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PREVENTION OF DIGITAL MUSIC FILE DUPLICATION

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ABSTRACT

Current digital music file duplication software only detects the duplication of digital music file in the hard disk of a personal device [1, 2]. This study develops a biologically inspired model for storing audio data (BiMSAD) to prevent duplication of digital music files when the data are inserted into the hard disk. This paper presents the activities in developing of the theoretical and conceptual frameworks. Experiments testing are performed to show the usability of BiMSAD and the results are reported. The outcomes of BiMSAD indicate that it prevents duplication of digital music files in a personal device better than the existing methods which only detect duplication after it occurs. The hard disk of personal device can be controlled and optimized for extra digital music record collection by BiMSAD.

Keywords: multimedia database, software engineering, biologically inspired system.

INTRODUCTION

A digital music collection contains many records of digital music files. Duplication of digital music records may occur if there is no proper control of the storing management process. This situation is obnoxious when the digital music collection is stored to a personal device with small hard disk capacity. A new and better method must prevent duplication of digital music files in a personal device when the data are inserted into the hard disk. Digital music duplication detection software can detect duplicated digital music records in the hard disk; however, duplication still happened because there is no precise control of the storing management process. The replicated digital music files are merely searched and moved into other folders. User needs manually to delete, these files. This study undertakes a new method to prevent duplication from occurring when a digital music file is inserted into the personal device. Biologically inspired concept is adapted to solve the duplication problem. Human learning concept is also qualified to offer set procedures to unravel the process of storage management in preventing duplication. The elements for the biologically inspired concept are critically examined and identified in this study. A model called the Biologically Inspired Model for Storing Audio Data (BiMSAD) was designed, and an approach called the Cognitive and Constructive Learning (CCL) with the CCL algorithm were developed.

THEORETICAL FRAMEWORK

The theoretical framework is a collection of interrelated concepts. It guides for the development of BiMSAD. It is built based on the collaboration of the digital audio, biologically inspired, and human learning concepts. The elements from these ideas are analyzed and identified, and they are listed as the participating elements for developing BiMSAD. It recaps and concludes the arrangement of the human learning concept. The digital audio, the biologically inspired and the human learning concepts, bring to the development and implementation of BiMSAD. Theoretically, this study believes that it makes render to a personal device without duplication of digital music files. This study comes out with a plan that able to portray the agendas or to prevent duplication of digital music file in a personal device. Figure-1 visualizes the collaborative and comprehensive elements from the concepts chosen. This study then converts the theoretical framework into BiMSAD as well as the CCL approach.

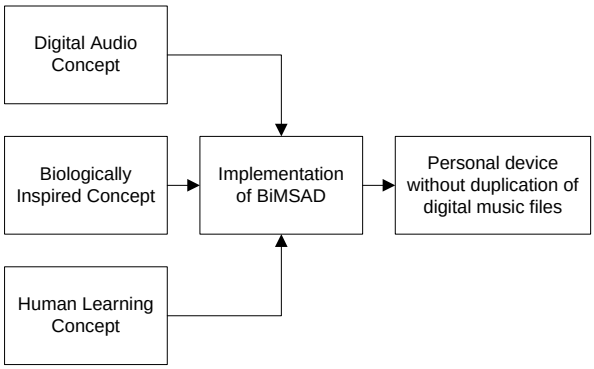

Figure-1. Theoretical framework.

The following sub-sections present the activities for founding the theoretical framework which is gathering the participating elements for BiMSAD.

Participating elements for BiMSAD

Elements of digital audio concept are analyzed and adapted to give specific ideas for the development of BiMSAD. The essential elements from the biologically inspired concept are also examined and modified for giving explicit notions for the development of BiMSAD. Essential elements of the human learning view are also inspected and improved for providing precise designs for the perfection of BiMSAD. All the participating elements are lined up and defined with a description to describe the use and implementation for BiMSAD. This study defines the chosen elements in the way that is appropriate for the

developmental process. These elements are categorized follows the separate ideas of the analysis performed. The participating elements of the digital audio concept are shown in Table-1. The participating elements of the biologically inspired concept are shown in Table-2. The participating elements of the human learning concept are shown in Table-3.

