is a group of techniques to represent data in the form of colour, colour groups and some symbols known as rainbow format. This representation will generate rainbow Picture (figure 1). Each rainbow picture contains a header, body, footer, parity, Rainbow boundary mapper etc. Header contains the measurement of the rainbow picture.

The algorithm which is being used etc. it also contains an efficiently designed error checking mechanism. Most of the living organisms are getting huge amount of data through vision. Our eyes can understand colours only. But our brain is doing many complex operations like distance calculation of objects by using images from two eyes.

So the visible light contains a huge amount of data. We can use any colour representable media as storage medium including paper and plastic sheets. Ordinary sheet of paper with normal printer and scanner will give poor density, but it can be used for some specific purposes.

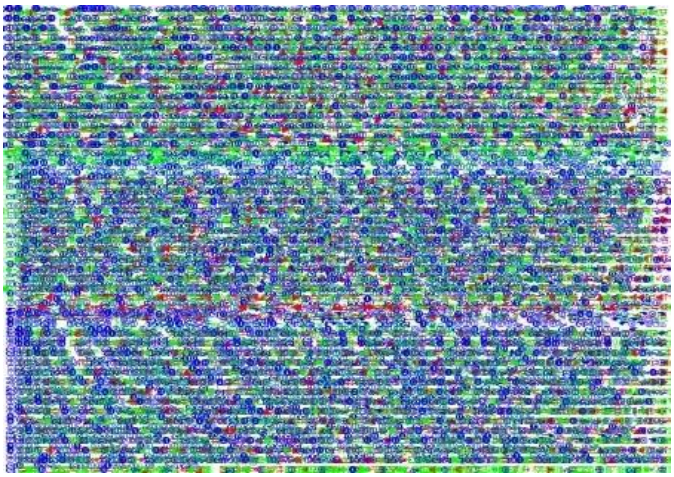

Figure 1: Rainbow Picture Storing Data

SCOPE OF PROJECT

- As it is said earlier that we are going to implement it for audio and text file, it can also Be developed for storing video files, images and any other data.
- We can represent '0' as black pixel and '1' as white pixel which is of maximum intensity to construct black and white images of data. These will form simple black and white image with no Intermediate gray level pixels. We will get pixel value range between 0 to 255 instead of two values in above case for gray scale image representation. So this image will be 8 times smaller than previous one means great amount of compression. Let us go further that if we convert data in to colour pixels one pixel value will be going to store data of 24 bits which leads to more compression.
- With the advent in the techniques of compression and encryption it will become possible to store Data equivalent to CD's or DVD's in a piece of paper. Therefore it can turn out as good option for storage in near future.

WORKING PRINCIPLE

Paper Player is basically storing an audio file and text file on paper in a form of image. We will take print out of this paper and by scanning it we can retrieve the data stored on paper back.

Representing data in the form of black and white image is basic step, but here we have discussed conversion in to gray scale image directly as it leads to smaller image size and more compression.

Encoding

- **Audio in to Black & White Image**

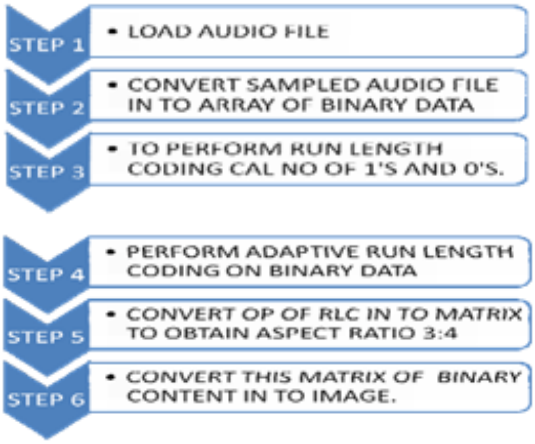

Figure 2: Overview of Encoding

For this we will first load and read that audio file. By this we will get array of sampled values of audio file. Transfer this sampled values to binary numbers. Now calculate number of 1's and 0's and perform dynamic run length coding on this binary numbers. Convert this calculated number of 1's and 0's in to binary. In dynamic run length coding we need to insert a pixel value 0.5 i.e. escape character after each converted number to differentiate between successive values of binary data at the time of decoding. Convert this array obtained in to matrix so that we can convert it in to proper image i.e. aspect ratio of 4:3. Convert this obtained matrix into an image in which one is represented as one corresponds to white pixel and zero corresponds to black pixel. Now print the image on paper which is containing pattern of black and white dots.

- **Audio in to Gray Scale Image**

We will initially read 'audio' file to get sampled values of audio file which will be between -1 and 1. Now convert this value between 0 to 1. To overcome limitations of normal printer and scanner we replicated each sampled value two times, this will control error till some extent. To obtain proper image we will convert this array into matrix with aspect ratio 4:3. Like this we have successfully created image whose pixel values are between 0 to 255 which corresponds to range 0 to 1. After that print out of this image is taken.