Table-1. Findings for the participating elements of digital audio concept.

Elements	Descriptions
Digital audio file [3, 4]	To offer manipulation of digital music records.
Data modelling [3, 4]	To create a new form of audio data modelling based on the human learning concept.
Classification [5]	To establish a newly created classification process known as CCL approach.
User interface [3]	To establish user interfaces to receive the stored digital music file and to provide support for any user involvements.
Storage [3]	To establish an optimized storage in a personal device from duplicating file.
Fingerprinting [6]	To offer matching and retrieving process.
Semantic-based retrieval [7]	To give semantic-based matching and retrieving process.
Content-based retrieval [7]	To provide content-based matching and retrieving process.
Object recognition [8]	To offer object-oriented matching and retrieving process.

Table-2. Findings for the participating elements of biologically inspired concept.

Element	Descriptions
Human ear [9].	To establish an interface based on the human ear only to receive the information of the digital music file to be stored in the device storage.
Human brain [10].	To establish a central processor such as to recognize and learn, to store, to provide information, and to display output based on particular human brain's learning functions (based on the human learning concept) not the holistic brain functions and memory storage source.

Table-3. Findings for the participating elements of human learning concept.

Elements	Descriptions
Memory structure [11, 12]	To provide an interface, processor, and storage.
Familiarity [13]	Forming the process and storage for recognized records.
Recollection [13]	Forming the process and storage for cognitive learning and constructive learning records.
Recognition [13]	To match the inserted record with a record in storage.
Cognitive learning [14]	To receive the updated record.
Constructive learning [15]	To receive the newly inserted record.

As a conclusion, from all the participating elements of three (3) concepts obtained; the development of the conceptual framework for this study is described in the following sub-section.

CONCEPTUAL FRAMEWORK

The conceptual framework is made to show the layers of architecture in BiMSAD. The layers are adopted from the human memory structures by [11], where it models the acceptance of external information and layers

their structure. There are three (3) layers in the conceptual framework which are the interface, processor, and database. In the interface layer, the components are linked to the input and output methods. The middle layer is the processor that includes the recognition and the learning processes. The third layer is the database that represents the hard disk in a personal device. The focus of the conceptual framework is centered to the recognition process. It is the primary function that triggers the other related functions in the accepting updates and in displaying messages. The learning process is to support the recognition process by providing guides to user in guiding the user to store the digital music file. The hard disk of a personal device is organized with only the exact updates from the learning process. The biggest contribution out of this conceptual framework is it clearly visualizes how the duplication prevention action can be executed through the recognition and learning process. Significance of this conceptual framework is the vision of how to add newly learned record into the hard disk. The learning function is displayed through the acceptance of updating and inserting records into the hard disk. The feature to receive an update and insert a new record recognizes the cognitive and constructive learning processes which are the main R and D elements of this study. Hence, BiMSAD is conceptually capable of preventing duplication of digital music file from happening in the hard disk of a personal device. Figure-2 expresses the conceptual framework of BiMSAD.

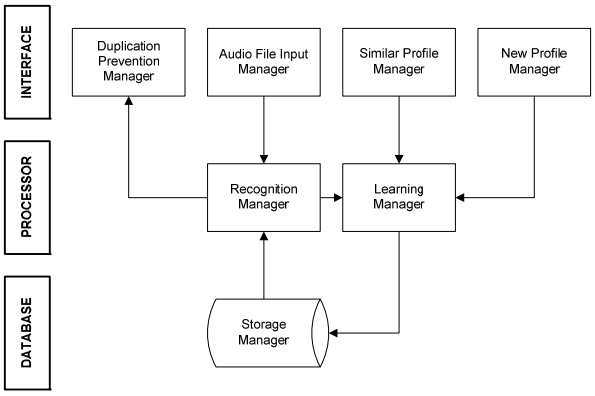

Figure-2. Conceptual framework.

BiMSAD

Mapping the essential elements for BiMSAD

The mapping of the human ear and the human brain are made to extract the features of how the human recognizes and learns the signal sound. The ability of humans to accept newly corrected information is also mapped into BiMSAD. The human ability to judge the right or wrong information to be accepted is also plotted into BiMSAD. BiMSAD is developed to process the best informative data that could be controlled only by human judgment, and any error occurred was made by human failure to support the audio storing control process. In mapping the essential elements for BiMSAD, this study performs the assessment of the qualified features in the literature review and tables the participating elements in the Table-1, Table-2 and Table-3. From the lists of participating elements, only the essential elements are mapped for the construction of BiMSAD. The essential elements of BiMSAD are shown in a diagram for a clearer picture (see Figure-3).

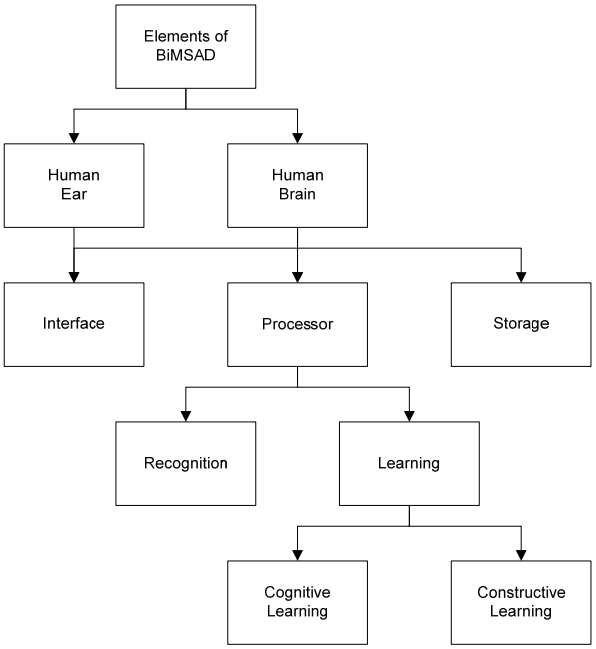

Figure-3. Essential elements of BiMSAD.

Organizing the BiMSAD matching mechanism

There are two (2) activities in founding the BiMSAD matching mechanism, they are; the organization of the basic and the complete matching mechanism of BiMSAD. This study creates the BiMSAD matching mechanism, with the recognizing and learning functions to prevent duplication from happening. Fundamentally, the matching mechanism executes two (2) main functions; that is the recognition and the learning function. The blueprint for the BiMSAD basic matching mechanism flowchart is drawn in this study. Besides the recognition function, the learning function is structured to show how the records in the hard disk are updated. From the learning function, it then submits the new information in a loop for another searching process to execute in finding the recognized record. Figure-4 presents the flowchart of this basic matching mechanism.