Figure 3 represents image obtained after conversion of audio file and Figure 5 represents scanned image which can be used to reconstruct audio file.

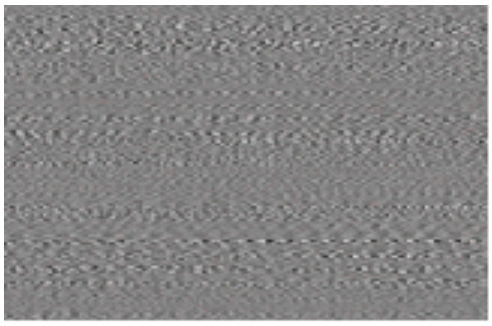

Figure 3: Gray Scale Image Ready to Print

- **Audio in to Colour Image**

Here encoding procedure is similar to that of gray scale encoding. The only change is, we need to convert data in

3D matrix instead of 2D, where 3rd parameter is either red, green or blue pixel values. So here one pixel will store 24 bits, 8 bits each for RGB. Hence data is 24 times more compressed than black and white image.

- **Text in to Gray Scale Image**

Initially read text file which will give us output in string. Convert this string in to array of character. We will convert this array in to ASCII code of characters. By dividing this code by 255 we will get values in range of 0 to 1. We can consider these values as pixel value of gray scale image. Convert this image in to aspect ratio 4:3.

Decoding

- **Black & White Image in to Audio**

First of all scan the printed image. After this select desired area using image processing. Then read the pixel value of image which will be 0,128 or 255. Convert these values in to 0, 0.5 and 1 respectively. Convert obtained matrix of data in to array and convert binary data in to integer form. Convert this integer data in to binary form. Convert this binary form of data in to reconstructed sample values. Play reconstructed audio file.

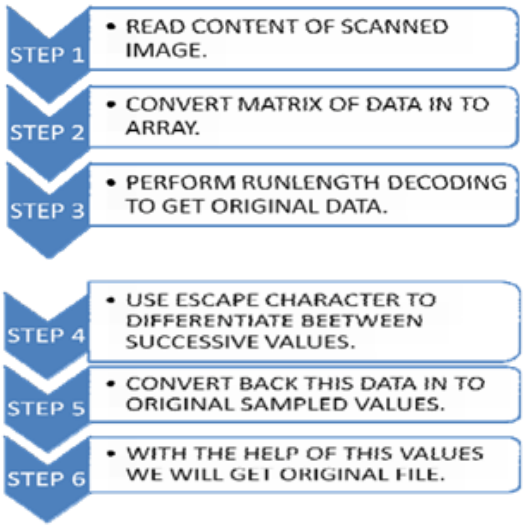

Figure 4: Overview Decoding

- **Gray Scale & Colour Image in to Audio**

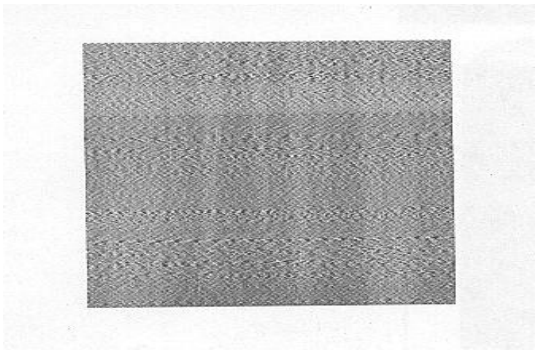

Figure 5: Scanned Gray Scale Image from which Data can Be Retrieved

In decoding part scanned gray scale image is converted back in to audio file. We will select desired area of paper and read content of selected area. For colour image entire procedure is similar as above except matrix will be of 3D instead of 2D. These values are between 0 to 255 we will convert this to values between 0 to1. This matrix of aspect ratio 4:3 is converted in to array. Now take average of two successive pixels to get actual value of pixel. Convert this value between -1 to 1. This is the reconstructed audio file now play this audio file.

- **Gray Scale Image in to Text**

In decoding convert values from 0-1 to 0-255. Convert this in values to character. From which original message can be retrieved.

EXPERIMENTAL RESULTS

Original size of audio file is 121kb, which when converted in to gray scale image gets stored in 53kb.

Audio file	:	'laughter.wav'
Size	:	121 kb
Number of samples	:	52634
Size of bmp file after encoding	:	52.3 kb
Size of scanned array during decoding	:	53354

APPLICATION

- It can be used for faster audio transfer over the internet with much less interference
- Morphing can be implemented to modify vocal information.
- It can be used in identification systems.
- It can be used in lie detectors by using image analysis.

CONCLUSIONS

Here we have got compression while storing original data in the form of image. Although it has some errors we can use proper filtering and error correction technique to make output more efficient. Although environmental light differences and colour shading is a problem during reconstruction, it can be overcome up to a certain limit by using efficient mapping functions. We can also use acid paper with special ink which can last to many decades, so fading problem can be solved considerably.

Here we conclude that paper can be used as an alternative to current storage devices in future if it is nurtured properly.

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