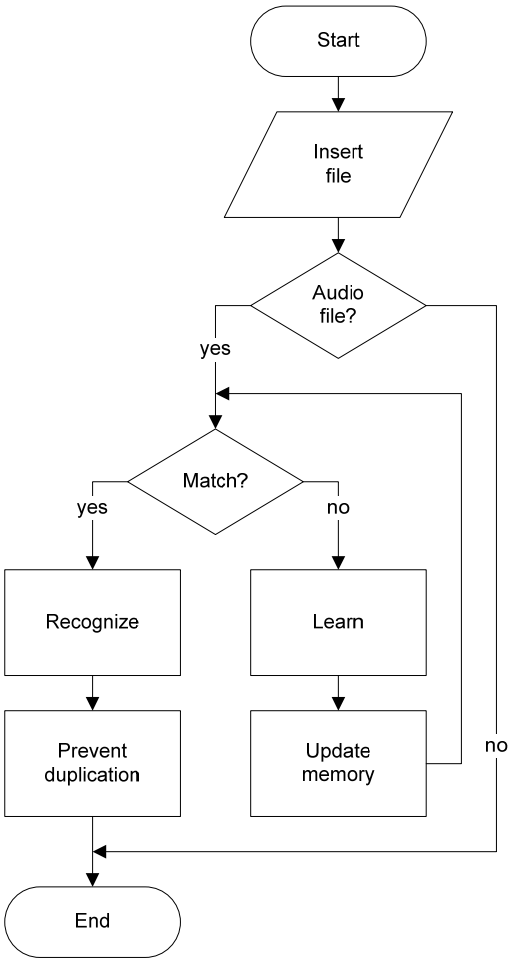

Figure-4. BiMSAD matching mechanism.

This study also incorporates a unique kind of learning function to update the record in the memory that already exists in the hard disk storage. There are the cognitive and constructive learning. The blueprint for the BiMSAD full matching mechanism flowchart is drawn in this study (see Figure-5). There are three (3) matching conditions to classify the BiMSAD learnings structure which are similar match, partial match and no matching at all.

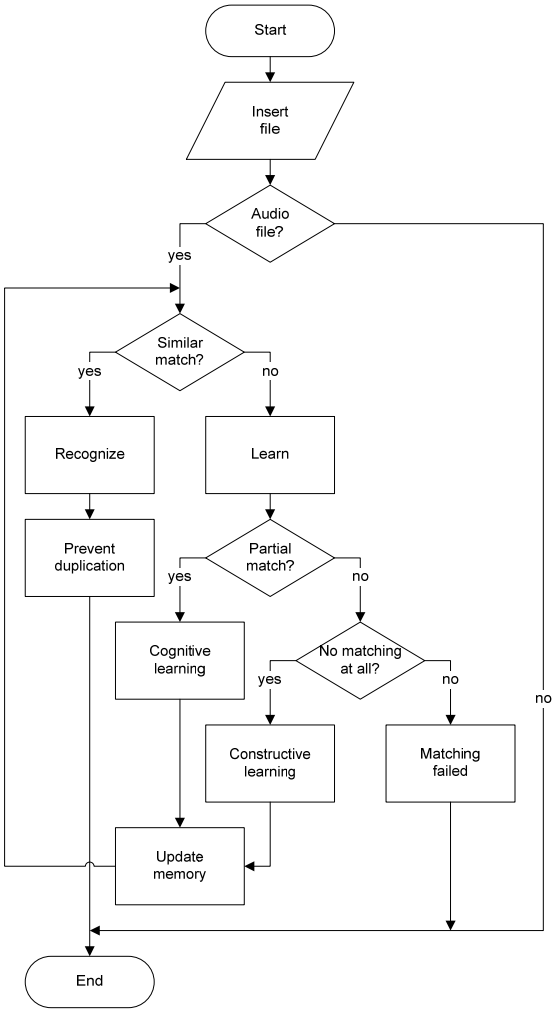

Figure-5. BiMSAD full matching mechanism.

Designing the BiMSAD

BiMSAD is made to guide any development of data storage management application to prevent duplication of digital music file in a personal device. It is designed to exhibit the adoption of the human ear and the human brain from the biologically inspired approach. It also adjusts the recognition and the learning process from the human learning concept [16]. These combinations are applied into a computational data modelling for a helpful, informative plan. It is based on the human memory structure presented by [11] and then refined by [12], [17]. The processes are clearly defined, the storage is well organized and structured and also the ease of data manipulation is found in this model. Besides, it visualizes the flows and the directions of the known processes that capable of making BiMSAD as a method to prevent duplication of digital music files from happening in a personal device right from the start when a digital music record is inserted into a personal device. Figure-6 depicts the biologically inspired components to create the BiMSAD.

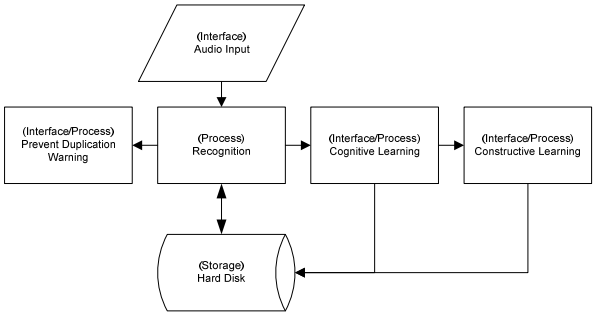

Figure-6. The component of BiMSAD.

COGNITIVE AND CONSTRUCTIVE LEARNING (CCL) APPROACH

The CCL approach only focuses on storing management process for preventing duplication in a personal device. It is unlike any other research on digital audio or learning process because it familiarizes with a new kind of recognition and learning process. BiMSAD provides special mechanisms that are cognitive and constructive learning components in the learnings structure for supporting the recognition process. It enhances the number of getting articulate matching by not limiting the recognition process [18]. The following sub-sections describe the activities in this section that are; organizing the flow for CCL matching conditions, organizing the CCL flowchart and the formulating the CCL algorithm.

Organizing the flow of CCL matching conditions

With the suitable conditions, to match digital music file, it could enhance the searching and retrieval process. For matching an inserted digital music file with the records in the hard disk of a personal device, the CCL matching conditions offer the classification factor the matched records. The classification enhances the searching and retrieval process [5, 19]. There are many stages of conditions for the CCL approach which are the recognition, the cognitive learning, and the constructive learning. Please be noted that the conditions for the matching process only inspired by the CCL approach. These conditions are primarily inspired from the human learning concept [1, 16, 18]. For the working flow of the CCL matching conditions, the inserted digital music file will be compared and defined into certain conditions. Then, an articulated matching will be achieved. The categorization of CCL matching conditions contributes to the classification procedure in handling duplicate digital music records from happening, specifically in storing management process. For every condition, it makes a decision into two (2) different criteria to separate the category of the inserted data. If the matching falls under any category, the decision is not final until user judgment is made to control articulate record. There will not be any modification made to the original data, but the user only capable of adding on the new record to the permanent storage. With the association of the CCL matching conditions, this study furthers the development towards achieving the organization of CCL flowchart. Figure-7 shows on how the classification procedures for the CCL matching conditions are organized.

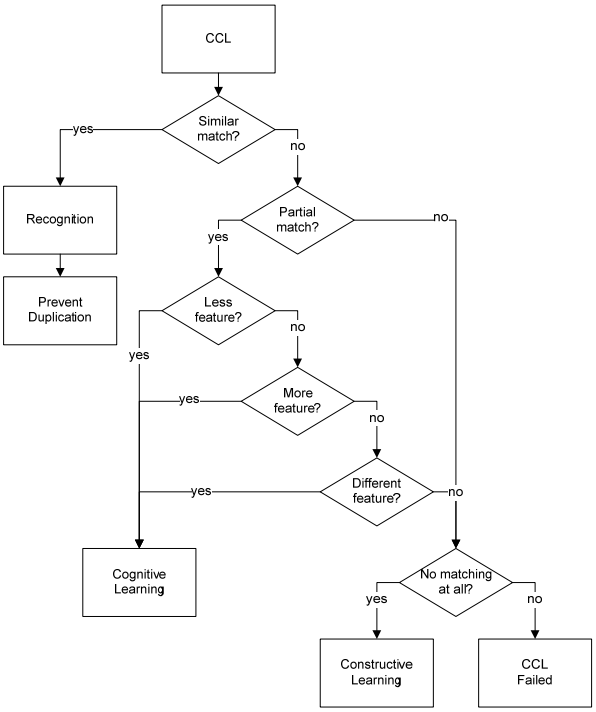

Figure-7. CCL matching conditions.

Organizing the CCL flowchart

The CCL flowchart is created to represent the CCL algorithm for BiMSAD in diagram forms. It visualizes the matching conditions classification of accepting the stimuli information and the path of the corresponding response to the inserted file. It also portrays how the digital music file storing control expands the digital music collection in the hard disk of a personal device. It also represents how the dynamic functions of updating the digital music records in the hard disk and CCL approach executes looping process for better recognition. This feature resembles the Baddeley and Hitch Model of Working Memory by [17]. The CCL flowchart modified the method to create better recognition and learning process. It also provides a function to receive any error that is called as CCL failed function. The execution of the CCL failed function to promote error exception handling and ends the storing process. No storing management process happens here. User needs to try to insert the digital music file once again [16, 18]. Figure-8 shows a flowchart for the execution of the CCL approach.

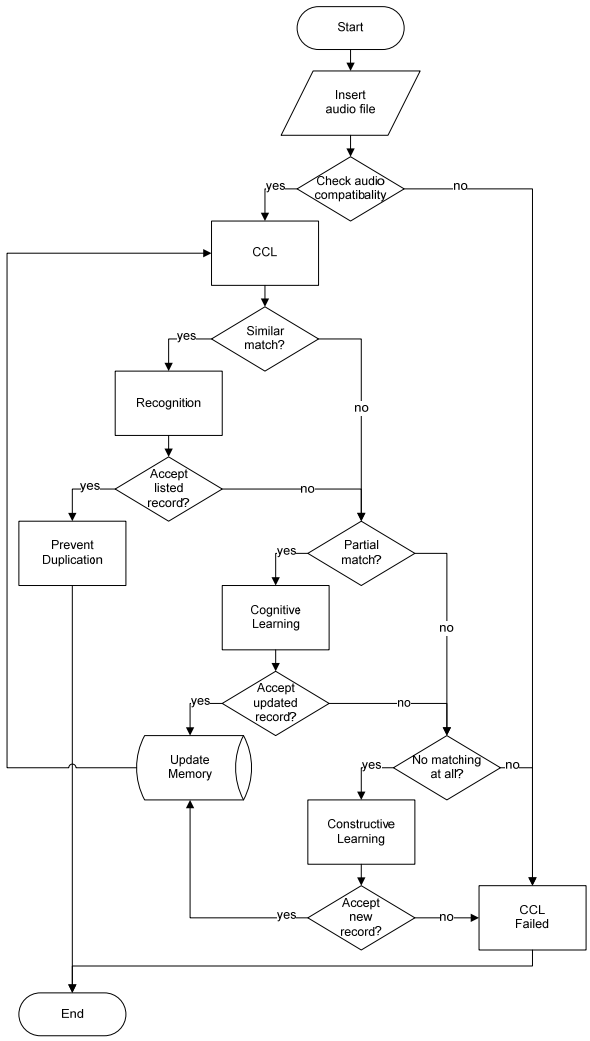

Figure-8. CCL flow chart.

Formulating the CCL algorithm

Referring to the CCL flowchart from the previous section, the CCL algorithm is developed. It is an essential solution for the problem of this study. It offers the matching procedure of inserting digital music files with the digital music records / collections in a personal device [1], [16], [18]. The CCL algorithm is presented as in Figure-9. The CCL algorithm presents the step by step instructions for executing the CCL approach. It acts as an intelligent agent, to prevent duplication of digital music record in the hard disk of a personal device. The following section elaborates of the BiMSAD conceptual framework.

```
The CCL Algorithm
1. START;
2. INSERT file;
3. IF checkAudioCompatibility = 1 THEN EXECUTE ccl;
4.  IF similarMatch = 1 THEN DO recognition;
5.    IF acceptListedRecord = 1 THEN DO duplicatePreventionAction;
6.    ELSEIF partialMatch = 1 THEN DO cognitiveLearning;
7.      IF acceptUpdatedRecord = 1 THEN UPDATE memory;
8.        EXECUTE ccl;
9.      ELSEIF noMatchingAtAll = 1 THEN DO constructiveLearning;
10.         IF acceptNewRecord = 1 THEN UPDATE memory;
11.           EXECUTE ccl;
12.         ELSE cclFailed;
13.         ENDIF;
14.       ELSE cclFailed;
15.       ENDIF;
16.     ELSEIF noMatchingAtAll = 1 THEN DO constructiveLearning;
17.       IF acceptNewRecord = 1 THEN UPDATE memory;
18.         EXECUTE ccl;
19.       ELSE cclFailed;
20.       ENDIF;
21.     ELSE cclFailed;
22.     ENDIF;
23.   ELSEIF partialMatch = 1 THEN DO cognitiveLearning;
24.     IF acceptUpdatedRecord = 1 THEN UPDATE memory;
25.       EXECUTE ccl;
26.     ELSEIF noMatchingAtAll = 1 THEN DO constructiveLearning;
27.       IF acceptNewRecord = 1 THEN UPDATE memory;
28.         EXECUTE ccl;
29.       ELSE cclFailed;
30.       ENDIF;
31.     ELSE cclFailed;
32.     ENDIF;
33.   ELSEIF noMatchingAtAll = 1 THEN DO constructiveLearning;
34.     IF acceptNewRecord = 1 THEN UPDATE memory;
35.       EXECUTE ccl;
36.     ELSE cclFailed;
37.     ENDIF;
38.   ELSE cclFailed;
39.   ENDIF;
40. ELSE cclFailed;
41. ENDIF;
42. END;
```

Figure-9. CCL algorithm.

RESULTS AND DISCUSSIONS

This paper presents two (2) types of experiments made; they are the usability testing experiments and the benchmarking of BiMSAD with several scenarios. The details of these activities are provided in the following sub-sections.

Usability testing experiments

Usability experiments are executed to evaluate the usability of BiMSAD. Specific examples for experiments are performed to verify the capabilities of BiMSAD. This study executes two (2) cases of experiments to portray the usability of BiMSAD. The cases are explained in details in the following sub-sections, namely as:

- 114 Surah in Al-Quran.
- 50 random MP3 music files.

The numbers of digital music records for surah in Al-Quran are fixed to 114 records only. These records are from the same album type. Consequently, a number of 155 insertions are performed until the 114 surah are stored into the hard disk of a personal device, and the results are seen. Figure-10 depicts the details of the insertion events presented for the analysis.

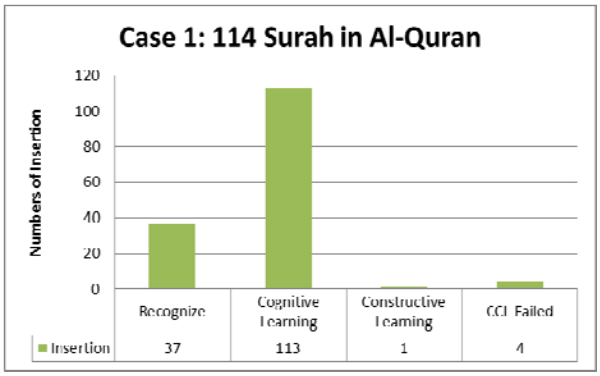

Figure-10. Result for inserting 114 Surah in Al-Quran.

The first record inserted ignites the constructive learning function of BiMSAD. From this single record, the matching of over 113 records is executed as cognitive learning functions as the process matches the same album type but keep updating the records with different file names. From the random records of surah in Al-Quran performed, this experiment executes 37 recognize same record as the insertion process is made. Hence, BiMSAD successfully prevents the same records from being inserted into the hard disk. Other than this action, BiMSAD executes a number of four (4) CCL Failed function as handling error from the insertion made. Another experiment of a different case attempts by inserting 50 random MP3 music files. These records are from different albums, artist, and genre types. They are not identical and unconnected to each other. This test takes 85 times of events with different categories of function from BiMSAD to insert 50 records of random MP3 music files. Figure-11 shows the effect of this experiment example.

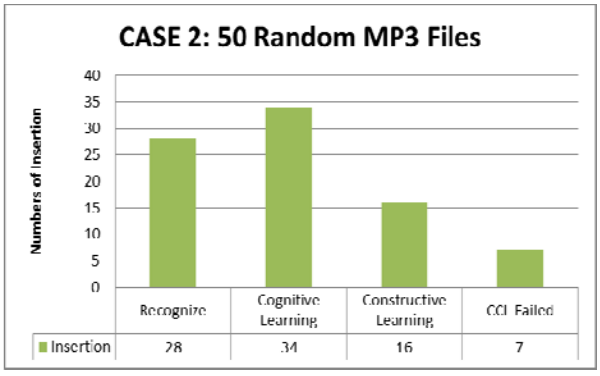

Figure-11. Result for inserting 50 random MP3 music files.

This experiment accepts 16 new-learning function of the first different single. Then, 34 cognitive learning functions are made. These cognitive learning function executions perhaps are from the same artist, album, or genre learned by BiMSAD. From the 16 constructive learning function events and 34 cognitive learning function events, it is enough to insert 50 random music files. In this experiment case also, a number of 28 recognize function events are performed and prevented the duplication from happening. This case also has failed to perform any function to a number of seven (7) events.

CONCLUSIONS

This section presents the theoretical and the practical implications, the contributions, the limitations, as well as the future directions of this study.

Theoretical implications

- Human ear contributes as the interface for BiMSAD to configure every digital music file that is inserted into personal device.
- Human brain plays important roles as the processor and the storage management for the implementation of BiMSAD.
- Human memory structures contribute distinct assistant in the development of BiMSAD in organizing the structure of matching of inserting file with the records in the hard disk.
- Human learning concept especially the cognitive and constructive learning perspectives escalate the storing management process to a new method of accepting not only any digital music file into the hard disk. It also provides support to the user for guiding the user to store the digital music file without worrying of any duplication can occur.
- Human recognition and learning perspectives bring significant implication for adding digital music records into the hard disk.
- Human learning approach supports the use of BiMSAD with update learning process and also a new learning process.
- An audio data consists of the audio data information and the audio data content for better matching of BiMSAD execution.
- High-Level MMDBMS Architecture [3] can be extended for the development of real BiMSAD application.
- MPEG-7 DSs for audio provides an excellent representation for the information and content for audio data towards the recognition and learning process of BiMSAD.
- DRM, audio fingerprinting, and audio watermarking, offer control of the audio data information and content for recovering the primary function of BiMSAD.
- Current digital music duplication detection software(s) deliver adequate information for the matching procedure of BiMSAD.
- Audio classification and categorization useful scheme for the matching function of BiMSAD.

Practical implications

- BiMSAD can slow down the physical process to insert the digital music file into the hard disk of a personal device.
- BiMSAD can distract the user willingness to apply this process as an application tool because there can

be many prompted messages for the user to manage before any digital music file could be stored in the hard disk.
- User should use BiMSAD to prevent duplication of digital audio file.
- User should aware with unnecessary files; the personal device is not optimized.

Contributions
- A new method for preventing duplication of digital music file in a personal device.
- A newly created model called BiMSAD to provide direction to solve the commenced problem.
- A newly formulated algorithm known as the CCL algorithm that is capable of recognizing and learning music records based on human learning mechanism in determining particular digital music records.

Limitations
- BiMSAD is not fully automatic process to prevent duplication of digital music files in the storage of a personal device.
- BiMSAD requires user involvement in to support the decision.
- BiMSAD only supports digital music file data type.
- BiMSAD only supports digital music storing management process on the hard disk of a personal device.

Future works
- The elaboration of the implementation for BiMSAD for other multimedia data type like image, video, and animation.
- The used of other storage components as cloud storage and system installation.
- The necessity and usability issues for delivering the digital music storing management system.

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